

and, like information on a computer tape or disc, can be replicated. It can also be played back or transcribed to produce a message. The message must translate into some action, such as a series of calculations with the ultimate display of the results, for the message to be useful.

Cells operate with an analogous system. Figure 4.1 displays the *central dogma* of biology. Information is stored on the DNA molecule. That information can be *replicated* directly to form a second identical molecule. Further segments of information on the molecule can be *transcribed* to yield RNAs. Using a variety of RNAs, this information is *translated* into proteins. The proteins then perform a structural or enzymatic role, mediating almost all the metabolic functions in the cell. The information content of the DNA molecule is static; changes occur slowly through infrequent mutations or rearrangements. Which species of RNA that are present and in what amount varies with time and with changes in culture conditions. Likewise, the proteins that are present will change with time but on a different time scale than for RNA species. Some of the proteins produced in the cell bind to DNA and regulate the transcriptional process to form RNAs.

The important feature of the central dogma is its universality from the simplest to most complex organisms. One important, although relatively minor, deviation is that some RNA tumor viruses (*retroviruses*) contain an enzyme called *reverse transcriptase*. (The virus that causes AIDS, the human immunodeficiency virus or HIV, is a retrovirus, and

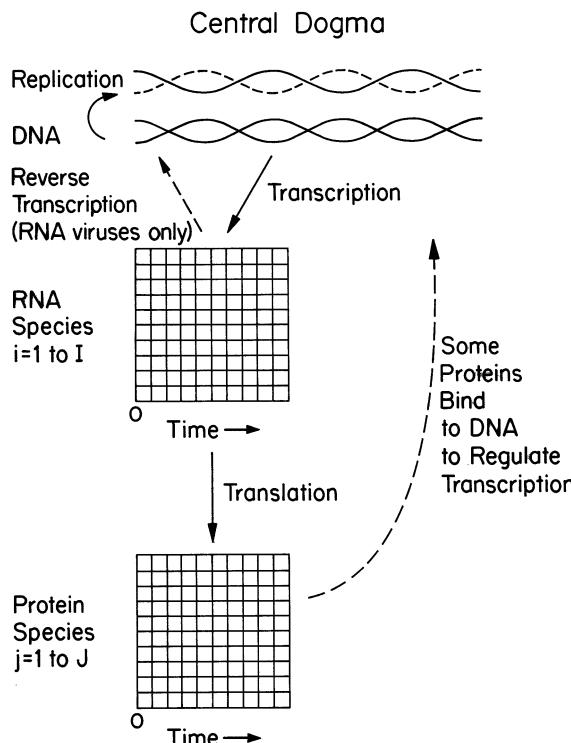


Figure 4.1. The primary tenet of molecular biology is the central dogma, which applies to all organisms. DNA serves as the template for its own replication, as well as transcription to RNA. The information transcribed into the RNA can then be translated into proteins using an RNA template. Note that information on the DNA molecule is relatively time independent, while the information which exists in the form of RNA and protein molecules depends on the history and environment of the cell and is time dependent. Some of the proteins interact with DNA to control which genes are transcribed.