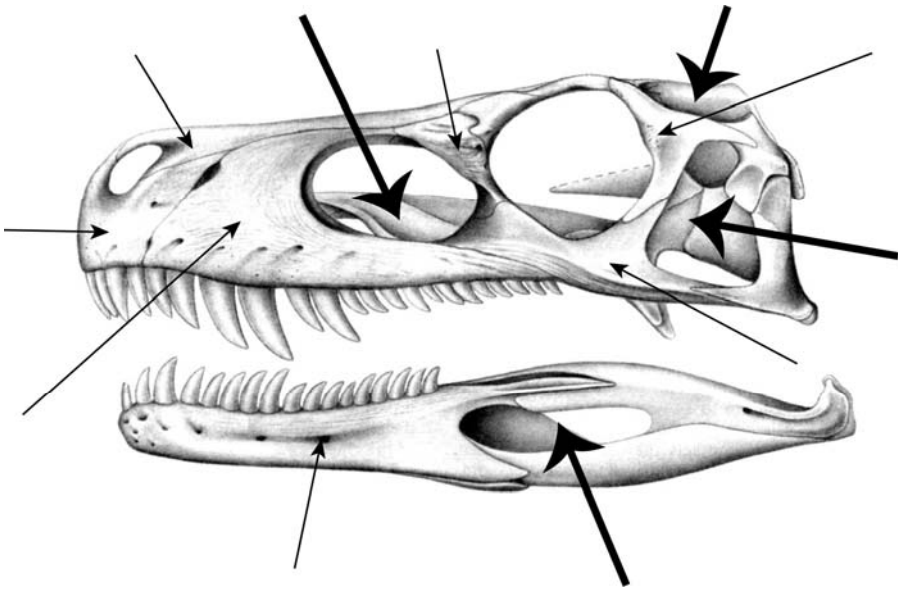
Name: _____

GEOL 104 Dinosaurs: A Natural History
Anatomy, Taxonomy, Evolution & Systematics Assignment

DUE: Mon. October 1

Part I. Comparative Anatomy

Below is the skull of the early primitive meat-eating dinosaur *Herrerasaurus ischigualastensis.*



Herrerasaurus ischigualastensis

For 1-7: Using the handout from class and the website, label the bones indicated on the skull above by the **thin** arrows. There are 7 bones to label. Write the name of the bone at the end of the thin arrow.

For 8-11, you will identify the four openings in the skull indicated by the **thick bold** arrows. Use the information below to recognize the different openings:

- **Antorbital fenestra**: anterior to the orbit, posterior to the naris, surrounded by the maxilla, lacrimal, and nasal bones
- **Infratemporal fenestra**: posterior to the orbit, ventral to the supratemporal fenestra, surrounded by the jugal, quadratojugal, squamosal, and postorbital bones
- **Mandibular fenestra**: within the mandible (lower jaw), surrounded on the anterior end by the dentary and the posterior end by the surangular and angular bones
- **Supratemporal fenestra**: posterior to the orbit, dorsal to the infratemporal fenestra, surrounded by the squamosal, postorbital, frontal, and parietal bones

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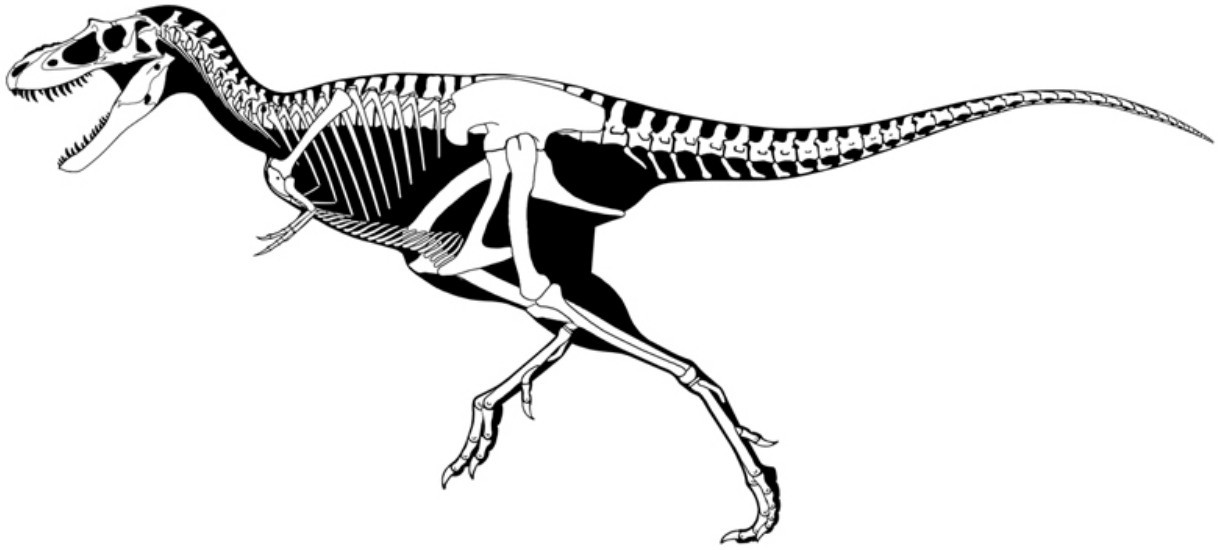

Gorgosaurus libratus (juvenile)

In the skeleton above, identify by name or number the following bones (the handouts will help with this):

12) A Cervical (neck) Vertebra 13) A Dorsal (back) Vertebra 14) A Caudal (tail) vertebra

15) A Rib 16) A Gastralium 17) Scapula 18) Ilium 19) Ischium

20) Pubis 21) Humerus 22) Femur 23) Tibia 24) Fibula 25) Manus (the hand)

Extra Credit) This dinosaur is in [dorsal | right lateral | left lateral | left medial] view.

Part II. Taxonomy

26) *Euoplocephalus tutus* was named in 1910; *Scolosaurus cutleri* was named in 1928. If later studies indicate that these are two different species within the **same** genus, what would be the name of each of these two species?

27) If, instead, *Euoplocephalus tutus* and *Scolosaurus cutleri* are discovered to be different specimens of the same **species**, what would be the complete name of this single species?

Extra Credit) What is the ONLY proper abbreviation of *Tyrannosaurus rex*?

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Part III. Evolutionary Patterns

Evolutionary biologists, including paleontologists, have observed a number of different patterns that occur throughout the history of life. Some of the major ones are:

- **Divergence**: From a single common ancestral population, two or more different descendant lineages each evolve their own different specializations over time. Thus, while early members of each lineage were similar (having changed little from their common ancestor), the later descendants get more and more different.
- **Convergence**: Sometimes different lineages of organisms evolve similar traits, appearances, and behaviors independently, as the ancestors of each "hit upon" (that is, are selected for) the same or similar evolutionary solutions to problems. This is very common when the adaptations have to do with mechanical processes (feeding, locomotion, etc.), but can occur in other situations as well. The basic pattern is that the ancestors were different from each other, but the descendants become more and more similar.
- **Sexual Selection**: Since evolutionary fitness is simply whose genes are represented the most in the next generation, than traits that lead to more successful mating (i.e., that are "attractive") will tend to be favored.
- **Correlated Progression**: As a lineage evolves traits for a particular way of life, new traits that continue to enhance that form of existence and work well together will be selected for, and those traits that counter that adaptive trend will be selected against.
- **Adaptive Radiation**: When an ancestor arrives in a previously uncolonized region, or has its competitors wiped out, or evolves an adaptation that allows it to live in an entirely new way, than many divergent lineages from that common ancestor are likely to survive. Therefore, in a geologically very short period of time, many different descendants radiate from a single ancestral population.
- **Niche Partitioning**: When species with similar habits live in the same region, those variants that do not have quite the same habits as other species will tend to do better, while the other variants (who are in greater competition with other species) will do worse. So over time, each species will "split up" their resource base: in other words, evolve features for particular sub-habits within the larger ecological niche.
- **Living Fossils**: Evolutionary change does happen at the same pace for all lineages. Some groups of organisms do very well in some specific niche, and so are unchanged for vast periods of geologic time.
- **Exaptation**: Evolution does not always work by developing entirely new structures or behaviors. Instead, it is far more common for a structure of behavior that was adapted ("fit for") to some other context to be **exapted** ("fit from" or "fit out of") to a new function.
- **Heterochrony**: Evolutionary change can also occur by changing the timing of development of the organism. This could either be by retaining the juvenile traits of the ancestor into adulthood (**paedomorphosis**) or by evolving extremes beyond the adult stage of the ancestor (**peramorphosis**).

For this section, identify which of the above evolutionary phenomena/patterns best describes each of the scenarios given:

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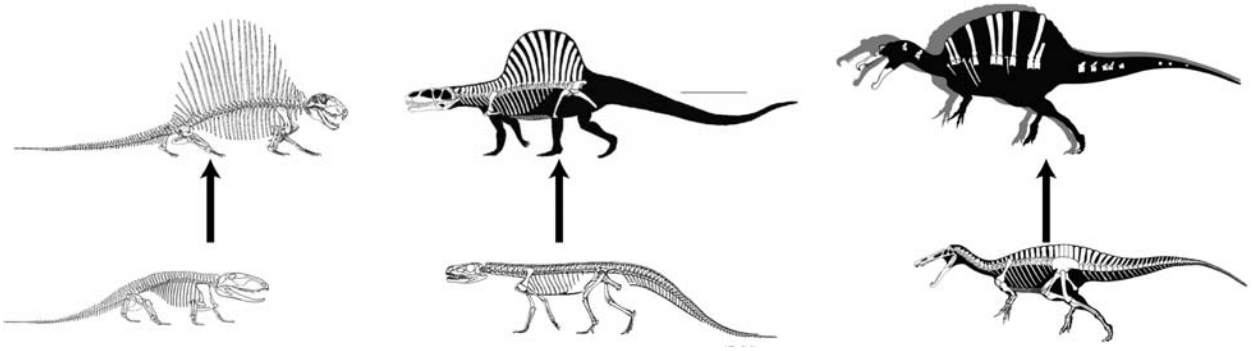
28) Below are a set of high-spined fossil animals, and beneath each is the ancestral condition from which they evolved. By comparison the ancestors (below) to each other, and the descendants (on top) to each other, the evolution of high neural spines is an example of what evolutionary pattern?

_____



29) The sails in each of the cases above are formed by a simple elongation (stretching out) of the neural spines, a structure already present in the vertebrae of ancestors. In the ancestors the neural spine serves as an anchor for back muscles, but the sail may have been used for display and/or to help regulate body temperature. In any given example, this change in function is an example of which evolutionary pattern?

_____

30) The skulls of baby prosauropods was very short, while the adult skulls had big snouts. The sauropods (descendants of prosauropods) had short snouts even as adults. This is an example of which evolutionary pattern?

_____

31) Prior to the extinction 200 million years ago of a number of different types of plant-eating reptile, the ornithischians (beaked plant-eating dinosaurs) were rare and not particularly specialized. After that extinction, however, many diverse lineages evolved in a very short time interval, each adapted to a different way of life. This rapid evolution of different lineages is an example of which evolutionary pattern?

_____

32) Related to question 30, each of the descendant groups of ornithischian dinosaur started out with the same feeding equipment, but each lineage adapted to a different mode of getting food and processing food. This selection for a specific mode of life in each descendant lineage is an example of which evolutionary pattern?

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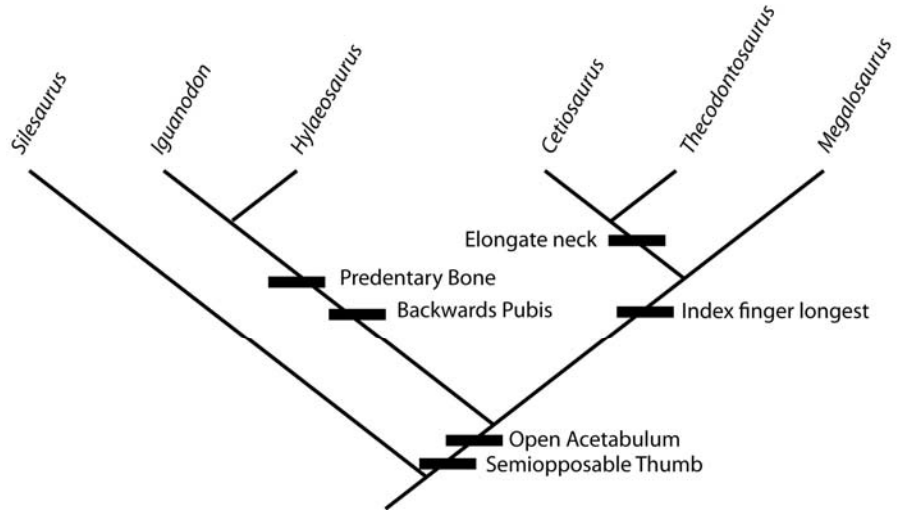
Part IV. Systematics

Below is a cladogram showing the interrelationship of various dinosaurs and related forms. The positions of derived characters are indicated by the heavy bold horizontal lines.



33) What is the sister group to *Hylaeosaurus* on this cladogram? _____

34) What is the sister group to *Thecodontosaurus* on this cladogram? _____

35) The clade **Ornithischia** is defined as "*Iguanodon* and all taxa sharing a more recent common ancestor with *Iguanodon* than with *Megalosaurus*." Circle all the taxa in the list below which are members of Ornithischia:
Silesaurus *Iguanodon* *Hylaeosaurus* *Cetiosaurus* *Thecodontosaurus* *Megalosaurus*

36) Name one of the shared derived character of Ornithischia <u>as listed on the cladogram</u>, with extra credit for the second.

37) What taxon on the above cladogram has a semiopposable thumb, an open acetabulum, an index finger the longest, but does not have an elongated neck?

38) **Dinosauria** is defined as the most recent common ancestor of *Iguanodon* and *Megalosaurus* and all of its descendants. According to the cladogram above, is *Silesaurus* a dinosaur? [Yes | No]

Extra Credit) Is *Thecodontosaurus* a dinosaur? [Yes | No]

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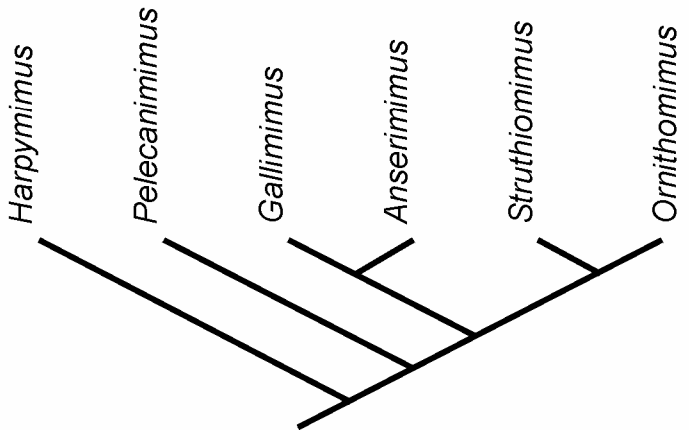
Below is a cladogram and data matrix of the ostrich dinosaurs (Ornithomimosauria). In the data matrix, a "0" indicates that the derived feature (mentioned on the left) is absent; "1" indicates that the derived feature is present; and "?" means that the feature cannot be evaluated (in these cases, that part of the body isn't known for the genus). For example, *Ornithomimus* is **toothless**, has a **long metacarpal I**, and a **pinched metatarsal III**. *Harpymimus* shows the primitive (ancestral) condition: it has teeth, a short metacarpal I, and an unpinched metatarsal III.

	Harpymimus	*Pelecanimimus*	*Gallimimus*	*Anserimimus*	*Struthiomimus*	*Ornithomimus*
Toothless?	0	0	1	?	1	1
Metacarpal I Long?	0	1	1	1	1	1
Pinched Metatarsal III?	0	?	1	1	1	1



39) Based on the cladogram above, which dinosaur is characterized by a toothed jaw and a long metacarpal I?

40) The skull of *Anserimimus* is not known at present. Based on the data available, I predict that this dinosaur was

[toothed | toothless] Circle the correct answer

41) Justify your answer to 40

42) Only the front end of *Pelecanimimus* is known at present. Based on the information above, which of the following best describes the simplest explanation for the metatarsal condition in *Pelecanimimus*?

a. had a pinched metatarsal III

b. did not have a pinched metatarsal III

c. ambiguous as to whether it did or did not.