

Name: _____

Period: _____

Biochemical Evidence for Evolution

If two organisms have similar DNA molecules, they have similar proteins. Similar proteins have similar amino acid sequences. Thus, if amino acid sequences are similar, DNA of the organisms is similar.

Scientists believe that similar DNA sequences indicate a common origin. The more similar the DNA of two living organisms, the more closely related they might be to one another.

Hemoglobin, a protein in red blood cells, has been studied. Scientists know the specific amino acids and their arrangements in hemoglobin molecules of humans, gorillas, and horses.

In this investigation, you will:

- a. count and record differences in the sequence of amino acids in similar portions of human, gorilla, and horse hemoglobin
- b. count and record the molecules of each amino acid present in similar portions of human, gorilla, and horse hemoglobin
- c. use these data to show how biochemical evidence can be used to support evolution

Procedure

Amino Acid Sequence

Examine the amino acid sequences of the corresponding portions of the hemoglobin molecules of horses, gorillas, and humans.

Read the amino acid sequences from left to right beginning in the upper left-hand corner of the chart. Compare the sequence of humans to the sequences of gorillas and horses.

Record the total number of differences in the sequences of gorilla and human amino acids. Then repeat this procedure for horse and human sequences, and for gorilla and horse sequences.

Number of Differences in the Amino Acid Sequence	
Organisms	Number of Differences
GORILLA AND HUMAN	
HORSE AND HUMAN	
GORILLA AND HORSE	

Amino Acids Sequences for a Segment of Hemoglobin for Humans, Gorillas, and Horses:

Human:	Val	His	Leu	Thr	Pro	Glu	Glu	Lys	Ser	Ala	Val	Thr	Ala	Leu	Try
Gorilla:	Val	His	Leu	Thr	Pro	Glu	Glu	Lys	Ser	Ala	Val	Thr	Ala	Leu	Try
Horse:	Val	Glu	Leu	Ser	Gly	Glu	Glu	Lys	Ala	Ala	Val	Leu	Ala	Leu	Try
Human:	Gly	Lys	Val	Asp	Val	Asp	Glu	Val	Gly	Gly	Glu	Ala	Leu	Gly	Arg
Gorilla:	Gly	Lys	Val	Asp	Val	Asp	Glu	Val	Gly	Gly	Glu	Ala	Leu	Gly	Arg
Horse:	Asp	Lys	Val	Asp	Glu	Glu	Glu	Val	Gly	Gly	Glu	Ala	Leu	Gly	Arg
Human:	Leu	Leu	Val	Val	Tyr	Pro	Try	Thr	Glu	Arg	Phe	Phe	Glu	Ser	Phe
Gorilla:	Leu	Leu	Val	Val	Tyr	Pro	Try	Thr	Glu	Arg	Phe	Phe	Glu	Ser	Phe
Horse:	Leu	Leu	Val	Val	Tyr	Pro	Try	Thr	Glu	Arg	Phe	Phe	Asp	Ser	Phe
Human:	Gly	Asp	Leu	Ser	Thr	Pro	Asp	Ala	Val	Met	Gly	Asp	Pro	Lys	Val
Gorilla:	Gly	Asp	Leu	Ser	Thr	Pro	Asp	Ala	Val	Met	Gly	Asp	Pro	Lys	Val
Horse:	Gly	Asp	Leu	Ser	Asp	Pro	Gly	Ala	Val	Met	Gly	Asp	Pro	Lys	Val
Human:	Lys	Ala	His	Gly	Lys	Lys	Val	Leu	Gly	Ala	Phe	Ser	Asp	Gly	Leu
Gorilla:	Lys	Ala	His	Gly	Lys	Lys	Val	Leu	Gly	Ala	Phe	Ser	Asp	Gly	Leu
Horse:	Lys	Ala	His	Gly	Lys	Lys	Val	Leu	His	Ser	Phe	Gly	Glu	Gly	Val
Human:	Ala	His	Leu	Asp	Asp	Leu	Lys	Gly	Thr	Phe	Ala	Thr	Leu	Ser	Glu
Gorilla:	Ala	His	Leu	Asp	Asp	Leu	Lys	Gly	Thr	Phe	Ala	Thr	Leu	Ser	Glu
Horse:	His	His	Leu	Asp	Asp	Leu	Lys	Gly	Thr	Phe	Ala	Ala	Leu	Ser	Glu
Human:	Leu	His	Cys	Asp	Lys	Leu	His	Val	Asp	Pro	Glu	Asp	Phe	Arg	Leu
Gorilla:	Leu	His	Cys	Asp	Lys	Leu	His	Val	Asp	Pro	Glu	Asp	Phe	Leu	Leu
Horse:	Leu	His	Cys	Asp	Lys	Leu	His	Val	Asp	Pro	Glu	Asp	Phe	Arg	Leu
Human:	Leu	Gly	Asp	Val	Leu	Val	Cys	Val	Leu	Ala	His	His	Phe	Gly	Lys
Gorilla:	Leu	Gly	Asp	Val	Leu	Val	Cys	Val	Leu	Ala	His	His	Phe	Gly	Lys
Horse:	Leu	Gly	Asp	Val	Leu	Ala	Leu	Val	Val	Ala	Arg	His	Phe	Gly	Lys
Human:	Glu	Phe	Thr	Pro	Pro	Val	Glu	Ala	Ala	Tyr	Glu	Lys	Val	Val	Ala
Gorilla:	Glu	Phe	Thr	Pro	Pro	Val	Glu	Ala	Ala	Tyr	Glu	Lys	Val	Val	Ala
Horse:	Asp	Phe	Thr	Pro	Pro	Leu	Glu	Ala	Ser	Tyr	Glu	Lys	Val	Val	Ala
Human:	Gly	Val	Ala	Asp	Ala	Leu	Ala	His	Lys	Tyr	His				
Gorilla:	Gly	Val	Ala	Asp	Ala	Leu	Ala	His	Lys	Tyr	His				
Horse:	Gly	Val	Ala	Asp	Ala	Leu	Ala	His	Lys	Tyr	His				

Analysis

1. Where is hemoglobin normally found? Be specific.
2. What does hemoglobin do?
2. Which of the following words correctly apply to or describe hemoglobin? (choose all that apply)
 - A. protein
 - B. carbohydrate
 - C. composed of amino acids
 - D. composed of DNA
3. How many different kinds of amino acids are present in these three animals' hemoglobin?

Use your data to answer the following questions:

4. How similar are the amino acid sequences of gorilla and human hemoglobin? (How many amino acids differ? Calculate the % difference for this amino acid sequence.)
5. How similar is horse and human hemoglobin? (How many amino acids differ? Calculate the % difference for this amino acid sequence.)
6. How similar is gorilla and horse hemoglobin? (How many amino acids differ? Calculate the % difference for this amino acid sequence.)
7. The sequence of amino acids corresponds to the sequence of nitrogen base molecules in DNA. Are the nitrogen base sequences of DNA most similar in gorilla and human, horse and human, or gorilla and horse?
8. In numbers, explain how the nitrogen base sequence (gene) for hemoglobin formation in human chromosomes differs from the sequence in gorilla chromosomes. (How many amino acids are different? How many nitrogen bases are different?)
9. Which amino acid is present for the human? the gorilla? Using the genetic code chart, list the mRNA codons that give the signal for each of the amino acids.
10. Based on the information, what genetic mechanism was most likely responsible for this base sequence change? Be specific. Explain.