

TI2800 Programming life

Seminar 1: Introduction molecular cell biology

DNA contains information that describes the construction of proteins. Proteins serve structural and functional roles that give individual cells—and by extension whole organisms—specific structures and functional characteristics. Each of our cells (with a few exceptions like red blood cells, eggs, and sperm) contain all the DNA required to code our genetic features. Individual regions of DNA that confer traits are called genes. The word “genome” refers to all the DNA in an organism. The human genome contains approximately 30,000 genes arrayed on 46 long stretches of DNA called chromosomes. The two strands of DNA are said to be complementary because the sequence of one strand indicates the sequence of the opposite strand. These four chemical units, adenine, cytosine, guanine, and thymine, are often abbreviated as A, C, G, and T, respectively. The base-pairing follows a certain set of rules, now called Watson-Crick base-pairing, in which a specific purine pairs only with a specific pyrimidine: A with T, and C with G.

Messenger RNA (mRNA) is used to relay information from genes in DNA to the protein synthesis machinery. Unlike DNA, which is usually double-stranded, mRNA is single stranded. When a gene is being transcribed into RNA, which is in turn directing protein synthesis, the gene is said to be expressed. The protein-synthesis machinery “reads” the nucleotides three at a time, assembling amino acid chains that correspond to the mRNA sequence.

At any one time, a cell is only expressing a few thousand of the genes in its genome. Proper regulation of gene expression is essential. Under- or over-expression of genes can have deleterious effects. For example, many forms of cancer are caused by mis-regulation of gene expression that results in uncontrolled cell division. To accomplish this regulated gene expression, the DNA contains control sequences in addition to coding regions. The control regions in DNA at which RNA polymerase binds to initiate transcription are called promoters. RNA polymerase binds more tightly to these regions than to the rest of the DNA and this triggers the start of transcription.

Four different bases in nucleic acids can specify proteins made up of 20 different types of amino acids. Each amino acid is encoded by a set of three consecutive bases. The three-base sets in RNA are called codons. There are three codons that do not encode an amino acid but instead signal the end of a protein-coding sequence. These are generally called the stop codons.

The prokaryotes are a vast group of unicellular microorganisms. Their cells are simple in structure, lacking a nucleus and other intracellular organelles such as mitochondria and chloroplasts. All animals, plants, fungi, algae, and protozoa are eukaryotes.

Molecular biologists can transfer genes from humans and other animals into bacteria, yeast, and other organisms to confer the ability to produce specific proteins that may be extracted for therapeutic use. Rather than thinking of genes as determinants of physical characteristics, they should be regarded as potentials or predispositions for characteristics. The ability to modify characteristics of cells is similarly limited by biological and physical constraints. Since some cells are rapidly replaced, induced changes will be quickly lost. Because it is not possible to fully predict the outcome of these procedures, scientists must perform experiments, take observations, refine theories, and finally develop functional applications.