

DNA Structures

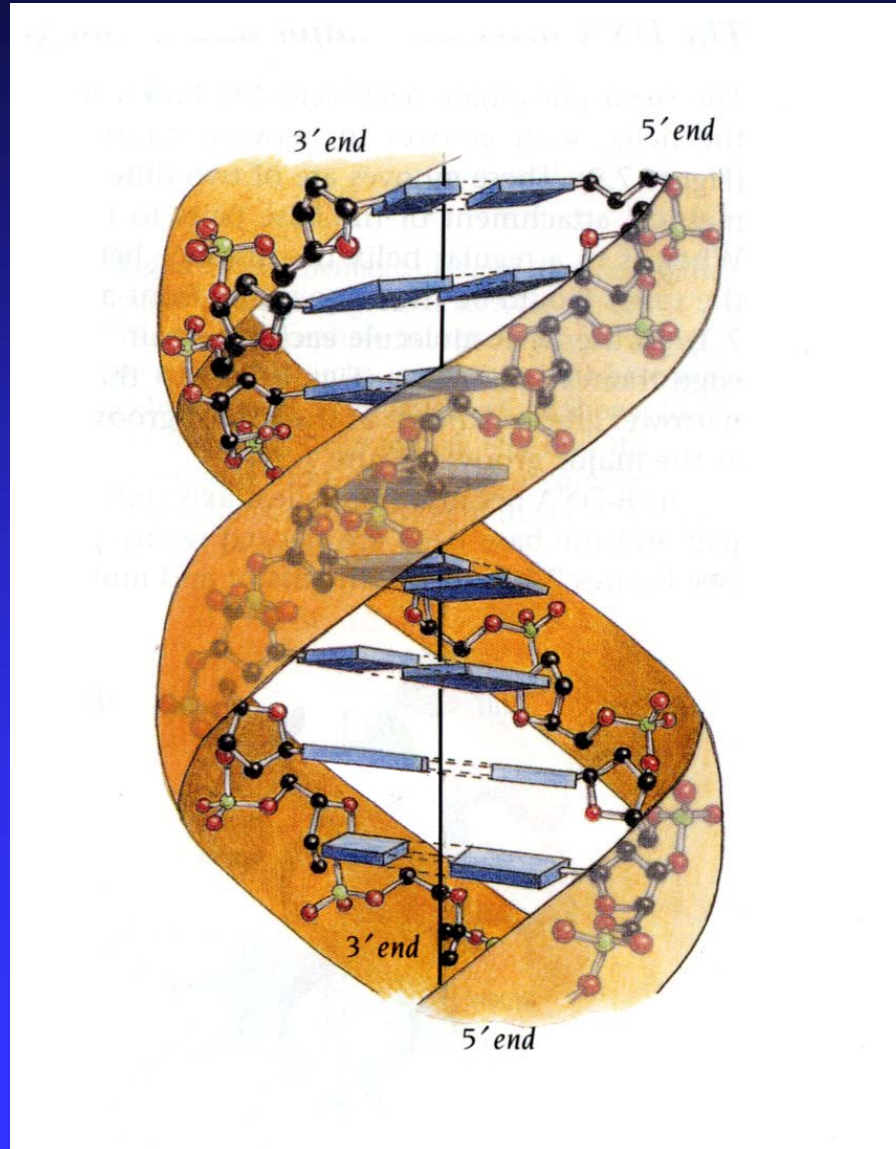
DNA Structures

-DNA replication, transcription and regulation of gene expression all depend upon the recognition of DNA by proteins.

-By a powerful combination of structural and genetic studies, in recent years we have begun to understand how these functions are achieved.

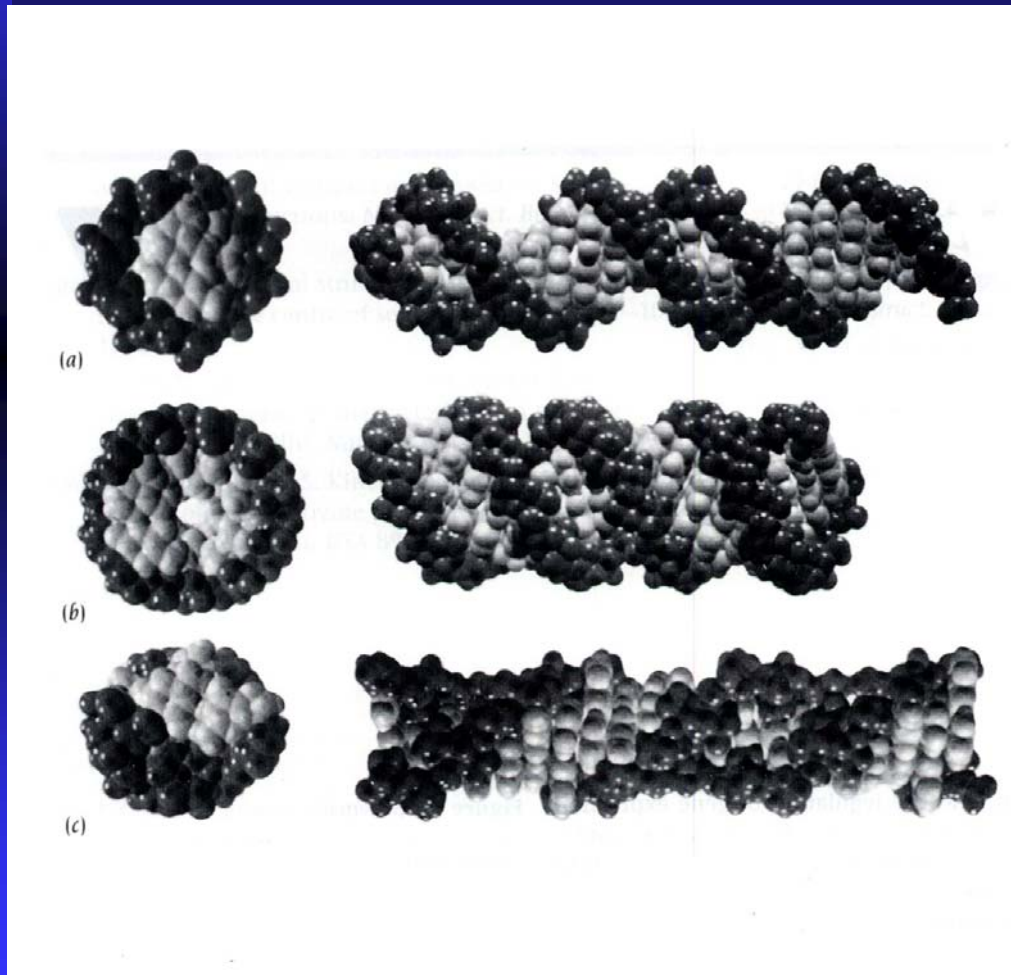
-Before tackling the structures of DNA-binding proteins and the complexes they form with DNA, we need to understand the structure of the **double-stranded, base-paired helical DNA** molecule on its own to see what possibilities it offers for the recognition of specific sequences by proteins.

DNA structures



The DNA double helix is different in A- and B-DNA

Three helical forms of DNA, each containing 22 nucleotide pairs, shown in both side and top views.

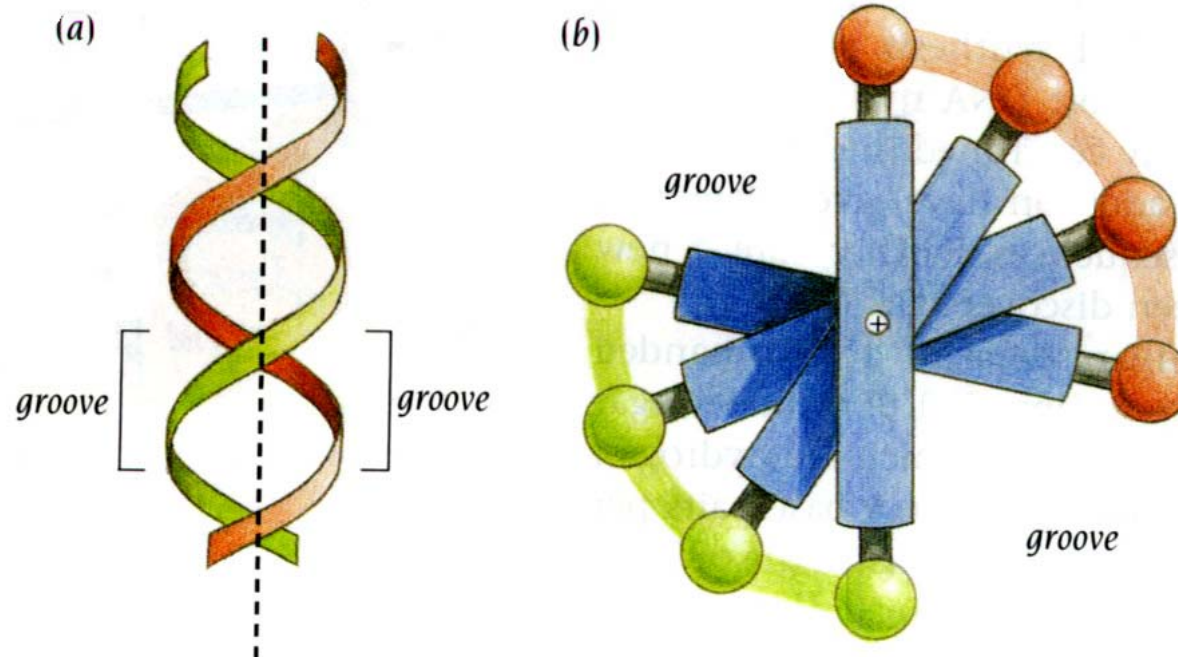


a) B-DNA, which is the most common form in cells.

b) A-DNA, which is obtained under dehydrated non-physiological conditions. Notice the hole along the helical axis in this form.

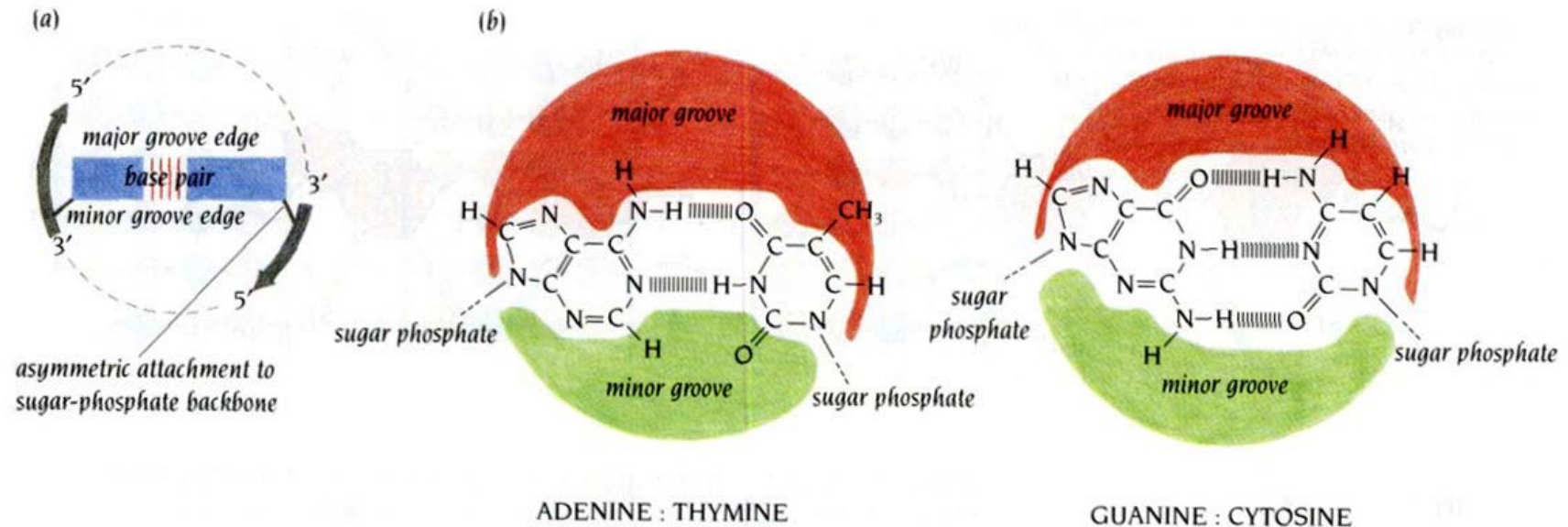
c) Z-DNA, which can be formed by certain DNA sequences under special circumstances.

The DNA helix has major and minor grooves



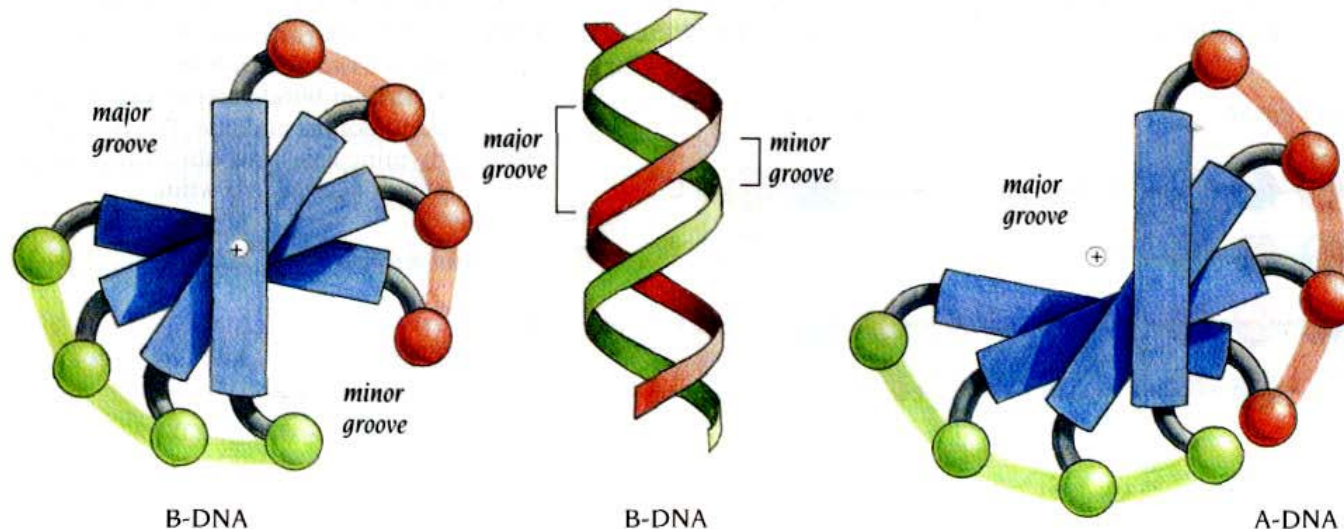
There are two similar grooves in a symmetric helical staircase.

The DNA helix has major and minor grooves



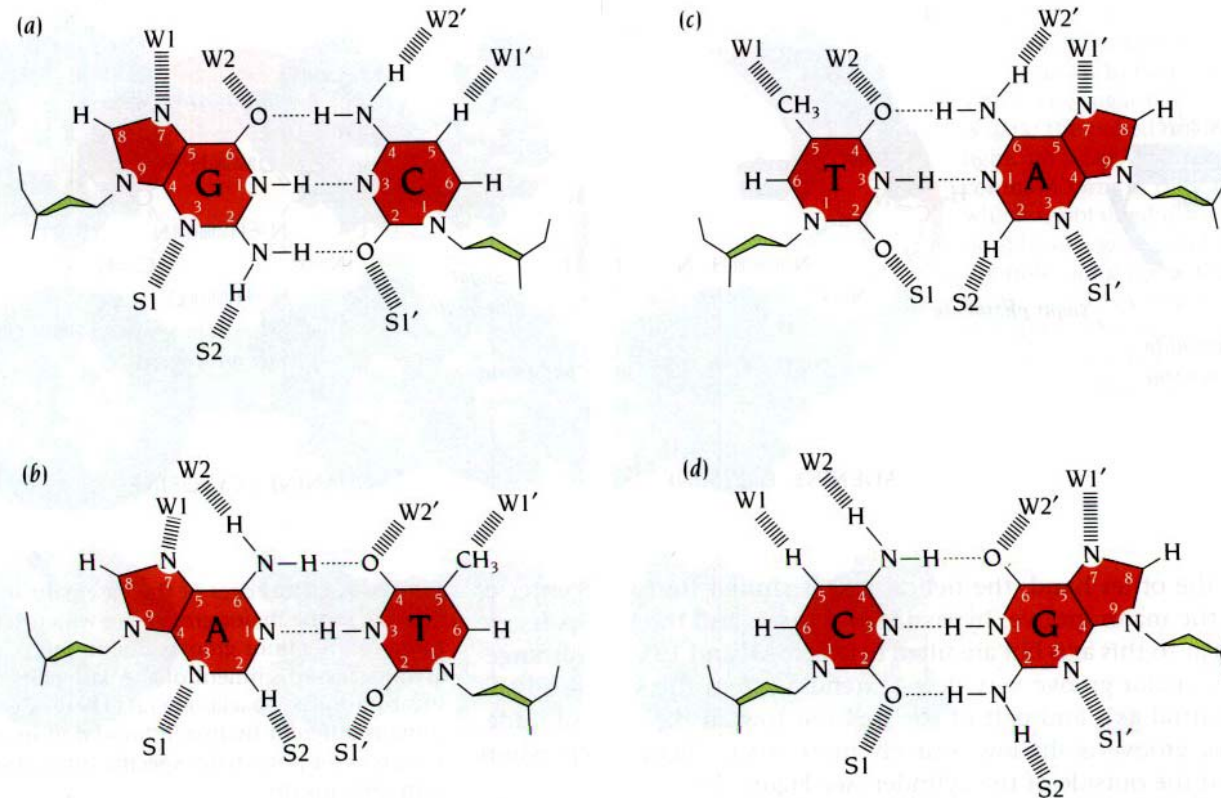
The edges of the base pairs in DNA that are in the major groove are wider than those in the minor groove, due to the asymmetric-attachment of the base pairs to the sugar-phosphate backbone (a). These edges contain different hydrogen bond donors and acceptors for potentially specific interactions with proteins (b).

The DNA helix has major and minor grooves



In A-DNA, the helical axis is shifted from the center of the bases into the major groove, bypassing the bases, and the base pairs are not perpendicular to this axis but are tilted between 13° and 19° . This arrangement makes the major groove very deep, while the minor groove is shallow.

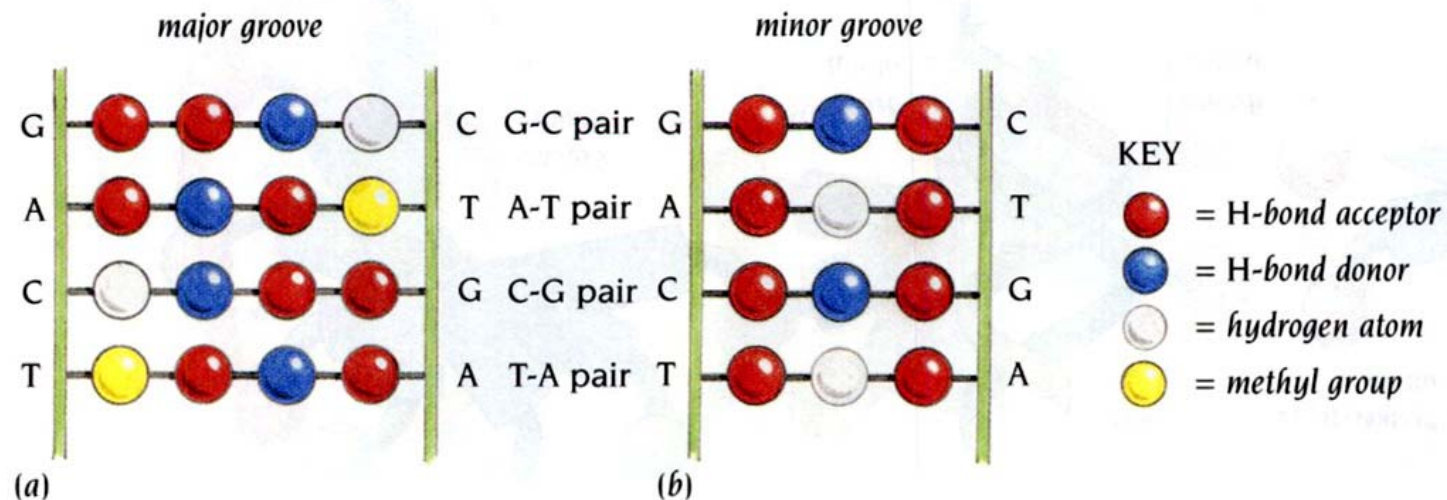
Specific base sequences can be recognized in B-DNA



The edges of the base pairs contain nitrogen and oxygen atoms that can make hydrogen bonds to protein side chains. An H atom in cytosin and a methyl group in thymine form additional sequence-specific recognition sites in DNA.

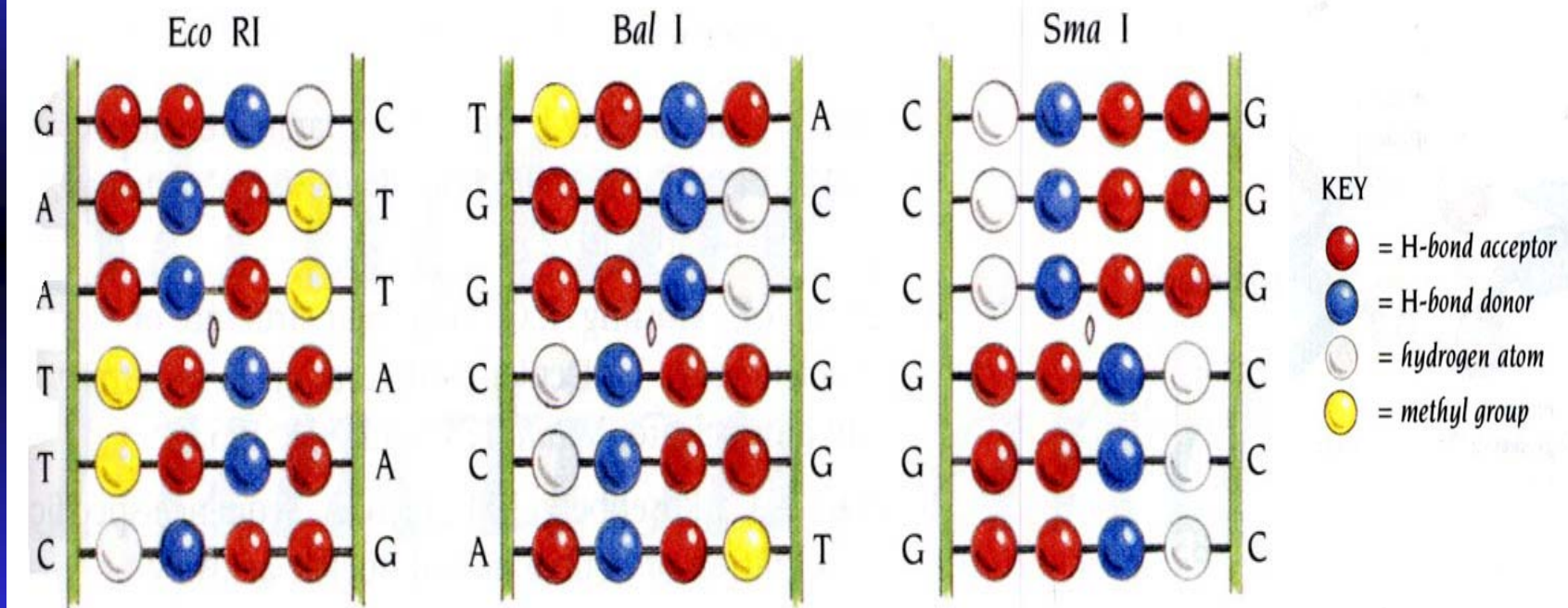
W1, W2, W2', and W1' are the recognition sites at the edges of the base pairs in the major groove and S1, S2', and S1' are those in the minor groove.

Specific base sequences can be recognized in B-DNA



Color codes for the recognition patterns at the edges of the base pairs in the major (a) and minor (b) grooves of B-DNA.

Specific base sequences can be recognized in B-DNA



Sequence-specific recognition sites in the major groove of DNA for three restriction enzymes – EcoRI, BalI, and SmaI.