

## CSIR NET Life Science Unit 3

### Deoxyribonucleic Acid (DNA)

DNA: There are 3 forms of DNA in which A and B forms are right-handed helix while Z form is left-handed. Watson - Crick Model is of B-form. The strands run anti-parallel in nature. There are about 10 base pairs per turn of the helix. One turn of the helix is 34 Å, and the base pairs are 3.4 Å apart. Sugar phosphates are on the outside, while base pairs are on the inside. There is a minor groove and a major groove.

- **B-form** of DNA is stable at high humidity conditions (95%), but at 75% humidity, it is converted into A form. B-DNA is the most hydrated and stable form of DNA under high humidity conditions. Since salt dehydrates DNA, thus, A-DNA converts to Z-DNA in solutions with high salt concentration. Phosphates are individually hydrated in B-form, but one water molecule forms a bridge between two phosphates in A and Z-forms, stabilizing these forms in low humidity.
- **A-form**, the helix axis is inclined by about 13 degrees, and there is ~10.9 bp per turn. The major groove is also very deep (~1.35 nm) and narrower (~0.27 nm) than the B form and is extensively hydrated. The minor groove is relatively wide (~1.1 nm) and shallow (~0.28nm) than B-form. It is a right-handed double helix and is short and stout compared to B-DNA. The A-form occurs only in dehydrated samples of DNA like those used in X-ray crystallographic experiments. Crystal structures of an intermediate form between A and B forms have been reported, often called the E-DNA *eccentric DNA*.
- **Z-DNA** has an interesting feature; it is left-handed with the backbone following a zig-zag pattern and contains 12 bp per turn. In contrast to B-DNA, where a repeating unit is 1 bp, the repeating unit is 2 bp in Z-form. The major groove of Z-DNA is shallow, allowing it to accommodate bulky substituents at C8 of purines or C5 of pyrimidines. Z-form is favoured in the regions rich in G-C pairs. *E. coli* and *Halobacterium* are known to contain left-handed forms of DNA. Segments of Z-DNA may occur in the enhancer region or may be formed behind RNA polymerase molecules that are moving along a gene while synthesizing mRNA. The associated negative supercoiling of the DNA could cause it to assume the Z-form. This region of Z-form can, in turn, be a site for interaction with specific proteins.

**Other Rare Variants -**

**C-DNA** - Formed at 66% relative humidity in the presence of  $\text{Li}^+$  and  $\text{Mg}^{2+}$  ions.

**D-DNA** - Scarce variant with 8 bp per helical turn found in some DNA molecules devoid of the guanine base.

**Table 1. Comparison of different DNA types**

Geometry attribute	A-form	B-form	Z-form
Helix sense	right-handed	right-handed	left-handed
Repeating unit	1 bp	1 bp	2 bp
Rotation/bp	33.6°	35.9°	60°/2
Mean bp/turn	10.7	10.0	12
Inclination of bp to axis	+19°	6°	7°
Rise/bp along axis	2.3Å	3.32Å	3.8Å
Pitch/turn of helix	24.6Å	33.2Å	45.6Å
Mean propeller twist	+18°	+16°	0°
Glycosyl angle	anti	anti	anti for pyrimidine, syn for purine
Sugar pucker	C3'-endo	C2'-endo	C: C2'-endo, G: C3'-endo
Diameter	26Å	20Å	18Å
Major groove	Narrow and deep	Wide and deep	Flat
Minor groove	Wide and shallow	Narrow and deep	Narrow and deep



**A form DNA**

**B form DNA**

**Z form DNA**