

Part B Hemoglobin

3. Look at the hemoglobin sequences for the five organisms shown below. Hemoglobin is the oxygen-carrying molecule of the red blood cells. Only a portion of the chain has been shown here, between amino acid numbers 87 and 116 in the sequence of 146 amino acids.

Figure 2: Hemoglobin amino acid sequences

	Human	Chimpanzee	Gorilla	Monkey	Horse
87	THR	THR	THR	GLN	THR
88	LEU	LEU	LEU	LEU	LEU
89	SER	SER	SER	SER	SER
90	GLU	GLU	GLU	GLU	GLU
91	LEU	LEU	LEU	LEU	LEU
92	HIS	HIS	HIS	HIS	HIS
93	CYS	CYS	CYS	CYS	CYS
94	ASP	ASP	ASP	ASP	ASP
95	LYS	LYS	LYS	LYS	LYS
96	LEU	LEU	LEU	LEU	LEU
97	HIS	HIS	HIS	HIS	HIS
98	VAL	VAL	VAL	VAL	VAL
99	ASP	ASP	ASP	ASP	ASP
100	PRO	PRO	PRO	PRO	PRO
101	GLU	GLU	GLU	GLU	GLU
102	ASN	ASN	ASN	ASN	ASN
103	PHE	PHE	PHE	PHE	PHE
104	ARG	ARG	LYS	LYS	ARG
105	LEU	LEU	LEU	LEU	LEU
106	LEU	LEU	LEU	LEU	LEU
107	GLY	GLY	GLY	GLY	GLY
108	ASN	ASN	ASN	ASN	ASN
109	VAL	VAL	VAL	VAL	VAL
110	LEU	LEU	LEU	LEU	LEU
111	VAL	VAL	VAL	VAL	ALA
112	CYS	CYS	CYS	CYS	LEU
113	VAL	VAL	VAL	VAL	VAL
114	LEU	LEU	LEU	LEU	VAL
115	ALA	ALA	ALA	ALA	ALA
116	HIS	HIS	HIS	HIS	ARG

4. For each organism, count the amino acids in the sequence that differ from the human sequence as you did for Part A and list them in Table 2 in the Additional Records and Observations section of your Vee. Be sure to list them in descending order according to their degree of evolutionary closeness to humans.

In the study of hemoglobin, which vertebrate is most closely related to humans? least closely related to humans?

In the Procedure section of the Vee Form, briefly summarize the procedure you followed. Use the information on the Knowing Side of the Vee Form to interpret your results from the Doing Side, then write your Knowledge Claim. Write a Value Claim for this lab.

HRW material copyrighted under notice appearing earlier in this work.

Procedure

Part A Cytochrome c

The greater the time that organisms have been diverging from a common ancestor, the greater the difference that can be expected in amino acid sequences for proteins found in their bodies.

1. Cytochrome c, a protein found in the mitochondria of many organisms, consists of a chain of 104 amino acids. Figure 1 shows the corresponding parts of discontinuous cytochrome c amino acid sequences of nine vertebrates.

Figure 1: Cytochrome c amino acid sequences

	Horse	Chicken	Tuna	Frog	Human	Shark	Turtle	Monkey	Rabbit
42	Gln	Gln	Gln	Gln	Gln	Gln	Gln	Gln	Gln
43	Ala	Ala	Ala	Ala	Ala	Ala	Ala	Ala	Ala
44	Pro	Glu	Glu	Ala	Pro	Gln	Glu	Pro	Tyr
46	Phe	Phe	Tyr	Phe	Tyr	Phe	Phe	Tyr	Pro
47	Thr	Ser	Ser	Ser	Ser	Ser	Ser	Ser	Ser
49	Thr	Thr	Thr	Thr	Thr	Thr	Thr	Thr	Thr
50	Asp	Asp	Asp	Asp	Ala	Asp	Glu	Ala	Asp
53	Lys	Lys	Lys	Lys	Lys	Lys	Lys	Lys	Lys
54	Asn	Asn	Ser	Asn	Asn	Asn	Asn	Asn	Asn
55	Lys	Lys	Lys	Lys	Lys	Lys	Lys	Lys	Lys
56	Gly	Gly	Gly	Gly	Gly	Gly	Gly	Gly	Gly
57	Ile	Ile	Ile	Ile	Ile	Ile	Ile	Ile	Ile
58	Thr	Thr	-	Thr	Ile	Thr	Thr	Ile	Thr
60	Lys	Gly	Asn	Gly	Gly	Gln	Gly	Gly	Gly
61	Glu	Glu	Asn	Glu	Glu	Gln	Glu	Glu	Glu
62	Glu	Asp	Asp	Asp	Asp	Glu	Glu	Asp	Asp
63	Thr	Thr	Thr	Thr	Thr	Thr	Thr	Thr	Thr
64	Leu	Leu	Leu	Leu	Leu	Leu	Leu	Leu	Leu
65	Met	Met	Met	Met	Met	Arg	Met	Met	Met
66	Glu	Glu	Glu	Glu	Glu	Ile	Glu	Glu	Glu
100	Lys	Asp	Ser	Ser	Lys	Lys	Asp	Lys	Lys
101	Ala	Ala	Ala	Ala	Ala	Ala	Thr	Ala	Ala
102	Thr	Thr	Thr	Gly	Thr	Ala	Thr	Ala	Thr
103	Asn	Ser	Ser	Ser	Asn	Ala	Ser	Asn	Asn
104	Glu	Lys	-	Lys	Glu	Ser	Lys	Glu	Glu

The numbers along the side of the figure refer to the position of these sequences in the chain. The letters symbolize the specific amino acids in the chain.

2. For each vertebrate, count the amino acids in the sequence that differ from the human sequence, and list them on scratch paper first. In Table 1 of the Additional Records and Observations section of your Vee, list the eight vertebrate sequences in descending order according to their degree of evolutionary closeness to humans.

According to this line of evidence, which organism is most closely related to humans? Which is least closely related to humans?
