Exploring the World of Science

University of Michigan Science Olympiad
2021 Invitational Tournament

Fossils C

Test length: 50 Minutes

Team name: KEY

Student names: KEY

Tiebreakers: 6, 23, 35, 34, 44, 63, 65, 75, 82, 88, 92 (in order)

Answers are marked in red.

1. The evolution of flight in pterosaurs and modern-day birds is an example of convergent evolution.

2. Typical specimens of bony fish are black in color. These fossils are examples of:
   a) impressions
   b) mummifications
   c) carbonizations
   d) bioimmurations

3. Which of the following is considered an index fossil for the Late Paleozoic Era?
   a) Genus Cryptolithus
   b) Order Fusulinida
   c) Genus Belemnitella
   d) Genus Exogyra

4. A remarkable concentration of fossils of the theropod dinosaur Coelophysis have been found at the Ghost Ranch Lagerstätte.

5. Which of the following can be determined by studying the fossilized footprints of an animal?
   a) bipedality vs. quadrupedality
   b) size
   c) speed
   d) a and b
   e) all of the above

6. Briefly explain, in your own words, how stromatolites are formed. What evolutionary role is it speculated that they play, and why?
   Formed by colonies of prokaryotic *cyanobacteria, which collected particles that accumulated in *layers, creating a *layered/striated formation. Stromatolites can be found all over the world, and cyanobacteria play an important role in *reducing carbon dioxide levels and emitting oxygen in exchange. For this reason, stromatolites are speculated to have played an important role in making Earth *hospitable for other forms of life.

7. The principle of faunal succession states that a species appears, exists for a time, and then goes extinct.

8. Which of the following laws states that all rock layers are laterally continuous and may be broken up or displaced by later events?
   a) the law of continuous conformity
   b) the law of lateral continuity
   c) the law of displacement
   d) the law of original horizontality

9. The method of dating that provides a numerical age or range is known as absolute dating.

10. Which of the following are theories for the occurrence of the Ordovician-Silurian extinction event?
    a) large amounts of plants drained away the planet's CO2
    b) volcanic activity
    c) falling sea levels
    d) excessive glaciation
    e) asteroid impact

11.  
    Specimen A Specimen B

    True or False? These two specimens represent the same phylum.

12. Specimen A was most likely which of the following?
    a) sessile
    b) lived in cold waters
    c) free-floating
    d) solitary
    e) colonial
    f) lived in warm waters

13. 

    Specimen C

    Which of the following is not true about this specimen?
    a) lived during the Cretaceous period
    b) its shell contained growth rings like trees
    c) it laid eggs on the sea floor
    d) it shares the same phylum as Genus Exogyra
    e) none of the above

14. Specimen C is the state fossil of Delaware.

15. In contrast to Specimen C, the external shells of Order Orthocerida and Genus Baculites are typically found as fossils.

16. 

    Specimen D

    Which of the following is true for this specimen?
    a) found commonly in the Navesink formation
    b) lived during the Cretaceous period
    c) commonly found in fossil plates along with Genus Turritella

d) its distribution is common in Asia
e) all of the above
f) none of the above

17. Specimen D is part of Phylum Mollusca.

18. Specimen D is most commonly confused with Genus Exogyra.

19. The study of the molluscan shell is called what?
    a) molluscology
    b) conchology
    c) shellology
    d) paleontology
    e) malacology
    f) none of the above

20. 

    Specimen E

    The leaves shown above are associated with which plant genus on your list?
    a) Glossopteris
    b) Platanus
    c) Populus
    d) Psaronius
    e) Metasequoia

21. Which of the following is not true for the genus to which Specimen E belongs?
    a) first appeared in the Devonian period
    b) there are over 250 classified species
    c) grew up to 10 m in height

d) had a root mantle in lieu of a true tree trunk
e) other plant species can be found in petrified trunk remains
f) it is extant

22. 
Specimen F

Name the genus of the stem with which this leaf specimen is most commonly associated.
Calamites

23. The stems of Specimen F are most commonly fossilized in what form? Why is this?
*Pith casts are the most common form because Calamites trunk/stems were *hollow.

24. 
Specimen G

Specimens like the one above would most likely be found in which of the following Lagerstätten?
a) Solnhofen

b) Green River
c) Burgess Shale
d) Ghost Ranch
e) Mazon Creek

25. 
Specimen H

Identify the genus of the animal on your fossil list that this specimen belonged to.
Mammuthus

26. There is a direct correlation between Specimen H and which of the following?
a) lifespan of the animal
b) social status of the animal
c) digestion of the animal
d) reproduction of the animal
e) all of the above

27. All mammals share which of the following characteristics?
a) have fur or hair
b) have a smaller cerebral cortex
c) have three-chambered hearts
d) are monotremes
e) all of the above

28. True or False? Synapsids are more closely related to reptiles than to mammals.

29. 

Specimen I

The name of this specimen roughly translates to:
a) drawn-out face
b) double caul
c) freshwater fish
d) spiny roof
e) water lizard

30. Specimen I most likely:
a) had gills only
b) was a vegetarian
c) was 6 feet long
d) lived in present-day Australia
e) had eight-fingered hands
f) lived during the Permian period

31. Which of the following is/are **not** characteristic(s) shared by all members of Phylum Chordata?
a) are cold-blooded
b) have an endoskeleton
c) have a well-developed brain
d) have a notochord at some point in development
e) have two pairs of appendages
f) are diploblastic

32. 

Specimen J

This mold clearly demonstrates the tooth shape of which of the following reptiles?

a) Order Crocodilia
b) Family Mosasauridae
c) Genus Velociraptor
d) Genus Stegosaurus
e) Order Plesiosauria
f) Genus Tyrannosaurus

33. True or False? Today's birds are directly evolved from ornithischian dinosaurs.

34. Briefly explain the difference between the hips of saurischian and ornithischian dinosaurs.
The *pubis of the hipbone points towards the *front of the animal in saurischians, and towards the *tail in ornithischians.
Also acceptable:
    - alongside/parallel to the ischium in ornithischians
    - Some ornithischians have a projection at the forward end of the pubis

35. 

Specimen K

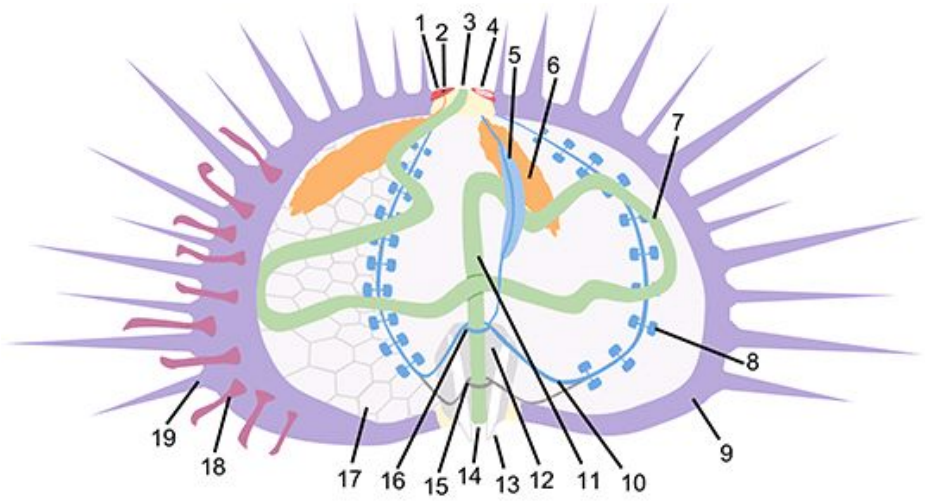
The above specimen represents Genus Lystrosaurus. It has been documented that members of this genus survived the Permian-Triassic extinction event. Based on your knowledge of the behavior of Genus Lystrosaurus, what is the most likely explanation for their incredible survival?

Members of this genus were *burrowing animals. This means that they likely *tunneled underground to avoid disaster, and survived the extinction event this way. (give credit for hibernation/torpor.) They also were known wanderers (immigrated), and have been found across a *wide geographical distribution. This means that they could have wandered into an unaffected area, and survived this way.

36. 

What is the name of the supercontinent pictured above? (Hint: ~900 mya)

Rodinia

37. 

True or False? Number 3 in the above diagram corresponds to the mouth of the organism.

38. Label the part of the above diagram that corresponds to the number 18.
Tube feet

39. Label the part of the above diagram that corresponds to the number 12.
Aristotle's lantern

40. What is the geological period during which the first vascular plants appeared on the Earth?
Silurian

41. 

Specimen L

Identify the above specimen. Please include the lowest taxonomic classification in your answer.
Genus Platystrophia

42. Specimen L most likely lived during which of the following geological periods?
    a) Cambrian
    b) Devonian
    c) Permian
    d) Ordovician

43. 
    Specimen M

    In which of the following formations would this specimen most likely have been found?
    a) Ghost Ranch
    b) Traverse Group
    c) Morrison Formation
    d) Hell Creek

44. 
    Specimen N

This specimen is classified under which taxonomic order? What characteristic allows it to be classified this way?
They are classified under *Order Tabulata, because individual corallites have horizontal layers called *tabulae.

45. Which dinosaur genus on your list is credited with parental care of offspring?
    a) Dracorex
    b) Spinosaurus
    c) Stegosaurus
    d) Maiasaura

For questions 46-50, use the following pictures.

Specimen O

Specimen P

Specimen Q

Specimen R

Specimen S

For the following statements, write down the letter (or letters) of the corresponding specimen shown above.

46. This specimen was an herbivore and a known prey of *T. Rex*.
    O

47. The name of this specimen means “fused lizard.”
    S

48. This specimen was discovered in both America and China.
    R

49. These specimens had spikes that were most likely used for defense.
    P, S

50. Specimens like this one can be found in the Djadochta formation and the Bayan Mandahu formation.
    Q

51. 
    Specimen T

    Members of this genus were most likely:
    a) detritivores
    b) herbivores
    c) filter feeders
    d) planktonivores
    e) deuterids

52. 

Specimen U

Members of the above genus most likely (mark all that apply):
a) had the same sized brains as modern-day humans
b) walked on two legs
c) were about 3-4 feet tall
d) were carnivores
e) made primitive tools
f) lived about 6 million years ago

53. 

Specimen V
True or False? Specimens like the one above typically had brains larger than those of most dinosaurs.

54. Specimen V is sometimes referred to by its German name, Urvogel.

55. 

Specimen W

The above organisms lived in colonies, called rhabdosomes. A singular organism was called a zooid, and they were all interconnected by stolons.

56. Which of the following is **not** true for the organisms shown on Specimen W?
    a) they were pelagic
    b) they have two kinds of thecae
    c) they have only one kind of theca
    d) they are good index fossils
    e) they are useful in biostratigraphy
    f) none of the above

57. Identify the order to which the organisms shown on Specimen W belong.
    Graptoloidea

58. 

Specimen X

Which of the following is true for the organism to which the above specimen belonged?
a) demonstrated aggressive behavior
b) pelagic
c) could not smell
d) had eyes on its ventral surface
e) all of the above
f) none of the above

59. True or False? Members of the order to which Specimen X belongs are extant.

60. 

Specimen Y

Which of the following suggests that organisms like Specimen Y were different from modern-day whales?
a) they had large brains
b) they were social creatures
c) their skulls were asymmetrical
d) they did not have echolocation skills
e) all of the above

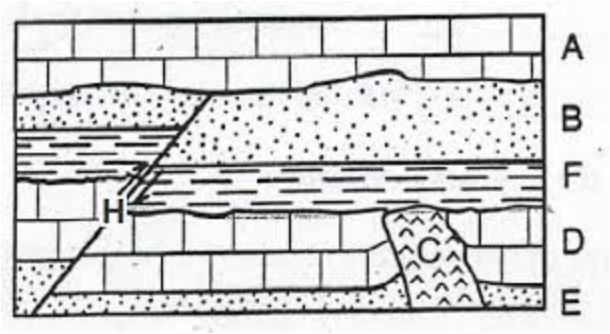
61. Which of the following are recognized gait patterns in modern-day horses? (Note: there may be more than one answer.)
    a) skip
    b) trot
    c) stroll
    d) ramble
    e) clip
    f) canter

62. 

    Specimen Z

    Organisms like Specimen Z would most likely be found in which Lagerstätte?
    La Brea Tar Pits

63. What is a possible reason for the eventual extinction of organisms like Specimen Z, given your knowledge of its behavioral patterns? (Hint: diet)
    Smilodon had a preference for *larger prey, so they were too *specialized at hunting them, and were unable to *adapt when large prey numbers *declined.

64. 

    What is the order in which the above rock layers were deposited, from oldest to youngest? Please write your answers with no commas or spaces in between (eg. ABCDEFG).
    EDCFBHA

65. What is the difference between permineralization and mineral replacement?
    Permineralization is when minerals fill in *empty spaces in an organism and the organic material disintegrates around it. Mineral replacement is the total replacement of *all organic matter, hard or soft.

For questions 66-68, use the following pictures.


Specimen A1


Specimen B1


Specimen C1

66. What is the type of trace fossil shown by Specimen A1?
    Coprolite

67. What is the type of trace fossil shown by Specimen B1?
    Repair scar

68. What is the type of trace fossil shown by Specimen C1?
    Predation mark

69. 

Specimen D1

Which of the following is **not** true for organisms like the above specimen?
a) commonly known as “Dudley locust”
b) burrowed under sand as a defense mechanism
c) lived during the Devonian period
d) frequently found rolled
e) were scavengers
f) none of the above

70. 

Specimen E1

The above specimen shows a fossilized trilobite eye. These types of eyes are called schizochroal eyes, noted for being able to see in all directions at once.

71. Genus Elrathia is the oldest trilobite on your fossil list.

72. 

Specimen F1

This specimen most likely did not:
a) have tentacles
b) ate trilobites
c) grew to be 15 cm long
d) have complex suture lines
e) existed before Genus Baculites
f) lived during the Ordovician period

73. 
Specimen G1

The shells of specimens like the one above consisted of a series of camerae, or chambers, that were connected to the animal by a tube called a siphuncle.

74. Identify the genus of Specimen G1.
Baculites

75. Why is carbon-14 used in radiometric dating, as opposed to carbon-12 or carbon-13?
Carbon-12 and carbon-13 are stable, whereas carbon-14 is the only *radioactive/unstable isotope. Live plants and animals maintain C-14 *equilibrium with the atmosphere, however, once the tissue dies, the equilibrium is lost, and C-14 levels begin to decrease through radioactive *decay.

76. 


Specimen H1 Specimen I1

True or False? These specimens were most likely created in an anaerobic environment.

77. Specimen I1 most clearly shows addition of which of the following?
a) manganese oxides
b) chromium
c) carbon
d) cobalt
e) copper
f) iron oxides

78. 

Specimen J1

Identify the order to which this specimen belongs.

Squamata

79. Based on your answer to the previous question, during what period did organisms like Specimen J1 first begin to appear?
Triassic

80. 
Specimen K1

Each of the individual tubular structures that appear as polygons in cross-section are called corallites.

81. 
Specimen L1

Organisms like Specimen L1 most likely (mark all that apply):
a) lived away from erosive settings
b) lived in deeper waters
c) were sessile
d) were suspension feeders
e) are preserved very well as fossils
f) had multiple larval stages

82. How do fossils like Specimen L1 play a role in understanding environmental conditions from the past?
    Barnacles play a key role in estimating paleo *water depths because they live in *shallow waters. The *completeness of fossils and the nature of the damage can also provide information on the *tectonic history of different regions.
    (for further explanation: not needed to receive credit.
    The degree of disarticulation of the fossils suggests how far they were transported, and since many species live in shallower water depths, it can be assumed that the animals broke down as they were washed down-slope.)

83. True or False? Most organisms like Specimen L1 demonstrated explicit sexual dimorphism.

84. 
    Specimen M1

    This specimen demonstrates a shape type most commonly referred to as a trochiform shape (“top” shell). It has a distinctive ornamentation along the medial edge of each whorl, termed the selenizone.

85. 

Specimen N1

Which of the following is not true for the organism to which this specimen belonged?
a) breathed air
b) was a powerful swimmer
c) lived in warm, shallow seas
d) gave birth to live young
e) lived much beyond the Cretaceous period
f) swallowed prey whole

86. True or False? The organism to which Specimen N1 belonged has extant relatives.

87. The organism to which Specimen N1 belonged was first discovered in a limestone quarry near the city of Maastricht, in the Netherlands.

88.  

Specimen O1 Specimen P1

Briefly explain the difference in the position of the siphuncle for both of the above specimens.
In ammonites, the siphuncle ran along the *ventral periphery of the shell. In nautiluses, the siphuncle ran through the *center of the septa and camerae.

89. 

Specimen Q1

The organism to which this specimen belonged most likely:
a) shared a habitat with Basilosaurus
b) was the direct ancestor to Megalodon
c) lived during the Paleocene epoch
d) was about 30-40 feet long

e) all of the above
f) none of the above

90. 
Specimen R1

The above specimen would be considered an index fossil for what era?
Paleozoic

91. Specimen R1 demonstrated which of the following?
a) slow growth
b) no significant population dimorphism
c) symbiosis with algae
d) relatively simple form and function
e) none of the above

92. 
Specimen S1

Name two tests that one could use to determine if the above specimen is amber or copal.
Possible answer choices are:

- heat/smoke test
- hardness test
- inclusion test
- lighting test
- acetone reaction test
- buoyancy/floating test

(award points for any 2 of the above)

93. 

Specimen T1

Identify the genus to which this specimen belongs.

Atrypa

94. Specimen T1 most likely lived during which of the following periods? (Mark all that apply.)

a) Carboniferous
b) Silurian
c) Ordovician
d) Devonian
e) Cambrian
f) Permian

95. 

Specimen U1

The fossilized part of the organism shown above is known as the crown.

96. Specimen U1 most likely exhibited commensalism/symbiosis with which of the following mollusks?
    a) Gryphaea
    b) Pecten
    c) Platyceras
    d) Conus
    e) Belemnitella
    f) Dactylioceras

97. Specimen U1 is the state fossil of which state?
    Missouri

98. Crinoids that were sessile and epifaunal bivalves were casualties of the Mesozoic marine revolution.

99. Bromalites are fossils of which kind?
    a) blood
    b) tails
    c) vomit
    d) bromine-encased
    e) reproductive fluids
    f) stomachs

100. Which of the following is/are not examples of terrestrial environments? (Mark all that apply.)
    a) karstic
    b) neritic
    c) permafrost
    d) fossorial

e) littoral
f) eolian