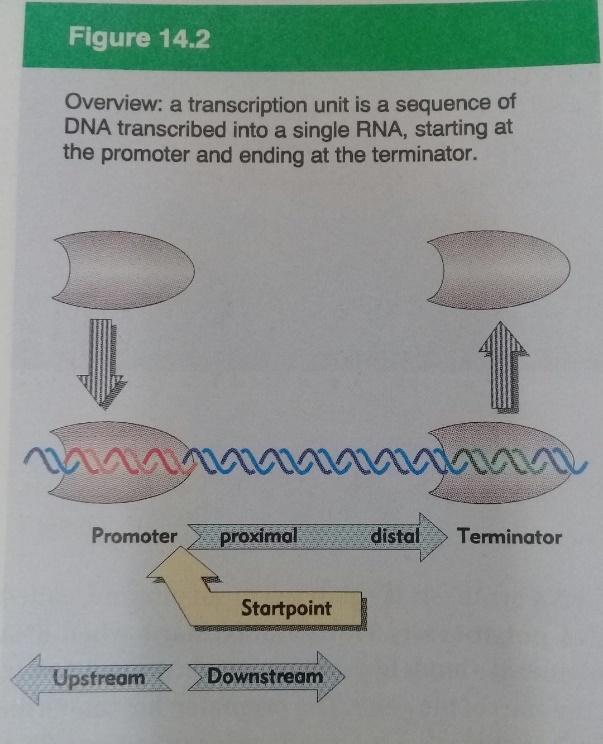
**RNA Metabolism**

* All RNA molecules except the RNA genomes of certain viruses are derived from information permanently stored in DNA.
* During **transcription**, an enzyme system converts the genetic information in a segment of double-stranded DNA into an RNA strand with a base sequence complementary to one of the DNA strands.
* Three major kinds of RNA are produced.
* **Messenger RNAs (mRNAs)** encode the amino acid sequence of one or more polypeptides speciﬁed by a gene or set of genes.
* **Transfer RNAs (tRNAs)** read the information encoded in the mRNA and transfer the appropriate amino acid to a growing polypeptide chain during protein synthesis.
* **Ribosomal RNAs (rRNAs)** are constituents of ribosomes that synthesize proteins.
* During replication the entire chromosome is usually copied, but transcription is more selective.
* Only particular genes or groups of genes are transcribed at any one time, and some portions of the DNA genome are never transcribed.
* Speciﬁc regulatory sequences mark the beginning and end of the DNA segments to be transcribed and designate which strand in duplex DNA is to be used as the template.

**DNA-Dependent Synthesis of RNA**

* Transcription has initiation, elongation, and termination phases.

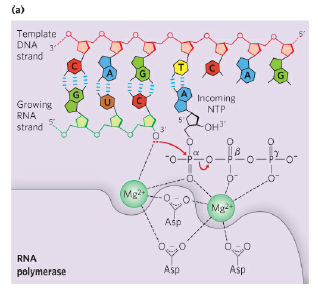


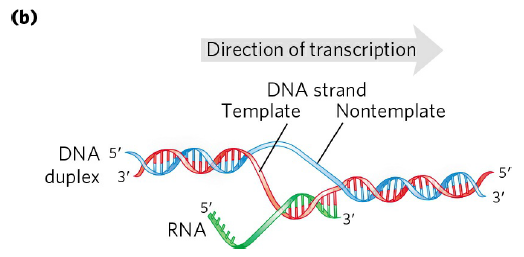
**RNA Is Synthesized by RNA Polymerases**

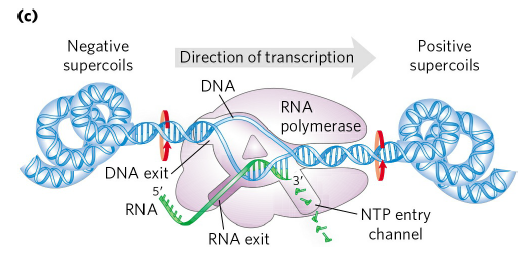
* *E. coli* RNA polymerase helped to define the fundamental properties of transcription.
* **DNA-dependent RNA polymerase** requires, in addition to a DNA template, all four ribonucleoside 5’-triphosphates (ATP, GTP, UTP, and CTP) as precursors of the nucleotide units of RNA **(Fig. 26–1a)**.
* RNA polymerase elongates an RNA strand by adding ribonucleotide units to the 3’- hydroxyl end, building RNA in the 5’  3’ direction.
* The overall reaction is

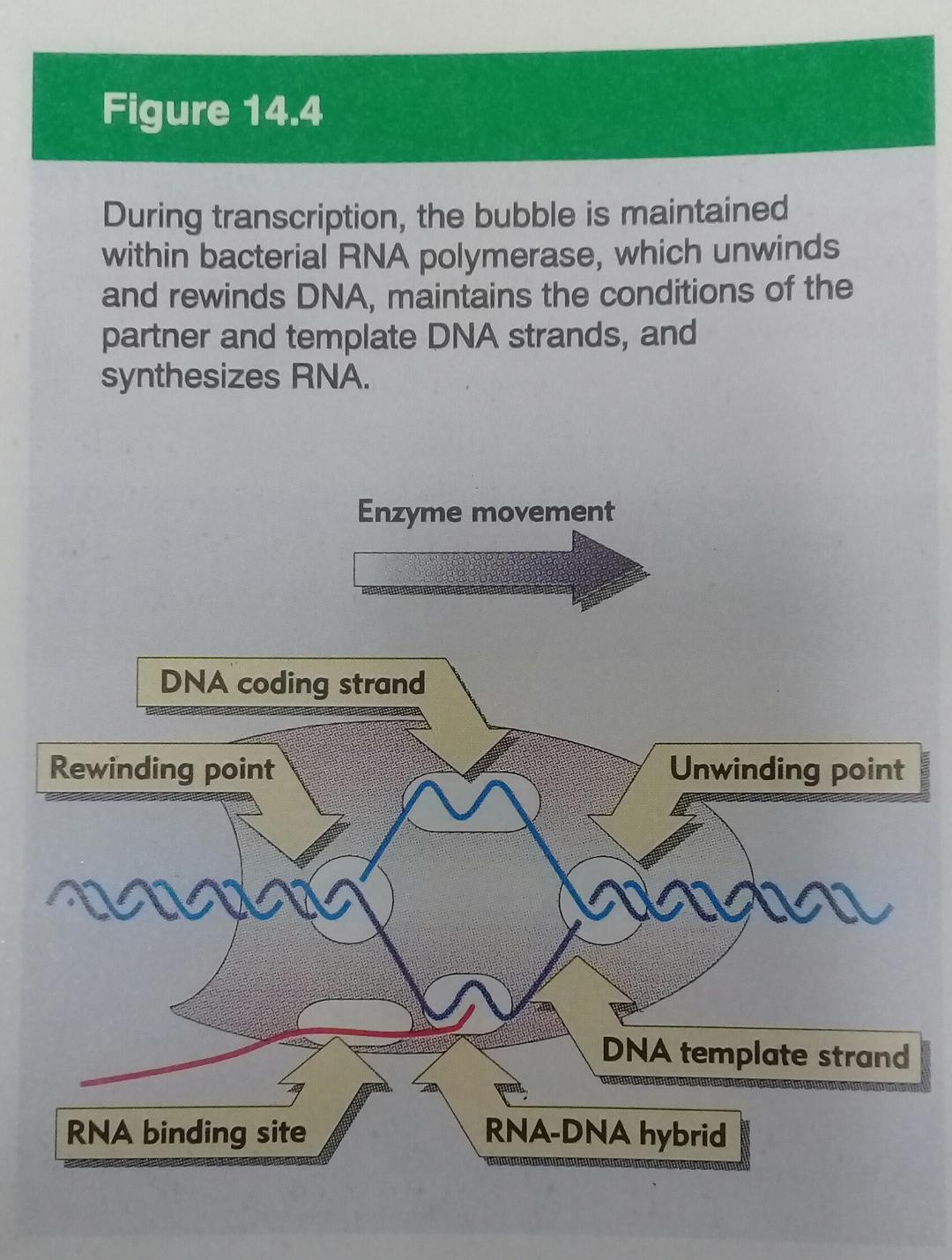
(NMP)*n +* NTP  (NMP)*n*+1 + PPi

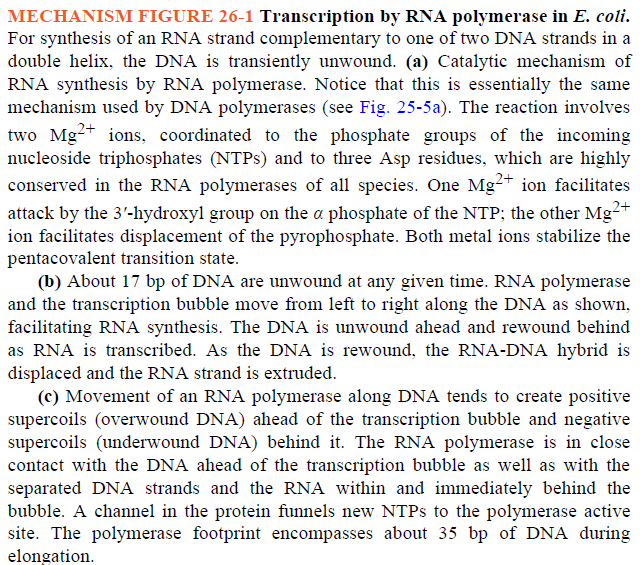
RNA Lengthened RNA



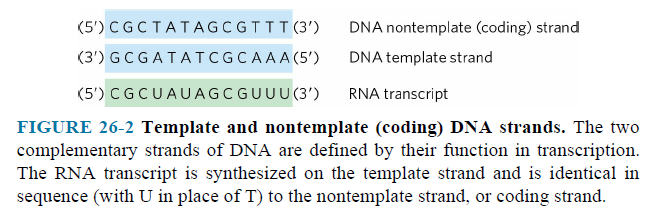




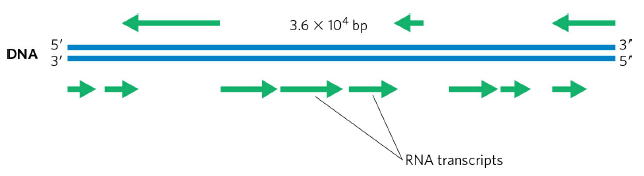


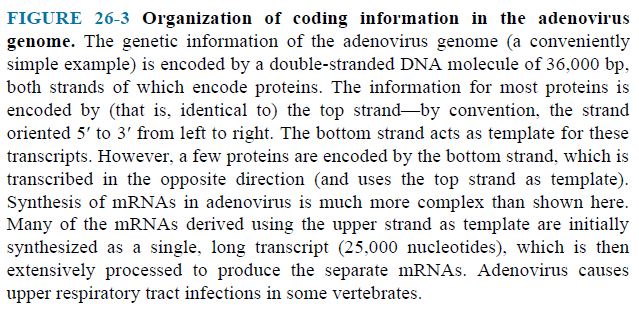


* The two complementary DNA strands have different roles in transcription **(Fig. 26–1b)**.
* The strand that serves as template for RNA synthesis is called the **template strand**.
* The DNA strand complementary to the template, the **nontemplate strand**, or **coding strand**,
  + is identical in base sequence to the RNA transcribed from the gene, with U in the RNA in place of T in the DNA **(Fig. 26–2)**.

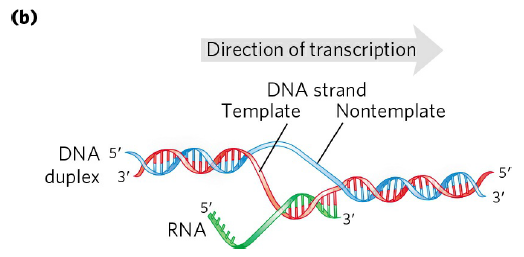


* The coding strand for a particular gene may be located in either strand of a given chromosome **(Fig. 26–3)**.

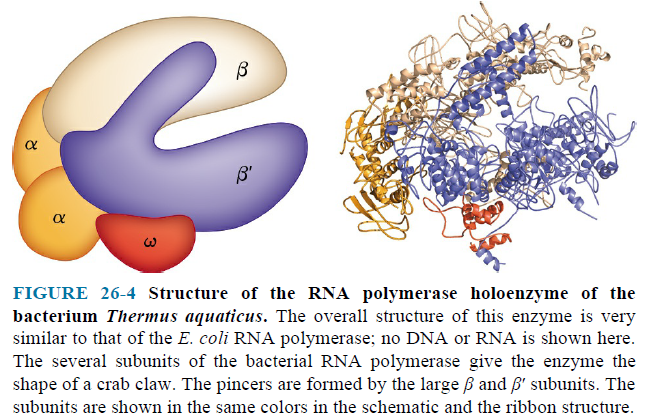


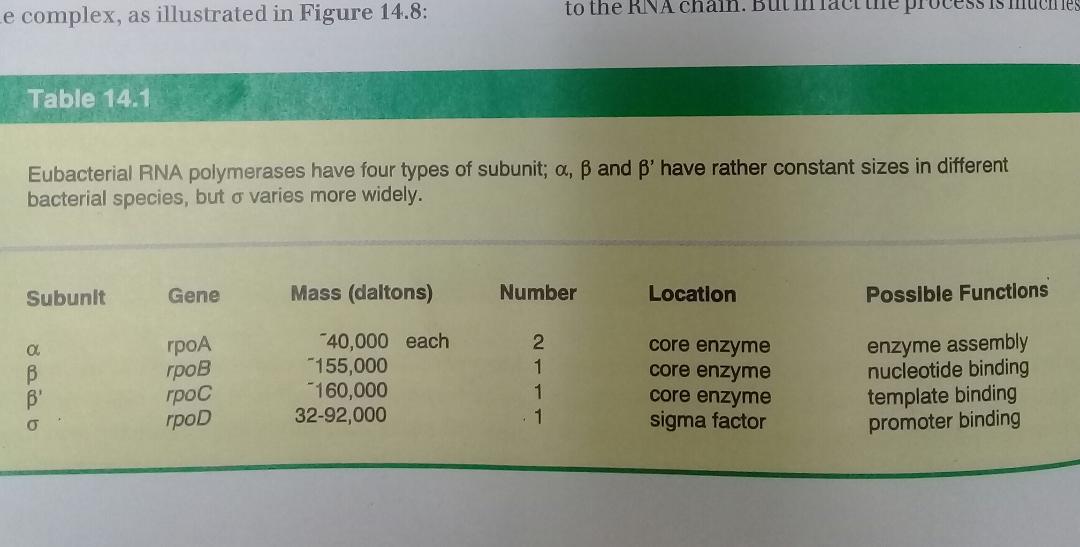


* The template DNA strand is copied in the 3’  5’ direction (antiparallel to the new RNA strand).
* Each nucleotide in the newly formed RNA is selected by base-pairing interactions; U residues are inserted in the RNA to pair with A residues in the DNA template, G residues are inserted to pair with C residues, and so on.
* Unlike DNA polymerase, RNA polymerase does not require a primer to initiate synthesis.
* Initiation occurs when RNA polymerase binds at specific DNA sequences called **promoters**.
* During the elongation phase of transcription, the growing end of the new RNA strand base-pairs temporarily with the DNA template to form a short hybrid RNA-DNA double helix, estimated to be 8 bp long **(Fig. 26–1b)**.



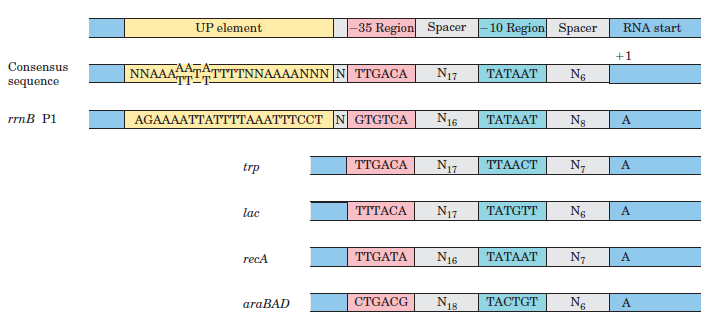
* Elongation of a transcript by *E. coli* RNA polymerase proceeds at a rate of 50 to 90 nucleotides/s.
* The DNA-dependent RNA polymerase of *E. coli* is a large, complex enzyme with ﬁve core subunits (') and a sixth subunit, one of a group designated .
* The subunit binds transiently to the core and directs the enzyme to speciﬁc binding sites on the DNA.
* These six subunits constitute the RNA polymerase holoenzyme **(Fig. 26–4)**.

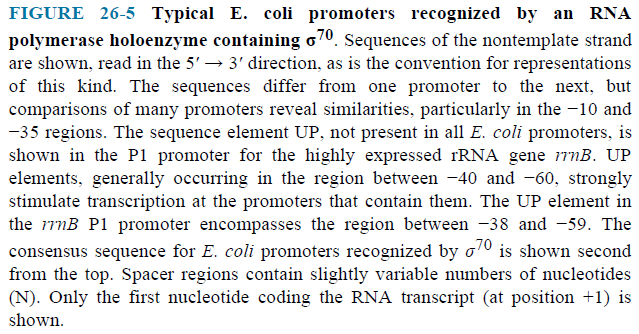




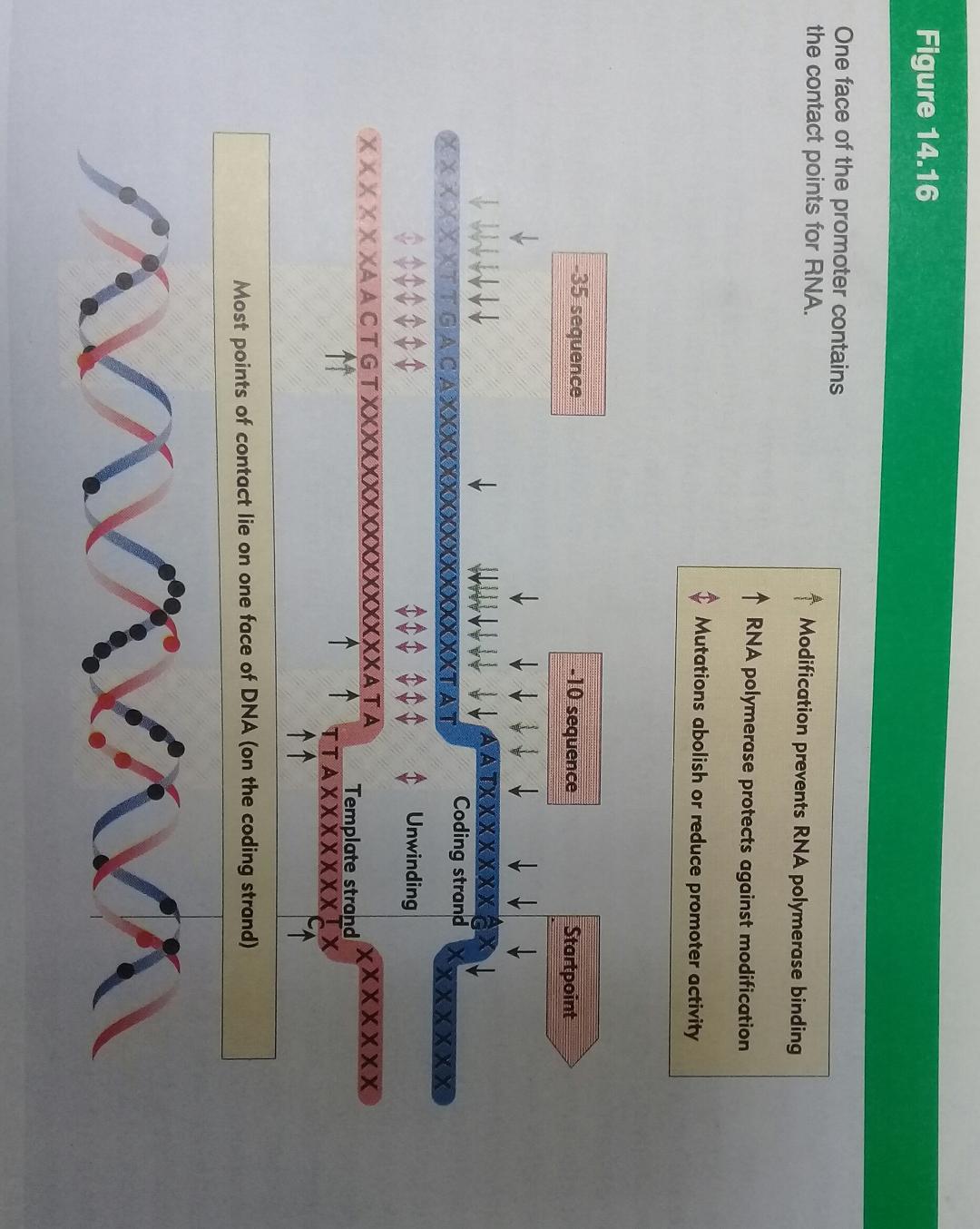
**RNA Synthesis Begins at Promoters**

* RNA polymerase binds to speciﬁc sequences in the DNA called **promoters**.
* The promoter region extends between positions -70 and +30.
* Bacterial promoters have similarities in two short sequences centered about positions -10 and -35.
* These sequences of the nontemplate strand, read in the 5’  3’ direction, are important interaction sites for the subunit **(Fig. 26–5)**.

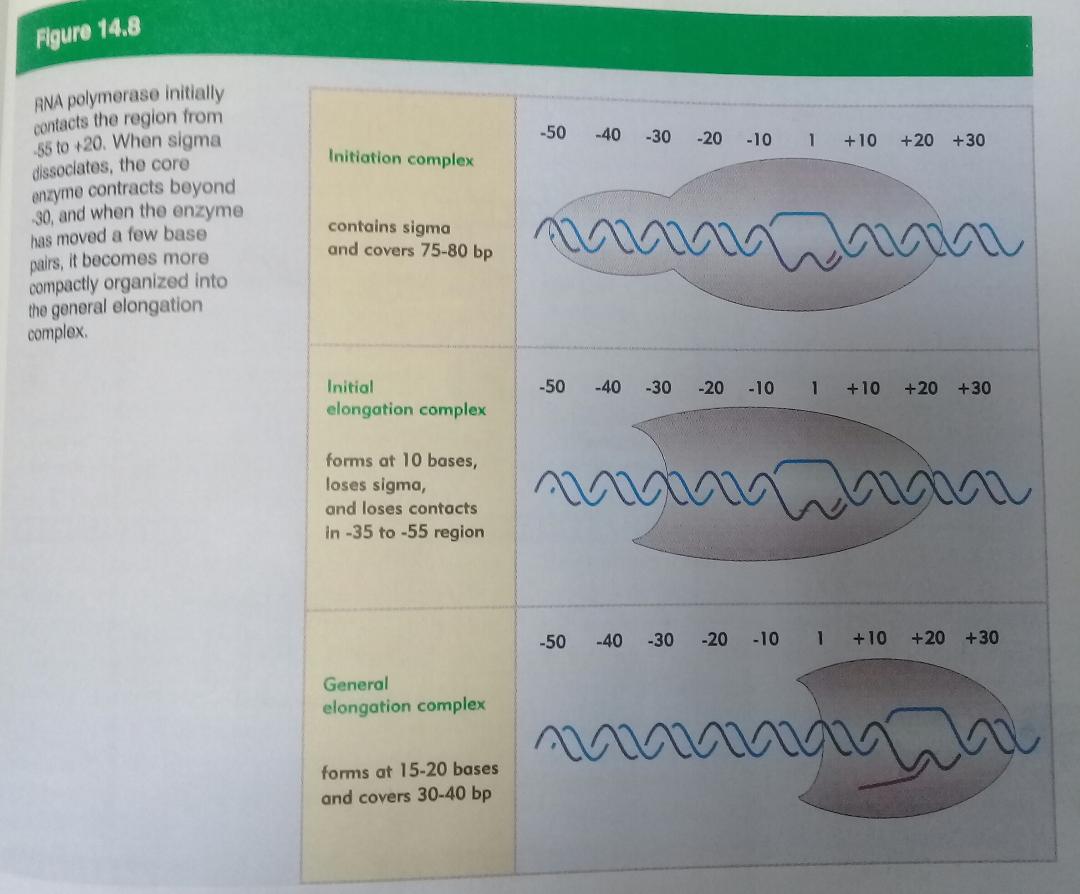


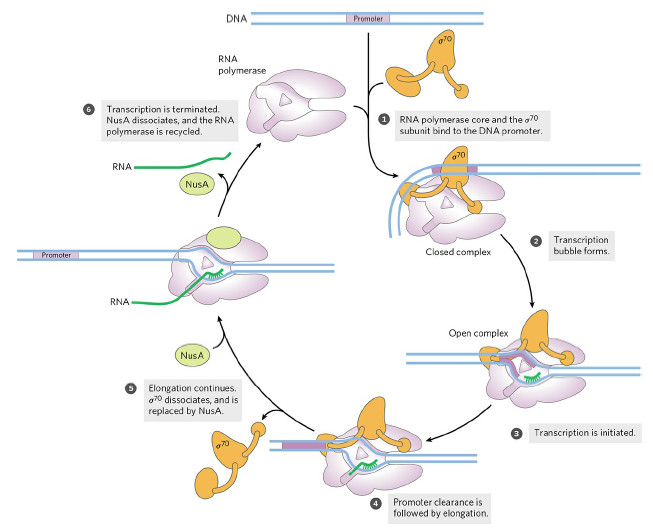


* The consensus sequence at the -10 region is (5’)TATAAT(3’); the consensus sequence at the -35 region is (5’)TTGACA(3’).

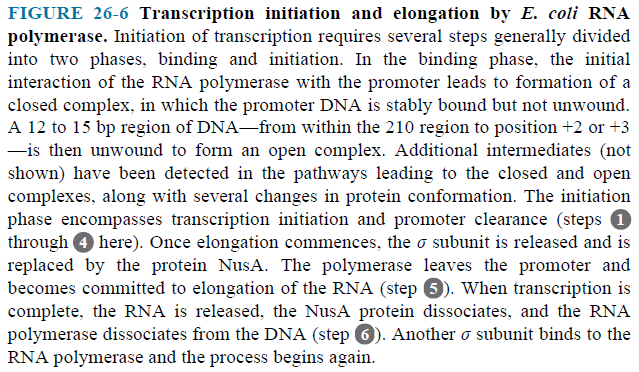


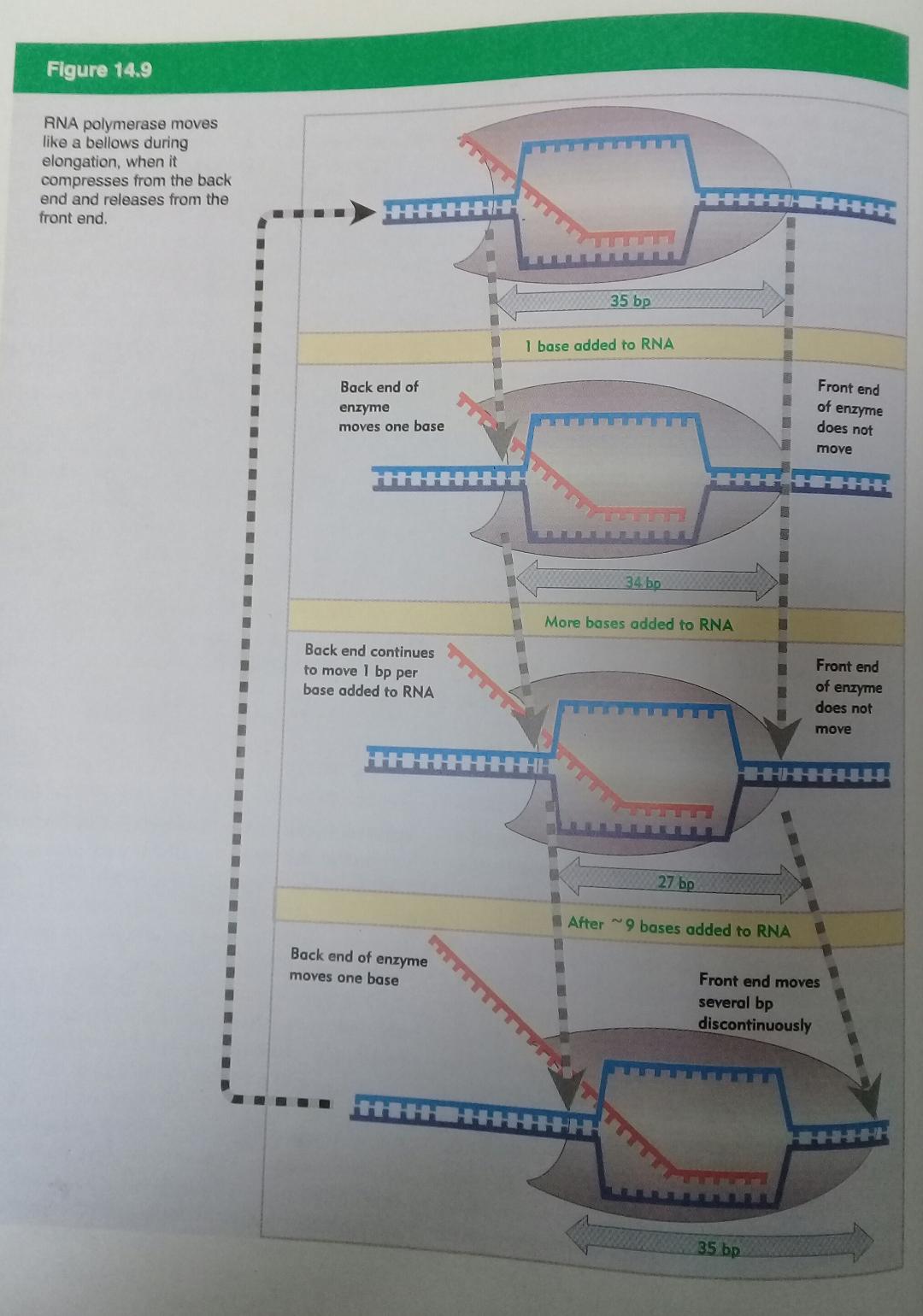
* RNA polymerase core binds to the DNA promoter **(Fig. 26–6)**.

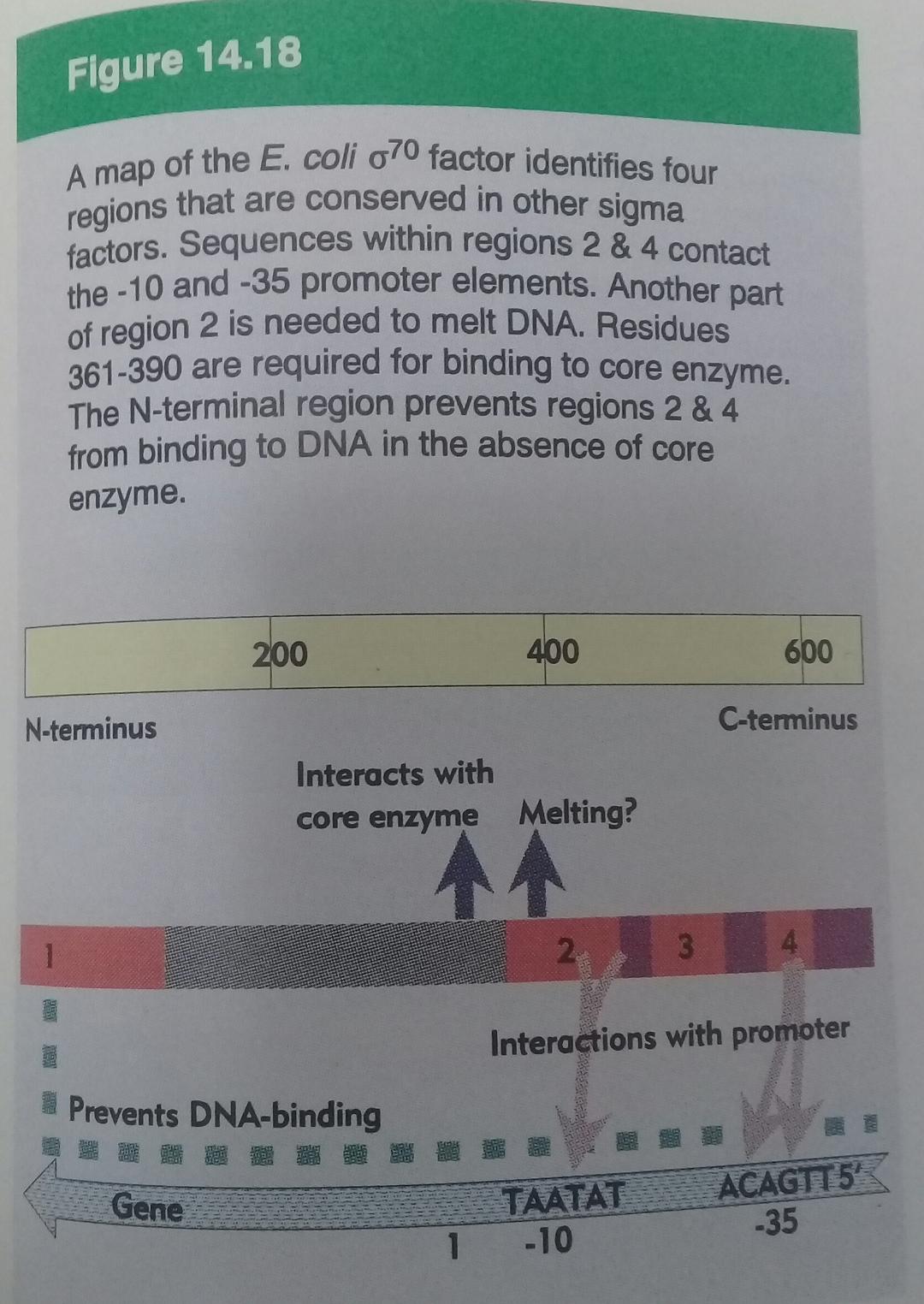


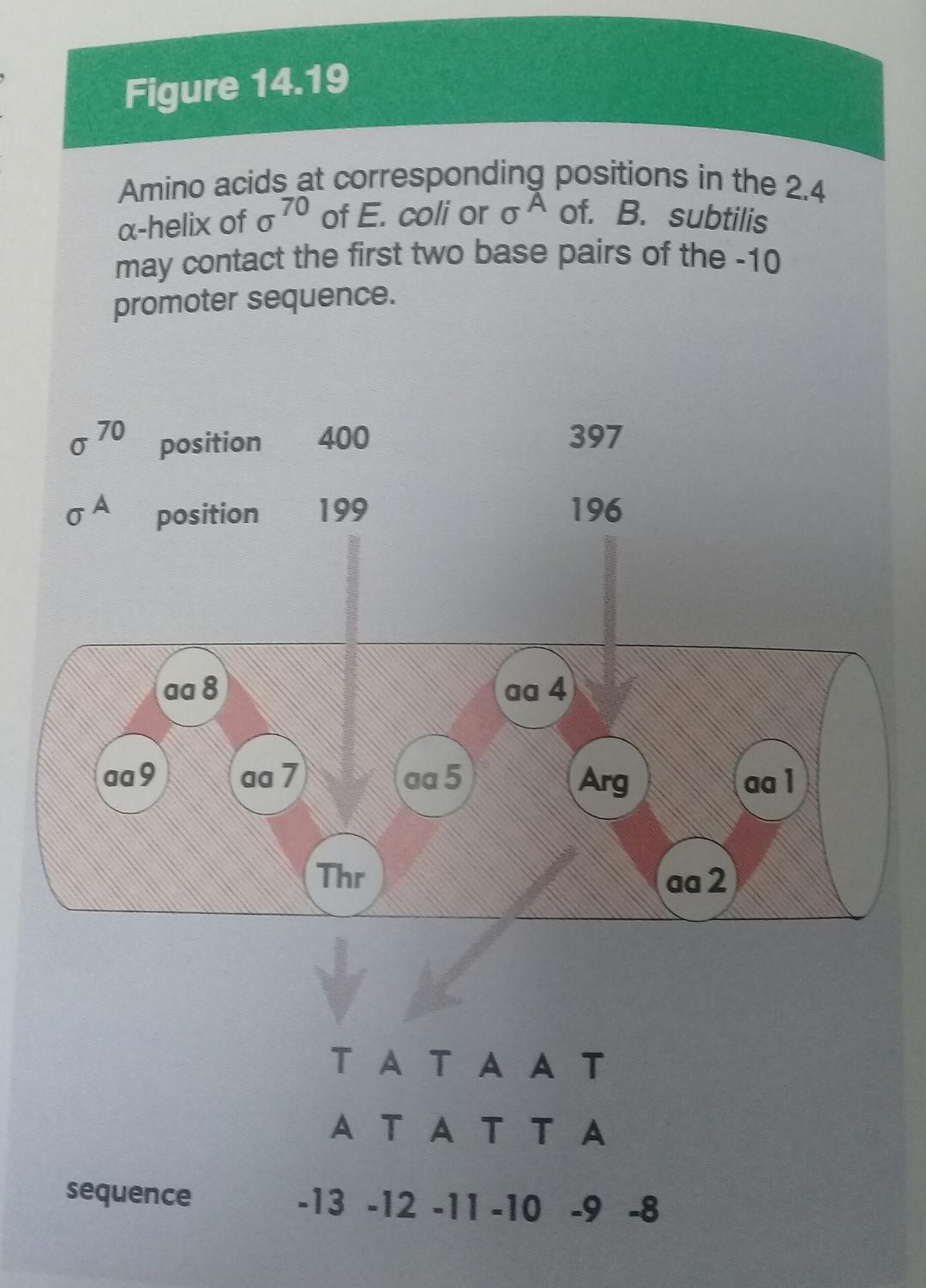


* Transcription bubble forms.
* Transcription is initiated.
* Promoter clearance is followed by elongation.
* Elongation continues.  dissociates, and is replaced by protein NusA.
* Transcription is terminated. NusA dissociates, and the RNA polymerase is recycled.
* factor can again bind to the enzyme to initiate transcription.





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