

Name: _____

GEOL 104 Dinosaurs: A Natural History

Smithsonian Assignment I: Life on Land before the Dinosaurs, and the Dinosaurs Themselves!

DUE: November 2

“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: you don’t have to change trains, and the NMNH is just on the other side of the Archives Building.

For this exercise you may wish to bring along the anatomy sheets handed out in class. 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, please sign the following so that you may receive credit for this assignment.

I pledge on my honor that I have not given or received any unauthorized assistance on this assignment

Signature

UID

Date

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

This package works as sort of a self-guided tour. It will start in the Conquest of the Land exhibit, and end up in the Dinosaur Hall.

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PART I – LIFE ON LAND BEFORE THE DINOSAURS

For this exercise, you will probably find the anatomy sheets handed out in class (also available on the website) a useful guide in identifying the homologous bones in these different animals.

On the first floor, find the exhibit called “Conquest of the Land” (also labeled “Fossil Plants” on some maps). These exhibits discuss the colonization of land by plants and early stegocephalians (“amphibians” in the old sense).

Find the case labeled “Amphibians—The Vertebrates Take to Land”, and locate the model of the crossopterygian fish *Eusthenopteron*.

1) The front (pectoral) fin is organized as:

[a single long bone, followed by a pair of long bones distally, followed by a series of long bones | a single plate-like bone, with a larger number of elongate bones coming off of it like the tines of a comb].

Find the mounted skeleton of *Eryops*, a large stegocephalian.

2) Based on the shape of its teeth, do you think that it ate fish and meat, or that it ate plants?

3) What evidence led to you to your answer in question 2?

[Note also the skeleton of *Pelosaurus laticeps*, a possible “tadpole” of *Eryops*.]

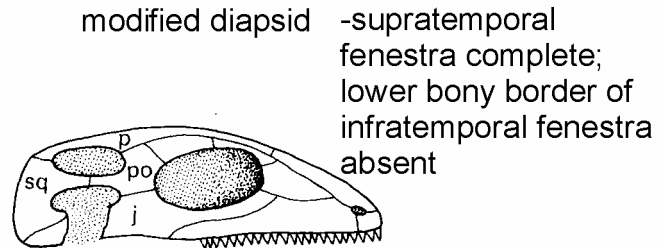
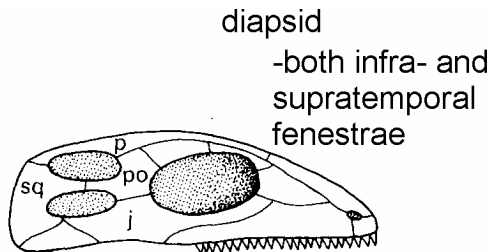
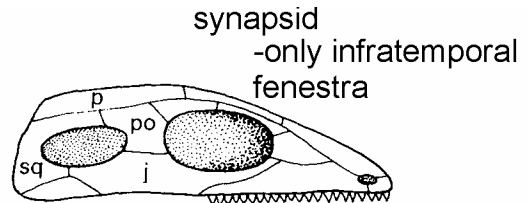
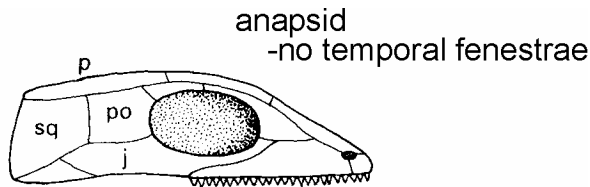
In the center of this room is a set of fossils of the stegocephalian *Buettneria perfecta* that were found together.

4) Based on the text (hanging from the ceiling), what is the likely reason for the particular grouping and position of the bones?

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Head for the early “reptiles” (really “early amniotes”) exhibits: look for an *Allosaurus* foot in a glass cylinder to find your way.

Below are cartoons of four major skull types found in amniotes. They differ by the patterns of the **temporal fenestrae** (the openings for jaw muscle attachments).



Find the skeleton of *Diadectes* in the display case labeled “Stem” Reptiles”. This creature is very close to the base of Amniota: some paleontologists think that it is a true amniote, while others think that it lies just outside that group.

5) What skull type does *Diadectes* have? [anapsid | synapsid | diapsid | modified diapsid]

Extra Credit) Paleontologists agree that *Diadectes* wasn't a flesh-eater. What feature(s) of the teeth suggests a non-meaty diet for this animal?

Find the exhibit labeled “The First Wave of Reptilian Diversity”, featuring the skeletons of *Dimetrodon grandis*, *Edaphosaurus boanerges*, and *Cotylorhynchus romeri*. In modern classifications, these animals would not be considered reptiles, although it is fair to say that they were part of the first wave of amniote diversity. *Dimetrodon*, with the largest skull, is probably the best one to look out for the next two questions.

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6) These animals have the [anapsid | synapsid | diapsid | modified diapsid] skull type.

7) These animals [do | do not] have an antorbital fenestra.

Extra Credit) In which of these three animals are the teeth most differentiated in size and shape between the different parts of the jaws? [*Dimetrodon* | *Edaphosaurus* | *Cotylorhynchus*]

The ancestral state for limb postures in tetrapods is **sprawling** (limbs oriented out to the sides); the derived state is **parasagittal** (limbs oriented downward).

Indicate the limb posture of the following tetrapods:

8) *Dimetrodon* [Sprawling | Parasagittal] 9) *Edaphosaurus* [Sprawling | Parasagittal]

10) *Diadectes* [Sprawling | Parasagittal] 11) *Cotylorhynchus* [Sprawling | Parasagittal]

Find the exhibit labeled “Cynodont Flesh-Eaters”. On display is the skull of the large *Cynognathus crateronotus* and the much smaller skeleton of *Thrinaxodon liorhinus*.

12) These taxa have a [anapsid | synapsid | diapsid | modified diapsid] skull type.

The primitive condition for tetrapod teeth is **undifferentiated** (the same shaped teeth from the front of the snout to the back); the derived state is **differentiated** (specialized teeth in different parts of the jaws)

13) The jaws of the cynodonts show [undifferentiated | differentiated] teeth.

Find the case labeled “Early Reptilian Plant-Eaters” (again, these are actually synapsids, not true reptiles). The particular group here are dicynodonts. Find the large skull of *Aulacephalodon baini*.

14) How many teeth (total) are present in the skulls of these animals? _____

Move on to the exhibit un-creatively named “Non-Dinosaurs”. Find the skeleton of the Triassic reptile *Trilophosaurus buettneri*.

15) The limbs of *Trilophosaurus* are [sprawling | parasagittal].

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Look behind you at the skeletons of dicynodonts, and back at *Edaphosaurus*, *Dimetrodon*, and *Cotylorhynchus*.

Now look back at *Trilophosaurus*.

16) Out of all of these creatures, which would you suspect was the fastest? Why?

PART II – THE DINOSAURS

Turn left, and walk into the Dinosaur Hall. Look around for a bit: this hall will be the focus of the second Smithsonian assignment. However, we'll look at a few dinosaurs before we go.

You'll find the right pelvises of *Stegosaurus* and *Allosaurus*.

17) In these two dinosaurs, the acetabulum (hip socket) is [covered by a sheet of bone | open].

18) In which of these two dinosaurs is the main shaft of the pubis pointing backwards?

[*Allosaurus* | *Stegosaurus* | both | neither]

19) These pelvises are shown in [left lateral | right lateral | dorsal | ventral] view.

Let's take a look at the complete skeletons! Find the complete skeleton of *Allosaurus fragilis*.

20) The jaws of *Allosaurus* show [undifferentiated | differentiated] teeth

21) *Allosaurus* [does | does not] have an antorbital fenestra.

22) The hindlimbs of *Allosaurus* are [sprawling | parasagittal].

23) *Allosaurus* is a [biped | quadruped].

Nearby is the recently restored skeleton of *Stegosaurus stenops*.

24) *Stegosaurus* is a [biped | quadruped].

25) *Stegosaurus* has a(n) [anapsid | synapsid | diapsid | modified diapsid] skull type.

26) The hindlimbs of *Stegosaurus* are [sprawling | parasagittal].

27) *Stegosaurus* has a [unguligrade | digitigrade | plantigrade] stance in its hindlegs.

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We'll return to these two skeletons shortly. But for now, go to the skeleton of *Tyrannosaurus rex* skeleton (shouldn't be too hard to find...). Gaze at its majesty for a bit. Incidentally, Dr. Holtz worked on the (admittedly limited) text associated with this exhibit. Now, answer the following questions:

28) Which are larger? [Its largest manual unguals | Its longest teeth]

29) How many digits does it have per manus? _____

30) How many digits does it have per pes? _____

Find the metatarsus (the long bones of the foot between the ankle and the toes). Compare the length of the metatarsus as a whole to the length of the femur.

31) The metatarsus is [less than $\frac{1}{4}$ the femur length | about $\frac{1}{2}$ the femur length | as long as the femur].

The *Tyrannosaurus* is facing its contemporary, the ceratopsid *Triceratops*. The *Triceratops* exhibit has been greatly expanded and updated in recent years. Go back down the steps into the alcove of the *Triceratops* exhibit. Read the text and view some of the videos.

32) Where was the original skeleton discovered? _____

Now go up the steps and look at "Hatcher", the Smithsonian's new *Triceratops* mount.

33) In *Triceratops* the metatarsus is

[less than $\frac{1}{4}$ the femur length | about $\frac{1}{2}$ the femur length | as long as the femur].

Continue on through the ceratopsian and pachycephalosaur exhibits.

34) There are specimens of a couple of centrosaurines represented by fossils here. In *Centrosaurus*, which horn is larger? [The nasal horn | The postorbital horns]

35) What centrosaurine genus (formerly considered its own genus and species, "*Brachyceratops montanensis*") is represented by a juvenile individual?

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Primitive (non-ceratopsid) ceratopsians are represented by three skulls: *Protoceratops*, *Bagaceratops*, and *Psittacosaurus*.

36) In the specimens on display here, which one of these is represented by an embryo or hatchling?

37) Several pachycephalosaurs are also on display here. List one of the **species** of pachycephalosaurs on display.

38) Where the original fossil of the specimen you described in question 36 discovered?

Thescelosaurus neglectus and *Heterodontosaurus tucki* are two ornithischian dinosaurs. Both mounted on the wall near the Marginocephalia exhibit.

39) These two dinosaurs are [bipedal | quadrupedal].

40) Where was the specimen of *Heterodontosaurus* discovered? _____

41) [*Thescelosaurus* | *Heterodontosaurus*] is the younger of the two.

Move along to the hadrosaurids, much larger ornithopods.

42) The hind end of *Corythosaurus casuarius* is displayed. Note that the scales of this dinosaur were preserved.

Describe (or draw) what these scales look like:

Further down, the complete skulls of an adult hadrosaurine and a juvenile lambeosaurine are on display.

Examine the skull of the hadrosaurine *Edmontosaurus annectens*, one of the “duckbill-iest” of the duckbills.

43) The naris of *Edmontosaurus* is [larger than | about the same size | smaller than] the orbit.

44) Adults of *Corythosaurus* have a very tall crest over the top of the skull. The skull of the juvenile *Corythosaurus* [does | does not] have the same very tall crest.

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Turn around, and find the eggs of the deinonychosaur *Troodon* (the only raptor fossils on display here!) and the baby *Maiasaura* skeleton. *Maiasaura* is a hadrosaurine hadrosaurid. (These Cretaceous fossils are a bit out of place, since all the other dinosaurs in this central island are from the Late Jurassic Morrison Formation).

45) Adult *Maiasaura* have a long broad duckbill, similar in proportion to that of *Edmontosaurus*. Does the baby *Maiasaura* have the same proportioned bill? [Yes | No].

Turn back around to the wall, and pass the cast of the *Tyrannosaurus rex* skull. Examine the skeleton of *Ceratosaurus nasicornis*. This is the **type specimen** (the original one to which the name was assigned). New research indicates that it wasn't fully grown when it died.

46) How many fingers does it have on each hand? _____

47) From what Epoch did *Ceratosaurus* come? _____

Turn around and face the main island. As mentioned above, all the dinosaurs in the central island (other than the eggs and baby fossils) are from the Late Jurassic Morrison Formation of western North America. In front of you, on the floor of that display, is a dinosaur mounted in "death position" (i.e., the way it looked when it was found in the rocks), rather than "life position" (standing upright).

48) What dinosaur species is shown in death position at this point?

(Incidentally, note the bony armor knobs around the cervical vertebrae)

The central island is dominated by *Diplodocus*, a very long sauropod.

49) Find the **distal** caudals (the tail tip) of *Diplodocus*. Circle whichever of the following is a better description of the anatomy of these bones:

- A. Very complex, with large transverse processes and tall neural spines
- B. Very simple cylinders, with no transverse processes and no neural spines

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50) The fore- and hindlimb bones of this dinosaur are very straight (not very flexed at the joints). Why might sauropods have very straight limbs?

51) Move to the front end of the animal, and look up at the *Diplodocus* head. Even without rearing, it is still pretty tall! If you thought that it couldn't rise up any higher than shown, what range of plants might it be able to eat:

- A. Herbs (less than 30 cm (1 foot) high) only.
- B. Herbs and Bushes (about 1 m (3 feet) high) only.
- C. Herbs, Bushes, and Trees.
- D. Trees only: incapable of lowering its head.

Continue along the central island. Move down the rail, and find a pair of sauropod skulls. One is a macronarian, and one is a diplodocoid. Identify what representative from each group is shown:

52) Macronarian:

53) Diplodocoid:

Extra Credit) Which genus has thicker teeth?

54) The *Camarasaurus lentus* skeleton directly beneath the two sauropod skulls from the previous question is in [life | death] position.

From this position you can see skeletons of three of the most common herbivorous dinosaurs of the Morrison Formation: *Camarasaurus*, *Diplodocus*, and (down the path) *Stegosaurus*. (The fourth most common Morrison herbivorous dinosaurs, the ornithopod *Camptosaurus dispar*, is currently taken down for repairs). In nature, animals with similar diets divide up the ecosystem so that they reduce direct competition with each other (that is, they show **niche partitioning**). One way of doing this is by feeding at different heights.

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Arrange these three dinosaurs in relative feeding height (assume that they did not rear up):

55) Tallest feeder:

56) Middle feeder:

57) Lowest feeder:

Continue along, and find the recently remounted skeleton of *Stegosaurus*.

58) How many **pairs** of spikes in the *Stegosaurus* thagomizer? _____

59) The many little osteoderms (not the plates or spikes) protect what part of this dinosaur?

Continue along, and stop at the *Allosaurus* skeleton.

60) Which are larger? [Its largest manual unguals | Its longest teeth].

61) How many digits per manus does it have? _____

62) How many digits per pes does it have? _____

Incidentally, this particular individual had a tough life. Its left scapula was broken and rehealed improperly. The real ribs of this specimen (which are in the collections rather than on display: what are on display are plaster ones) are damaged along the left side, and the left dentary was so damaged and rehealed in such an unusual way that it was thought to be from a whole new dinosaur (named “*Labrosaurus*”). All this points to the *Allosaurus* having suffered a massive blow along one side that broke bones from the jaw tip through the torso. Because the scapula has healed (improperly), we know that the *Allosaurus* survived the blow.

63) The blow that damaged the *Allosaurus* was more likely from *Diplodocus* than from *Stegosaurus*. How can you tell?

Behind you are the stairs to the upper deck of the Dinosaur Hall. Before walking up the stairs, examine the small display of Mesozoic mammals and insects.

64) The Mesozoic mammal fossils here represent animals closest in size to [a mouse | a big dog | a horse].

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Now head up the stairs. From the upper deck of the Dinosaur Hall, find the overlook and look down at the central island. Look at the dinosaurs from above.

Extra Credit) Note that the *Allosaurus* is skinnier in the torso and hips than *Stegosaurus* or *Diplodocus*. What advantage might herbivores get from having a wider body?

Turn around and look at the pterosaur exhibit.

Overhead is a reconstruction of the giant pterosaur *Queztlacoatlus*. Find the cast of an actual bone of this pterosaur.

65) As precisely as possible, which bone is represented by a cast? (I.e., don't just say "arm bone"!! You are getting college credit for this...)

66) What evidence on this bone is there that pterosaurs had powerful muscles to flap their wings?

Move around to the main pterosaur displays. Take a look at the *Pteranodon* skeletons (either the mounted complete skeleton, or the larger isolated wing).

67) The distal part of the pterosaur wing is comprised of digit [I | II | III | IV | V | VI | VII].

Move to the other side of this panel, and find the exhibit on early "birds". There are casts of the first two skeletons of *Archaeopteryx lithographica* on display.

68) In *Archaeopteryx* the bony part of the tail is [less than half as long | about as long | definitely twice as long] as the cervical plus dorsal part of the vertebral column.

Head over to the ramp, and walk up it a bit. Find the exhibit sign labeled "What's for Dinner?" that describes the two wall-mounted specimens on the opposite wall. One is the hadrosaurine *Edmontosaurus* (in life position), a contemporary of *Tyrannosaurus* and *Triceratops*. The other (in death position, although tilted so that what was once

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the upper surface is facing you) is the tyrannosaurid *Albertosaurus* (actually it's *Gorgosaurus* by current taxonomy), a dinosaur from about 10 million years earlier than *Edmontosaurus*. In fact, it was a contemporary of the centrosaurine *Centrosaurus* that you saw in question 34.

Edmontosaurus, *Triceratops*, and *Tyrannosaurus* are the three most common large dinosaurs of the Hell Creek Formation (the youngest rocks from the Age of Dinosaurs in North America). Take a look at them together from your vantage point (you won't be able to see all of *Triceratops*, but you can see enough).

69) Which herbivore would have had a higher feeding range? [*Edmontosaurus* | *Triceratops*]

70) Which of the two tyrannosaurids is larger? [*Albertosaurus* | *Tyrannosaurus*]

That's it for the first Smithsonian Assignment! I hope you enjoyed it. If you have the time, feel free to examine the many other great exhibits in this museum.

NOTE: If you went on this project as a group, please list all the members of the group: