Name:_____

GEOL 104 Dinosaurs: A Natural History

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

DUE: October 25

"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.

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.

Throughout, when given a set of choices in brackets "[ ]", circle the **single best** possible answer.

Name:_____

This package works as sort of a self-guided tour. It will start in the Osteology ("Hall of Bones") exhibit on the 2nd floor, then move to the 1st Floor Conquest of the Land exhibit, and wind up in the Dinosaur Hall.

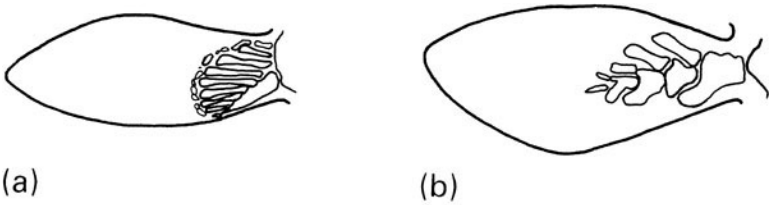
PART I – OSTEOLOGY

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.

In order to better understand the dinosaurs, we first have to understand the anatomy, behavior, and ecology of modern vertebrates. The Smithsonian's Osteology ("Bones") Hall gives us an excellent opportunity for comparison. We do know a lot more about modern animals (their complete anatomy, including soft tissue; their behavior; their physiology; etc.) than we do about extinct creatures, so that way we can better tell when a particular skeletal structure matches a particular behavior or function. We can then take this information and apply it to extinct creatures, like the dinosaurs of the Mesozoic.

Go to the second floor of the museum, and enter into the hall labeled "Bones/Reptiles/Insect Zoo". This is one of the older halls, but it contains a lot of useful specimens and information. The end of the osteology exhibit proper is a chamber with the skeletons of various fish (if you get to the exhibit with stuffed reptiles, the Orkin Insect Zoo, or the excellent temporary exhibit on forensic anthropology, you've gone to far).

Find the case labeled "Perciform Fish", and identify the swordfish *Xiphias gladius*. (It is easy to identify, because it is the biggest one in the room!) Compare the front (pectroral) fin to the images below. Note that only the BONES are shown: the rest of the fin in both conditions is made up of thin rays.



(a) (b)

1) The bony support of the front (pectoral) fin of *Xiphias* is organized as in [(a) | (b)].

Name:_____

Turn around, and look on the right hand wall exhibits. Find for the case labeled “Flying Fish”. Find the skeleton of the flying fish *Danichthys*.

2) The “wings” of the flying fish are actually pectoral fins. Compared to *Xiphias*, the fins are:

[of totally different parts and structures | the same underlying skeleton, but of different relative proportions].

3) The condition in *Xiphias* represents the ancestral state for this major group of fish; that of *Danichthys* is the specialized one. Thus, the transformation of the fin for swimming into a wing for flying would be considered an example of which evolutionary pattern?

[convergence | exaptation | heterochrony | mass extinction].

The next hall combines the skeletons of the reptiles and amphibians. We’ll ignore the amphibians for this project, and go to the lizards. The lizard exhibit is to your left as you pass through the passage; it is the other side of the wall that had *Danichthys* on it.

As you recall, the first dinosaurs to be named (*Megalosaurus* and *Iguanodon*) were thought to be immense monitor lizards and iguanas, respectively. Representatives of both groups can be found in this hall. Check out the skeletons of the monitor lizard (*Varanus bengalensis*) and the rhinoceros iguana (*Cyclura cornuata*).

Now find the specimen of the black tegu (*Tupainambis negropunctatus*).

4) How many digits (fingers) per manus (hand) does it have? _____

5) How many digits per pes (foot) does it have? _____

6) How many sacral vertebrae (hip vertebrae which connect to the ilia) are present? _____

When Owen named the Dinosauria, he said one of the distinguishing features of this group was their **parasagittal** (upright) **stance**: that is, their limbs were oriented directly underneath the body. Look at the black tegu again.

7) The limbs of the black tegu are [parasagittal | sprawling out to the sides].

Name:_____

Find the skeletons of *Varanus bengalensis* and its relative the Gila monster (*Heloderma suspectum*). Note that these two lizards are about the same length from their shoulders to their hips.

8) Based on the relative limb length, [*Varanus* | *Heloderma*] is likely the faster runner.

9) What is your anatomical basis for your answer to 8?

Turn left to find the crocodilian skeletons. Shown are the American alligator (*Alligator mississippiensis*), the gavial (*Gavialis gangeticus*), and the black caiman (*Melanosuchus niger*).

Compare the skulls of *Alligator* and *Gavialis*.

10) Which genus do you think is a specialist in eating smaller fish? [*Alligator* | *Gavialis*]

11) What is your anatomical basis for your answer to 10?

12) Which genus do you think was capable of eating larger fish, turtles, and land mammals?

[*Alligator* | *Gavialis*]

13) What is your anatomical basis for your answer to 12?

14) Look at the skeleton of *Alligator*. How many sacral vertebrae (hip vertebrae which connect to the ilia) are present? _____

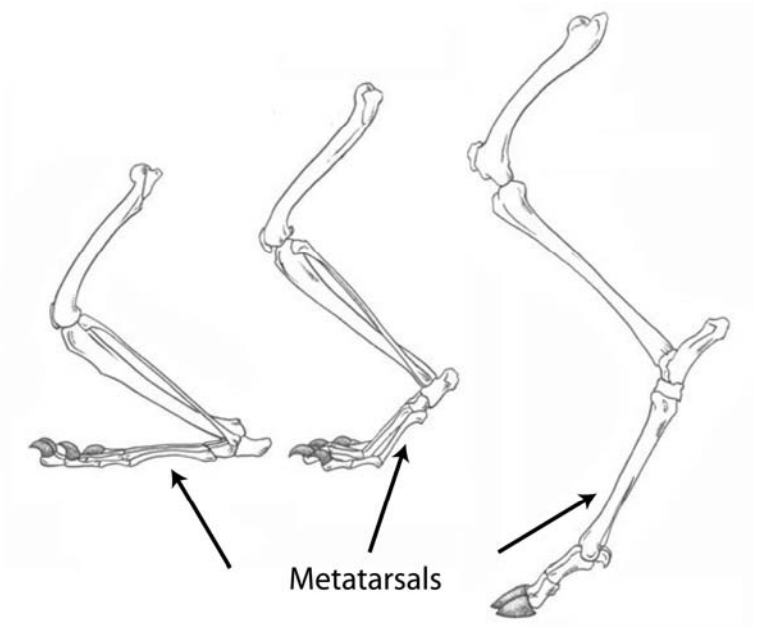
15) The *Melanosuchus* specimen shows well-preserved osteoderms (bones in the skin). Looking at the pattern of osteoderms, what function do you think the osteoderms would serve for a crocodilian?

Name:_____

Biologists use the following terms to describe the foot posture of different vertebrates:

- **Plantigrade**: The animal walks with the unguals, other digits, and metacarpals and metatarsals all touching the ground ("flat-footed")
- **Digitigrade**: The animal walks with the unguals and other digits touching the ground, but the metacarpals and metatarsals held up
- **Unguligrade**: The animal walks only on the unguals ("tip-toes"), and the other digits and metacarpals and metatarsals are held up

Here is a graphic showing these foot postures:



16) Nearly all modern lizards and crocodilians share the same foot posture. Take a look at the manus and pes of *Gavialis* and of *Varanus*. Which posture does it show? [plantigrade | digitigrade | unguligrade]

Continue your counterclockwise turn, to find the snake cases. Locate the skeleton of the Indian python *Python molurus*, and find the splint-like bones along its sides. These are actually the pelves (hips) of the snake, much reduced.

Name:_____

17) The pelves indicate where the dorsal vertebrae (and therefore the trunk of the body) ends, and the caudal vertebrae (and thus the tail) begins. Based on what you see in *Python molurus*, snake tails:
[make up most of the length of the body | are about as long as the trunk | are much shorter than the trunk].

Extra Credit) Look at the skeletons of other snakes. Many groups lack pelves, but you could still recognize where the dorsal series ends and the caudal series begins. What anatomical features would you use to recognize this change?

Take another left turn, and see the enormous skeleton of the leatherback turtle *Dermochelys coriacea coriacea*.

18) How many digits (fingers) does it have in each manus? _____

19) How many digits (toes) does it have in each pes? _____

20) Based on the shape of its hands and feet, how would you be able to tell that *Dermochelys* was a swimmer?

Move past the frog skeletons, and find the skeleton of a young Galápagos tortoise *Geochelone elephantopus*.

21) What evidence on the skull is there that this animal has a horny beak rather than a toothy mouth?

22) Based on the shape of its hands and feet, how would you be able to tell that *Geochelone* was a land-dweller?

Name:_____

Before leaving the reptiles, go back and look at the teeth of *Alligator mississippiensis*, *Tupainambis negropunctatus*, and *Varanus bengalensis* (or pretty much most all the other toothed reptiles in the halls).

23) In general, the **shape** of the teeth

[stays the same from the front of the jaws to the back of the jaws, although the size might change | are very different in different parts of the jaws].

Move on to the bird skeleton hall. Next to the skeleton of the huge leatherback turtle (*Dermochelys coriacea coriacea*), in one of the first bird display cases you come across, is the skeleton of various "Aquatic birds". Take a look at these, including the penguin species *Spheniscus demersus* and the loon *Gavia immer*. The **sclerotic ring** is a series of small platy bones that wrap around the eyeball: this gives you a darn good idea of which opening is the orbit! The naris (nostril opening) is the long slit-like opening on the beak.

24) *Gavia* and *Spheniscus* [do | do not] have an antorbital fenestra (an opening on each side of the face between the orbit and the naris).

Find the display labeled "Arboreal Birds" (that is, tree-dwelling birds), and locate the skeleton of the oropendola *Gymnostinops montezuma* (now called *Psarocolius montezuma*). This has the foot of a typical perching bird, in which digit I (the homologue to our "big toe") faces backwards and grasps the back of the branch, while digits II-IV grasp the front.

25) Digit I is [much shorter than | about the same length as | much longer than] the other digits.

26) The unguals are [slender and curved | wide and relatively flat].

27) The phalanges immediately proximal to the unguals are [much shorter than | as long or longer than] the proximal-most phalanges.

Find the case labeled "Running Birds". Find the skeleton of the cariama *Cariama cristata*, and look at its feet.

28) Pedal digit I is [much shorter than | about the same length as | much longer than] the other digits.

Find the skeleton of *Rhea americana* in the same case.

29) The pedal unguals are [slender and curved | wide and relatively flat].

Name:_____

30) The pedal phalanges immediately proximal to the unguals are [much shorter than | as long or longer than] the proximal-most phalanges.

Pass through the bird room, and through the round chamber beyond, to the Mammal exhibit. As you enter turn right and find the skeleton of the Indian rhino *Rhinoceros unicornus*.

31) How many cervical (neck) vertebrae does *Rhinoceros* have (**note**: cervicals do not have ribs)? _____

Now go opposite side of the passage and find the skeleton of the giraffe *Giraffa camelopardalis*.

32) How many cervical (neck) vertebrae does *Giraffa* have? _____

Different animals have different locomotory (moving) habits. Some are fast running specialists (**cursorial**), some are slow plodders (**graviportal**), and many are intermediate. The pronghorn (*Antilocapra americana*) and the common zebra (*Equus burchelli*) are cursors, while their close relatives (such as the Borneo pig (*Sus cristatus*) and Tapir (*Tapirus bairdi*), respectively) are slower.

Compare *Antilocapra* to *Sus*, and *Equus* to *Tapirus*.

33) The limbs of cursors (*Antilocapra* and *Equus*) are [proportionately longer | proportionately shorter] than their less cursorial relatives (*Sus* and *Tapirus*).

34) The manus and pedes of cursors are [more slender | wider] than their less cursorial relatives.

In the "Monkeys" case, find the mandrill (*Papio sphinx*), a rather impressive baboon in life and as a skeleton.

35) Which of the following statements best describes the **shape** of its teeth?

[stays the same from the front of the jaws to the back of the jaws, although the size might change | are very different in different parts of the jaws].

You can compare across the room, and find that except for species with very specialized diets (like grazers), the condition you found in the mandrill is very similar to that in most other mammals, and distinguishes us as a group.

Name:_____

Now in the "Cloven-Hoofed Mammals" case, find the skeleton of the lightly-built pronghorn (*Antilocapra americana*).

36) How many teeth does it have in the ***premaxilla***? (Do not consider the maxilla) _____

37) The grinding teeth in the lower jaw are [directly behind the teeth in the front of the dentary | concentrated towards the back of the jaw, with a toothless gap in between].

38) Most of the bigger mammals in this exhibit (those a quarter your size or larger) have limbs that are [parasagittal | sprawling out to the sides].

Review the different types of foot posture listed on p. 5, and indicate if the following mammals are **plantigrade**, **digitigrade**, or **unguligrade**. We will only look at the **pes** and ignore the manus for this.

39) Bison (*Bison bison*) [plantigrade | digitigrade | unguligrade]

40) Tiger (*Panthera tigris*) [plantigrade | digitigrade | unguligrade]

41) Red fox (*Vulpes vulpes*) [plantigrade | digitigrade | unguligrade]

42) Pronghorn (*Antilocapra americana*) [plantigrade | digitigrade | unguligrade]

43) Common zebra (*Equus burchelli*) [plantigrade | digitigrade | unguligrade]

44) Beaver (*Castor canadensis*) [plantigrade | digitigrade | unguligrade]

45) Aardvark (*Orycteropus afer*) (near the entry for the exhibit) [plantigrade | digitigrade | unguligrade]

46) Human (*Homo sapiens*) (near the entry for the exhibit) [plantigrade | digitigrade | unguligrade]

Our last stop in the Osteology Hall is to look at bats. Find the display case for "Bats". As you can see, the basic bat body plan is very similar among all these species. We'll use the Samoan fruit bat (*Pteropus samoensis*) as our example, because it is one of the larger skeletons on display.

47) Which of the following descriptions best describes the wings of a bat?

a. It is made up mostly of a long arm with three shorter fingers and a ***very long*** fourth finger (ring finger)

b. It is made up of a long arm with a hand where most of the bones are fused together

c. It is made up of a long arm with very long fingers (especially fingers three, four, and five).

Name:_____

PART II – LIFE ON LAND BEFORE THE DINOSAURS

Go to 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*. As you did with *Xiphias* at the start of the Osteology Hall, compare the front (pectroral) fin of the model of *Eusthenopteron* to the images below. Note that only the BONES are shown: the rest of the fin in both conditions is made up of thin rays.

(a) (b)

48) The bony part of the front (pectoral) fin of *Eusthenopteron* more closely resembles fin [(a) | (b)]

Move along and find the case labeled “The Double Life of Ancient Amphibians”. Find the mounted skeleton of *Eryops*, a large stegocephalian.

49) Based on the shape of its teeth, what do you think that it ate? [fish and meat | plants]

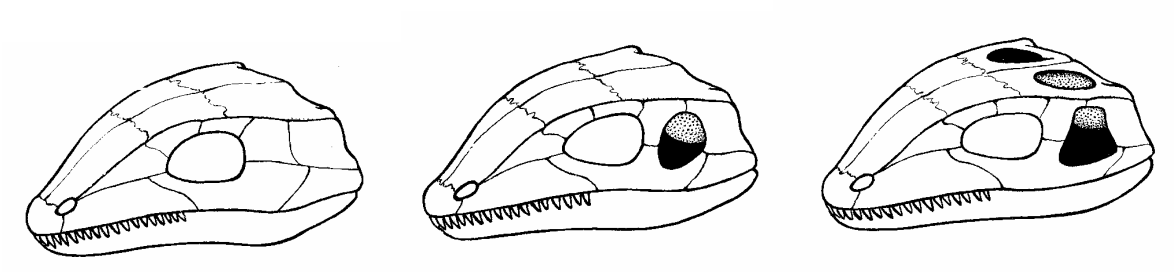
Extra Credit) What evidence led to you to your answer in question 49?

50) Look at the skeleton of *Pelosaurus laticeps*. What stage of the amphibian life cycle does it represent?

Head for the early “reptiles” (really “early amniotes”) exhibits: go past “The Egg” exhibit in the glass cylinder and beyond the Fossil Café to find your way.

Name:_____

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



Anapsid (no temporal fenestrae) Synapsid (infratemporal fenestra) Diapsid (supra- and infratemporal fenestrae

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.

51) What skull type does *Diadectes* have? [anapsid | synapsid | 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.

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

53) Which of these animals was most likely a carnivore? [*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).

54) *Diadectes*, *Dimetrodon*, *Edaphosaurus*, and *Cotylorhynchus* all have which limb posture?

[Sprawling | Parasagittal]

Name:_____

Around the corner of that display is one labeled “Cynodont Flesh-Eaters”. On display are the skull of the large *Cynognathus crateronotus* and the much smaller skeleton of *Thrinaxodon liorhinus*.

55) These two animals have a [anapsid | synapsid | 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).

56) 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 is the dicynodonts. Find the large skull of *Aulacephalodon baini*.

57) 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*.

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

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

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

PART III – THE DINOSAURS

Turn left, and walk towards the Dinosaur Hall. You’ll find the right pelves of *Stegosaurus* and *Allosaurus* on display on the right wall.

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

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

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

62) These pelves are shown in [left lateral | right lateral | dorsal | ventral] view.

Name:_____

Let's take a look at the complete skeletons. Walk down the hall and find the complete skeleton of *Allosaurus fragilis*.

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

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

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

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

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

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

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

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

69) *Stegosaurus* has a [unguligrade | digitigrade | plantigrade] stance in its pes. (Check p. 5 for a reminder of these terms.)

We'll return to these two skeletons shortly. But for now, go to the skeleton of *Tyrannosaurus rex* (shouldn't be too hard to find…).

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

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

72) 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.

73) The metatarsus is [less than ¼ the femur length | about ½ 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. Find the original skull of *Triceratops horridus* on display.

Name:_____

74) In *Triceratops*, which horn is larger? [The nasal horn | The postorbital (“brow”) horns]

Now go up the steps and look at “Hatcher”, the Smithsonian’s new *Triceratops* mount.

75) In *Triceratops* the metatarsus is

[less than ¼ the femur length | about ½ the femur length | as long as the femur].

Continue on through the ceratopsian and pachycephalosaur exhibits.

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

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

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

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

79) Several pachycephalosaurs are also on display here. Which is the largest species?

80) Where was the original fossil of the specimen you described in question 79 discovered?

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

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

Name:_____

82) Where was the specimen of *Thescelosaurus* discovered? _____

83) [*Thescelosaurus* | *Heterodontosaurus*] is the older of the two.

Move along to the hadrosaurids, much larger ornithopods. The hind end of *Corythosaurus casuarius* is displayed. Note that there are impressions of patches of scaled skin preserved.

84) How many digits are present on each pes of *Corythosaurus*? _____

Further down, find the skull of the saurolophine *Edmontosaurus annectens*, one of the "duckbill-iest" of the duckbills. (This dinosaur was once called "*Anatosaurus*", and there are some paleontologists who want to restore that name.)

85) The naris of *Edmontosaurus* is [about as large or slightly larger | much smaller than] the orbit.

86) Which of the following best describes the tooth pattern in *Edmontosaurus*?

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

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 saurolophine 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).

87) Adult *Maisaura* have a long broad duckbill and tooth patterns similar in proportion to that of *Edmontosaurus*. In the juvenile, the teeth are:

a. found all the way up to the front of the snout.

b. absent in the front, but still present thoughout most of the length of the jaw.

c. present only in the posterior one-half of the jaw.

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.

Name:_____

88) Look at the horn of the nose. It is [a tall narrow cone, as in *Centrosaurus* | a narrow crest].

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).

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

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

Continue on to the brand-new (2010) wall displays "Local Fossils on a Global Stage". These highlight discoveries made in the Washington, D.C. region (most especially northern Prince Georges County, MD!) Take a look at these panels, and concentrate on the actual fossils and casts.

90-92) List at least 3 non-dinosaur species or genera (animal or plant) found in this region, and describe what sort of organism they are:

93-95) List at least 3 distinct groups of dinosaurs represented by fossils in this display.

96) What is unusual about the preservation of the juvenile nodosaur found in Maryland?

Name:_____

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

97) Find the **distalmost** caudals (the end of the tail) 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

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

99) 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.

100) Which genus has a dorsoventrally deep skull with a huge naris and thicker teeth?

101) Which genus has a longer skull with a smaller naris on the top of the skull and narrower teeth?

102) 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

Name:_____

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.

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

103) Tallest feeder:

104) Middle feeder:

105) Lowest feeder:

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

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

107) The many **little osteoderms** (not the plates or spikes) protect which part of this dinosaur?

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

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

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

110) 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.

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

Name:_____

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.

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

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*. How might the wider hips and torso of the herbivores be related to their diet?

Turn around and look at the pterosaur exhibit.

Overhead is a reconstruction of the giant pterosaur *Queztalcoatlus*. Find the cast of an actual bone of this pterosaur (along the side of the exhibit facing the stairway to the downstairs).

113) As precisely as possible, which bone is represented by a cast? (Use the proper technical anatomical name, not the English vernacular form given here. You are getting college credit for this…)

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

114) Which of the following descriptions best describes the wings of a pterosaur?

a. It is made up mostly of a long arm with three shorter fingers and a ***very long*** fourth finger (ring finger)

b. It is made up of a long arm with a hand where most of the bones are fused together

c. It is made up of a long arm with very long fingers (especially fingers three, four, and five).

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.

115) 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.

Name:_____

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 saurolophine *Edmontosaurus* (in life position), a contemporary of *Tyrannosaurus* and *Triceratops*. The other (in death position, although tilted so that what was once 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 76.

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).

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

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

You can see *Stegosaurus* from this location, too. *Stegosaurus* was among the largest ornithischians in the Jurassic Period.

118) The skulls of the Late Cretaceous ornithischians (*Triceratops* and *Edmontosaurus*) were

[smaller than | the same size as | larger than] that of *Stegosaurus*.

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: