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Comparing Primates

(adapted from "Comparing Primates" Lab, page 431-438, Biology Lab Manual, by Miller and Levine, Prentice Hall Publishers, copyright 2000, ISBN 0-13-436796-0)

Background: One of the most compelling arguments for the modern theories of evolution is supported by the ability of scientists and researchers to compare the similarities and differences between modern primates. Even in his book The Origin of Species and The Descent of Man, naturalist Charles Darwin formulated a hypothesis that human beings share a common ancestor with other modern primates. He claimed, and it is commonly accepted today, that these adaptations resulted from the process of natural selection. In fact, we observe four different features that can be compared and contrasted: the opposable thumb and refinements of dexterity, the size of the primate braincase, the angle of the jaw, and the dentition (teeth). However, we can only infer that the opposable thumb is an indicator of humanity as other primates do have such thumbs and are limited only in regard to their dexterity.

Perhaps more convincing is the recent discoveries of similarities in the biochemistry of the different species. Modern advances with regard to DNA and protein synthesis seem to indicate the aforementioned common ancestry may not be as distant as we once thought. We can now show with relative accuracy that many primates have the same amino acid sequences. Since the Central Dogma of DNA implies that "DNA gives rise to RNA, which gives rise to proteins" and we share common protein compounds then we may very likely possess some of the same DNA. Even more tangible is the seemingly endless array of fossils that suggest that primates have been, over a great expanse of time, evolving toward a more human form. However, as humans we must also be humbled by the fact that nature will, in all likelihood, continue to evolve and possibly change these traits in the expansive future that lies before us.

Laboratory Safety Precautions: The following symbols represent the precautions that are required for this lab:



Purpose: The purpose of this laboratory experience is:

Part A

- to discover, research, and hypothesize what is happening in regard to primate evolution.
- to compare what features we share with other primates.
- to understand the similarities presented through amino acid sequencing.

Part B

- to determine the similarities and differences between the hand of a modern human and that of a modern non-human primate.
- to discover and infer why modern humans rely so heavily on an opposable thumb.

Materials: The following materials are needed to complete this laboratory experience:

Part A

- metric ruler
- lab papers
- protractor
- pen/pencil

Part B

- Masking Tape (or medical tape)
- jacket or sweater (with buttons)
- door with round handle
- lab papers
- large sewing needle
- stopwatch
- empty soda bottle with cap
- shoe with laces
- pen/pencil
- wristwatch
- thread

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Procedure: The following procedure is utilized to perform this experience:

Part A: Comparing Primates

This part of the laboratory exercise will have you comparing primates to modern humans using the following evidence: Amino Acid Sequencing, Relative Lower Jaw Angle Measurements and Skull Comparison, Dentition Comparison, and Skeletal Feature Comparison.

Amino Acid Sequencing of Vertebrate Proteins

Figure 1 below shows a small representation of amino acids found in the hemoglobin of vertebrates. Note that not all animals listed are mammals and those that are may not be primates.

Animal →	Human	Chimp	Gorilla	Baboon	Lemur	Dog	Chicken	Frog
1	SER	SER	SER	ASN	ALA	SER	GLN	ASP
2	THR	THR	THR	THR	THR	SER	THR	SER
3	ALA	ALA	ALA	THR	SER	GLY	GLY	GLY
4	GLY	GLY	GLY	GLY	GLY	GLY	GLY	GLY
5	ASP	ASP	ASP	ASP	GLU	ASP	ALA	LYS
6	GLU	GLU	GLU	GLU	LYS	GLU	GLU	HIS
7	VAL	VAL	VAL	VAL	VAL	LEU	ILU	VAL
8	GLU	GLU	GLU	ASP	GLU	ASP	ALA	THR
9	ASP	ASP	ASP	ASP	ASP	ASP	ASN	ASN
10	THR	THR	THR	SER	SER	THR	SER	SER
11	PRO	PRO	PRO	PRO	PRO	PRO	PRO	ALA
12	GLY	GLY	GLY	GLY	GLY	SER	GLU	HIS
13	GLY	GLY	GLY	GLY	SER	ASN	THR	ALA
14	ALA	ALA	ALA	ASN	HIS	LYS	LYS	LYS
15	ASN	ASN	ASN	ASN	ASN	ASN	ASN	ASN
16	ALA	ALA	ALA	ALA	ALA	ALA	SER	ALA
17	THR	THR	THR	GLN	GLN	ALA	GLN	LYS
18	ARG	ARG	LYS	LYS	LYS	LYS	ARG	ARG
19	HIS	HIS	HIS	HIS	HIS	LYS	ALA	ARG

Figure 1

- Count the number of molecules of each amino acid in the human hemoglobin.
- Count the number of molecules of each amino acid in the hemoglobin of the other vertebrates.
- Going from top to bottom, note the position of each amino acid. Count the number of similarities in the amino acid positions in human hemoglobin as compared to the hemoglobin of each of the other vertebrates in Figure 1. Record your observations in the "Data" portion of this lab.

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Relative Lower Jaw Angle Measurements and Skull Comparison

1. Using the protractor and ruler provided by your teacher, determine the relative size of the lower jaw of each primate by measuring the length in millimeters of lines **ab** and **bc** in Figure 2. Record your observations in the Data portion of this lab.
2. Determine the angle of the lower jaw and record this angle in the Data portion of this lab. Note: You may wish to extend the lines already marked on the diagrams to more accurately measure their angle.

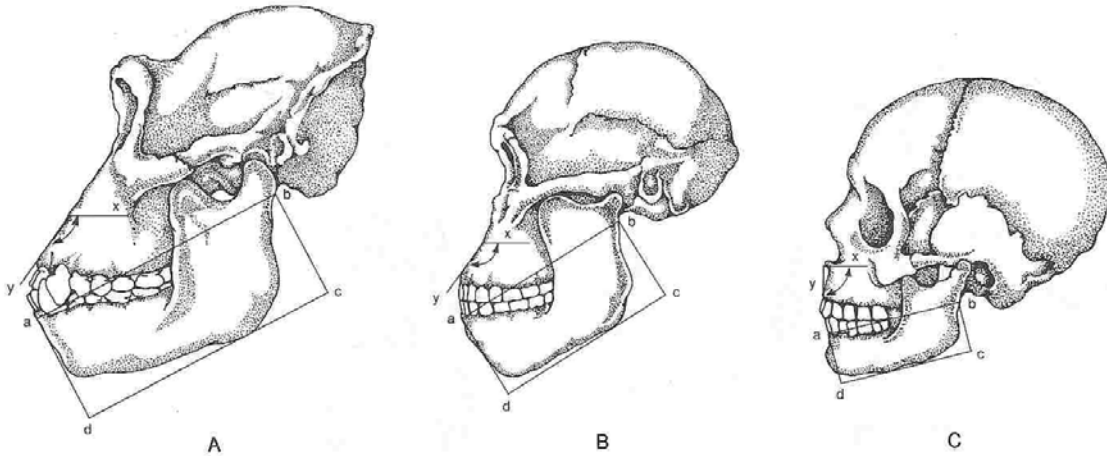


Figure 2

Dentition Comparison

1. Compare the teeth of the three primates in Figure 3, being careful to determine the number each of incisors, canines, premolars and molars.
2. Record your observations in the Data portion of this lab.

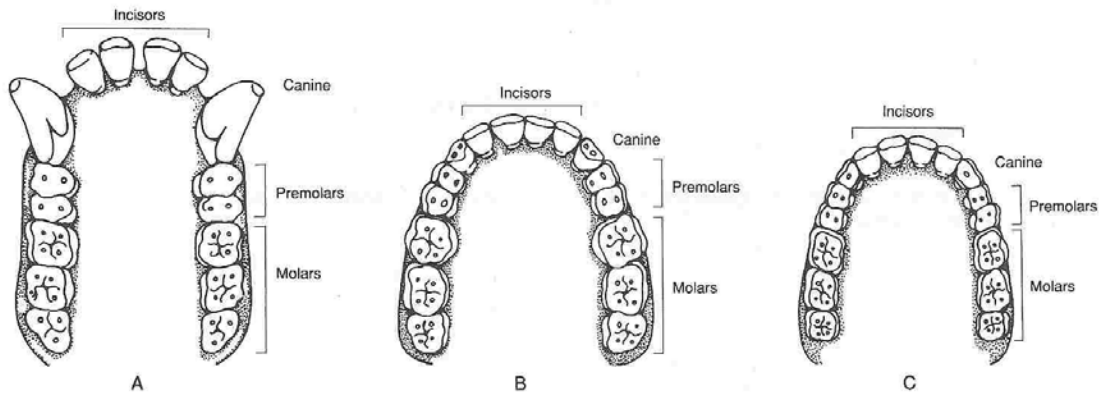


Figure 3

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Skeletal Feature Comparison

1. Compare the two primate skeletons in Diagram 4.
2. Record your contrasts and comparisons between these two skeletons in the Data portion of this lab.

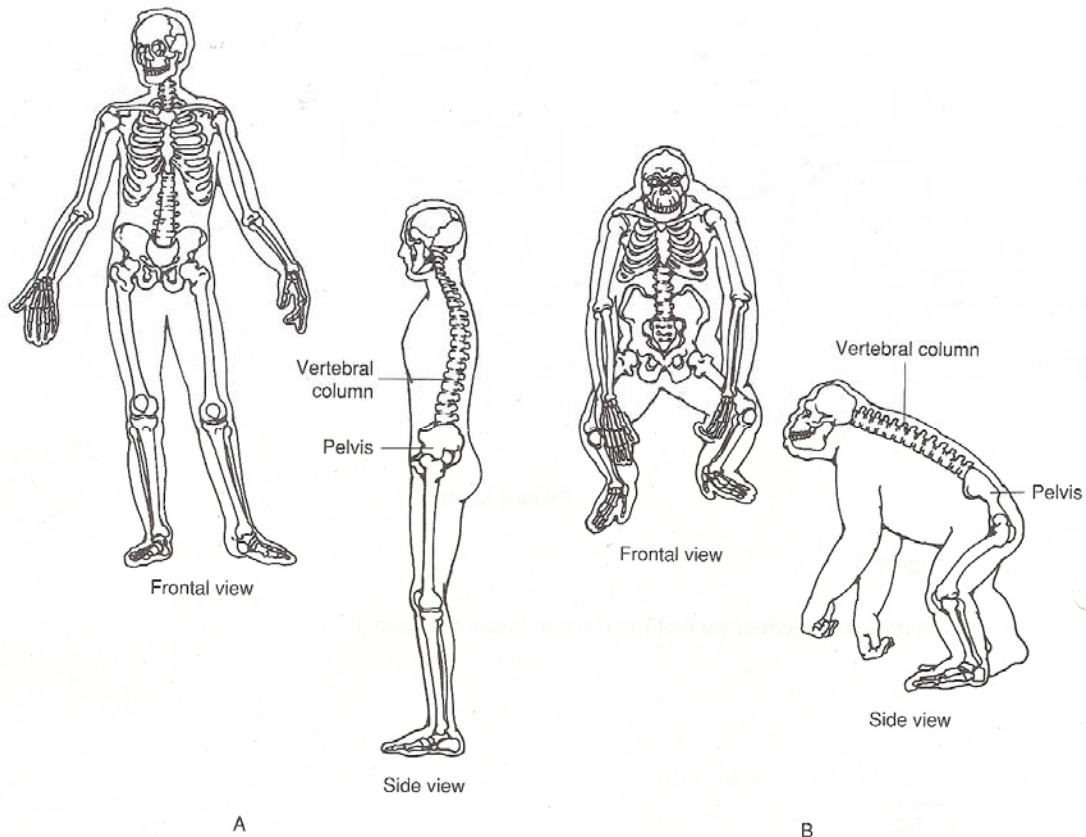


Figure 4

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Data: The following data was collected during this experience:

Data Table: Amino Acid Sequencing of Vertebrate Proteins

Number of Molecules of Different Amino Acids in Some Vertebrates

Amino Acid	Abbreviation	Human	Chimp	Gorilla	Baboon	Lemur	Dog	Chicken	Frog
Alanine	ALA								
Arginine	ARG								
Asparagine	ASN								
Aspartic Acid	ASP								
Glutamine	GLN								
Glutamic Acid	GLU								
Glycine	GLY								
Histidine	HIS								
Isoleucine	ILU								
Leucine	LEU								
Lysine	LYS								
Proline	PRO								
Serine	SER								
Threonine	THR								
Valine	VAL								

Data Table: Similarities and Differences in Amino Acid Positions in Hemoglobin

Organisms	Number of Amino Acid Position Similarities	Number of Amino Acid Position Differences
Human and Chimp		
Human and Gorilla		
Human and Baboon		
Human and Lemur		
Human and Dog		
Human and Chicken		
Human and Frog		

Data Table: Relative Lower Jaw Angle Measurements and Skull Comparison

Skull	Length of Lower Jaw (mm) (ab)	Depth of Lower Jaw (mm) (bc)	Area of Lower Jaw (mm ²) (ab x bc)	Angle of Jaw
A				
B				
C				

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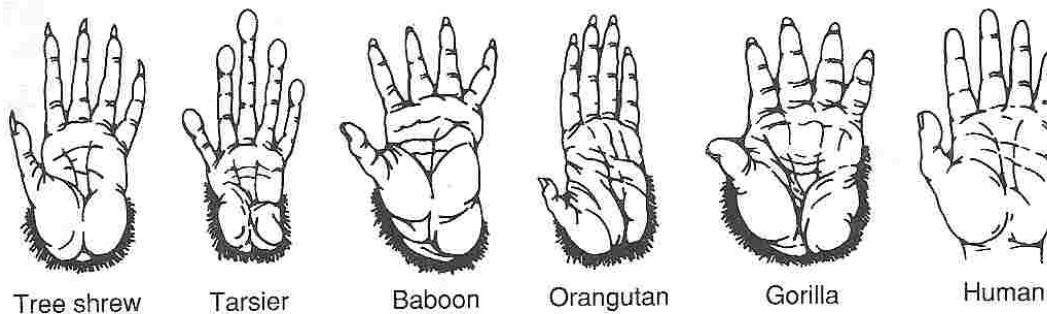
Data Table: Dentition Comparison

Type of Teeth	Mandible A	Mandible B	Mandible C
Incisors			
Canines			
Premolars			
Molars			

Part B Comparing the Hands of Primates

Procedure: The following procedure is utilized to perform this experience:

1. Study the six different primate hands shown in the diagram below.



2. Answer questions B1 and B2 after your careful examination of these hands before continuing.

(intermission...)

3. Working with a partner, perform each of the following activities and write down the time it takes to do each activity in the table provided in the Data Portion of this lab.
4. Once you have completed the activities, switch roles with your partner and time him/her for the same activities.
5. After collecting your times, use two strips of masking or medical tape to secure your thumb to the side of your index finger and hand. Make sure that some of the tape strip covers the tip of the thumb to avoid any "cheating".
6. Perform each of the activities a second time, recording your time for each once again. Once you have completed the activities, switch roles with your partner and time him/her for the same activities. IF ANY ACTIVITY TAKES LONGER THAN 3 MINUTES, RECORD "Unsuccessful" IN THE SPACE PROVIDED.

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Activities for Opposable versus Non-opposable Thumbs

Activity	Time needed WITH thumbs	Time needed WITHOUT Thumbs
Remove one shoe (must untie and remove, not simply kick off)		
Put shoe on again and re-tie the shoelace		
Put on a sweater/jacket		
Unbutton the sweater and button it up again.		
Unscrew a bottle cap on a soda bottle		
Unlock and open a door using a round door knob		
Write your full name and address in this space		
Take off a wristwatch		
Thread a sewing needle		
Average Time for all Activities		

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Analysis Questions: Answer the following questions in the space provided.

A1. From your observations, which primate organism is most closely related to human beings? ...least closely related?

A2. Which non-primate organism is most closely related to human beings? ...least closely related?

A3. Which primate skull, judging from your observations, has the largest skull/braincase? ...the smallest skull/braincase?

A4. what is the relationship between mandible size and brain size, if one exists?

A5. From your observations, what dental characteristics do primates have in common?

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A6. How would the diet of primate A and Primate C be similar?... different?

A7. Define the term "bipedal". What is an advantage to being bipedal?

B1. List two features that all of the hands have in common.

B2. List one unique feature of each hand.

B3. What features does a tree shrew have that make it well adapted for where it lives?

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B4. Based on the activities that you have tried and timed with your thumbs free and then taped down, briefly summarize WHY you need your opposable thumb to “be human” so to speak.

B5. Would it be useful to have opposable toes? Why or why not?

B6. List three other activities not included in this lab and tell why they would be difficult to perform without opposable thumbs.

Bibliography of Images Used:

Sharp Instrument Safety Symbol: <http://www.beckman.com/customersupport/images/sharpobj.gif>

In Good Health Caduceus Symbol: <http://www.wpclipart.com/medical/symbols/Caduceus.png>