Name:_____

GEOL 104 Dinosaurs: A Natural History
Smithsonian Assignment

DUE ONLINE: Monday November 13

"Every man is a valuable member of society who by his observations, researches, and experiments procures knowledge for men."

> -James Smithson (1765-1829), a British natural historian whose legacy of over $500,000 was given to the government of the United States of America for the creation of "an Establishment for the increase and diffusion of knowledge": the Smithsonian Institution.

The Smithsonian Institution's National Museum of Natural History (NMNH) has one of the largest collections of dinosaur and other fossils in the world. The Smithsonian museums are free; hours for the NMNH are 10 am to 5:30 pm 7 days a week. You can take the Metro from the College Park Station to any of a number of stations near the Museum. The quickest route is the Green Line from the UMd-College Park Station to Archives/Navy Memorial/Penn Quarter: you don't have to change trains, and the NMNH is just on the other side of the Archives Building. **NOTE**: Make sure to check on the current mask policy for the University shuttle, the Metro system, and the Smithsonian before heading downtown.

You may work in teams and discuss your answers; however, **ALL WORK YOU TURN IN MUST BE YOUR OWN**. (I have caught and reported a number of students in the past you have cheated by copying each other's work: please don't make me do that again…). To comply with University Senate regulations, this assignment is covered by the University's Honor Code: I pledge on my honor that I have not given or received any unauthorized assistance on this assignment

NOTE: Use your OWN OBSERVATIONS in order to answer the questions.

ALSO NOTE: This assignment requires knowledge from the course as well as from the exhibits. Not all the answers are indicated on museum signs or the like; you have to use your knowledge from GEOL104 to answer them.

The assignment itself is structured like the ELMS homeworks: you will eventually go onto ELMS and select your answers or type them in, just as you would in a quiz. You can print out this pdf or have it on your smartphone/tablet or whatever as you go along. Either take notes of the answers and enter them later, or (if you have a good enough connection) you can input the answers directly into ELMS.

The entire East Wing First Floor of the National Museum of Natural History was dedicated to fossil life, the brand-new (opened in June 2019) David H. Koch Hall of Fossils – Deep Time. This project focuses on that, and then you'll move down to the 1st floor to look at fossils from the Sant Ocean Hall on the First Floor.

Name:_____

1) List the day and time you did the project:

2) List any other GEOL104 students who are with you on your trip (or list "none" if you are there without another GEOL104 student.) (P.S. If you are part of a group with multiple GEOL104 students, each of you should choose different selections of options when there are multiple options of subjects in some of the questions below.):

PART I – DEEP TIME HALL

This is the newest major hall of the National Museum of Natural History. The main part of the hall is a walk through geologic time, looking at the diversity of life on Earth at these times. But the beginning of the hall (at least from the way this packet is organized) is the "Fossil Lab", which connects to the "African Voices" hall. The "Fossil Lab" includes both a glassed-in room in which fossil preparators are working at removing specimens from the matrix and cleaning them up for storage, as well as a number of exhibits about the nature of paleontology and how it works.

We'll start by taking a look at the preparation room. Depending on their (and your) schedule, some preparators may be at work when you visit. Whether they are or not, they should have little signs up that explain what it is they are working on.

3) List an example of a fossil which is currently being prepared in the preparation lab. (It doesn't have to be a dinosaur).

Opposite from the preparation lab is a dinosaur fossil mounted for display. This is actually the type specimen of that species!

4) What **species** (remember, species have two-word names) is on display?

Sometimes fossils are mounted in **life position**: the skeletons are shown as if the animal was still alive, but somehow had lost all of its flesh, organs, etc. Others are mounted in **death position**: the fossil is shown without restoring the bones to their orientation as in a living creature, but rather as the bones were found in the rock.

5) This specimen is shown in [life | death] position.

Move on, and past the preparation lab take a right into the "Fossil Basecamp" alcove. This section has exhibits on taphonomy, biochemistry, and evolution, among other things. Choose one of the major exhibits here to examine in more detail. If you are in a group, each group member should choose a different exhibit.

Name:_____

6) I chose:

"How Do Fossils Form?" "How Do We Date Fossils?" "How Does Life Evolve?"
"How Do We Find Fossils?" "How Does the Earth Work?"

7) Describe the key concepts given in that exhibit, and the types of objects and other visual displays used to convey that idea.

Head out towards the main path. There is no way we can look at all the exhibits for the project: for one thing, the Deep Time hall covers all of Life's history, not just dinosaurs! Pass through the section with ocean life, past the metal tree stump, and find the Early Permian exhibit. You can find it with the label "An Eat-and-be-Eaten World".

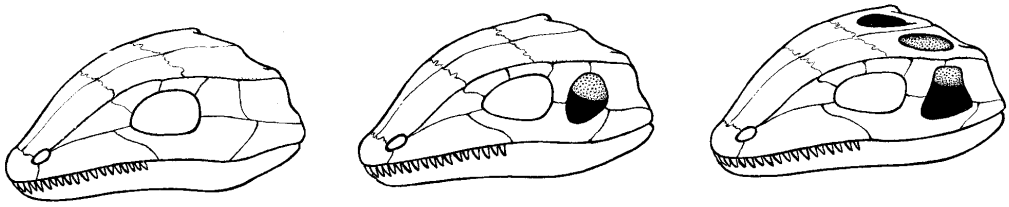
There are two skeletal mounts on this side of the exhibit: *Edaphosaurus* and *Eryops*.

8) Which **foot posture** do these Early Permian animals show? [plantigrade | digitigrade | unguligrade]

9) Which best describes the **resting stance of the hindlimb** shown in these Early Permian animals?
[Parasagittal (upright) | Sprawling]

10) Which of these two likely ate mostly fish? [*Edaphosaurus* | *Eryops*]

Recall the basic skull patterns for tetrapods:



Anapsid (no temporal fenestrae) Synapsid (infratemporal only) Diapsid (both infra- and supratemporal)

11) Which of these two Early Permian animals show a synapsid skull pattern? [*Edaphosaurus* | *Eryops*]

Look at the panel labeled "Light, Energy & Life".

12) These Early Permian terrestrial vertebrate communities had:

a. More herbivores than carnivores
b. Equal percentages of carnivores and herbivores
c. More carnivores than herbivores

Name:_____

Now move to the other side of this glass case. On this side you'll find mounted skeletons of *Dimetrodon*, *Ophiacodon*, *Xenacanthus*, and *Diplocaulus*.

13) *Dimetrodon* has which **skull pattern**? [Anapsid | Synapsid | Diapsid]

14) Which of these four seems to be the **apex predator on land**?

[*Dimetrodon* | *Ophiacodon* | *Xenacanthus* | *Diplocaulus*]

15) Which of these four seems to be the **apex predator in the water**?

[*Dimetrodon* | *Ophiacodon* | *Xenacanthus* | *Diplocaulus*]

Now move to the Late Permian, labeled by "Rise of the Herbivores".

16) According to the display, these Late Permian terrestrial communities had:

a. More herbivores than carnivores
b. Equal percentages of carnivores and hebivores
c. More carnivores than herbivores

17) Which of the following Late Permian animals shown on display is **NOT a synapsid**?

[*Bradysaurus* | *Diictodon* | *Oudenodon* | *Cynosaurus* | *Aulacocephalodon*]

Now move on to the Mesozoic and find "A Riot of Evolution" and its discussion of Triassic amniotes.

18) Which of the following best describes the teeth of the synapsid *Diademodon*?

a. Undifferentiated (essentially the same shape from the front of the jaws to the back, although maybe different in size)
b. Differentiated (teeth of very different shapes in different parts of the jaw)

19) Match the fossil genus to its proper description.

Smilosuchus	_____	a. A gliding reptile
Icarosaurus	_____	b. A large quadrupedal herbivorous reptile
Vancleavea	_____	c. Gigantic crocodile-like reptile
Haramiyavia	_____	d. Early turtle
Proterochersis	_____	e. Aquatic reptile covered by armored scales
Trilophosaurus	_____	f. Early mammal

20) Which **foot posture** does *Trilophosaurus* show?

[plantigrade | digitigrade | unguligrade]

Name:_____

21) Which best describes the **resting stance of the hindlimb** shown in the Late Triassic animals listed above for those in which you can see the limbs)?

[Parasagittal (upright) | Sprawling]

Okay, so how about a freaking dinosaur in this packet??

Among these Late Triassic animals is *Eoraptor*, one of the oldest and most primitive dinosaurs.

22) *Eoraptor* is [bigger | the same size | smaller] than *Trilophosaurus*.

23) Which **foot posture** does *Eoraptor* show? [plantigrade | digitigrade | unguligrade]

24) Which best describes the **resting stance of the hindlimb** in *Eoraptor*?

[Parasagittal (upright) | Sprawling]

25) *Eoraptor* is a(n) [obligate biped | facultative biped | obligate quadruped].

26) *Eoraptor* has which **skull pattern**? [Anapsid | Synapsid | Diapsid]

Move to the left, past the head of *Smilosuchus*, and come around the far side of the Triassic exhibit. You should be facing the Jurassic "island", and specifically the section labeled "Spikes and Claws". Head over to it and check out *Stegosaurus* and *Ceratosaurus*.

27) Which of these two seems to be winning in the fight? [*Stegosaurus* | *Ceratosaurus*]

28) Which of these two has **gastralia**? [*Stegosaurus* | *Ceratosaurus*]

29) Which best describes the condition of the **teeth** in *Ceratosaurus*?

a. Undifferentiated (essentially the same shape from the front of the jaws to the back, although maybe different in size)
b. Differentiated (teeth of very different shapes in different parts of the jaw)

30) Which of the body parts seems to have been the primary weapon in *Ceratosaurus*?

[the manual claws | the teeth and jaws]

31) In *Stegosaurus*, which **leg bone** is longer? [femur | tibia]

Move to the right past the tails of *Ceratosaurus* and *Stegosaurus* and follow along the edge of the Jurassic "island". The next pair of dinosaurs is a juvenile and subadult (labeled as "adult) of the iguanodontian

ornithopod *Camptosaurus*. (By the way, very few of the dinosaurs on display here are represented by fully-grown adults!)

32) Which growth stage of *Camptosaurus* has a highly curved **ischium and pubis**? [juvenile | adult]

33) Based on the snout shape, *Camptosaurus* was likely a [choosy | less choosy] feeder.

Keep moving to the right. The next dinosaur you encounter is the carnosaurian theropod *Allosaurus*.

34) The *Allosaurus* specimen is shown engaged in what **behavior**?

a. Stalking *Camptosaurus*
b. Defending against *Diplodocus*
c. Feeding on *Dryosaurus*
d. Protecting its own eggs

35) In *Allosaurus* **metatarsal III** is

[the same width at the top as II and IV | pinched out at top between II and IV].

36) In *Allosaurus* which is longer? [The largest tooth | The largest manual ungual]

Take a look at the skull of *Allosaurus*, and in particular the cranium (the upper half of the skull).

37) Which of the following best describes the **proportions of the cranium** of *Allosaurus*?

a. About as wide or wider mediolaterally at the posterior end than it is tall dorsoventrally.
b. Much narrower mediolaterally at the posterior end than it is tall dorsoventrally.

Allosaurus has triangular crests on the dorsal (top) surface of its **lacrimals**.

38) These lacrimal crests are [anterior to | directly dorsal to | posterior to] the orbits.

To the right of the *Allosaurus*, out where you can touch it, is the single largest bone in this entire hall.

39) Which **bone** (body part) is this?

40) What **genus** is this giant bone from?

Looming over this part of the island is the skeleton of a subadult *Diplodocus*. (Yes, this specimen is "merely" 27.2 m [that is, 90'] long; a fully-adult specimen is 33.5 m [110'] long and about twice as massive.)

41) Look at the **metacarpus** of *Diplodocus*. It is:

a. Wider mediolaterally than tall proximodistally
b. About equally wide as tall
c. Taller proximodistally than wide mediolaterally

Name:_____

42) The modern *Giraffa* has 7 cervical vertebrae. The number of **cervicals** in *Diplodocus* is [fewer than | the same number as | more than] the number in *Giraffa*.

Keep going to the right and find a pair of skulls of sauropods: the diplodocid *Diplodocus* and the macronarian *Camarasaurus*.

43) Which of these has **stout spatulate teeth**? [*Camarasaurus* | *Diplodocus*]

44) Which of these has **peg-like teeth** all at the front of the snout? [*Camarasaurus* | *Diplodocus*]

Before we leave the Jurassic "island", take a look at the mounted skeleton of a subadult *Camarasaurus*.

45) As mounted, this specimen is doing what?

a. On the ground, in death position.
b. Partially rearing up.
c. Watching the fighting *Stegosaurus* and *Ceratosaurus*.
d. Feeding on low vegetation.

Turn around and head over to the Cretaceous "island". Head towards the side on the left (the one facing the wall rather than the center of the hall) and find the section "Dinosaurs Take to the Air".

There are skeletons of four different genera of theropods displayed.

46) Match the genus with its proper description.

Sinosauropteryx _____ a. One of the oldest toothless birds
Caudipteryx _____ b. A flightless maniraptoran with broad feathers
Archaeopteryx _____ c. A compsognathid
Confuciusornis _____ d. A Jurassic bird with teeth and a long bony tail

47) Which of these genera occurs oldest in time?

[*Sinosauropteryx* | *Caudipteryx* | *Archaeopteryx* | *Confuciusornis*]

Move along to the left and find the exhibit "Dinosaur Diversity Peaks". This discusses the Late Cretaceous Epoch around 75 million years ago.

48) Match the following dinosaurs to their proper description:

Prosaurolophus _____ a. Tyrannosaurid
Centrosaurus _____ b. Pachycephalosaur
Gorgosaurus _____ c. Ankylosaurid
Euoplocephalus _____ d. Hadrosaurid
Stegoceras _____ e. Dromaeosaurid
*Saurornitholestes*_____ f. Ceratopsid

Name:_____

49) Take a look at the skull of *Prosaurolophus*. Which of the following best describes its **jaws**?

a. Teeth are present throughout the length of the jaws.
b. Teeth are absent in the front half of the jaw, and closely packed in the back of the jaw

50) Take a look at the **tail** of *Euoplocephalus*. Which of the following best describes it?

a. A thagomizer: two pairs of spikes
b. Flexible all the way to the tip
c. Rigid in its posterior half, ending with a tail club

51) Which of the following large herbivores is most likely to have a choosier diet?

[*Prosaurolophus* | *Centrosaurus* | *Euoplocephalus*]

52) In *Centrosaurus* the **nasal horn** is [larger than | equal in length to | smaller than] the postorbital horns.

Turn around and find the flightless Cretaceous marine bird *Hesperornis*.

53) Based on its skeleton, *Hesperornis* was a [wing-propelled | foot-propelled] diver.

Turn back to the Cretaceous island and move right: past the "Dinosaur Diversity Peaks" and "Dinosaurs Take to the Air", and along to "Dinosaurs in a Flowering World". Look for the display "Life Flourishes at the Water's Edge".

54) Match these non-dinosaurian organisms to their proper description.

Didelphodon	_____	a. Water plant related to the modern lotus
Stangerochampsa	_____	b. Freshwater clam
Plethobasus	_____	c. Turtle
Eubaena	_____	d. Marsupial mammal
Nelumbago	_____	e. Alligator

Now move around and find the specimen of *Tyrannosaurus* feeding on *Triceratops*. Hail to the King!

55) Look at the dorsal view of the *Tyrannosaurus* skull. Its **nasals** are
[separate from each other throughout their length | fused together for most of their length].

56) Which of the following best describes the **proportions of the cranium** of *Tyrannosaurus*?

a. About as wide or wider mediolaterally at the posterior end than it is tall dorsoventrally.
b. Much narrower mediolaterally at the posterior end than it is tall dorsoventrally.

57) In *Tyrannosaurus* which is longer? [The largest tooth | The largest manual ungual]

Name:_____

58) In *Tyrannosaurus* **metatarsal III** is

[the same width at the top as II and IV | pinched out at top between II and IV].

Now examine the *Triceratops* specimen

59) In *Triceratops* the **nasal horn** is [larger than | equal in length to | smaller than] the postorbital horns.

60) The **metatarsus** in *Triceratops* is [shorter than | the same length as | longer than] the metatarsus of *Tyrannosaurus.*

Compare the pelvic region of *Tyrannosaurus* and *Triceratops*. (You'll have to walk around to get different views of these).

61) Which dinosaur is **wider across at the hips**? [*Tyrannosaurus* | *Triceratops*]

Move to the right of *Tyrannosaurus* and *Triceratops* to find two more latest Cretaceous dinosaurs: *Edmontosaurus* and *Thescelosaurus*.

62) Which of these dinosaurs is an **obligate biped**? [*Edmontosaurus* | *Thescelosaurus*]

63) Which of these dinosaurs could feed higher in the trees? [*Edmontosaurus* | *Thescelosaurus*]

64) In which of these two dinosaurs are the **ossified epaxial tendons** (tendons along the neural spines which have turned to bone)? [*Edmontosaurus* | *Thescelosaurus* | both | neither]

Go the right past these two dinosaurs; around the corner is a discussion of the Cretaceous-Paleogene mass extinction 66 million years ago.

65) Based on the information presented here, match the different environmental effects of this catastrophe with the time scale on which they occurred.

Ferns flourish	_____	a. Days
Acid rain	_____	b. Weeks
Global warming	_____	c. Months
Wildfire	_____	d. Years
Devastated landscapes	_____	e. Centuries

Thus passes the glory of the world…

However, that isn't the end of the project in the Deep Time hall! With such a wealth of Cenozoic fossils it would be a shame to not have you take a look at some of them. So here is a Cenozoic scavenger hunt. Listed

are a series of fossil organisms in the remaining part of the exhibit, with some indication of the display case they are in.

66) Match the fossil taxon to its proper description.

Uintatherium ("Dense Forests Open Up") _____

Stenomylus ("Browsing, Grazing, Moving in Herds") _____

Moropus ("The Not-So-Distant Past") _____

Smilodon (near the Rotunda entrance) _____

Eremotherium (across from one of the Rotund entrances) _____

Mammut (facing the center of the hall) _____

a. Clawed-footed herbivorous "hoofed" mammal
b. Slender running camel
c. Giant ground sloth
d. Mastodon
e. Sabre-toothed cat
f. Sabre-toothed knob-headed quadrupedal herbivore

Since you are looking at fossils in the main gallery anyway, why not look at a few more for extra credit? Pick any two fossils in the main gallery that were not used in a previous question. Give all the relevant information (name, group to which it belongs, geologic age, geologic formation and place where this fossil was collected, specimen number (listed as USNM xxxxx; the "USNM" stands for "United States National Museum", the original name of the Smithsonian) for up to two other fossil species of any sort.

67 - EXTRA CREDIT)

68 - EXTRA CREDIT)

Now find one of the round- or oval-dioramas spaced down the main axis of the hall, representing Carboniferous through the Pleistocene environments. (If you are in a group, each person should choose a different diorama).

69) What time period does this diorama represent?

70) What part of the world does it represent?

71) List at least one taxon of animal and one taxon of plant represented in the diorama:

Name:_____

What does the diorama say about the following environmental factors at the time represented?

72) CO_2 Level:

73) Average Global Temperature:

74) Global Sea Level:

PART II – PALEONTOLOGY IN THE SANT OCEAN HALL

The Sant Ocean Hall is directly opposite the main entrance to the museum—beyond the elephant—on the first floor. The Ocean Hall has a big central concourse that concentrates on ocean life, a right-hand path that focuses on environments and human interactions, and a left-hand path about fossil marine life. Head over to that left-hand path, and we'll explore some issues about Mesozoic and Cenozoic marine life and the Cretaceous/Paleogene extinction event. But first, let's take a look at the history of fossil apex predators, in the exhibit "Who's On Top?" Use the data provided by this exhibit to answer the next set of questions.

75) Match the letter of the group of apex predator to the time period in which they were dominant. [5 pts total]

145-66 Ma	_____	A. Anomalocariidids
299-252 Ma	_____	B. Eurypterids
419-359 Ma	_____	C. Helicoprionids
444-419 Ma	_____	D. Mosasauroids
541-485 Ma	_____	E. Placoderms

Down the middle of the fossil marine life section are a set of free-standing displays. Find the one of these labeled "A Reef Built by Clams?". This exhibit concentrates on rudists, a group of extinct clams that were the major reef-builders in the Cretaceous seas. There are two major groups of rudists described, characterized by the different way they grow: **uprights** and **recliners**.

76) Which mode of growth does *Titanosarcolites* sp. show? [upright | recliner]

77) Which mode of growth does *Parastroma sanchezi* show? [upright | recliner]

The long wall of the fossil section, labeled "Global Vanishing Acts", discusses two great mass extinctions: the Permo-Triassic extinction and the Cretaceous-Paleogene extinction. We will focus on the Cretaceous-Paleogene extinction: find the section labeled "The Sky is Falling!" and specifically the part that says "How Do We Know?"

On display are models of two deep sea cores that sample sediments from before, during, and after the Cretaceous-Paleogene extinction. It describes the changes in the foraminiferans (armored amoeba-like single-celled organisms) over the event.

Name:_____

78) The average **size** of foraminiferans just **after the extinction** were [smaller | the same size | larger] than those before.

79) The **number of species** of foraminferans just **after the extinction** was [fewer | the same | greater] than those before the extinction.

80) Find the section labeled "Who Lives? Who Dies?" Indicate which of the species listed below was a "Victim" or a "Survivor". [4 pts total]

Lahilla larseni	[Victim | Survivor]	*Belemnites densus*	[Victim | Survivor]
Baculites corrugatus	[Victim | Survivor]	*Seriola prisca*	[Victim | Survivor]

Turn around and find the section labeled "The Evolution of the Whale". Whales are placental mammals; in fact, they are the aquatic descendants of terrestrial mammals related to the modern hippopotamus. Look up to find the skeletons of *Maiacetus inuus*, *Dorudon atrox*, and *Basilosaurus cetoides*: primitive whales from the early part of the Cenozoic Era. Of these three, *Maiacetus* is the oldest and the most primitive, *Dorudon* is the intermediate, and *Basilosaurus* is the closest to modern whales (although it is still far more primitive than any living whale).

81) Over their early history, whales [decreased | remained the same size | increased] in size.

82) Over their early history, the **relative size of the hindlimb** of whales

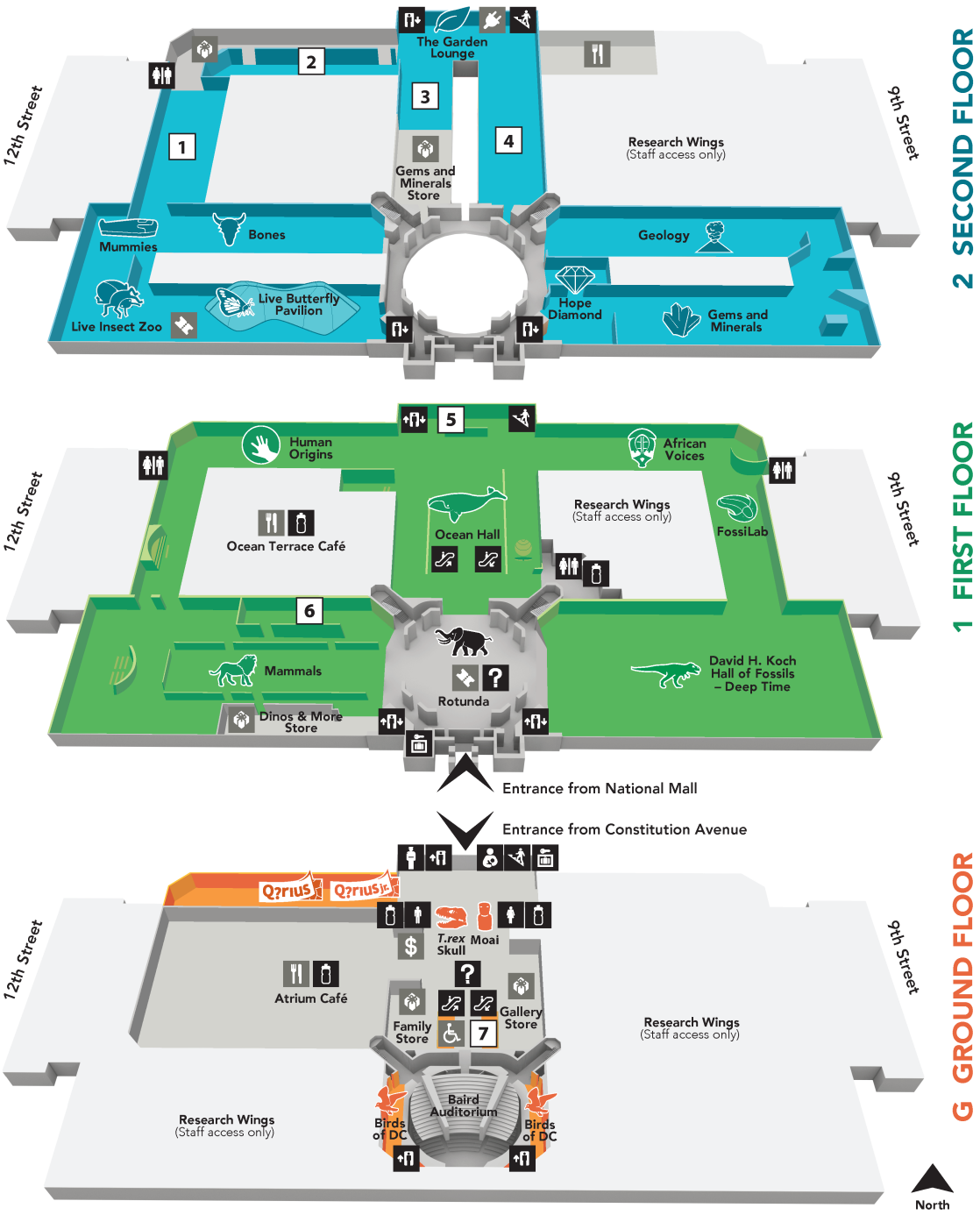
[decreased | remained the same size | increased].

83) In which of these genera is the **pelvic girdle still attached** to the vertebral column?

[*Maiacetus* | *Dorudon* | *Basilosaurus*]

That is it. Feel free to enjoy the rest of the Deep Time hall, and the rest of the museum.

Name:_____



AMENITIES

- Stores
- ATM
- Outlets
- Free Wi-Fi: si-visitor
- Tickets
- Dining
- Wheelchairs

FACILITIES

- Special Exhibitions
- Escalator
- Information Desk
- Security Office
- Stairs
- Elevator
- Lactation Room
- Locker Storage
- Restrooms
- Water Bottle Refill Station