BERG/STRYER VI STUDY GUIDE

CHAPTER 6

1. HOMEWORK 2, 3, 6, 7, 9, 11. Answers on p. C5. This short chapter shows how various kinds of biochemical information (DNA sequences, amino acid sequences, and structural information about proteins) can be used to learn about the evolutionary relationships between species. It is also possible to learn about the evolutionary relationships between proteins within a species. For example, Hemoglobin is a tetramer, $\alpha_2\beta_2$. Myoglobin is a monomer. The proteins have different roles in the body but obviously have a common ancestor, see Fig. 6.14, p. 173.

2. **Homologs** are proteins that come from a common ancestor. They are divided into orthologs and paralogs. **Paralogs** derive from a gene duplication event, and **orthologs** derive from a speciation event. Thus human hemoglobin is an ortholog of chimpanzee hemoglobin, but a paralog of human (or chimpanzee) myoglobin. Here the duplication event (Hb/Mb) took place hundreds of millions of years ago, but the speciation event (human/chimp) took place about six million years ago. The distinction is not made very clearly in the text.

3. Understand the discussion of sequence alignment, looking for identities, with and without gaps. Understand how shuffling helps determine the significance of a match. A sequence comparison which only looks at identities will miss many significant matches. Random mutations will produce many changes in codons which are permissible as long as the folding remains the same. Please study Fig 6.9 on page 169. Where do you see FILMYVW? A high score (positive number) means that an amino acid is replaced with an amino acid of similar shape and function. Look at F -> Y or V -> I. What are the least likely replacements on the table? This is known as a BLOSUM matrix and is used as part of computer programs for comparing sequences.

4. Some of the strange and wonderful information which has come out of this sort of research pertains to proteins with very different functions but very similar folds. Examples in the chapter include Actin, Hsp-70, and Hexokinase (see Fig. 6.15 and Fig 16.3). Hsp-70, a heat shock protein, is represented as the "steam iron" on the protein folding handout. Actin is involved in muscle contraction, and Hexokinase is an enzyme. Similarly Ribonuclease (the protein Anfinsen studied) and Angiogenin do very different things but look very similar (p. 166).

5. Paleontologists have combined evidence from the geological record with the study of genes of living animals to produce trees (Fig 6.20) and “molecular clocks.” If the date of divergence of two groups is known, then we can look at how much the DNA has changed since the time of the common ancestor. Fossil data is essential to this. Understand the discussion of ancient DNA in section 6.5. Dinosaur DNA, which would have to be more than 60 million years old, does not appear to have survived. But DNA which is substantially less than 1 million years old has been recovered from fossils and amplified, so we have some knowledge about the genes of Neanderthals and Mammoths.