MICROSCOPIC ANATOMY PRACTICE QUESTIONS
MUSCLE WEAKNESS & WEIGHT LOSS MODULES

PART I: DIRECTIONS – Each of the numbered items or incomplete statements in this section is followed by answers or by completions of the statement. Select the ONE lettered answer or completion that is BEST in each case.

1. Which of the following is involved in endochondral ossification, but not in intramembranous ossification:
   A. Matrix vesicles
   B. Mixed spicules
   C. Osteoid
   D. Osteoprogenitor cells
   E. Woven bone

2. Which of the following play(s) a role in the synthesis of epinephrine in the adrenal medulla:
   A. Glucocorticoids
   B. Phenylethanolamine N-methyltransferase
   C. Sinusoidal vessels of the adrenal cortex
   D. Spongiocytes of the adrenal cortex
   E. All the above

3. Of the three types of cartilage, __________ cartilage has the greatest tendency to calcify with age. Because of this, you may sometimes see bone tissue in the __________ in x-rays of your elderly patients.
   A. elastic .......... auditory (Eustachian tube)
   B. elastic .......... costal cartilages of the ribs
   C. fibrocartilage .......... cartilage of the nasal septum
   D. fibrocartilage .......... pubic symphysis
   E. hyaline .......... auricle of the ear
   F. hyaline .......... tracheal rings

4. Which of the following is/are produced by osteoblasts:
   A. Matrix vesicles
   B. Osteocalcin
   C. Osteoprotegerin
   D. PTH receptors
   E. All the above
Use the following diagram for QUESTIONS #5 & #6:

5. Which number corresponds to an Haversian canal?
   A. 1
   B. 7
   C. 8
   D. 9

6. Which number corresponds to a Volkmann’s (perforating) canal?
   A. 1
   B. 2
   C. 7
   D. 8
   E. 9
7. Which of the following structures found in skeletal muscle is the smallest:
   A. Fascicle
   B. Myofiber
   C. Myofibril
   D. Myofilament
   E. Sarcomere

Use the diagram below to answer QUESTION #8:
In these diagrammatic cross sections through different parts of a sarcomere, the small dots represent thin filaments, the large dots represent thick filaments and the lines represent linking proteins.

8. Which letter (A, B, C, or D) corresponds to a cross section that passes through the H-Band, but not through the M-line?

9. When a region of the central nervous system (CNS) is injured, astrocytes near the lesion eventually form a scar in a process known as reactive gliosis. Such scars are one factor that severely limits the ability of CNS neurons to regenerate after injury. We can confirm that the scar-forming cells are astrocytes by carrying out immunocytochemistry with labeled antibodies specific for what component of those cells:
   A. Gamma-tubulin in the microtubules
   B. Glial fibrillary acidic protein (GFAP) in the intermediate filaments
   C. Lamin in the basal lamina
   D. Vimentin in the microfilaments

10. Which of the following would account for the ‘red’ color typical of Type I (slow-twitch) muscle fibers?
    A. Abundant glycogen
    B. Myoglobin
    C. Rich blood supply
    D. Both B and C above
    E. A, B, and C above

11. The small skeletal muscles that control the fingers are adapted for rapid contraction and fine, precise movements. In comparison to red (slow twitch, oxidative) muscle fibers, these small muscles of the fingers:
A. Appear lighter in color in part because they store more glycogen and contain fewer mitochondria
B. Are composed of smaller motor units
C. Have a larger average diameter
D. Tend to fatigue more rapidly
E. All the above

12. Your patient has sporadic episodes of hypertension, rapid heart rate, sweating, and severe anxiety. A CT scan shows unilateral enlargement of an adrenal gland. Which of the following statements is/are most likely:
   A. The patient has a pheochromocytoma
   B. The symptoms are due to elevated levels of mineralocorticoids
   C. The tumor is composed of chromaffin cells
   D. All the above
   E. Choices A & C only
   F. Choices A & B only

13. Which of the following is true concerning the muscle Z-line?
   A. Alpha-actinin and nebulin anchor the thick filaments to the Z-line
   B. It bisects the A band
   C. Neighboring myofibrils are kept in register with one another via intermediate filaments at the Z-line
   D. The distance between Z-lines remains constant during a contraction
   E. Thin filaments are anchored to the Z-line by titin

14. Which of the following is true concerning the development of skeletal muscle?
   A. A myofiber can be considered to be a functional syncytium, but not an anatomical syncytium
   B. As the cell’s contractile apparatus develops, its nuclei are pushed towards the center of the cell
   C. Myofibers are derived from endoderm
   D. Myofibers are formed through the fusion of myoblasts into myotubes
   E. Satellite cells are retained in the muscles of children, but then degenerate once growth ceases

15. Which of the following statements about smooth muscle is true:
   A. Acetylcholine is the only neurotransmitter involved in smooth muscle innervation
B. During contraction, actin filaments slide along intermediate filaments composed of desmin rather than along myosin filaments
C. Regulation of contraction involves calcium binding to troponin C
D. Smooth muscle cells are capable of mitosis
E. Smooth muscle contraction is only initiated in response to a stimulus from a nerve

16. Achondroplasia is a common cause of nonlethal dwarfism. It is caused by a gene mutation that affects endochondral ossification. Which of the following bones is most likely to be unaffected in achondroplasia because it forms predominantly by intramembranous ossification:
   A. Femur
   B. Mandible
   C. Occipital bone at the base of the skull
   D. Radius
   E. Vertebra

17. Mesenchymal stem cells give rise directly or indirectly to:
   A. Adipocytes
   B. Bone tissue formed by endochondral ossification
   C. Bone tissue formed by intramembranous ossification
   D. Cartilage
   E. Skeletal muscle, cardiac muscle, and smooth muscle
   F. All the above
   G. Choices A, B, C, & D, but not choice E

18. The Schwann cells of a myelinated axon are functionally most similar to:
   A. Astrocytes
   B. Ependymal cells
   C. Microglia
   D. Oligodendrocytes
   E. Pituicytes

19. Thyroid biopsies on two of your patients both show columnar thyroid follicular cells, but the lab values for their thyroid hormone levels reveal that one patient is hyperthyroid and the other is hypothyroid. Which of the following diagnoses or conclusions is consistent with these results:
A. The hyperthyroid patient has a pituitary tumor composed of acidophils that are constitutively secreting their hormone; the hypothyroid patient has Graves' disease
B. The hyperthyroid patient has a pituitary tumor composed of basophils that are constitutively secreting their hormone; the hypothyroid patient has an iodine deficiency
C. The hyperthyroid patient has Hashimoto’s thyroiditis; the hypothyroid patient has damage to the pituitary resulting from radiation therapy for a brain tumor
D. The lab made a mistake on the thyroid hormone levels because it is impossible to have hypertrophied follicular cells and still be hypothyroid

20. Some forms of heart disease appear to involve a progressive disorganization of the t-tubule system in ventricular cardiac myocytes. This is most likely to result in:
   A. Loss of alignment of thin filaments at the Z-line
   B. Loss of ATP production
   C. Loss of cell-cell communication through gap junctions
   D. Loss of excitation – contraction coupling

21. Which of the following is best suited for successful tissue transplantation because of its low antigenicity, low metabolic rate, and lack of vascularity:
   A. Compact bone
   B. Hyaline cartilage
   C. Lamellar bone
   D. Woven bone

22. The blood-brain barrier (BBB) prevents many substances in the circulation from gaining access to the neurons and glia of the CNS. This presents difficulties in treating brain disorders pharmacologically since many drugs cannot cross the BBB. A blood-nerve barrier exists in peripheral nerves, where it serves the similar purpose of regulating the metabolic milieu of the nerve fibers. Which of the following is a component of such barriers:
   A. Oligodendrocyte end feet, which cover most of the outer surface of brain capillaries
   B. Tight junctions between capillary endothelial cells of the brain
   C. Tight junctions between cells of the endoneurium in a peripheral nerve
   D. All the above
   E. Choices A & B only

23. In synapses between neurons:
A. Each postsynaptic neuron receives input from only one presynaptic neuron
B. The plasma membrane of the postsynaptic neuron has numerous junctional folds at the site of the synapse
C. The synapse can be classified as axo-somatic, axo-dendritic or axo-axonal
D. The synaptic vesicles are located in the dendrite of the presynaptic neuron

24. Endochondral ossification:
   A. Begins shortly after birth
   B. Ends before bone modeling begins
   C. Ends with closure of the growth plate (epiphyseal fusion)
   D. Occurs only in long bones
   E. All the above

25. Which of the following is a non-encapsulated mechanoreceptor of the skin that continues to fire throughout most of the duration of a stimulus (i.e., is slowly-adapting). Because it is slowly-adapting, such a receptor would be good for detecting steady pressure:
   A. Meissner’s corpuscle
   B. Merkel’s corpuscle
   C. Pacinian corpuscle
   D. Ruffini corpuscle

26. Which of the following endocrine organs is/are formed by cells populations that arise from two separate embryological origins:
   A. Adrenal
   B. Pituitary
   C. Thyroid
   D. Parathyroid
   E. Choices A & B only
   F. Choices B & C only
   G. Choices A, B & C only

Use this diagram of a longitudinal section through the diaphysis of a long bone to answer QUESTION # 27:
27. The bone in this diagram is undergoing the process known as:
   A. Diaphyseal drift
   B. Diaphyseal enlargement
   C. Intracortical remodeling
   D. Metaphyseal waisting

28. Which of the following statements is true about the matrix of hyaline cartilage:
   A. It is rich in a highly sulfated proteoglycan called aggregan
   B. It contains large proteoglycan aggregates composed of proteoglycans bound to hyaluronic acid (hyaluranon)
   C. Its proteoglycan aggregates have a high affinity for water
   D. In well-preserved cartilage it is basophilic because of its high negative charge density
   E. The matrix has a glassy (hyaline) appearance by light microscopy in part because collagen type II forms very thin fibrils rather than thick fibers or fiber bundles
   F. All the above

29. The hormones oxytocin and vasopressin are secreted by:
   A. Acidophils
   B. Basophils
   C. Chromophobes
   D. Neurons
   E. Pituicytes
30. Fibrous joints:
   A. Are all located on the midline of the body
   B. Are the most common type of joint in the human body
   C. Consist of two or more bones united by fibrocartilage
   D. Include the sutures of the skull and the interosseous membrane
      between the radius and ulna
   E. Usually include an articular disk or meniscus composed of fibrocartilage

31. In the fetus, synthesis of __________ requires interaction between the
    placenta and the fetal __________ because neither the placenta nor the fetal
    organ contains all the enzymes required for total hormone synthesis.
    Intermediate compounds travel back and forth from one organ to the other
    until all the steps in hormone synthesis have been accomplished.
    A. ACTH ........... adenohypophysis
    B. Antidiuretic hormone ........... neurohypophysis
    C. Calcitonin ........... thyroid
    D. Glucocorticoids ........... adrenal cortex

32. Which of the following is true concerning the synovial membrane of a
    synovial joint:
    A. It is lined by an epithelium
    B. It lines all surfaces of the joint including the capsule and articular
       cartilage
    C. Its ‘Type B’ cells secrete synovial fluid
    D. Its connective tissue is avascular
    E. All the above

33. Which of the following is true concerning the pubic symphysis?
    A. It is an example of a type of cartilaginous joint
    B. It contains both type I and type II collagen fibers
    C. It is capable of extensive mobility
    D. All the above
    E. A and B only

34. Oxyphils:
    A. Are a sign of pathology
B. Are a stem cell population that can differentiate into parathyroid chief cells (principal cells)
C. Are highly basophilic due to their high content of RER
D. Are under negative feedback control by the adenohypophysis
E. Increase in number with increasing age

35. In one of the endocrine organs a venous portal system is essential to the proper functioning of the gland. That portal system carries:
   A. Epinephrine and norepinephrine to the adrenal cortex
   B. Oxytocin and vasopressin to the neurohypophysis
   C. Parathyroid hormone to the follicular cells of the thyroid
   D. Releasing and inhibitory hormones to the adenohypophysis

36. In what order would a surgeon’s scalpel penetrate the following layers of connective tissue when she makes her first incision into the biceps brachii: (1) endomysium, (2) epimysium, and (3) perimysium?
   A. 1, 3, 2
   B. 2, 3, 1
   C. 2, 1, 3
   D. 3, 2, 1

37. In the pituitary, Rathke’s cysts:
   A. Are also called Herring bodies
   B. Are characteristic of the neurohypophysis
   C. Are remnants of an outpocketing of oral ectoderm
   D. Contain colloid composed mainly of thyroglobulin
   E. All the above
   F. Choices A & B only

38. A neuron with a single, T-shaped process extending from its cell body is most likely to be found in:
   A. Autonomic ganglion
   B. Dorsal root ganglion
   C. Meissner’s plexus
   D. Retina
   E. Spinal Cord

39. The autonomic nervous system:
A. Includes a sympathetic division and a parasympathetic division, which often have opposing actions on the targets that they innervate
B. Includes ganglia where a preganglionic neuron synapses on a multipolar postsynaptic neuron
C. Innervates targets including smooth muscle and the cardiac conduction system
D. Regulates the secretory activity of most glands, including sweat glands and salivary glands
E. All the above

40. Your 49 year-old female patient presents with hypertension. You draw blood and order an electrolyte panel, which reveals that she has low serum potassium levels (hypokalemia). Eventually her condition is traced to a problem with adrenal function. If you could examine her malfunctioning adrenal gland histologically, which of the following findings would best explain her condition:
   A. A hormone-producing adenoma of the zona fasciculata
   B. A hormone-producing adenoma of the zona glomerulosa
   C. Atrophy of the adrenal medulla
   D. Atrophy of the zona fasciculata
   E. Atrophy of the zona glomerulosa

41. The neurons in a dorsal root ganglion and an autonomic ganglion are alike in that both:
   A. Are motor neurons
   B. Are pseudounipolar neurons
   C. Are sensory neurons
   D. Have strongly heterochromatic nuclei
   E. Have satellite cells around their cell body

42. The __________ growth of bone tissue is due to the activity of __________.
   A. Appositional .......... osteoblasts
   B. Interstitial .......... osteocytes
   C. Interstitial .......... cells of the endosteum but not those of the periosteum
   D. Both A and B are correct
   E. Both A and C are correct

43. Appositional deposition of bone tissue:
   A. Can occur as part of bone modeling
   B. Can occur as part of bone remodeling
C. Can occur on bone surfaces covered by a periosteum or an endosteum
D. Cannot occur at an articular surface
E. All the above

44. The major hormone released from the zona glomerulosa of the adrenal cortex is:
   A. Aldosterone
   B. Androgen (testosterone)
   C. Angiotensin
   D. Hydrocortisone
   E. Renin

45. Satellite cells of nerve tissue:
   A. Are a stem cell population that can differentiate into neurons
   B. Are a type of glial cell
   C. Are found only in the brain and spinal cord
   D. Are the major type of phagocytic cell in neural tissue
   E. All the above

46. Infant botulism is caused by ingestion of spores of the bacterium Clostridium botulinum. The spores can be found in honey, some corn syrups, and in the soil of some geographic regions including southeastern Pennsylvania. After being ingested, the bacteria replicate from the spores and begin releasing botulinum toxin. This toxin:
   A. Blocks acetylcholine release at neuromuscular junctions
   B. Causes demyelination of somatic motor neurons
   C. Causes massive, rapid release of acetylcholine at neuromuscular junctions, resulting in neurotransmitter depletion and muscle paralysis
   D. Inhibits ATP synthesis and thus produces a rigor state in skeletal muscle
   E. Only affects nerves that innervate smooth muscle

47. Which of the following is a portion of the sarcomere that shortens during a normal isotonic muscle contraction, and consists mainly of myosin:
   A. A band
   B. Bare zone
   C. H band
   D. I band
   E. Z line
48. In which of the following cell types is contraction regulated by a calcium-calmodulin complex:
   A. Cardiac muscle
   B. Cardiac muscle and smooth muscle
   C. Skeletal muscle
   D. Skeletal muscle and cardiac muscle
   E. Smooth muscle

49. In a typical synapse of a motor neuron on smooth muscle:
   A. Action potentials cause the muscle cell to secrete the contents of its numerous dense-cored vesicles
   B. One nerve varicosity (bouton) may innervate several muscle cells
   C. The neuron and the muscle cell are connected by multiple gap junctions
   D. The plasma membrane of the muscle cell (sarcolemma) is thrown into elaborate junctional folds
   E. The synaptic cleft is usually narrower than in a neuromuscular junction on skeletal muscle

50. Because milk is rich in calcium, nursing mothers are at risk for excessive bone loss due to overactivity of osteoclasts. The hormone that helps prevent this bone loss by inhibiting osteoclastic activity is produced by __________ in the __________ gland.
   A. Chief cells........parathyroid
   B. Follicular........thyroid
   C. Parafollicular cells........thyroid
   D. Oxyphils........parathyroid
   E. Zona glomerulosa........adrenal

51. Gigantism can be caused by:
   A. A hormone-producing tumor of the adenohypophysis that develops at the age of 8 years
   B. A hormone-producing tumor of the adenohypophysis that develops at the age of 38 years
   C. A pheochromocytoma
   D. Osteoarthritis
   E. Paget disease of bone

52. The component of bone tissue that gives bone tensile strength is the:
A. Elastic fibers
B. Hydroxyapatite
C. Periosteum
D. Proteoglycans
E. Type I collagen

53. Ordinary cardiac muscle cells:
   A. Are directly innervated at neuromuscular junctions formed by motor end plates that lie in primary synaptic clefts
   B. Are formed during embryological development by the fusion of myotubes
   C. Are supplied by a capillary network that is typically more extensive than that of skeletal muscle or smooth muscle
   D. Have mitochondria with relatively few cristae and a large matrix compartment
   E. Sequester calcium mainly in structures called caveolae, where it binds to calmodulin

54. Which of the following plays a major role in stimulating the activity of osteoclasts:
   A. Basophils of the adenohypophysis
   B. Hypothalamus
   C. Parafollicular cells
   D. Parathyroid gland
   E. Thyroid follicular cells
   F. Choices A, B and C
   G. Choices A, B, and D
   H. Choices A, B and E

55. The component of a neuromuscular junction that contains binding sites for synaptic vesicles is called the:
   A. Active zone
   B. Cleft of Schmidt-Lanterman
   C. Dendritic spine
   D. Junctional fold
   E. Node of Ranvier
   F. Postsynaptic membrane

56. The sensory receptor involved in the afferent limb of the stretch reflex (such as the biceps tendon reflex) is the:
A. Golgi tendon organ  
B. Merkel corpuscle  
C. Muscle spindle  
D. Pacinian corpuscle  
E. Ruffini corpuscle

57. Which of the following is true about a mixed spicule of bone:  
   A. It is composed of circumferential lamellae that surround a core of concentric lamellae  
   B. It is composed of cortical bone that surrounds a core of cancellous bone  
   C. It is composed of lamellar bone that surrounds a core of woven bone  
   D. It is composed of woven bone that surrounds a core of calcified cartilage  
   E. It is more likely to be found in the diaphysis than near the metaphysis of a growing long bone

58. In skeletal muscle, action potentials are conveyed deep into the interior of the muscle cell by:  
   A. Caveolae  
   B. Junctional folds  
   C. Primary synaptic clefts  
   D. T-tubules  
   E. Terminal cisternae

59. The small cells closely associated with the neuronal cell bodies in a ganglion are called:  
   A. Ependymal cells  
   B. Oligodendrocytes  
   C. Radial glia  
   D. Satellite cells  
   E. Schwann cells  
   F. Stem cells

60. Duchenne muscular dystrophy is caused by a mutation in the X-linked gene that codes for the protein dystrophin. The normal function of dystrophin in healthy skeletal muscle is to:  
   A. Actively transport calcium from the sarcoplasm into the sarcoplasmic reticulum at the conclusion of a muscle contraction
B. Block the myosin-binding site on thin filaments in relaxed muscle
C. Form part of the linkage between thin filaments the sarcolemma
D. Hold thick filaments in register at the middle of the A-band
E. Regulate the length of thin filaments

61. The blood-brain barrier (BBB) is formed by tight junctions between the endothelial cells of brain capillaries. Which of the following is a type of glial cell whose end feet cover most of the outer surface of brain capillaries and contribute to the maintenance of the BBB:
   A. Astrocytes
   B. Microglia
   C. Oligodendrocytes
   D. Pituicytes
   E. Satellite cells
   F. Schwann cells

62. In skeletal muscle, mitochondria and sarcoplasmic reticulum are located:
   A. Only at neuromuscular junctions
   B. Only at Z lines
   C. Surrounding (at the periphery of) each myofiber
   D. Surrounding (at the periphery of) each myofibril
   E. Surrounding (at the periphery of) each myofilament

63. Long-term snorting of cocaine can damage the mucosal lining of the nasal cavity and cause ischemic necrosis of the hyaline cartilage of the nasal septum that causes it to perforate or even collapse. The major type of collagen in the matrix of that cartilage is:
   A. Type I
   B. Type II
   C. Type III
   D. Type IV
   E. Type VII

64. The cell bodies of neurons that directly supply motor innervation to skeletal muscle cells are normally located in:
   A. A dorsal root ganglion
   B. A sympathetic chain ganglion
   C. The epimysium of the muscle that they supply
D. The myenteric plexus
E. The ventral horn of the spinal cord
F. The ventral root of a spinal nerve
G. The white matter of the spinal cord

65. Which statement is true of smooth muscle:
   A. Contraction of smooth muscle occurs only in response to neural stimulation
   B. It has cytoplasmic dense bodies that are analogous to the M-lines of skeletal muscle
   C. It has T-tubules that form one component of its dyads (diads)
   D. It is the most primitive type of muscle, appearing in evolution before cardiac or skeletal muscle
   E. Smooth muscle in the layer of the intestine called the muscularis externa is innervated by neurons of the myenteric plexus
   F. The arrangement of myosin molecules in its thick filaments is the same as that found in skeletal muscle

66. Articular cartilage:
   A. Contains elastic fibers
   B. Has a perichondrium
   C. Has randomly oriented cells and extracellular matrix
   D. Is acellular
   E. Is calcified where it contacts subchondral bone

67. Blood vessels that nourish the articular cartilage and joint space of a synovial joint would be found:
   A. In the connective tissue of the synovial membrane
   B. In the perichondrium that overlies the articular cartilage
   C. Within the articular cartilage
   D. All the above
   E. Only B and C

68. Which type of cell has the greatest capacity for synthesizing the collagen, elastin, proteoglycans, and other components of its extracellular matrix:
   A. Cardiac muscle
   B. Motor neurons
   C. Sensory neurons
D. Skeletal muscle
E. Smooth muscle

69. Myasthenia gravis is a disease that is characterized by extreme muscle weakness. Which of the following statements is correct with regard to myasthenia gravis:
   A. Autoimmune antibodies block calcium channels in the post-synaptic membrane at the neuromuscular junction (NMJ)
   B. Death of motor neurons causes the decrease of acetylcholine receptors at the NMJ
   C. The link between muscle cytoskeleton and extracellular matrix is interrupted
   D. There is a widening of the synaptic cleft and a decrease in junctional folds at the NMJ

70. Cartilage is considered a specialized form of connective tissue. In which of the following ways does cartilage differ from connective tissue proper:
   A. Cartilage has no ground substance; connective tissue proper contains abundant ground substance
   B. Chondrocytes have little if any mitotic capability; the cell types of connective tissue proper have high mitotic rates
   C. Cartilage is most often avascular; connective tissue proper is vascularized
   D. Cartilage matrix never contains elastic fibers; elastic fibers are often found in the extracellular matrix of connective tissue proper
   E. Cartilage regenerates easily after damage; connective tissue proper has a more limited regenerative capacity

71. Oxytocin is secreted by:
   A. Gonadotropes
   B. Hypothalamic neurons whose axons end in the pars nervosa
   C. Lactotropes
   D. Myoepithelial cells
   E. Pituicytes

72. Electron microscopic examination of active chief cells (principal cells) of the parathyroid is most likely to reveal:
   A. Membrane-bounded secretory vesicles in the cytoplasm
   B. Very extensive smooth endoplasmic reticulum
C. Tubular cristae in the mitochondria
D. Mitochondria that have shelf-like cristae, and are so numerous that they almost entirely fill the highly eosinophilic cytoplasm
E. Both B and C

73. Which of the following mimics many of the effects of the sympathetic division of the autonomic nervous system by secreting some of the same substances that postganglionic sympathetic neurons release as neurotransmitters:
   A. Adrenal cortex
   B. Adrenal medulla
   C. Parathyroid
   D. Pars nervosa of the pituitary
   E. Thyroid follicular cell

74. A 1-year old female undergoes bone marrow aspiration in order to confirm the diagnosis of a hematological disorder. The sample is collected from the diaphysis of the tibia (shin bone) using a large-bore needle. In which of the following items are the structures arranged in the order in which they would be traversed by the needle as it pierces the cortical bone and enters the marrow cavity:
   A. Cellular periosteum, fibrous periosteum, outer circumferential lamellae, inner circumferential lamellae, endosteum
   B. Periosteum, interstitial lamellae, outer circumferential lamellae, endosteum, osteons
   C. Periosteum, outer circumferential lamellae, osteoid, inner circumferential lamellae, endosteum
   D. Periosteum, outer circumferential lamellae, osteons, inner circumferential lamellae, endosteum
   E. Periosteum, endosteum, outer circumferential lamellae, trabeculae, inner circumferential lamellae

75. Crinophagy is most commonly observed in:
   A. Lactotropes after weaning
   B. Osteoclasts during bone resorption
   C. Skeletal muscle cells of patients with Duchenne muscular dystrophy
   D. Somatotropes of patients with acromegaly

76. Mitochondria with tubular cristae are typically found in which of the following:
   A. Acidophils of the adenohypophysis
B. Chromaffin cells  
C. Oxyphil cells  
D. Parafollicular cells  
E. Spongiocytes

77. Diabetes insipidus (decreased ability to concentrate the urine) is most likely to result from:
   A. A prolactin-producing pituitary tumor derived from mammotrophs  
   B. Failure of the pars intermedia to develop  
   C. Hypothalamic lesions affecting secretory neurons that project to the neurohypophysis  
   D. Obstructed blood flow through the hypophyseal portal veins

78. The cells of the zona fasciculata are often called:
   A. Chromaffin cells  
   B. Chromophobes  
   C. Corticotropes  
   D. Oxyphils  
   E. Spongiocytes

79. Chondrocytes:
   A. Are the primary target cells affected by parathyroid hormone  
   B. Can differentiate into osteocytes if stimulated by calcitonin  
   C. Hypertrophy and die prior to matrix calcification during endochondral ossification  
   D. Characteristically form linear isogenous groups in hyaline cartilages such as tracheal rings

80. Which of the following is true concerning interstitial lamellae:
   A. Their presence suggests that intracortical remodeling has occurred  
   B. They may contain partial remnants of Haversian systems  
   C. They may contain remnants of areas of circumferential lamellar bone  
   D. All the above  
   E. A and B only

81. The hormone that decreases urine volume by increasing the reabsorption of water by certain kidney tubules is:
   A. Called antidiuretic hormone (ADH) or arginine vasopressin
B. Contained within Herring bodies  
C. Secreted in the pars nervosa  
D. Secreted by pituicytes  
E. All the above  
F. Choices A, B, & C only  

82. When inactive thyroid follicular cells are stimulated by TSH they undergo a shape change from squamous to cuboidal because:  
A. Their cytoplasm becomes filled with large secretory vacuoles in which they store and iodinate thyroglobulin  
B. They accumulate numerous lipid droplets that store the substrate used for hormone synthesis  
C. They develop extensive folds in their basal plasma membrane in order to accommodate more copies of the active transport system for iodide  
D. They develop more RER and Golgi cisterna in order to produce more thyroglobulin  

83. Increase in the length of a growing long bone is greatly retarded when there is a lack of the hormone normally produced by:  
A. Certain acidophils of the pituitary  
B. Chief cells of the parathyroid  
C. Chromaffin cells  
D. Parafollicular cells  
E. Pituicytes  

84. Identify the correct statement concerning cardiac muscle:  
A. Each cell is a true structural (anatomical) syncytium  
B. In high magnification electron micrographs, cardiac muscle cells have fewer mitochondria between adjacent myofibrils than are found in skeletal muscle cells  
C. It has a larger average cellular diameter than smooth muscle or skeletal muscle cells  
D. Its sarcoplasmic reticulum (SR) is less well-developed than in skeletal muscle  
E. It is directly innervated by neurons called Purkinje cells  

85. Bone formation that does not involve a pre-existing cartilage model is called:  
A. Cancellous bone formation  
B. Endochondral bone formation
C. Intramembranous bone formation
D. Trabecular bone formation
E. Woven bone formation

86. Which of the following statements about cancellous bone is correct?
   A. In the adult it is largely composed of concentric lamellae formed around Haversian canals
   B. It is characterized by more bone tissue per volume than in cortical bone
   C. It is found predominantly in the diaphyses of long bones
   D. It tends to be more cellular than cortical bone
   E. The spaces between trabeculae in adult bone are occupied by the marrow cavity

87. A venous portal system plays a direct role in regulating the secretion of hormones from the:
   A. Adenohypophysis
   B. Adrenal cortex
   C. Neurohypophysis
   D. Parathyroid
   E. Thyroid

88. Which of the following is the connective tissue sheath that surrounds an entire skeletal muscle and is synonymous with the investing fascia described in gross anatomy:
   A. Endomysium
   B. Endoneurium
   C. Epimysium
   D. Epineurium
   E. Perichondrium
   F. Perimysium
   G. Perineurium
   H. Periosteum

89. The ground substance of hyaline cartilage is basophilic because it contains large amounts of:
   A. Collagen type II fibrils
   B. Elastic fibers
   C. RER
90. Which of the following is derived in part from the floor of the oral cavity and in part from the neural crest:
   A. Fetal adrenal cortex
   B. Parathyroid
   C. Pituitary
   D. Thyroid

91. Folliculostellate cells:
   A. Are a type of chromophobe found in the adenohypophysis
   B. Are a type of glial cell found in ganglia of the peripheral nervous system
   C. Are a type of hormone-producing cell of the pars distalis
   D. Are a type of neuron found in the hypothalamus
   E. Line the central canal of the spinal cord and produce cerebrospinal fluid

92. Which of the following cell types is characterized by abundant RER, numerous small lysosomes, junctional complexes between cells, and PAS-positive endocytic vacuoles:
   A. Acidophils of the pituitary
   B. Chief cells of the parathyroid
   C. Chromaffin cells
   D. Parafollicular cells
   E. Thyroid follicular cells

93. What is contained within a cleft of Schmidt-Lanterman:
   A. Axonal cytoplasm
   B. Myelin
   C. Neurotransmitter molecules released from synaptic vesicles
   D. Nissl substance
   E. Schwann cell cytoplasm
   F. None of the above; the clefts are gaps between Schwann cells

94. Pheochromocytoma is characterized by:
   A. A palpable mass in the anterior neck
   B. Cognitive defects and sluggishness
C. Deposition of subcutaneous fat in the fat ("moon-face")
D. Hyperpigmentation of the skin
E. Increased circulating levels of epinephrine and norepinephrine

Use the diagram below to answer QUESTION #95:

95. Identify the component that binds ATP and hydrolyzes it during skeletal muscle contraction.
   A. Structure X, which is actin
   B. Structure X, which is myosin
   C. Structure Y, which is tropomyosin
   D. Structure Y, which is troponin
   E. Structure Z, which is tropomyosin
   F. Structure Z, which is troponin
   G. None of the above

96. During repair of a bone fracture:
   A. The first phase (inflammation) involves the formation of a hematoma
   B. The primary bony callus consists of lamellar bone
   C. The primary bony callus forms by intramembranous ossification rather than by endochondral ossification
   D. The soft callus develops well-ordered zones equivalent to those in an epiphyseal plate
   E. The soft callus is composed of elastic cartilage

97. Some forms of cortical dysplasia are due to the failure of neurons to migrate to their proper location in the brain during development. Which type of cell normally serves as a "scaffold" or substrate that guides the migration of neurons during development in the central nervous system:
A. Bipolar neurons
B. Ependymal cells
C. Microglia
D. Oligodendrocytes
E. Radial glia

98. Which of the following might characterize the bone microstructure found in the lumbar vertebral body of a 66 year-old woman diagnosed with osteoporosis who has recently suffered a compression fracture?
   A. The trabeculae are thicker than normal with little space between them
   B. The trabeculae have a large number of active osteoblasts lining their surface
   C. There is a patchwork of woven and lamellar bone within each trabecula
   D. There is woven bone in regions of fracture calluses

99. Which of the following structures will be most seriously affected by a defect in the synthesis of type I collagen:
   A. Articular cartilage
   B. Cartilage rings of the trachea
   C. Epiglottis
   D. Epiphyseal plates in growing bones
   E. Intervertebral disks

100. The free surface of a synovial membrane is composed of:
    A. A layer of fibroblast-like and macrophage-like cells
    B. A stratified squamous epithelium
    C. Bone-lining cells
    D. Endosteum
    E. Hyaline cartilage that lacks a perichondrium

101. Unlike the thick filaments of skeletal muscle, the thick filaments of smooth muscle:
    A. Interact directly with intermediate filaments to cause contraction, but not with actin filaments
    B. Contain caldesmon, calponin and myosin light chain kinase
    C. Contain myosin light chains but no heavy chains
D. Form the I-band
E. Have no bare zone

102. Clusters of acidophilic cells filled with mitochondria are most likely to represent which of the following:
A. Cells of the zona fasciculata of the adrenal cortex
B. Oxyphil cells in the parathyroid glands
C. Parafollicular cells of the thyroid gland
D. Pituicytes in the pars distalis of the hypophysis
E. Thyrotropes in the pars intermedia of the hypophysis

103. What type of sensory receptor is most likely to be involved in sensing a painful stimulus:
A. Encapsulated receptors in the superficial layer of the epidermis
B. Free nerve endings
C. Meissner’s corpuscles
D. Merkel corpuscles
E. Ruffini endings

104. In mature lamellar bone, the blood vessels of adjacent osteons are directly connected to one another by:
A. Nutrient arteries
B. Osteogenic buds
C. Vessels that travel through canaliculi
D. Vessels that travel through Haversian canals
E. Vessels that travel through Volkmann’s canals

105. Which cell type fits the following description? The cells form an epithelium whose height varies with their degree of hormonal stimulation. There are junctional complexes between neighboring cells of the same type. The cells have apical microvilli, distended cisternae of RER in their basal cytoplasm, mitochondria with shelf-like cristae, and numerous lysosomes.
A. Cells of the zona reticularis of the adrenal cortex
B. Chondroblasts
C. Follicular cells of the thyroid gland
D. Osteoclasts
E. Parafollicular cells of the thyroid gland

106. Which of the following is an example of a synostosis?
A. The anterior fontanelle of a newborn
B. The epiphyseal plate of a newborn
C. The fusion of the epiphysis and metaphysis in a mature bone
D. The intervertebral disk
E. The pubic symphysis of a normal adult

DIRECTIONS: Each of the numbered items or incomplete statements in this section is negatively phrased, as indicated by a capitalized word such as NOT, LEAST, or EXCEPT. Select the ONE lettered answer or completion that is BEST in each case.

107. Your 33 year-old female patient complains of episodes of double vision and generalized muscle weakness, both of which improve with rest. During the physical examination you carry out eye tests, asking the patient to follow your finger from side to side and up and down (the “H in space” test). You notice that during this exercise she develops ptosis (drooping) of both eyelids. Which of the following statements is most likely to be FALSE:

A. The patient’s condition is due to defective release of neurotransmitter at the neuromuscular junction
B. The patient has an autoimmune disease
C. Pharmacological treatment with acetylcholinesterase inhibitors is likely to provide symptomatic relief
D. Biopsy of her skeletal muscle is likely to show loss of junctional folds and widening of the synaptic cleft

108. The process by which bones are shaped during growth (‘modeling’ or ‘external remodeling’) may include all of the following EXCEPT:

A. Increase in the size of the marrow cavity through endosteal bone resorption, with simultaneous deposition at the periosteal surface
B. Removal of excess bone from the metaphyseal region as the bone elongates to form the diaphysis
C. Coordinated activity of osteoblasts and osteoclasts at a single site resulting in the formation of Haversian systems
D. Cortical drift

109. Identify the FALSE statement concerning the relationships of cell types associated with bone:

A. If osteoblasts become quiescent before being surrounded by bone matrix, they can become squamous bone-lining cells
B. Osteoprogenitor cells are derived from a mesenchymal stem cell population that can also give rise to fibroblasts and adipocytes
C. Osteoprogenitor cells can differentiate into osteoblasts
D. Osteoprogenitor cells differentiate into chondroblasts during intramembranous ossification
E. When osteoblasts become completely surrounded by bone matrix they become osteocytes

110. All the following are characteristic of smooth muscle cells EXCEPT:
   A. Caveolae
   B. Dense bodies
   C. Innervation by autonomic neurons
   D. Presence of calmodulin, and absence of troponin
   E. Sarcomeres

111. Identify the FALSE statement about osteoclasts:
   A. Osteoclasts actively transport protons (H+) into the extracellular space where the low pH begins to dissolve the mineral crystals of bone matrix
   B. Osteoclasts are true anatomical syncytia
   C. Osteoclasts can be found on the periosteal or endosteal surfaces of a bone
   D. Osteoclasts resorb pieces of necrotic bone during fracture repair
   E. Osteocytes can differentiate into osteoclasts to initiate the process of intracortical remodeling

112. Identify the FALSE statement. Intramembranous ossification:
   A. Forms most flat bones of the body including many bones of the skull
   B. Forms the periosteal collar of bone around the diaphysis during endochondral ossification of long bones
   C. Involves a condensation of mesenchyme, and differentiation of osteoprogenitor cells from mesenchymal stem cells
   D. Begins with hypertrophy of chondrocytes in a cartilage model of the bone

113. Identify the FALSE statement. Fibrocartilage:
   A. Contains type I and type II collagen in its matrix
   B. Is found in the pubic symphysis, and in some locations where tendon inserts on bone
C. Is found in locations where resistance to shearing forces is required (i.e., resistance to compressive stress one direction and tensile stress in another direction)
D. Is the most highly cellular type of cartilage
E. Often contains linearly arranged isogenous groups
F. Typically lacks a perichondrium

114. Identify the FALSE statement concerning osteoclasts:

A. They are derived from mononuclear CFU-GM precursor cells of the bone marrow (i.e., the granulocyte/monocyte line)
B. They have PTH receptors on their cell membranes
C. Their differentiation is stimulated by signaling molecules such as RANKL
D. Their activity is inhibited by calcitonin
E. They contain numerous lysosomes

115. Identify the FALSE statement concerning nerve ganglia:

A. All ganglia contain neuronal cell bodies
B. All ganglia contain synapses of preganglionic neurons on postganglionic neurons
C. Ganglia are all located only in the PNS, not in the CNS
D. The neurons and Schwann cells of ganglia are derived from the neural crest

116. Identify the FALSE statement. Alpha-actinin helps to anchor:

A. Actin filaments to the dense bodies of smooth muscle cells
B. Dystrophin to the M line of sarcomeres
C. Microfilaments to the zonula adherens in junctional complexes of epithelial cells
D. Thin filaments to the transverse portions of intercalated disks
E. Thin filaments to the Z-line of skeletal muscle sarcomeres

117. Identify the FALSE statement concerning joints:

A. Fibrous joints are the least mobile of the three major types of joints, and synovial joints are the most mobile
B. In fibrous joints, the tissue that unites the bones together is fibrocartilage
C. A gomphosis is a type of fibrous joint that unites a tooth with the alveolar bone of the tooth socket
D. The articular surfaces of the bones in a synovial joint are covered by hyaline cartilage that lacks a perichondrium
E. Destruction of articular cartilage is a common finding in joints affected by osteoarthritis

118. The pituitary secretes hormones that regulate the activity of all the following EXCEPT:
A. Androgen-producing cells (Leydig cells) of the testis
B. Parathyroid chief cells
C. Thyroid follicular cells
D. Uterine smooth muscle
E. Zona fasciculata of the adrenal

119. Which of the following is FALSE concerning the bone modeling process?
A. It is a coordinated process of bone resorption and deposition at different sites
B. It occurs at a high rate during growth but then slows in adulthood
C. It results in the formation of secondary osteons (Haversian systems)
D. “Metaphyseal waisting” is an example of modeling in which the neck of a long bone is re-shaped following longitudinal growth of the bone

120. Identify the FALSE statement concerning Pacinian corpuscles:
A. Multiple layers of flattened Schwann cells form an inner core that surrounds the axon
B. They are onion-shaped mechanoreceptors found in the skin and in other organs such as pancreas
C. They are the largest encapsulated receptors found in human skin
D. They consist of an expanded nerve terminal tightly apposed to a modified epidermal cell
E. They rapidly adapt to high frequency vibration or pressure

121. All the following structures are part of a typical muscle spindle EXCEPT:
A. Intrafusal muscle fibers
B. Innervated bundles of collagen fibers
C. Afferent nerve endings
D. Efferent nerve endings
122. Identify the **FALSE** statement regarding axons and dendrites:
   A. Axons and dendrites both contain microtubules and neurofilaments
   B. Dendritic spines increase the surface area available for synapse formation on the plasma membrane of a dendrite
   C. In the central nervous system (CNS), all axons are myelinated
   D. In the peripheral nervous system (PNS), all axons are associated with Schwann cells
   E. Neurons generally have only one axon

123. Identify the **FALSE** statement. Gap junctions:
   A. Are important in passing small nutrient and signaling molecules between osteocytes
   B. Are present in intercalated disks
   C. Coordinate the contraction of single-unit (unitary) smooth muscle cells
   D. Coordinate the contraction of skeletal muscle cells
   E. Exist between osteoblasts
   F. Form the rare electrical synapses that exist between some neurons

124. The importance of bone as an endocrine organ is becoming increasingly evident. One substance that acts locally within a bone and also has a role as a hormone is osteocalcin. Identify the **FALSE** statement concerning osteocalcin:
   A. It acts as a hormone that stimulates insulin production by beta cells of the pancreas
   B. It also has hormonal effects on adipocytes
   C. It binds to hydroxyapatite in bone matrix
   D. It is a steroid hormone
   E. It is produced by osteoblasts

125. Identify the **FALSE** statement. A Merkel corpuscle:
   A. Is an encapsulated receptor
   B. Is a slowly-adapting mechanoreceptor that responds best to steady pressure
   C. Is located in the stratum basale of the epidermis
D. Is characterized by the presence of neurosecretory vesicles in the cytoplasm of the Merkel cell
E. Includes an expanded nerve terminal that forms a flattened disk or plate where it contacts the Merkel cell

126. Increased levels of circulating T3 would normally tend to result in all the following **EXCEPT**:
   A. A more squamous appearance of the thyroid follicular cells
   B. Decreased release of secretory granule contents by thyrotropes
   C. Decreased secretion of thyrotropin-releasing hormone (TRH) from the hypothalamus
   D. Increased scalloping of the edge of the colloid in thyroid follicles
   E. Negative feedback of T3 on the adenohypophysis and hypothalamus

127. Which of the following is **LEAST** characteristic of cardiac muscle fibers:
   A. Branched fibers
   B. Binucleate cells
   C. Triads
   D. Intercalated discs
   E. Thick filaments

128. Which of the following is a feature of cardiac and smooth muscle, but **NOT** skeletal muscle:
   A. An endomysium
   B. Centrally located nuclei
   C. Cytoplasmic dense bodies
   D. Intercalated disks
   E. Myofibrils

**PART II: MATCHING**

**DIRECTIONS**: Each set of matching questions consists of numbered questions that are printed below a list of lettered choices. For each numbered question, select the ONE lettered response that is most closely associated with it. Each lettered response may be used **once**, **more than once**, or **not at all**.

*Use the diagram below to answer QUESTIONS #129 - 131:*
A. Neuron A  
B. Neuron B  
C. Neuron C  
D. None of the above  

Give the letter corresponding to the type of neuron that:  
129. Supplies motor innervation to skeletal muscle cells  
130. Supplies motor innervation to smooth muscle cells  
131. Innervates a Golgi tendon organ  

**QUESTIONS #132-135:**  
A. Osteoblast  
B. Osteoclast  
C. Osteocyte  
D. Osteoprogenitor cell  

132. Responsible for the formation of a cutting cone  
133. Responsible for the formation of a Howship’s lacuna  
134. Lines the surface of a closing cone  
135. Gives rise directly to bone lining cells  

**QUESTIONS #136-138:**  
A. Adenohypophysis  
B. Adrenal cortex
C. Chief cell of the parathyroid gland
D. Hypothalamus
E. Neurohypophysis
F. Parafollicular cell
G. Thyroid follicular cell

136. Produces a hormone that increases the uptake of Na\(^+\) from the collecting tubules of the kidney
137. Produces hormones that reach their target cells through a venous portal system
138. Site of secretion of a hormone that has a potent effect on the contraction of smooth muscle

QUESTIONS #139-142:
A. Cardiac muscle
B. Skeletal muscle
C. Smooth muscle
D. Cardiac and smooth muscle
E. Skeletal and cardiac muscle

139. Striated muscle
140. Specialized for slow, sustained contractions
141. Most likely to be either uninucleate or binucleate
142. Most recently evolved form of muscle

QUESTIONS #143-145:
A. Axon
B. Dendrite
C. Neurotransmitter
D. Myelin
E. Nissl body
F. Node of Ranvier
G. Schmidt-Lantermann cleft
H. Synapse

143. Junction between neurons or between neurons and effectors
144. Structure that maintains the viability of the inner layer of Schwann cell cytoplasm in a myelinated nerve fiber
145. Process of a neuron that often includes neurotransmitter receptors

QUESTIONS #146-149:
A. Muscle spindle
B. Ruffini ending
C. Free nerve ending
D. Pacinian corpuscle
E. Meissner's corpuscle
F. Golgi tendon organ

146. Is innervated by both motor and sensory neurons Responds most sensitively to muscle contraction

148. Spindle shaped, slowly adapting, encapsulated mechanoreceptor. It contains centrally located bundles of collagen fibers and is most sensitive to steady pressure

149. Contains a centrally located axon that is surrounded by multiple, concentric layers of flattened Schwann cells and fibroblasts
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