

## Chapter 21: Genomes and their Evolution

### 3. What is bioinformatics?

Bioinformatics is the application of computational methods to the storage and analysis of biological data.

### 4. What is the goal of scientists who study proteomics?

The success in sequencing genomes and studying entire sets of genes has encouraged scientists to attempt similar systematic study of proteomes, the full protein sets encoded by genomes, an approach called proteomics.

### 5. How might a human gene microarray chip be of medical importance?

These chips are being used to analyze gene expression patterns in patients suffering from various cancers and other diseases, with the eventual aim of tailoring their treatment to their unique genetic makeup and the specifics of their cancers. This approach has had modest success in characterizing subsets of several cancers.

### 19. What is the evolutionary significance of the relationship between the genes on human chromosome 16 and those same blocks of genes on mouse chromosomes 7, 8, 16, and 17?

This relationship suggests that the DNA sequence in each block has stayed together in the mouse and the human lineages since the point at which they diverged from a common ancestor.

### 20. Explain several processes involved in genomic evolution in the globin gene families. ✍

The comparison of gene sequences within the multigene globin family indicates that all globin genes evolved from one common ancestral globin gene that underwent duplication and divergence into the  $\alpha$ -globin and  $\beta$ -globin ancestral genes about 450–500 million years ago. Each of these genes was later duplicated several times, and the copies then diverged from each other in sequence, yielding the current family members. After the duplication events, the differences between the genes in the globin families undoubtedly arose from mutations that accumulated in the gene copies over many generations.

The current model is that the necessary function provided by an  $\alpha$ -globin protein, for example, was fulfilled by one gene, while other copies of the  $\alpha$ -globin gene accumulated random mutations. Many mutations may have had an adverse effect on the organism and others may have had no effect, but a few mutations must have altered the function of the protein product in a way that was advantageous to the organism at a particular life stage without substantially changing the protein's oxygen-carrying function. Presumably, natural selection acted on these altered genes, maintaining them in the population.

### 21. Explain why exon shuffling could lead to a novel protein.

Exon shuffling, the occasional mixing and matching of different exons either within a gene or between two different (nonallelic) genes owing to errors in meiotic recombination, could lead to new proteins with novel combinations of functions. Exons, each encoding a particular protein domain, could have been shuffled from ancestral forms of certain genes into the evolving tissue for a gene coding for a specific protein consisting of several domains.