Field Trip: Harvard Museum of Natural History (HMNH)

Note: There is no pre-lab for this lab.

Objectives

To observe the diversity of life; To compare and contrast the various adaptations, body plans, etc. of the animals found at the HMNH; To review concepts discussed in lecture.

Introduction

The most casual observation indicates that not all animals look the same. Darwin's theory of "evolution through the process of natural selection" tells us that the reason animals (or plants) do not look the same is that they have evolved to fit into particular environmental niches and that most differences which we observe reflect some kind of special adaptation to the environment. One of the easiest ways to examine the changes that have occurred during the course of evolution is to visit the Harvard Museum of Natural History at Harvard University. (http://www.hmnh.harvard.edu.) Here, mounted animal specimens from all parts of the world are arranged in groups according to their evolutionary relationships as well as the geographic regions in which they are found. The purpose of this lab is to examine these animals and for you to teach yourself certain principles of animal diversity by using your own observations to answer the questions in these pages. You will also visit the Glass Flowers exhibit in the same museum. It contains glass models of many important plant types.

You can easily walk from the Harvard Square MBTA station to the HMNH (see map on next page; tear it out and take it with you). It is best to go to Harvard Square by subway (red line) or by bus since parking places around the museum are either enormously difficult to find, or they are reserved for the faculty and staff of Harvard (and reserved parking is strictly enforced). The trip from UMass to the HMNH takes about 45 minutes each way. Tickets will be given out in class to the HMNH; this will get you free admission (it is normally $10 for students). You can go to the HMNH at any time that the museum is open. TAs will be at the museum- times will be announced in class and posted on Blackboard. The HMNH is open daily 9:00 AM to 5:00 PM. Admission is free (even without a ticket) Sundays from 9 to 12.

VERY IMPORTANT NOTICE: This lab will take you a while to complete, especially if you are unprepared. In order to be able to complete it in 3 hours, you should **be sure to do the following before you go to the HMNH**:

• Read up on classification systems (see your text) and familiarize yourself with terms like kingdom, phylum, class , order, etc.

• Read over **all the questions** and make a plan of how you might go about answering them.

Phylogenetic Data Gathering and Expression

When studying evolution, it is very important to pay special attention to *characters* (the particular features of the organisms under study). You should strive to be very specific about the characters and traits you are comparing within and between species. In doing such, evolutionary relationships between organisms will be made apparent.

First, some definitions:

• **Character** - a feature of an organism. For example, "leg form" or "number of eyes".

• **Trait** - a particular form of a character. For example: the character "leg shape" could have the traits "long", "bent", and "none"; these would be used to describe organisms with long legs, bent legs, and no legs. Similarly, the character "number of eyes" could have the traits "two" and "none".

At the HMNH

Be sure to get a map - it will show you where to find various types of organisms. During your visit, you should make notes on your lab manual from which you can answer the questions below. You will hand in answers to these questions next week to your TA for a grade.

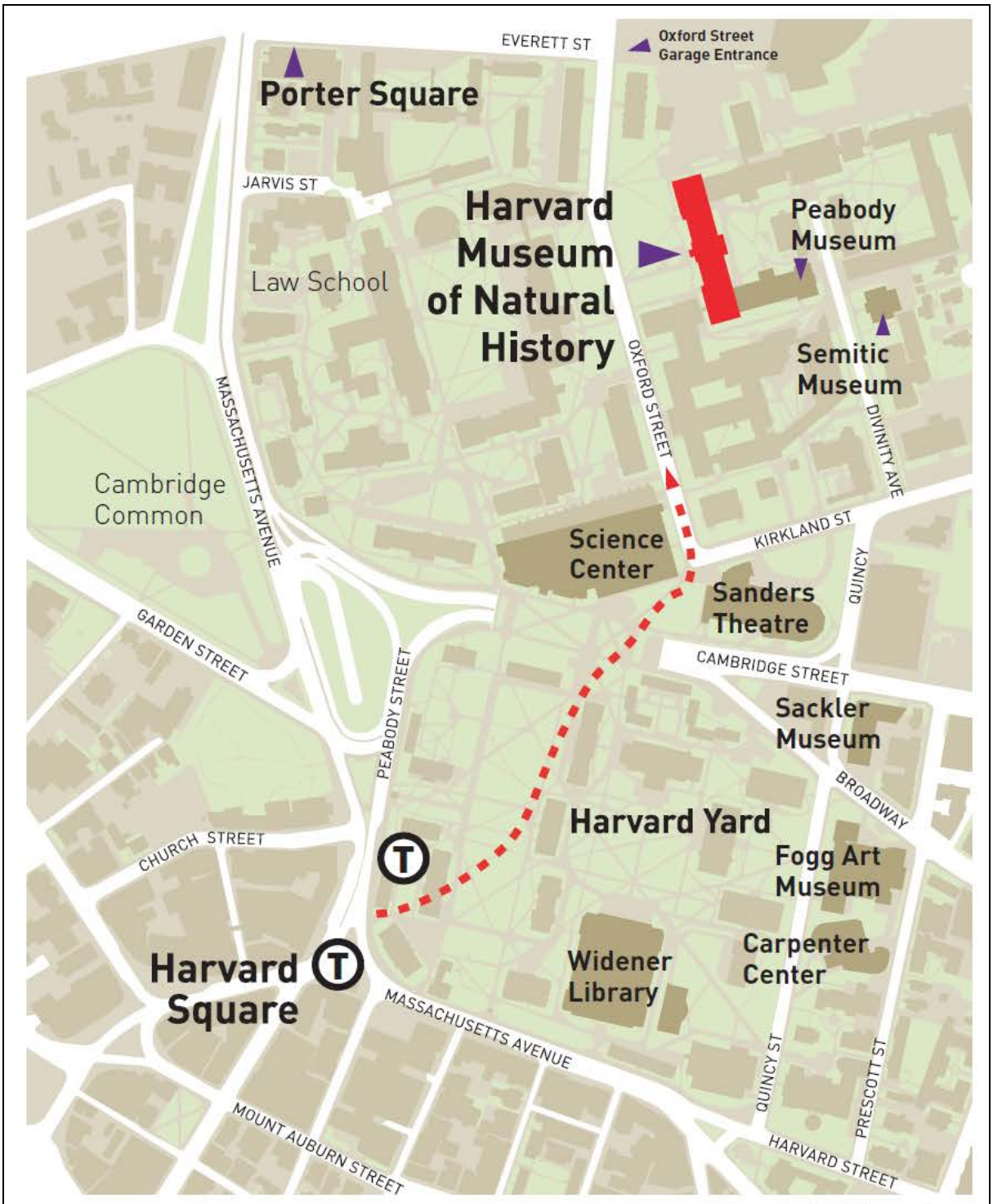
Assigned Questions:

Important note: these questions are difficult and involve some speculation and interpretation on your part. Our purpose is to get you thinking about these issues rather than to emphasize a right answer (of which there may not be in some cases). Your answers should be reasonable and clearly-explained. Do not plagiarize; your answers must be your own and cite any references used.

Answer all the questions in the lab manual they are due at the start of your next lab.

Type out your answers and include hand-drawn and labeled drawings when necessary.

Although you will perform these activities as a group, each member of the group must turn in an individual lab report. Each person's report must be in his or her own words as much as possible.



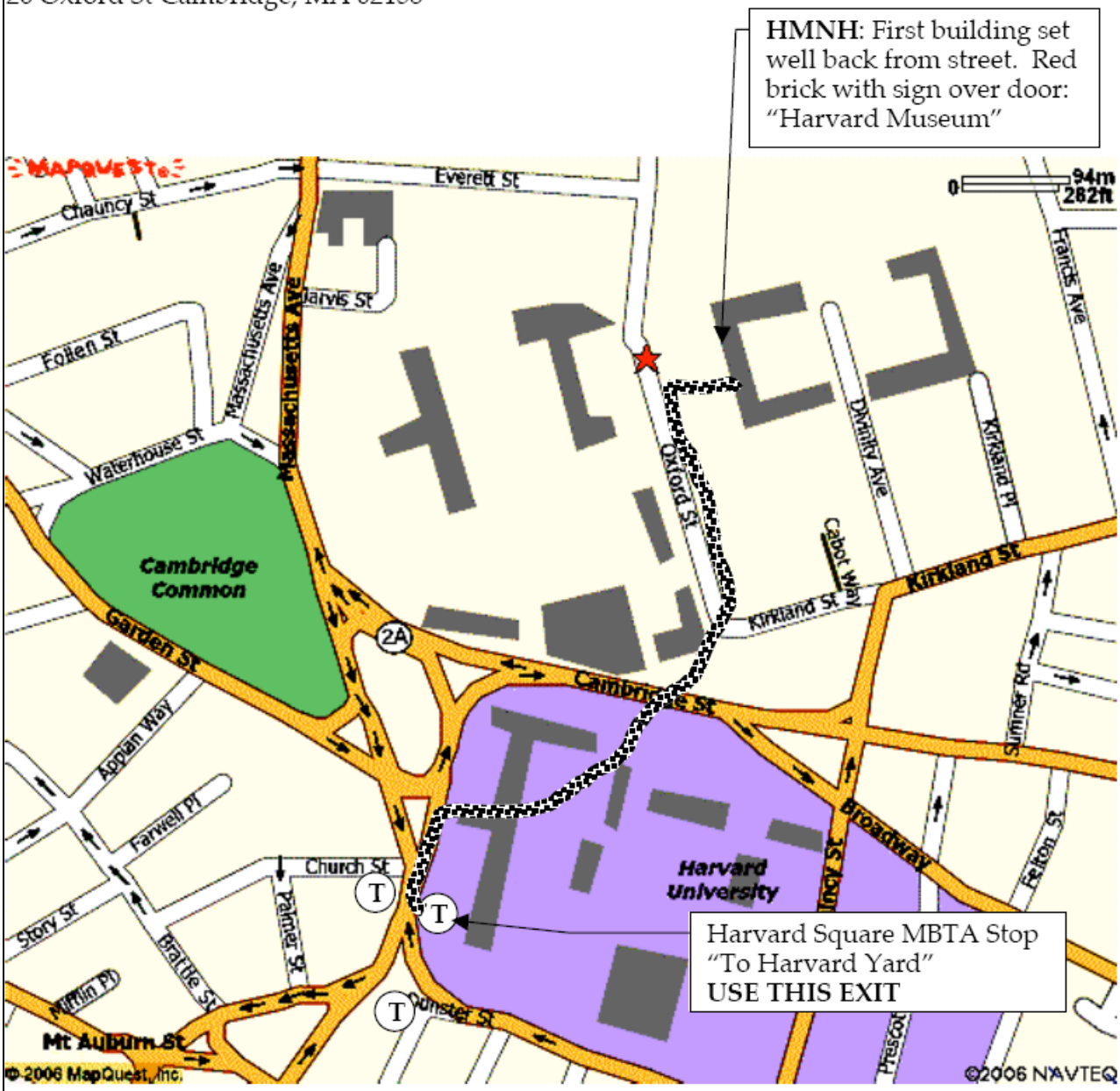
Harvard Museum of Natural History

26 Oxford Street | Cambridge, MA | 02138
617.495.3045

Open daily from 9 am to 5 pm, 361 days a year.
The museum is closed on New Year's Day, Thanksgiving Day, Christmas Eve, and Christmas Day.

Getting to the HMNH (not all buildings shown)

26 Oxford St Cambridge, MA 02138



- Exit Harvard station using the "To Harvard yard" exit.
- Go along Massachusetts Ave with the brick and wrought iron fence on your right.
- Go through the first gate you come to; it's near a bus stop.
- Go diagonally across Harvard yard to the gate at the north end (you'll see a big plaza).
- Cross the plaza with the Science Center on your left.
- Cross the street at the corner where Kirkland and Oxford intersect.
- Walk along Oxford with the street on your left until you come to the HMNH.

1) Flowers and Pollinators

For this question, visit the *Glass Flowers* Exhibit gallery. This is the first gallery you come to at the top of the stairs by the Gift Shop. The Glass Flowers are FRAGILE. Please do not lean on or bump the cases.

Flowers are so variable because they have evolved to attract certain pollinators. There are many different types of pollinators: bees, butterflies, moths, ants, beetles, flies, birds, and even mammals. Some pollinators feed on the pollen itself. Many seek another reward — nectar, which the plant makes just for them. As they feed on nectar, these animals are dusted with pollen and inadvertently carry it from flower to flower, thus allowing the plants to mate without having the ability to move. The flowers you will look at could be pollinated by one or more of the following pollinators:

Hummingbird

Wants: Nectar from the base of the flower. Can feed while hovering — doesn't need to land.

Sees: Reds and oranges.

Uses: Its long beak to suck nectar.

Bee

Wants: Pollen and/or nectar. Likes something to land on.

Sees: Some colors — white, yellow, blue. Stripes, dots, or bull's-eye patterns help guide the bee to the center of the flower.

Uses: Pollen sacs on its legs to carry pollen, and its mouth to eat nectar.

Butterfly

Wants: Nectar and a surface to land on for feeding (can't hover while feeding).

Sees: Bright colors, including pink, red, yellow, orange, and purple.

Uses: Its proboscis (long tongue) to sip nectar.

Look at the flowers listed below. Using the descriptions above and your observations of the flower, choose which pollinator(s) you think would pollinate that flower. Explain your reasons why. Pollinators can be used more than once or not at all.

Plant name	Pollinator	Explanation
Blue flag *Iris versicolor* C21		
Milkweed *Asclepias syriaca* L63		
Trumpet creeper M76 *Campsis radicans*		
Black-eyed susan O90 *Rudbeckia speciosa*		

2) Evolution Exhibit: You should go through this entire room as a review of lecture material, as a basis for answering questions about other exhibits, and to answer the questions below. Make sure you also look at the "How To Read The Tree of Life" video in this room. You will need this information to answer later questions.

a. Look at the Evolution timeline and answer the following questions (give time in millions of years)
When did life appear? _____

When did the first animal appear?_____

Name of the first animal fossil?_____

When did the first land plant appear? _____

Name of this plant?_____

When did the first land animal appear? _____

Name of this animal?_____

When did mammals appear?_____

When did humans first appear?_____

Use this information to reconstruct a timeline in the form of a clock analogy (refer to your textbook for additional information).

b. <u>Natural Selection</u>
i. Look at the exhibit on Natural Variation. Describe the variation in Pocket Gophers *Geomys bursarius*.

ii. Why might some of these variants be more common (typical) while others are rare (unusual)?

iii. Next Look at the video on Natural Selection in Action pocket mice.
Given this example, describe how the Pocket Gophers might change over time if their habitat changed to a light color like a sandy substrate, and why this would happen.

3) <u>Convergent Evolution</u>

a. Look at the Convergent evolution case in the Evolution room.

i. Explain convergent evolution, using the frog and kangaroo as an example.

ii. Explain why the frog and kangaroo do not share the trait you described as the result of <u>homology</u>?

[For part "b" you'll need to look through the rest of the museum, but stay in this room for now.]

b. Consider the wing bones of the following three flying vertebrates:

- Pterandon – a flying dinosaur. Its skeleton can be found on the wall in the Romer Hall of Vertebrate Paleontology.
- Bird - A bird (Northern Harrier) skeleton can be found in case C6 on the balcony in the Hall of Mammals with the hawks.
- Bat – flying mammal. A bat skeleton can be found in the Hall of Mammals in case A2 which is against the wall that separates the Hall of Mammals room from the Holarctic Mammals and Birds room.

All three wing structures are based on the same tetrapod vertebrate arm and five-fingered hand structure that is shown in *Campbell,* Figure 22.15. Using Figure 22.15 as a guide, sketch the wing bones of a bird, a bat, and a pterandon and identify (as best you can) how the bones in each of your sketches correspond to the bones in the human arm and hand. Be sure to label the parts of the wing skeleton that correspond to:

- Humerus (upper arm bone) {shown in purple in figure 22.15}
- Radius & ulna (lower arm or "forearm" bones) {orange and beige}
- Palm & finger bones (carpals, phalanges, & metacarpals) {green and blue}

For each wing, give a one-sentence description of its structure. For example, if we had asked about figure 22.15, you would say something like, "The cat's foot is like a human hand, but it walks in its tiptoes."

4) <u>Evolutionary radiations</u>:

a. Look at the *Anolis* lizards. Different species of lizards on Hispañola have adapted to coexist on trees by taking different parts of the tree as their habitat. What are the different regions of the tree each species live in?

b. *Anolis* lizards also live on other islands near Hispañola. How are the islands a case of convergent evolution for *Anolis* species?

5). The Arthropod Exhibit

a. "Eye Spots and False Heads" Exhibit

- What is one function the large spots on these organisms serve?

b. “Partnerships: Welcome Guests” display

- This display describes several mutualistic relationships between two species where one or both species denefits from the association. Describe one of the mutualistic relationships shown between pairs of species.

6). The Mollusk Exhibit

a. How do snails in the genus *Conus* attack and obtain their prey?

b. What potential positive effects for humans are being developed from this evolutionary adaptation of *Conus* species?

c. **"Molluscs in Research" Video**

i. Watch the video of Dr. Gonzalo Giribet describing recent discoveries by Harvard researchers on mollusks. What "living fossil" group of mollusks was thought to be extinct, but was recently rediscovered?

ii. When was the group though to have gone extinct?

iii. According to Dr. Giribet's DND analysis and phylogenetic tree, what does he think the closest relative of this group is, among the other kinds of mollusks?

6). Fish Diversity Exhibit

a. Go to the Fish room. Look at the Evolution of Fish exhibit. Name the major groups of fish, and list what the important characters are that evolved in each of these groups.

b. Which group is most closely related to the land vertebrates?

6) Go to the Great Mammal Hall.

a. In the cases on the right side wall find the monotremes. Name a species of montreme. What trait do monotremes share with other mammals? How are they different from other mammals (Marsupials & Eutherians)?

b. Next look at the marsupials. Name a species of marsupial. How are marsupials different from Eutherian mammals (humans, dogs, horses, etc)?

7). The "New England Forests" Room

a. "Life on a Rock: Lichens" Table and interactive video

i. What two organisms are lichens a combination of?

ii. What does this *symbiosis* (two organisms living together as one) allow lichens to do?

b. "Fungi in the Forest" Table and interactive video

What is the primary and most important process that fungi do for the forest ecosystem? (Hint: In the interactive video, first select "How Do They Live?", then select "Decomposition").