

Central Dogma of Molecular Biology

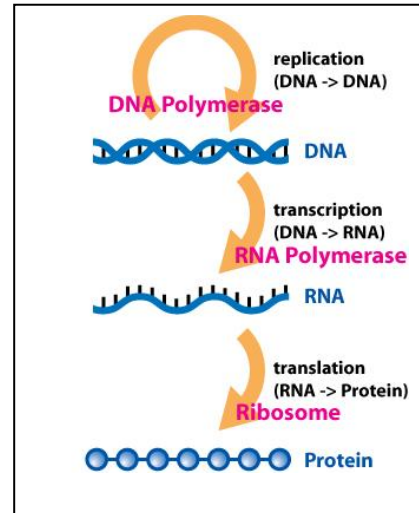
There is a very concise set of statements, which describe the essence of life on molecular level. They were first formulated by Francis Crick in mid-1960s and are known as “The Central Dogma of Molecular Biology”. Here is the Central Dogma:

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The genetic information in all living things is stored in the form of the double-stranded DNA molecule. Cell's functions are performed by proteins, which execute all biochemical reactions. A section of the DNA molecule on which the information about one protein is encoded is called the *gene*. The gene is *transcribed* from its beginning to the end in the form of an RNA molecule, called messenger RNA (mRNA). The mRNA molecule is *translated* into a protein chain on the ribosome via the *Genetic Code*. Therefore, the following flow of information is carried out within the living cell:

DNA → RNA → protein

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Comments:

1. In addition to cells, in which genetic information is always stored in the form of double-stranded DNA, numerous viruses exist, in which genetic information can be in the form of single-stranded DNA (ssDNA) or single- or double-stranded RNA (ssRNA or dsRNA), as well as in the form of duplex DNA (dsDNA). However, viruses are not living things because they cannot replicate autonomously, without the cell. They are cellular parasites consisting of a nucleic acid and proteins, which is capable of multiplication within the cell but totally lifeless outside the cell. Out of two complementary DNA strands of the given gene, only one carries a sensible message about amino acid sequence of a protein. The sequence of the other strand is senseless. The strand, which sequence is identical (except the U→T replacement) to the mRNA copy of the gene, is called the *coding* or *sense* strand. The complementary, senseless strand is called the *template* or *antisense* strand. The assignment holds only within the given gene. The adjacent gene may happen to have the opposite assignment of the strands.
2. After discovery, in 1970, of reverse transcriptase, an enzyme catalyzing synthesis of the DNA

strand on the RNA template, the Central Dogma looked overturned since the reverse flow of information from RNA to DNA became feasible. However, although the discovery of David Baltimore and Howard Temin was extremely important and was eventually awarded by Nobel Prize, it proved to be not that revolutionary. There is no reverse flow of information in the cell from RNA to DNA. In the contemporary Molecular Biology the reverse transcriptase plays an important but modest role. It is mostly used by a special class of viruses, so-called retroviruses, in which ssRNA serves as the genetic molecule, such as HIV. Each HIV particle carries two identical RNA molecules and two molecules of reverse transcriptase, which synthesize complementary DNA strands as soon as the virus particle infects the competent cell. Another important role the reverse transcriptase plays in the process of telomere extension: the protein part of telomerase is reverse transcriptase and it elongates 3' telomeric ends of chromosomes (using them as primers) by utilizing the RNA part of the telomerase enzyme as a template.

Further reading: [Unraveling DNA, chs. 2, 4.](#)