

PHYLOGENIC TREES**(32 points)**

1. (12 pts.) On the line next to the letter write in the appropriate organismal group name and **ONE** major evolutionary advancement (new adaptation) for that group.

+1 pt for group +1 pt for advancement/adaptation

E = Hominoids (Apes) / Large bodies, even larger brains, no tails

D = Primates / fwd facing eyes, opposable thumbs, inability to synthesize vitamin C

C = Early Mammals / fur, milk

F = Diapsids / 2 holes in skull

B = Early Reptiles (Anapsids) / hard-shelled eggs, tough skin

A = Bony Fish / calcified skeleton, esp. jaws

2. (6 pts.) On the line next to the letter write in the appropriate organismal group name and **ONE** major evolutionary advancement (new adaptation) for that group.

+1 pt for group +1 pt for advancement/adaptation

C = Conifers / seeds in cones

B = Cyanobacteria / photosynthesis

A = Cells / cell membrane

3. (14 pts.) Draw a phylogenetic tree containing the four fossils below. Include your **brief** justifications for each branching and placement.

Fossil A: 4.2-3.2 mya; brain cavity = $\pm 300\text{cm}^3$; arms longer in length than legs; S-curved spine with enlarged lower back vertebrae and leg bones; jaws protrude from face with largest molars in this group.

Fossil B: 2.0-1.5 mya; brain cavity = $\pm 750\text{cm}^3$; arms slightly shorter in length than legs; S-curved spine with enlarged lower back vertebrae and leg bones; jaws regressed with smallest molars in this group.

Fossil C: 3.9-2.8 mya; brain cavity = $\pm 400\text{cm}^3$; arms equal in length to legs; S-curved spine with enlarged lower back vertebrae and leg bones; jaws protrude from face with molars smaller than A but bigger than B.

Fossil D: 2.5-1.4 mya; brain cavity = $\pm 550\text{cm}^3$; arms slightly shorter in length than legs; S-curved spine with enlarged lower back vertebrae and leg bones; jaws protrude from face with molars same size as C.

	TIME (mya)	BRAIN (cc)	ARM:LEG	BIPED SPINE	JAWS	MOLARS
A	4.2-3.2	300	A>L	yes	protrude	largest
B	2.0-1.5	750	A<L	yes	regress	smallest
C	3.9-2.8	400	A=L	yes	protrude	>B, <A
D	2.5-1.4	550	A<L	yes	protrude	=C

All are bipedal so all have common hominid ancestor (CA). A & C overlap almost completely in time but are very different in brain size, A:L and molars, so they must have CA back in time. C & D have same jaws and molars, only differ in arms and brain size. B is very different from all the others in all characters except for bipedalism. D has same size molars as C and brain is 150cc greater than C. D & B are the only two with A<L, but B's brain is 200cc bigger than D's brain. D & B are closer in A:L and brain size to C than A. B appears 500,000 years after D. Both D & B end about the same time (1.5-1.4 mya).

On tree there must be time scale.

WRITTEN (14 points)

2. (6 pts.) Complete the table for visual, tactile and olfactory communication by listing **ONE** advantage and **ONE** disadvantage for using each mode to send a message.

	Advantage	Disadvantage
Visual	Receiver can easily to locate sender; high amount of info can be transmitted	Predator can easily to locate sender; complexity of info can take time to learn
Olfactory	No misunderstandings; no learning needed; info can stay around without sender's presence	Low information content possible; predators could pick up signal of sender in area
Tactile	Easy for sender to be located; low eavesdropping potential;	Low information content possible; sender and receiver have to be close to each other

2. (8 pts.) **A)** Provide an example of a stereotypic behavior, describing its THREE components. **B)** Also, describe your example behavior's proximate and ultimate causation.

*A. +4pts Sign Stimulus -----> innate releasing mechanism-----> fixed action pattern
The example behavior needs to have these 3 elements*

*B. +2pts Proximate Cause: sign stimulus, actual trigger for behavior- the how
+2pts Ultimate: evolutionary benefit- the why. Default ultimate causation is live longer and have more offspring.*

MULTIPLE CHOICE (34 points, 2 points each)

Directions: Place the letter corresponding to the best answer to the following questions on the line before the question. Use "T" for True and "f" for false.

B 1. Which of the following best fits with all the hypotheses for how life originated on Earth?

- A) Sunlight was source of energy for chemical reactions. C) Molecules were trapped together inside air bubbles.
B) Earth's volcanic activity was source of energy for reactions. D) Earliest chemical reactions were oxidative.

B 2. Place the following compounds in the probable order in which they appeared from oldest to most recent.

- 1- molecular oxygen (O₂) 2- amino acids 3- DNA 4- RNA 5- amino acids inside membrane
A) 3, 2, 5, 4, 1 B) 2, 4, 3, 5, 1 C) 4, 3, 2, 1, 5 D) 2, 4, 5, 1, 3 E) 2, 1, 4, 5, 3

D 3. Place the following organisms in order in which they evolved from oldest to most recent.

- 1- stiff-winged insects 2- aquatic arthropod 3- soft-bodied animal 4- folding-winged insect 5- wingless hexapod
A) 5, 2, 3, 1, 2 B) 2, 5, 3, 1, 4 C) 2, 3, 5, 4, 1 D) 3, 2, 5, 1, 4 E) 3, 2, 5, 4, 1

B 4. Adaptive radiations occur after mass extinction events. Why does this happen?

- A) The surviving species are adapted for extinction events. C) The surviving species feed on the dead animals.
B) There is little competition for niches. D) There is little oxygen in atmosphere to cause decay.

A 5. What was the first source of molecular oxygen (O₂) on Earth?

- A) cyanobacteria B) plants C) volcanic eruptions D) algae E) ozone layer

E 6. Class Reptilia contains the highest total number of species (extinct + living) of the terrestrial vertebrates. What adaptation(s) has/have allowed them to be so successful?

- A) waterproof egg shell B) skin made of scales C) large calcified bones D) Both (B) and (C) E) All of these.

B 7. Which of the following probably led to the incredible variety of shapes and sizes of eukaryotes during the great increase in species before the first mass extinction event (MEE)?

- A) sexual reproduction C) evolution of aerobic metabolism
B) evolution of cyanobacteria E) evolution of double-stranded DNA

D 8. Which of the following animal groups evolved the adaptations for powered (not gliding) flight first?

- A) birds B) pterosaurs C) mammals D) insects E) diapsid reptiles

F 9. Which of the following has been proposed as the cause of a MEE?

- A) continental drift C) changes in sea level E) Both (A) and (B)
B) volcanic activity D) meteor impact F) All of these have been proposed.

T 10. (True/False) There are fish living today that use lungs or lung-like structures to breathe air.

E 11. Place the following adaptations in human evolution in the order in which they evolved from oldest to most recent.

- 1- opposable thumb 2- fur 3- S-curved spine 4- third molar (wisdom tooth) 5- skeleton of calcified bone
A) 2, 1, 5, 4, 3 B) 5, 2, 3, 4, 1 C) 2, 5, 1, 4, 3 D) 1, 5, 2, 3, 4 E) 5, 2, 1, 4, 3

D 12. What is the name given communication odors that were first described in mate selection behavior of moths?

- A) hormones B) chemotoxins C) endorphins D) pheromones E) ephedrine

D 13. Two mockingbirds are standing head-to-head on the sidewalk. First one then the other hops to the left then to the right while hissing and spreading its wings. They repeated the hopping and hissing twice until one flew off. This is an example of ____.

- A) territoriality B) courtship C) ritualized aggression D) Both (A) and (C) E) All of these are correct.

__B__14. How is information transmitted in the gustatory communication?

- A) hormone binds to specific receptor C) specific mechanoreceptor cell is stimulated
B) molecule binds to specific taste receptor D) photoreceptor cell is stimulated

__C__15. What is the sign stimulus for plants doing phototaxis behavior?

- A) touch B) hormones C) sunlight D) daylength (photoperiod) E) Both (B) and (D)

__D__16. When worker honeybee adults emerge from their pupae, they already know how to interpret the waggle dance of scout bees. This is an example of what type of behavior?

- A) stereotypic B) genetic C) conditioning D) Both (A) and (B) are correct. E) All of these are correct.

__B__17. In which of the following situations should you expect a male deer to expend the most energy?

- A) guarding his females after the females are pregnant D) Both (A) and (C)
B) guarding his females while females are ovulating E) Both (B) and (C)
C) guarding his feeding area of widely available grasses

ESSAY (20 points)

Answer **ONE** of the two questions below in an essay format (sentences in paragraphs) on the back side. Indicate clearly which question you are writing about. Your explanations must cover all the observed phenomena. Include your reasoning. Please, take a few moments to plan your essay.

1. Howler Monkeys (Genus *Alouatta*) are the largest monkeys in Central and South America: 50-100cm long, not including their long prehensile tails. They live in groups of 16-18 individuals. The sex ratio in groups is approx. 1 male to every 4 females. They live 15-20 years in the wild. Unlike all other monkeys in the Americas, they eat mostly leaves, supplemented with some fruit, flowers and nuts. Their name comes from the very loud, noise they make with their enlarged throats. The noise can be heard up to 3 miles away. The group all joins together in a chorus at dawn and dusk. Other howler groups can be also be heard at same time. They stay almost exclusively up in trees, spending 80% of their day resting and grooming each other. They do not like humans coming close to their trees. When they spot a human on ground, howlers will make a soft volume, "hooff-hooff" noise and urinate on the human. Others in the group will join in making "hooff-hooff" noises and urinating. All species in Genus *Alouatta* are endangered or threatened with extinction. **A)** Explain all the behaviors of howlers mentioned above. **B)** What are possible reasons explaining why all the howler species face extinction?

*The key for answering this essay is to be sure that ALL the howler behaviors are explained as to their purpose. The howlers join together to chorus at dawn and dusk to defend group territory from other howler groups – let the other groups know that this group survived the night and the day (similar to territorial display of blackbirds discussed in class). In addition to being loud the noise must be low frequency to travel so far (3 miles). This chorusing also helps promote bonding between group members. The grooming is a form of tactile communication so very important in primates. The response to human intrusion is an alarm call (on/off pattern) similar to ground predator alarm calls in birds (easy to locate). The alarm call causes the other members of the group to mob the predator (human). The urination is both a mobbing attack to get human to leave (we don't like being urinated on and they know that) and a territorial marker. The urination is also olfactory communication, plus perhaps visual and tactile, too, to tell us to leave howlers' territory. The howlers are trouble because they are specialist: **the only monkey in the Americas to eat mostly leaves**. Specialists have hard time when times are tough. Humans are destroying howlers' forests that they specialize in eating. Howlers can't switch diet (competitive exclusion is the reason they specialized; there are already species in other niches).*

*The communication behavior and predators finding the monkeys is not the problem – otherwise the behavior would have been selected against generations ago (only silent monkeys have kids because predators eat the noisy ones). They are the largest monkeys in the Americas – too many of you wrote about their small size being a problem for them. As you will find out in a few lectures, the fact they are **biggest** monkey is the disadvantage.*

2. *Ceolophysis* is currently considered to be the ancestor of all theropod dinosaurs (meat-eaters such as *Velociraptor* and *T. rex*). *Ceolophysis* first appears in the late Triassic Period, making it one of the early dinosaurs. It had sharp, curved, blade-like teeth. It stood on large back legs with significantly smaller arms. They had large eye sockets and nostrils. Fossils of *Ceolophysis* are found in groups of 10 or more individuals near ancient rivers. It had four fingers but only three are actually functional. It is thought to be able to run very fast using its tail as a counter-weight to its extended, long S-curved neck. There are two sizes of individuals in the groups: smaller ones (2m long head to tip of tail) that probably weighed about 22kg and larger ones (3m long head to tail tip) that weighed about 40kg. *Ceolophysis* fossils can also be found in the very early Jurassic Period immediately after the possible mass extinction at the end of the Triassic. But, they do not continue on into the Jurassic for long. **A)** What hypotheses can you make about how *Ceolophysis* lived (i.e., what's their probable niche and likely behavior)? **B)** Explain the two sizes of *Ceolophysis*. **C)** Why did they survive the Triassic-Jurassic extinction event only to go extinct in the early to mid-Jurassic Period?

*With its big back legs and S-curved neck we can deduce *Ceolophysis* was a fast bipedal runner that hunted using its good vision (huge eyes) and good sense of smell (huge nostrils). As they have been found in groups near riverbanks, they hunted aquatic animals that needed to be torn open with sharp, curved, blade-like teeth. Because of the large size dimorphism in fossils, they lived (and hunted) in groups of both sexes (if like predatory birds, then the female could be the large one) or adults and juveniles. *Ceolophysis* was a generalist that could eat variety of prey. So, it was able to survive the Triassic-Jurassic extinction event (generalists do better in tough times). But with time, adaptive radiation (happens to all survivors of an extinction event) and competitive exclusion favored *Ceolophysis* evolving into several specialist species (all the theropod dinosaurs of the mid-Jurassic to end of Cretaceous). It is already "losing" the fourth finger. In *T. rex* that will be further reduced down to only two fingers (remember my demo of *T. rex* arms in class?).*