



Exploring the World of Science

University of Michigan Science Olympiad
2021 Invitational Tournament

Anatomy & Physiology C

Test length: 50 Minutes

Team name: KEY

Student names: KEY

*Welcome to the 2021 University of
Michigan Science Olympiad Invitational!*

Anatomy & Physiology Div C

*Thank you so much for participating! We hope that you
enjoy this event and have a wonderful day of competing.
We would greatly appreciate any feedback on this test -
please email sangini@med.umich.edu :)*

-- Sangini Tolia & Baylor Wiggins

- Event Supervisors

INSTRUCTIONS:

Welcome to the University of Michigan 2021 Invitational Anatomy and Physiology Division C test! Make sure you have a stable internet connection and are ready to compete!

For this test, you are allowed the following resources:

- A Google Meet/Zoom/Skype/Phone/Video call with your partner
- A cheat sheet, printed (one double-sided sheet or two-single sided sheets) or in pdf format on your computer (two pages)
- Two non-programmable, non-graphing calculators
- Scratch paper

You **MAY NOT** take advantage of the following resources. Doing so will result in a disqualification plus 30 points added to your team's overall score.

- ANY internet resource
- Help from any person other than your partner
- A printed version of the test

Section 1: Labeling

Instructions: Please refer to the supplemental PDF with images. Please identify the structures and record your answers on the answer sheet. Most questions ask about muscles, which have been carefully selected to test from the official event rules' muscle list (which would serve as your "word bank"). Make sure you write your answer in the correct box!

1a.	Deltoid	7b.	Latissimus dorsi
1b.	Biceps brachii (or biceps)	8a.	Thoracic
2a.	Deltoid	8b.	Lumbar
2b.	Teres major	8c.	Cervical
2c.	Triceps brachii (or triceps)	9a.	Diaphragm
3a.	Extensor carpi radialis	10a.	Orbicularis oris
3b.	Extensor carpi ulnaris	10b.	Zygomaticus major
3c.	Extensor digitorum	11a.	Arrector pili muscle
4a.	Iliopsoas	11b.	Sebaceous glands
4b.	Vastus intermedius	12a.	Stratum corneum
4c.	Vastus medialis	12b.	Stratum granulosum
4d.	Tensor fasciae latae	12c.	Stratum spinosum
4e.	Vastus lateralis	12d.	Stratum basale
5a.	Soleus	12e.	Meissner's corpuscle
5b.	Gastrocnemius	12f. 2pts	1. Palms or soles of feet 2. Due to presence of stratum lucidum
6a.	Pectoralis major		
6b.	Serratus anterior	13a.	ACL
7a.	Trapezius	13b.	MCL

Section 2: Multiple Choice

14. Which of the following is a structural, fibrous protein found in the dermis?

- a. **Collagen**
- b. Heparin
- c. Lipocyte
- d. Melanin
- e. Sebum

15. Which of the following is a protein that retains water in keratinocytes and is often mutated in atopic dermatitis?

- a. Collagen
- b. Elastin
- c. **Filaggrin**
- d. Fibrillin
- e. Integrin

16. Which of these species are normal skin flora? Select all that apply.

- a. **Candida albicans**
- b. **Staphylococcus aureus**
- c. Streptococcus viridans
- d. Mycobacterium leprae
- e. **Cutibacterium acnes**
- f. Sarcoptes scabiei

17. Which of these organisms cause impetigo? Select all that apply.

- a. Candida albicans
- b. **Staphylococcus aureus**
- c. Streptococcus viridans
- d. Mycobacterium leprae
- e. Cutibacterium acnes
- f. Sarcoptes scabiei

18. Smooth muscles differ from skeletal and cardiac muscles in that they _____.

- a. **Lack myofibrils**
- b. Are under voluntary control
- c. Lack myosin
- d. Lack actin

19. Which of these is the medical term for dry skin?

- a. **Xerosis**
- b. Psoriasis
- c. Dermatitis
- d. Cellulitis
- e. Necrotizing fasciitis

20. Which of the following is not a function of the integumentary system?

- a. Excrete wastes
- b. Maintain homeostasis
- c. Protect underlying tissues
- d. **Production of minerals**
- e. Storage of nutrients

21. _____ burns affect that epidermis and dermis and result in pain, redness, and blistering.

- a. First degree
- b. **Second degree**
- c. Third degree
- d. Fourth degree

22. Which of the following statements describes smooth muscle cells?

- a. **They are resistant to fatigue**
- b. They have rapid onset of contractions
- c. They cannot exhibit tetanus
- d. They primarily use anaerobic metabolism

23. Which of the following are the most correct symptom(s) of growth plate fractures (select all that apply).

- a. **Inability to put weight on joint**
- b. **Tenderness of affected area**
- c. Internal bleeding
- d. Discoloration of skin (dark blue/green)

24. Which of the following is a potential treatment for acne?

- a. Diphenhydramine
- b. **Isotretinoin**
- c. Varenicline
- d. Chlordiazepoxide
- e. Propanolol

25. Which of the following is the correct order of structures in a skeletal muscle, from largest to smallest?

- a. Fibril - fascicle - fiber
- b. Fibril - fiber - fascicle
- c. Fascicle - fibril - fiber
- d. **Fascicle - fiber - fibril**
- e. Fiber - fibril - fascicle

26. A muscle that inserts into the greater tubercle of the humerus is most likely involved in...

- a. Flexion
- b. Extension
- c. **Lateral rotation**
- d. Medial rotation
- e. Abduction

27. Which of the following muscles does not have an action that is antagonistic to the action of the brachialis?

- a. Anconeus
- b. Triceps brachii lateral head
- c. Triceps head long head
- d. **Brachioradialis**

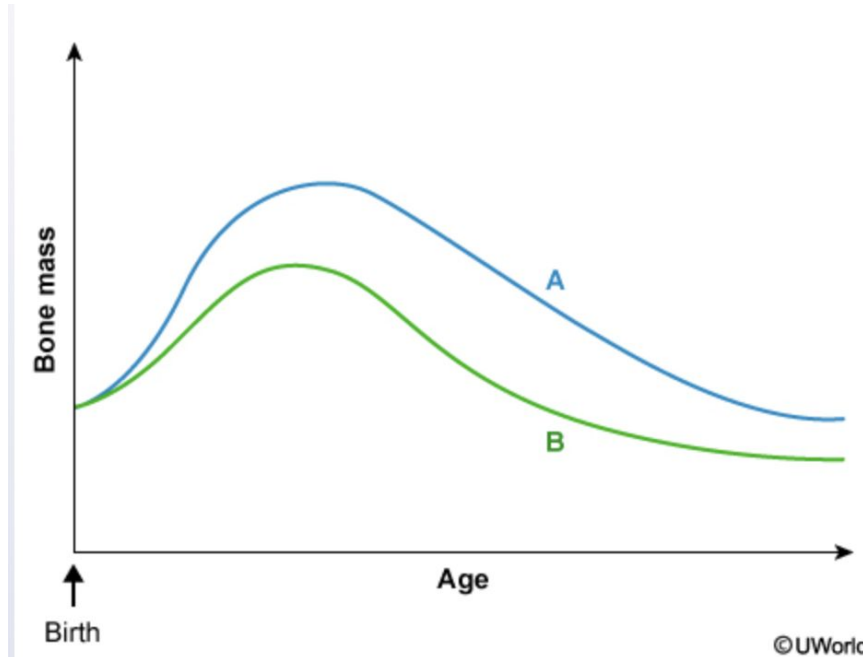
28. Which of the following is **not** a muscle of facial expression?

- a. Buccinator
- b. Depressor labii
- c. Risorius
- d. **Masseter**
- e. Mentalis

29. A suture is an example of a...

- a. **Synarthrosis**
- b. Syndesmosis
- c. Symphysis
- d. Diarthrosis
- e. Amphiarthrosis

30. A prospective observational study is performed to determine factors affecting bone mass and fracture risk. Detailed information is obtained from a large group of volunteers, and bone mass is monitored over time. The data from 2 specific groups of women is shown below. Which of the following choices would create curve A?



- a. Early menopause
- b. Increased physical activity**
- c. Lower body mass index
- d. Positive smoking history
- e. Use of glucocorticoids

31. Identify the disease in Image 14 (refer to supplemental images powerpoint).

- a. Boil
- b. Carbuncle
- c. Callus
- d. Wart**
- e. Squamous cell carcinoma

32. What is causing the disease in Image 14?

- a. Viral infection**
- b. Bacterial infection
- c. Fungal infection
- d. Excess friction
- e. Uncontrolled cell division

33. A synovial joint is an example of a...

- a. Synarthrosis
- b. Amphiarthrosis
- c. Diarthrosis**
- d. Symphysis
- e. Syndesmosis

34. Which of the following is **not** a characteristic of articular cartilage?

- a. There is no perichondrium
- b. The matrix contains more water than other cartilage
- c. Surfaces are slick and smooth
- d. It is composed of hyaline cartilage
- e. It secretes synovial fluid**

35. Like the shoulder joint, the hip joint permits motion in three axes. Therefore the hip joint is an example of a...

- a. Plane joint
- b. Saddle joint
- c. Ball and socket joint**
- d. Cartilaginous joint
- e. Fibrous joint

36. Scoliosis is defined by a Cobb angle of at least ____ degrees.

- a. 5
- b. 10**
- c. 15
- d. 20
- e. 25

37. The foramen magnum would be found in this bone:

- a. Sphenoid
- b. Temporal
- c. Occipital**
- d. Frontal

38. The foramen rotundum would be found in this bone

- a. **Sphenoid**
- b. Temporal
- c. Occipital
- d. Frontal

39. The four curves of the adult spine column are not all present at birth. Which of the following are the secondary curves (i.e. one that appear several months after birth)

- a. **Cervical and lumbar**
- b. Thoracic and lumbar
- c. Sacral and lumbar
- d. Thoracic and sacral

40. The odontoid process is found on the

- a. Atlas
- b. **Axis**
- c. Ribs
- d. First thoracic vertebra

41. Which of these statements is true about the fibula?

- a. Forms an important part of the knee joint
- b. Articulates with the femur
- c. Helps bear the weight of the body
- d. **Provides lateral stability to the ankle joint**

42. The bone that serves as a bridge uniting the cranial nerve and facial bones is the

- a. Ethmoid
- b. **Sphenoid**
- c. Frontal
- d. Lacrimal
- e. Nasal

43. The bones that form the palms of the hands are the

- a. Carpals
- b. Tarsals
- c. Metacarpals**
- d. Metatarsals
- e. Phalanges

44. The _____ of the radius assists in the stabilization of the wrist joint

- a. Olecranon process
- b. Coronoid process
- c. Radial tuberosity**
- d. Styloid process
- e. Capitulum

45. The clavicle articulates with the scapula at the

- a. Acromion process**
- b. Coracoid process
- c. Glenoid tuberosity
- d. Scapular spine

46. The muscle that inserts on the superior surface of the pubis around the symphysis is the

- a. Internal oblique
- b. External oblique
- c. Rectus abdominis**
- d. Transversus abdominis
- e. Scalene

47. The major abductor muscle of the upper arm is the

- a. Supraspinatus
- b. Subscapularis
- c. Deltoid**
- d. Coracobrachialis

48. Damage to the pectoralis major would interfere with a person's ability to

- a. Extend the forearm
- b. Abduct the humerus
- c. Adduct the humerus**
- d. Elevate the scapula
- e. External rotate the humerus

49. The plateau phase of the cardiac muscle action is due to

- a. The movement of fewer sodium ions across the cell membrane
- b. The calcium channels remaining open longer than the sodium channels**
- c. The increased membrane permeability to potassium channels
- d. A decrease in the amount of calcium diffusing across the membrane
- e. An increased membrane permeability to sodium ions

50. During muscle contraction, all of the following occur, **EXCEPT**

- a. ATP is hydrolyzed
- b. Myosin heads bind to actin
- c. The H band becomes shorter
- d. Calcium concentration in the sarcomere increases
- e. Hemoglobin concentration in muscle fibers increases**

51. After death, muscle fibers run out of ATP and calcium begins to leak from the sarcoplasmic reticulum into the sarcoplasm. This results in a condition called

- a. Tetany
- b. Treppe
- c. Depolarization
- d. Rigor mortis**
- e. Oxygen debt

52. **[Tiebreaker 2]** The following is a list of the events that occur during a muscle contraction. What is the correct order of events?

1. Myosin cross-bridges bind to actin
2. The free myosin head splits ATP
3. Calcium ion is released from the sarcoplasmic reticulum
4. The myosin head pivots towards the center of the sarcomere
5. Calcium ion binds to troponin
6. The myosin head binds an ATP molecule and detaches from the actin

- a. 1,3,5,4,6,2
- b. 5,1,4,6,2,3
- c. 3,5,1,2,4,6
- d. 3,5,1,4,6,2**
- e. 1,4,6,2,3,5

53. How would a drug that competes with acetylcholine for receptors at the motor end plate affect skeletal muscle?

- a. It would make the muscles more excitable
- b. It would produce uncontrolled muscle spasms
- c. It would cause spastic paralysis (muscles are contracted and unable to relax)
- d. It would cause flaccid paralysis (muscles are relaxed and unable to contract)**
- e. It would have no effect on skeletal muscles.

54. The suture that forms the articulation between the two parietal bones is called the

- a. Rostral
- b. Frontal
- c. Sagittal**
- d. Coronal

55. Duchenne and Becker muscular dystrophies are passed along by which form of inheritance?

- a. Autosomal dominant
- b. Autosomal recessives
- c. Mitochondrial
- d. X-linked dominant
- e. X-linked recessive**

Section 3: Fill in the Blank

56. The **femur** is the large bone found superior to the patella and inferior to the ischium.
57. **HPV (human papillomavirus) infection** is the main cause of cervical cancer that has shown to also cause some vaginal, anal, and oropharyngeal cancers.
58. Age, hormones, and UV radiation decrease the amount of **elastin** in the dermis, causing wrinkles.
59. The **dermis** is the layer of skin that contains capillaries, nerves, and hair follicles.
60. **Melanoma** is a type of skin cancer that begins in pigment cells.
61. Muscle fascicles are covered by **perimysium**.
62. Muscle fibers are covered by **endomysium**.
63. The role for the fontanelles is to **allow for compression/molding of the skull during childbirth**.
64. Name the nerve that passes through the foramen rotundum. Be as specific as you can.
Maxillary branch of the trigeminal nerve (or CN V2)
65. Which are the three bones that form the acetabulum in the pelvis? **Ilium, ischium, pubis**.
66. With age, red bone marrow is replaced by **fat**.
67. What's the problem in image 15? **Spinal fracture**
68. What condition does the child in image 16 likely have? **Muscular dystrophy**
69. **Myasthenia gravis** is a neuromuscular disorder that can be treated by taking medications that act as acetylcholinesterases.
70. **[Tiebreaker 1] Mohs surgery** is a surgical technique used to treat skin cancers on the face, in which small sections of skin are removed and looked at under the microscope. If more cancer cells are seen, the dermatologist goes back and removes another section in the affected area. This continues until the section is fully clear of cancer cells. The purpose of this is to make sure all the cancer is removed and that normal skin is spared as much as possible.

Section 5: Short Answer [Total score is Tiebreaker 3]

Underlined = key words that are required to earn the point.

71. *Describe where single-unit smooth muscle and multiunit smooth muscle are found in the body. (2pts)*

1 pt: single unit = in walls of hollow organs

1 pt: multi unit = lung airways OR large arteries

72. *Why can smooth muscles contract over a wider range of resting lengths than skeletal and cardiac muscle? (1pt)*

1 pt: Smooth muscles can contract over a wider range of resting lengths because the actin and myosin filaments in smooth muscle are not as rigidly organized as those in skeletal and cardiac muscle.

73. *What causes differences in skin color among people? (1pt)*

1 pt: It is due to higher or lower activity of melanocytes, NOT number.

74. *On an X-ray, what colors do bones, soft tissue, and air appear as? Can you explain why? (3pts)*

1 pt: Bones appear as white, soft tissue is gray, and air is black (must get all correct).

2 pts: Colors on an x-ray depend on the density of the structure. Bones are very dense and made of calcium, which absorbs a lot of the radiation and are therefore white. In contrast, air is black because it is the least dense. Soft tissues and water are in the middle, and look gray.

75. You and some friends find some human bones on the Diag. The bones appear to belong to 3 different individuals, to which you decide to give fictional names. Harry's femur shows the presence of an epiphyseal plate while the other individuals (Ron and Hermione) have epiphyseal lines. Ron's bone is very light and porous and not nearly as dense as the other two. Rank the 3 people in age from youngest to oldest and explain your logic (3 pts).

1 pt: Harry, Hermione, Ron (oldest)

1 pt: Children have epiphyseal plates, which later close into epiphyseal lines. So Harry is the youngest.

1 pt: As people get older, they begin to lose bone mass and their bones become lighter. Therefore, Ron is older than Hermione.

76. Describe the location, product, and function of sebaceous glands, apocrine glands, eccrine glands, and ceruminous glands (4 pts).

1 pt for each correctly described gland. Full points will be given if the underlined terms are mentioned.

	Sebaceous	Apocrine	Eccrine	Ceruminous
Location	<i>Associated w/ hair follicles</i>	<i><u>Armpits</u>, nipples, groin</i>	<i><u>All over body</u></i>	<i><u>Ears</u> (external auditory canal)</i>
Product	<i><u>Sebum</u></i>	<i>Type of sweat (thick, cloudy)</i>	<i>Type of sweat (thin, watery)</i>	<i><u>Cerumen</u></i>
Function	<i><u>Waxy</u> substance that <u>lubricates skin</u> <u>and hair</u>, prevents bacterial overgrowth</i>	<i><u>Smelly sweat</u> that starts being produced around <u>puberty</u>, released into hair follicles</i>	<i>Sweat released directly onto skin surface, salty, helps excrete wastes and <u>dispel excess body</u> <u>heat</u>, prevent bacterial growth</i>	<i><u>Waxy</u> substance that <u>lubricates ear</u> and <u>protects</u> from bacteria</i>