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Molecular Genetics is the Study of the Molecular Structure of DNA

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Introduction

Molecular Biology is the field of biology that studies the composition, structure and interactions of cellular molecules such as nucleic acids and proteins that carry out the biological processes essential for the cells functions and maintenance.

Molecular genetics is the study of the molecular structure of DNA, its cellular activities (including its replication), and its influence in determining the overall makeup of an organism.

Molecular Biology and Genetics seek to understand how the molecules that make up cells determine the behavior of living things. Biologists use molecular and genetic tools to study the function of those molecules in the complex milieu of the living cell. Groups in our department are using these approaches to study a wide variety of questions, including the fundamental processes of transcription and translation, mechanisms of global gene control including signal transduction pathways, the function of the visual and olfactory systems, and the nature of genetic diversity in natural populations and how that affects their evolution, among others. The systems under study cover the range of model organisms (bacteria, yeast, slime molds, worms, fruit flies, zebrafish, and mice) though the results of these studies relate directly or indirectly to human health.

Having studied the synthesis of DNA and RNA and the structure of proteins, we are now prepared to examine the process of protein synthesis. We will first be concerned with the actual steps of protein synthesis. Then, to develop further our understanding of cellular processes, we will discuss the rate of peptide elongation, how cells direct specific proteins to be located in membranes, and how the machinery that translates messenger RNA into protein in cells is regulated in order to use most efficiently the limited cellular resources. The major part of the translation machinery is the ribosomes. A ribosome consists of a larger and smaller subunit, each containing a major RNA molecule and more than twenty different proteins. The synthesis and structure of ribosomes will be considered in a later chapter. In outline, the process of protein synthesis is as follows. Amino acids are activated for protein synthesis by amino acid synthetases which attach the amino acids to their cognate t-RNA molecules. The smaller ribosomal subunit and then the larger ribosomal subunit attach to messenger RNA at the 5' end or near the initiating codon. Translation then begins at an initiation codon with the assistance of initiation factors. During the process of protein synthesis, the activated amino acids to be incorporated into the peptide chain are specified by three base codon-anticodon pairings between the messenger and amino acryl RNA. Elongation of the peptide chain terminates on recognition of one of the three termination codons, the ribosomes and messenger dissociate, and the newly synthesized peptide is released. Some proteins appear to fold spontaneously as they are synthesized, but others appear to utilize auxiliary proteins to help in the folding process. The actual rate of peptide elongation in bacteria is just sufficient to keep up with transcription; a ribosome can initiate translation immediately behind an RNA polymerase molecule and keep up with the transcription. In eukaryotic cells, however, the messenger is modified and transported from the nucleus to the cytoplasm before it can be translated.

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