TUTORIAL FIGURES: Basic Molecular Biology

This document contains illustrations of the following basic molecular biology concepts.

- Structure of DNA and RNA: nucleotide units, base-pairing.
- DNA Molecule: double-stranded, helix structure.
- Information Transfer Processes: replication, transcription, translation.
- Transcription Process.
- RNA processing: poly(A) tail, introns, exons.

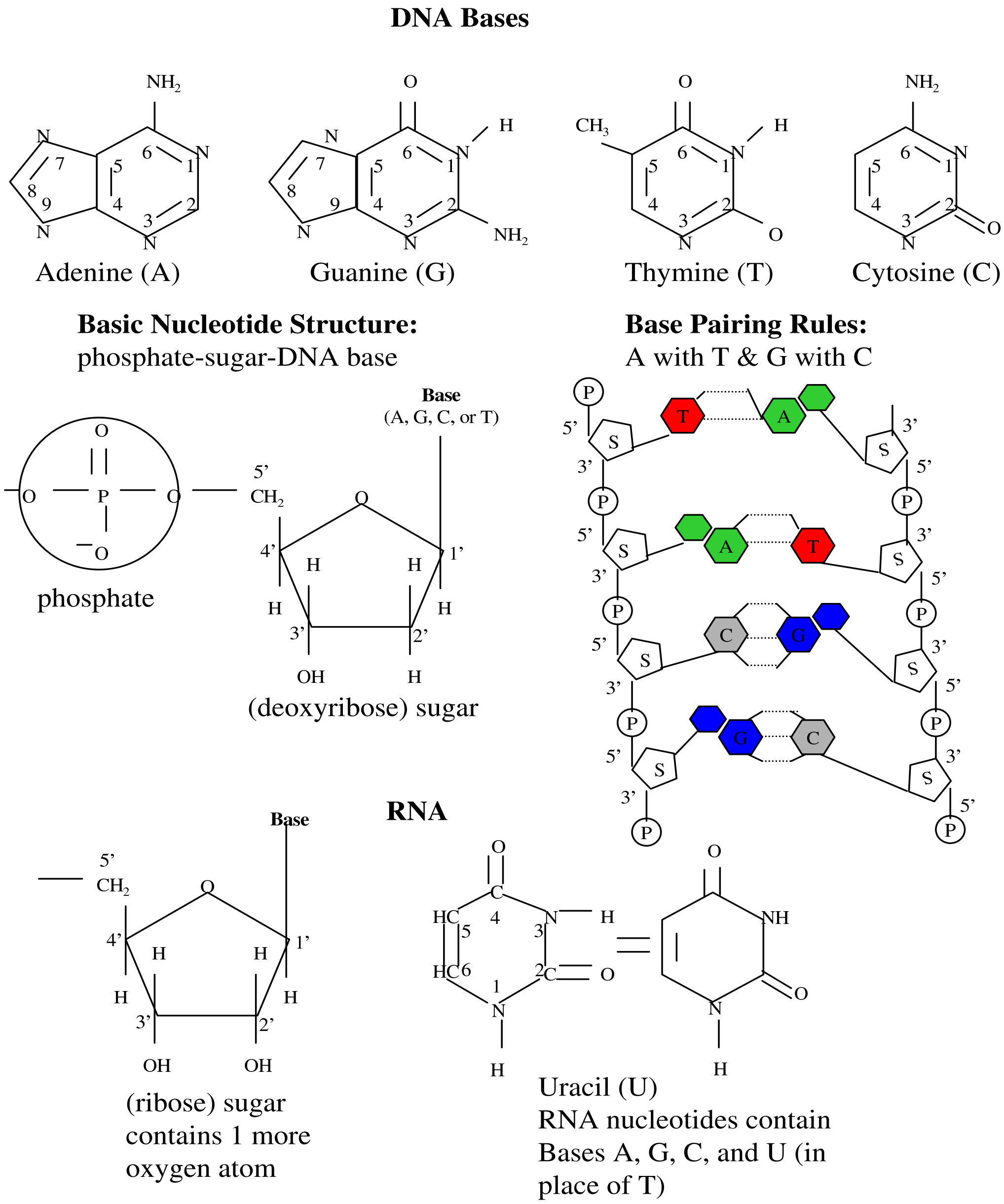

Figure 1: **Chemical structure of DNA and RNA**. A DNA molecule comprises of two chains consisting of nucleotide units. The basic structure of each nucleotide comprises of a phosphate, a deoxyribose sugar, and a base (nucleotide = P-S-Base). There are 4 DNA bases: A (adenine), G (guanine), T (thymine), and C (cytosine). The nucleotides p-s-A and p-s-G are called purine nucleotides and the remaining two, p-s-C and p-s-T, are called pyrimidine nucleotides. The nucleotide units on a chain are held together by phosphodiester bonds and the two chains are held together by hydrogen bonds ($\cdots$) between A-T and G-C bases exclusively. Chemical structures of the bases are such that A pairs with T and G pairs with C only (base pairing rules). Bases of RNA (ribonucleic acid) A, G, and C are as in DNA, but U (uracil) is found in place of T. Also the sugar in RNA (ribose) differs from the one in DNA only by the addition of 1 oxygen atom.

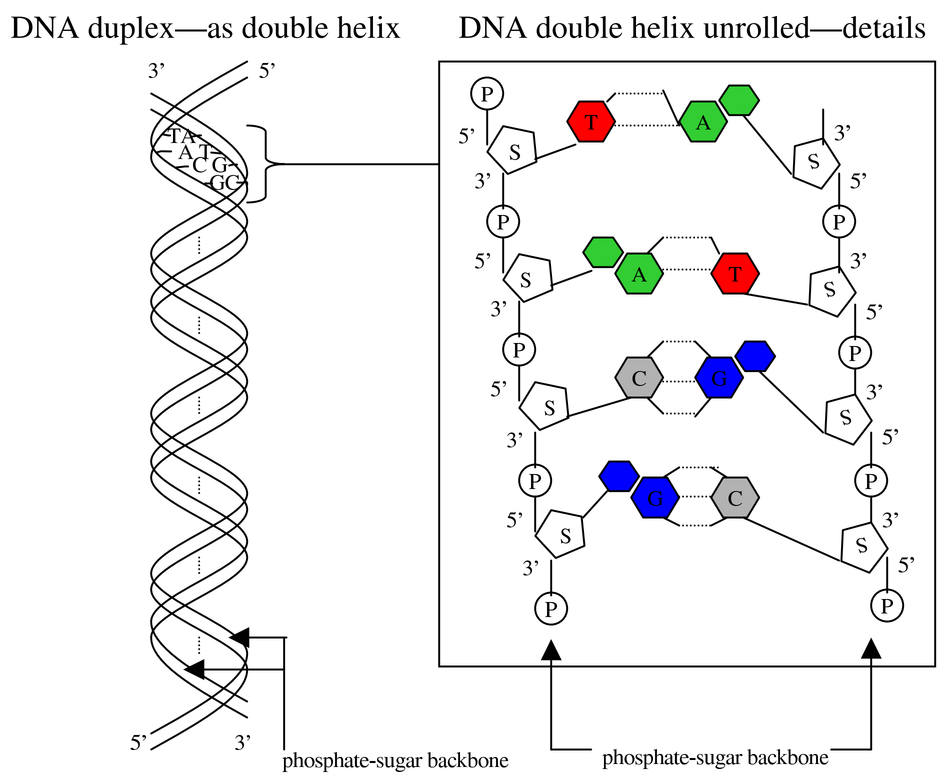

Figure 2: **DNA molecule**. The double-stranded DNA molecule (DNA duplex) is a double-helix (left) where the helices are the phosphate-sugar backbones. On the right, the double helix is unrolled to show the phosphate-sugar backbone and base pairing structure in details.

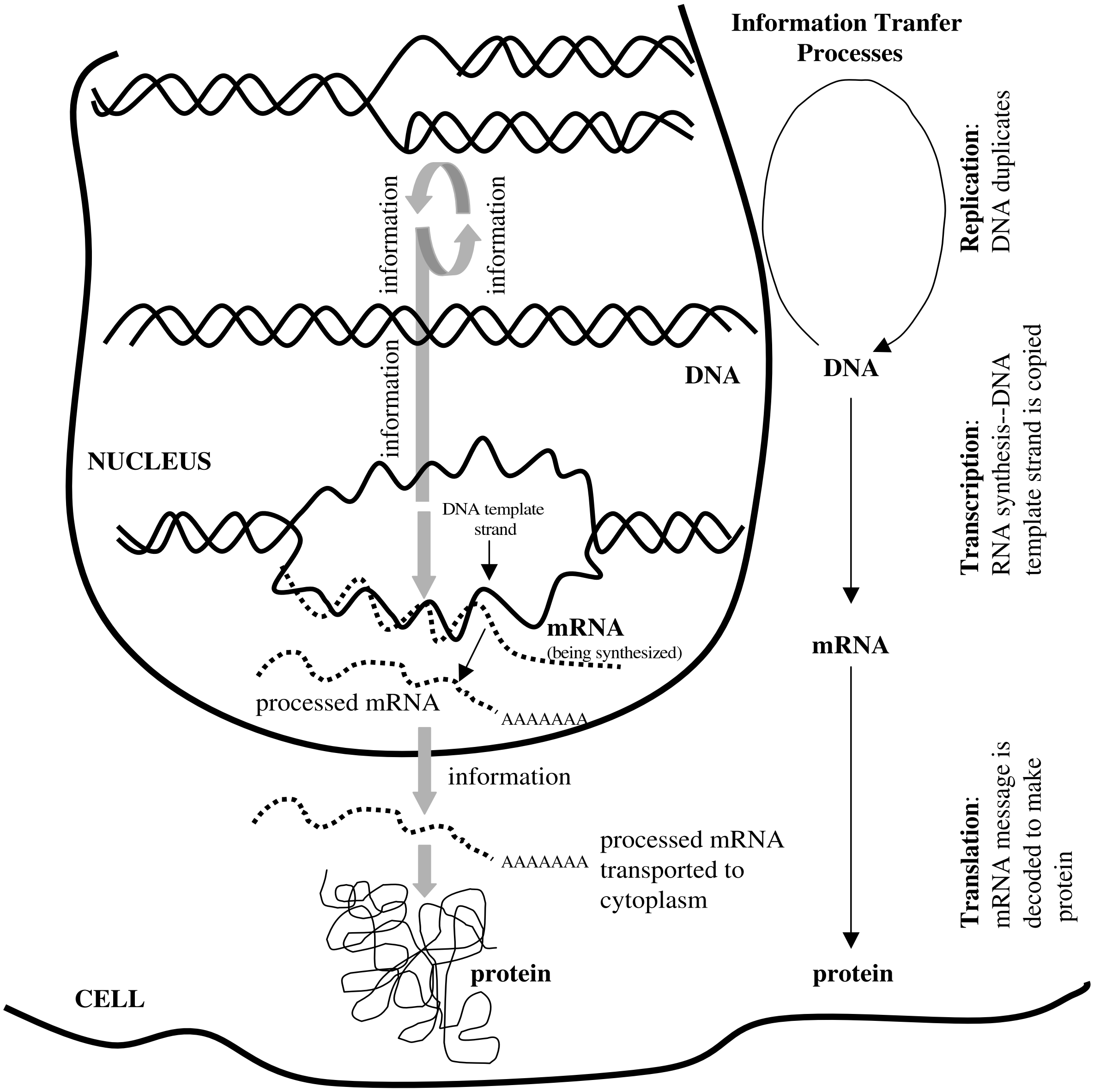

Figure 3: **Information transfer processes: the central dogma of molecular biology.** Depicted are three information transfer processes: (1) replication when DNA duplicates, (2) transcription when DNA copied to RNA ■ ■ ■ ■), and (3) translation when the RNA message is translated to make protein. Microarray experiments aims to detect the expressions of thousands of genes in each sample (array) by measuring the abundance of mRNA corresponding to the thousands of genes from DNA transcription.

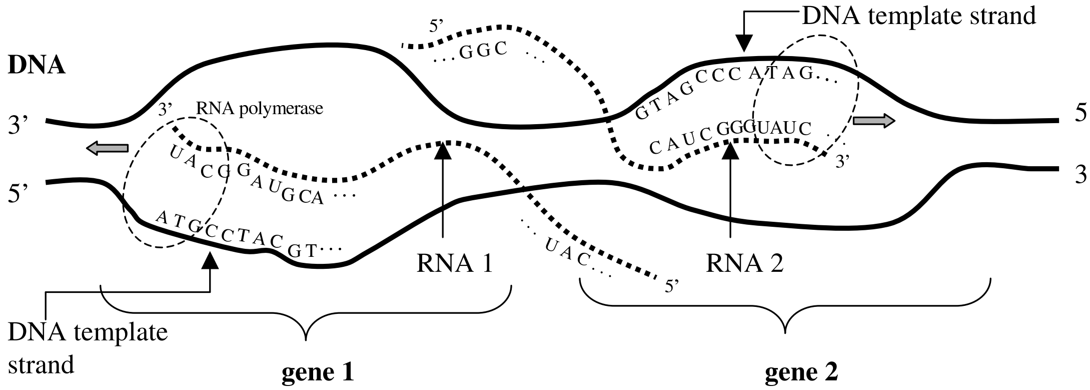

Figure 4: **The transcription process**. Displayed are the transcription of two genes. The DNA templates of gene 1 and 2 are copied (transcribed) to RNA strands (■ ■ ■ ■) 1 and 2 respectively. RNA synthesis is catalyzed by an enzyme called RNA polymerase (dashed ellipses). The RNA strands are always synthesized in the $5'$ to $3'$ direction, as indicated by the solid (gray) arrows next to the RNA polymerase depicted above. Note that the complementary base pairing rules between DNA template strands and the resulting RNA strands: A-U, T-A, C-G, and G-C. The information product of transcription is mRNA, the basic quantity to detect in microarray experiments.

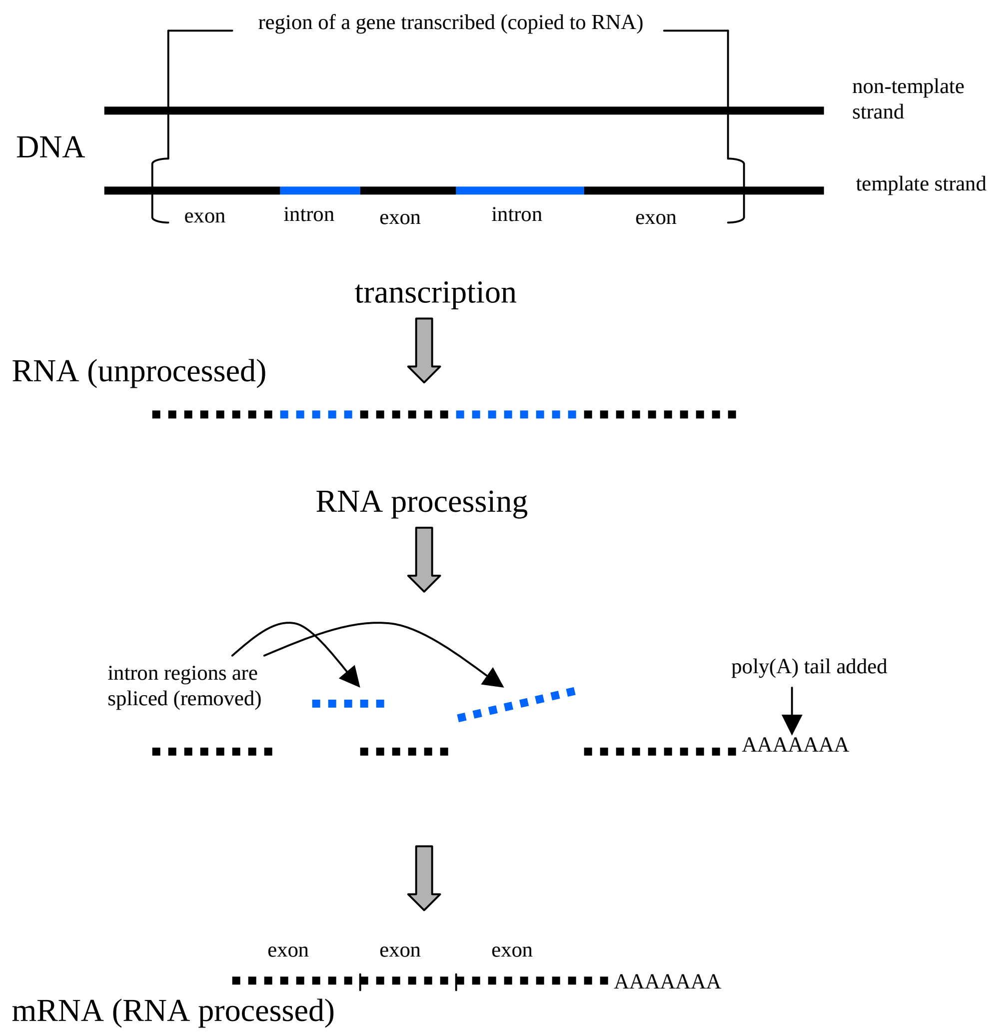

Figure 5: **RNA processing**. The DNA segment corresponding to a gene (top) consists of coding regions called exons and these regions are interrupted with intervening non-coding regions called introns (blue). During transcription the whole segment of DNA corresponding to the gene is copied to RNA. An RNA processing removes the introns and the exons are joined at the intron-exon junctions (bottom). Also, a poly(A) tail (sequence AAAA...) is added to mRNA. The poly(A) tail is a "signature" of mRNA (distinguishing it from other types of RNA such as rRNA and tRNA) and is exploited in an experimental process called reverse transcription (see Figure 1 in the article) utilized to prepare cDNAs in microarray experiments. RNA processing occurs in the nucleus where transcription takes place and once processed the mRNAs are transported to the cytoplasm.