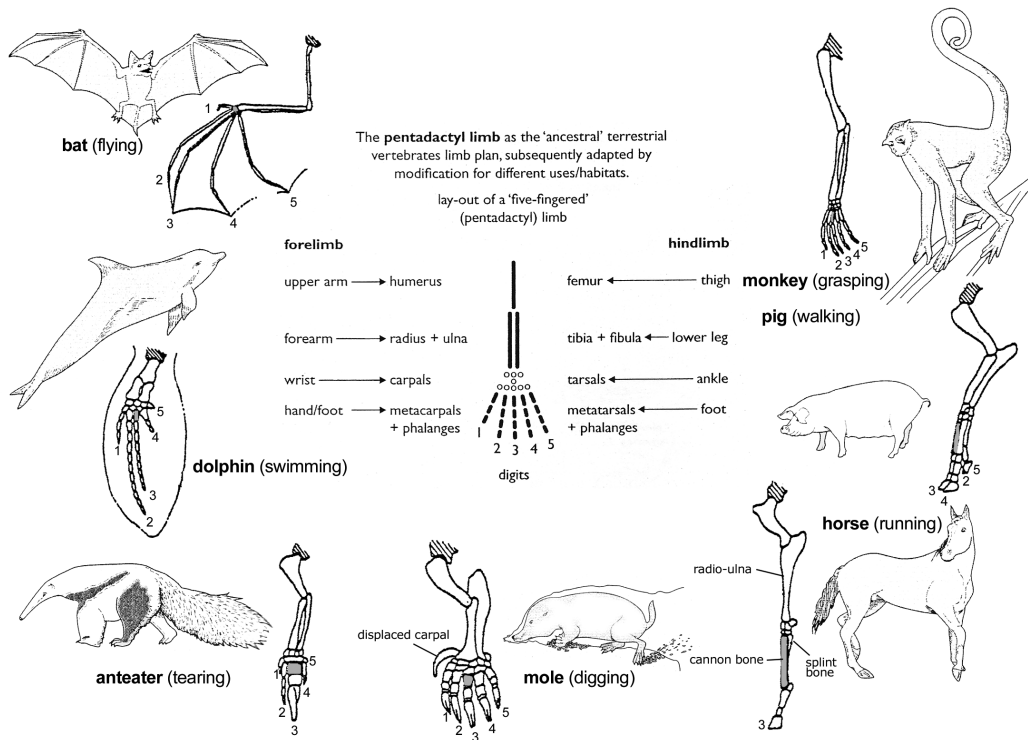


Lab 24. Descent With Modification: Does Mammalian Brain Structure Support or Refute the Theory of Descent With Modification?

Introduction

One of Darwin's most revolutionary ideas was that all living things are related. According to Darwin, all life on Earth today is actually related because all life on Earth shares a common ancestor. This ancestor, he argued, lived on Earth sometime in the distant past but is now extinct. As a result of this common ancestor, all organisms now share some common features. An example of how organisms share common features can be seen in the figure below. The figure illustrates how the limbs of mammals have a similar internal structure. These limbs are examples of homologous structures because they have a similar internal structure but serve different functions (such as walking, swimming, or grasping).

Bones found in the limbs of seven different mammals



To explain the similar internal bone structure in these mammals, Darwin said that they must be descendants of the same ancestor that had a limb that consisted of the same set of bones. He reasoned that the difference in the shape of the bones was a result of gradual modifications that made the organisms better adapted to survive in a particular environment. He called this idea descent with modification. He argued that environmental factors, over time, could slowly select for or against subtle variations in the basic shape of the bones in the limbs of organisms but could not completely change the basic body plan. This selection process would gradually result in whale fins and bat wings that had fingers similar to the fingers of a lizard, a frog, or a monkey. These variations would give their owners an advantage in a particular environment, such as the ocean in the case of the whale or the air in the case of the bat.

According to this theory, all species will share some physical features because all species share a common ancestor. This theory, however, also predicts that two species that have diverged from one another relatively recently in time will share more features than species that diverged from one another earlier. This prediction is based on the assumption that the longer it has been since two species separated from the same ancestral species, the more time there will be for differences to accumulate in each independent line.

The theory of descent with modification certainly seems reasonable. However, like all theories in science, the principles of descent with modification must be tested in many different ways before it can be considered valid or acceptable by the scientific community. In this investigation, you will determine if mammalian brain structure is consistent with the principles of descent with modification.

Your Task

Collect data about the brain structure of at least 10 different mammals. Then use the data you collect to test the theory of descent with modification.

The guiding question of this investigation is, **Does mammalian brain structure support or refute the theory of descent with modification?**

Materials

You will use an online database called Comparative Mammalian Brain Collections to conduct your investigation. You can access the database by going to the following website: <http://brainmuseum.org>.

Safety Precautions

1. Use caution when working with electrical equipment. Keep away from water sources in that they can cause shorts, fires, and shock hazards. Use only GFI-protected circuits.
2. Wash hands with soap and water after completing this lab.
3. Follow all normal lab safety rules.

Getting Started

To answer the guiding question, you will need to compare and contrast the brains from a sample of at least 10 different mammals. You **MUST** include the polar bear, the domestic dog, the domestic guinea pig, and the gorilla in your sample. To compare and contrast these brains, you will need to access the online database Comparative Mammalian Brain Collections, which is sponsored by the University of Wisconsin, Michigan State University, and the National Museum of Health and Medicine.

Once you have accessed the database, you must determine what type of data you will need to collect, how you will collect it, and how you will analyze it. To determine *what type of data you will need to collect*, think about the following questions:

- What would you expect mammalian brains to look like if the theory of descent with modification is valid? What would you expect mammalian brains to look like if the theory of descent with modification is not valid? (Hint: Think about what the brains of mammals would look like if mammals did not share a common ancestor.)
- How will you be able to identify the major structures of the mammalian brain, and how will you determine the function of each structure? (Hint: The database includes information about the structure and function of mammalian brains. You can access this information at <http://brainmuseum.org/functions/index.html>.)
- Which characteristics of the mammalian brain will you examine?
- How many different characteristics of the mammalian brain will you need to examine? (Hint: You should examine at least four different characteristics of each brain.)

To determine *how you will collect the data you need*, think about the following questions:

- How will you quantify differences and similarities in brain characteristics? (Hint: If you decide to examine the texture of the brain, you could look at the presence or absence of folds on the surface of the brain. If you decide to examine the shape of the brain, you could calculate the height-to-length ratio. If you decide to examine the size of different structures found in the brain, you could calculate a ratio between the length of a particular structure and the overall length of the brain.)
- How will you make sure that your data are of high quality (i.e., what will you do to help reduce measurement error)?
- What will you do with the data you collect?

To determine *how you will analyze your data*, think about the following questions:

- How will you compare and contrast the various brains?
- What type of graph or table could you create to help make sense of your data?

Investigation Proposal Required? Yes No

Connections to Crosscutting Concepts and to the Nature of Science and the Nature of Scientific Inquiry

As you work through your investigation, be sure to think about

- the importance of looking at proportional relationships in science,
- the relationship between structure and function in nature,
- how science as a body of knowledge develops over time, and
- the different types of methods that scientists use to answer questions.

Argumentation Session

Once your group has finished collecting and analyzing your data, prepare a whiteboard that you can use to share your initial argument. Your whiteboard should include all the information shown in the figure to the right.

To share your argument with others, we will be using a round-robin format. This means that one member of your group will stay at your lab station to share your group's argument while the other members of your group go to the other lab stations one at a time to listen to and critique the arguments developed by your classmates.

The goal of the argumentation session is not to convince others that your argument is the best one; rather, the goal is to identify errors or instances of faulty reasoning in the arguments so these mistakes can be fixed. You will therefore need to evaluate the content of the claim, the quality of the evidence used to support the claim, and the strength of the justification of the evidence included in each argument that you see. In order to critique an argument, you will need more information than what is included on the whiteboard. You might, therefore, need to ask the presenter one or more follow-up questions, such as:

- How did you use the database to collect your data? Why did you decide to do it that way? Why did you focus on those features of the brain?
- What did you do to make sure the data you collected are reliable? What did you do to decrease measurement error?
- What did you do to analyze your data? Why did you decide to do it that way? Did you check your calculations?
- Is that the only way to interpret the results of your analysis? How do you know that your interpretation of your analysis is appropriate?
- Why did your group decide to present your evidence in that manner?
- What other claims did your group discuss before you decided on that one? Why did your group abandon those alternative ideas?
- How confident are you that your claim is valid? What could you do to increase your confidence?

Once the argumentation session is complete, you will have a chance to meet with your group and revise your original argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the most valid or acceptable answer to the research question!

Report

Once you have completed your research, you will need to prepare an investigation report that consists of three sections that provide answers to the following questions:

1. What question were you trying to answer and why?
2. What did you do during your investigation and why did you conduct your investigation in this way?

Argument presentation on a whiteboard

The Guiding Question:	
Our Claim:	
Our Evidence:	Our Justification of the Evidence:

3. What is your argument?

Your report should answer these questions in two pages or less. This report must be typed, and any diagrams, figures, or tables should be embedded into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid!