Fall 2015

Evidence of Evolution 3: Evolutionary Evidence and Inferences Lab: A Discussion Guide

IMSA Biology Team

Evolutionary Evidence and Inferences Lab:

A Discussion Guide

I. Introduction

This lab activity was designed to provide you with opportunities to make inferences and draw conclusions about evolution and the common ancestry of various animals based on their anatomical characteristics and comparative anatomy. You will be given tasks to accomplish or questions to answer at each of 11 stations. In order to do this successfully, you must make careful observations of the specimens on display.

II. Lab Stations

There are 11 stations to this lab activity. The following pages provide information on 1) the materials needed for each station, and 2) the task or challenge to be completed by the student at each station.

A. Station 1 (vertebrate skeletons)

Materials: Skeletons of several vertebrate species (e.g., human, mole, bat, turtle, rabbit, dog, and monkey).

Task: Are the organisms on display related to one another; that is to say, do they share a common ancestry? Support your answer with evidence.

B. Station 2 (horse leg, pig leg, and human leg)

Materials: The skeletal hind leg of a horse, a pig, and a human.

Task: Examine the skeletal hind leg of the horse and compare it to that of a pig and a human. Are the organisms on display related to one another; that is to say, do they share a common ancestry? Support your answer with evidence.
Is there anything about the horse's leg that provides evidence that ancestors to the horse used their limbs differently than the modern horse? Explain your answer.

C. Station 3 (congo eel)

Materials: One preserved freshwater or marine eel, one preserved congo eel (*Amphiuma means*), and one preserved salamander such as a tiger salamander.

Task: Examine the three preserved specimens on display and determine which two are most closely related. Provide evidence for your answer. Notice the small forelimbs on the congo eel, how does this affect your answer? Explain.

D. Station 4 (fossil blocks)

Materials: Some plastic blocks containing a diverse array of young invertebrate fossils and other plastic blocks containing a diverse array of very old invertebrate fossils.

Task: Carefully examine the blocks of fossils on display and determine which of the two sets of blocks contains the youngest fossils. You must do this without looking up information on the fossils and without reading the names or looking up the geological time periods labeled on the plastic blocks. You must also do this without using complexity as a criterion. What criterion did you use to make your decision? Why do you think you are prohibited from using complexity in your answer? Explain.

E. Station 5 (hominin skulls)

Materials: A model of a modern human skull and models of fossilized skulls of hominid species belonging to the Hominini tribe from various time periods (e.g., skulls of *Homo neanderthalensis, Homo erectus*, *Homo habilis*, *Paranthropus boisei*, and *Australopithecus africanus*).

Task: All six skulls on display are of hominins that lived during various periods of time (with overlap in some cases) on the human side of the fork after the lineage that gave rise to chimpanzees split from the lineage that gave rise to humans. Knowing only that the modern human skull is the youngest, rank these skulls according to their age. How were you able to do this? What does the fact that there was overlap between some of the hominins tell you about the change in that lineage over time? Explain.

F. Station 6 (brain models)

Materials: Models of vertebrate brains (made by different companies) for several different species.

Task: Examine the vertebrate brain models on display. One set of models has blue bases and the other has green bases. The two sets of models are also color-coded differently. Are all of the brains represented by the blue-based models homologous? Are all of the brains represented by the green-based models homologous? Are the brains with blue bases homologous to the brains with green bases? Explain your

answers. Why is it important to look at soft tissues of currently existing organisms when we are trying to construct an evolutionary history/ determine ancestry?

G. Station 7 (armadillo shell and turtle shell)

Materials: The shell of an armadillo and the shell of a turtle.

Task: Examine the armadillo shell and turtle shell and determine whether they are homologous or analogous. Explain the reasoning behind your decision.

H. Station 8 (wings)

Materials: A bird and a butterfly.

Task: Examine the bird's wings and the butterfly's wings and determine whether they are homologous or analogous. Explain the reasoning behind your decision.

I. Station 9 (vertebrate embryos)

Materials: Pictures of vertebrate embryos, including a human embryo, house cat embryo, and spotted dolphin embryo.

Task: Examine the pictures of the human, house cat, and spotted dolphin embryos on display. As adults these species look very different from one another. Are there any characteristics of these embryos that suggest that these three species are related (i.e., evolved from a common ancestor)? Explain your answer.

The spotted dolphin embryo is labeled, but can you tell which one is the cat embryo and which is the human embryo? Explain.

Also, the picture of the spotted dolphin embryo has structures labeled with the letters *f* (forelimb) and *h (hindlimb)*. Can you find these same structures on the other embryos? What do you think they are? Are you surprised that the structure labeled *h* is even on a dolphin embryo? Explain.

J. Station 10 (preserved specimens)

Materials: Numerous preserved animals and animal skeletons from different phyla.

Task: Examine the organisms on display and determine how many phyla are represented. How did you do this? Also, pick one or more phyla and try to separate the specimens from that group into even smaller, more closely related groups. How

did you do this? Why is this kind of grouping important? What kinds of technology do you think allow us to do this even more accurately today?

Phylum *= a level of taxonomic classification below the level of kingdom and above the level of class. [Note: The levels of taxonomic classification from least specific to most specific are Kingdom, Phylum, Class, Order, Family, Genus, and Species]. Animal species that share sets of homologous characteristics are placed into the same phylum. Animal species with no anatomical/structural homologies belong to different phyla.*

K. Station 11 (protein structure)

Materials: A table showing the amino acid sequences for the cytochrome c protein, which is an essential regulator in the cell, for humans and nine other organisms.

Task: *Cytochrome c* is a protein that plays a critical role in transporting electrons in the mitochondrion. The table at this station provides information on the amino acid sequences of *cytochrome c* for humans and nine other organisms (i.e., Bullfrog, Chicken, Chimpanzee, Cow, Rhesus Monkey, Rice, Silkworm Moth, Snapping Turtle, and Tuna). Your task is to compare the amino acid sequences in these organisms to that of humans, and to construct a phylogenic tree that is based on these comparisons. How similar or different is your tree to one based on anatomical characteristics that you know each of these organisms' has? Based on a single protein, how confident are you in your tree? What other information would you want to collect? Explain.