

# **STRUCTURE OF DNA**

## **A, B and Z Form**

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# Different Types of DNA Conformations

- DNA, the genetic information carrier molecule of the cell, is a long polymer of nucleotides and can adopt different types of structural conformations. The various types of conformations that the DNA can adopt depend on different factors such as:
  - 1. Hydration level
  - 2. Salt concentration
  - 3. DNA sequence
  - 4. Quantity and direction of super-coiling
  - 5. Presence of chemically modified bases
  - 6. Different types of metal ions and its concentrations
  - 7. Presence of polyamines in solution.

# Different Types of DNA Conformations

- The most common types of structural conformations of DNA are named as:
  - (1). A-DNA
  - (2). B-DNA
  - (3). Z-DNA
- Among these three types, the most abundant type of DNA is B-DNA, commonly known as Watson-Crick Model of DNA double helix.

# B-DNA

- The B-DNA is the most common and predominate type of structural conformation of DNA in the cells. The DNA prefers to occur in B form under the natural physiological conditions (pH and salt concentration) in the cell.
- The B-DNA is better described as the Watson – Crick Model of DNA described for the first time by James Watson and Francis Crick. Important structural features of B-DNA are given below:
- Majority of the DNA in a cell is in B-DNA conformation.
- B-DNA is a right handed helix.



DNA and proteins usually coil into right-handed helices.



A right-handed helix curves in the direction of the fingers in a right hand when the thumb points upward.



# B-DNA

- In B-DNA, the bases occupy at the core whereas the sugar phosphate backbone occurs at the peripheral portion of the helix.
- In B-DNA only the edges of the base pairs are exposed to the solvent.
- Each base pair in B-DNA has the same width.
- The width of A – T and G – C in B-DNA is 10.85 Å.
- The helical diameter of B-DNA is 20 Å.
- Each turn on helix in B-DNA possess a helical height of 34 Å.
- Each turn in the B-DNA consists of 10 base pairs.

# B-DNA

- The distance between adjacent base pairs in B-DNA is 3.4 Å.
- Each base pair will have a helical twist of  $36^0$  ( $360/10$ ).
- The plane of inter-strand hydrogen bonds are perpendicular to the helical axis.
- B-DNA has a solid central core.
- The major groove of B-DNA is wide and deep.
- The minor groove of B-DNA is narrow and deep.
- The sugar pucker in B-DNA is C2' endo form.
- The glycosidic bond conformation in B-DNA is in anti- form.

# A-DNA

- A-DNA is a rare type of structural conformation that a DNA can adopt under dehydrating conditions. A-DNA is a double stranded helical structure almost similar to B-DNA but with a shorter and more compact structural organization.
- A-DNA was discovered by Rosalind Franklin and the credit for the naming of A-DNA and B-DNA was also accounted to her.
- Important structural features of A-DNA are given below:
- A-DNA is formed from B-DNA under dehydrating condition.
- A-DNA is much wider and flatter than B-DNA.

# A-DNA

- Similar to B-DNA, the A-DNA is also a right handed helix.
- The helix diameter of A-DNA is 26 Å.
- The helix pitch (height of a turn) of A-DNA is 28.6 Å.
- A DNA is 20 to 25% shorter than B-DNA due to the smaller rise per turn.
- A-DNA contains 11.6 base pairs per turn.
- The distance between the adjacent base pairs is 2.9 Å.
- The helical twist per base pair in A-DNA is  $31^{\circ}$ .

# A-DNA

- A-DNA has an axial hole at the center (hollow central core).
- In A-DNA the base pairs are inclined to the helical axis.
- Individual base pairs in A-DNA are  $20^{\circ}$  tilted with respect to the helical axis.
- A-DNA has narrow and deep major grooves.
- The minor grooves of A-DNA are wide and shallow.
- The deoxyribose sugar pucker in A-DNA is C3' endo form
- The conformation of glycosidic bond in A-DNA is in Anti-form.

# Z-DNA

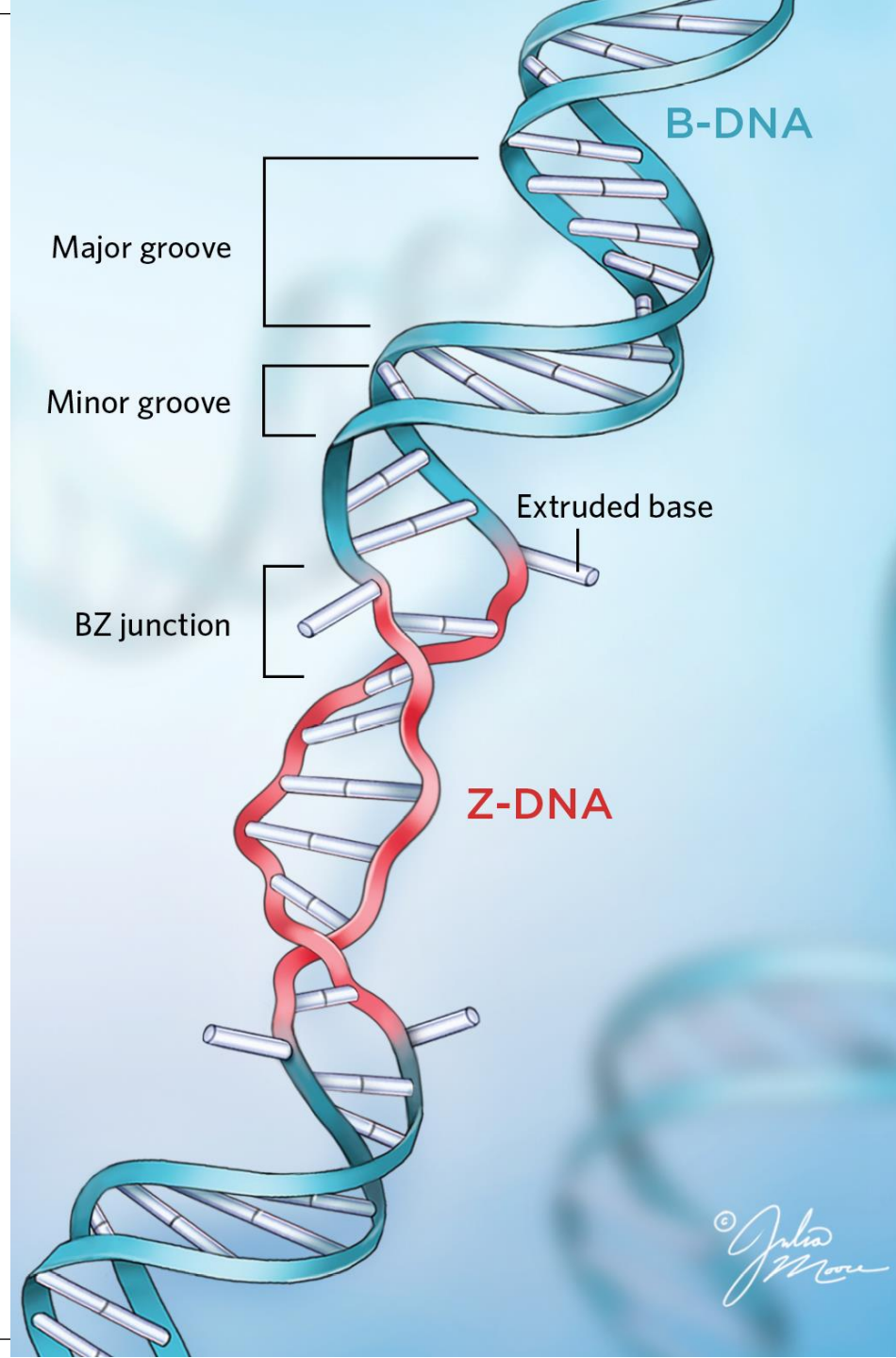
- Z-DNA is a left-handed double helical conformation of DNA in which the double helix winds to the left in a zig-zag pattern. The DNA strand with complementary nucleotides can form Z DNA conformation at high salt concentration.
- The existence of Z DNA was discovered by Andres Wang and Alexander Rich. Z-DNA is one of the biologically active forms of DNA found in vivo in the cells. The exact biological function of Z-DNA is not clear. The Z-DNA is usually located upstream of the start site of a gene and thus it may have some role in the regulation of gene expression.

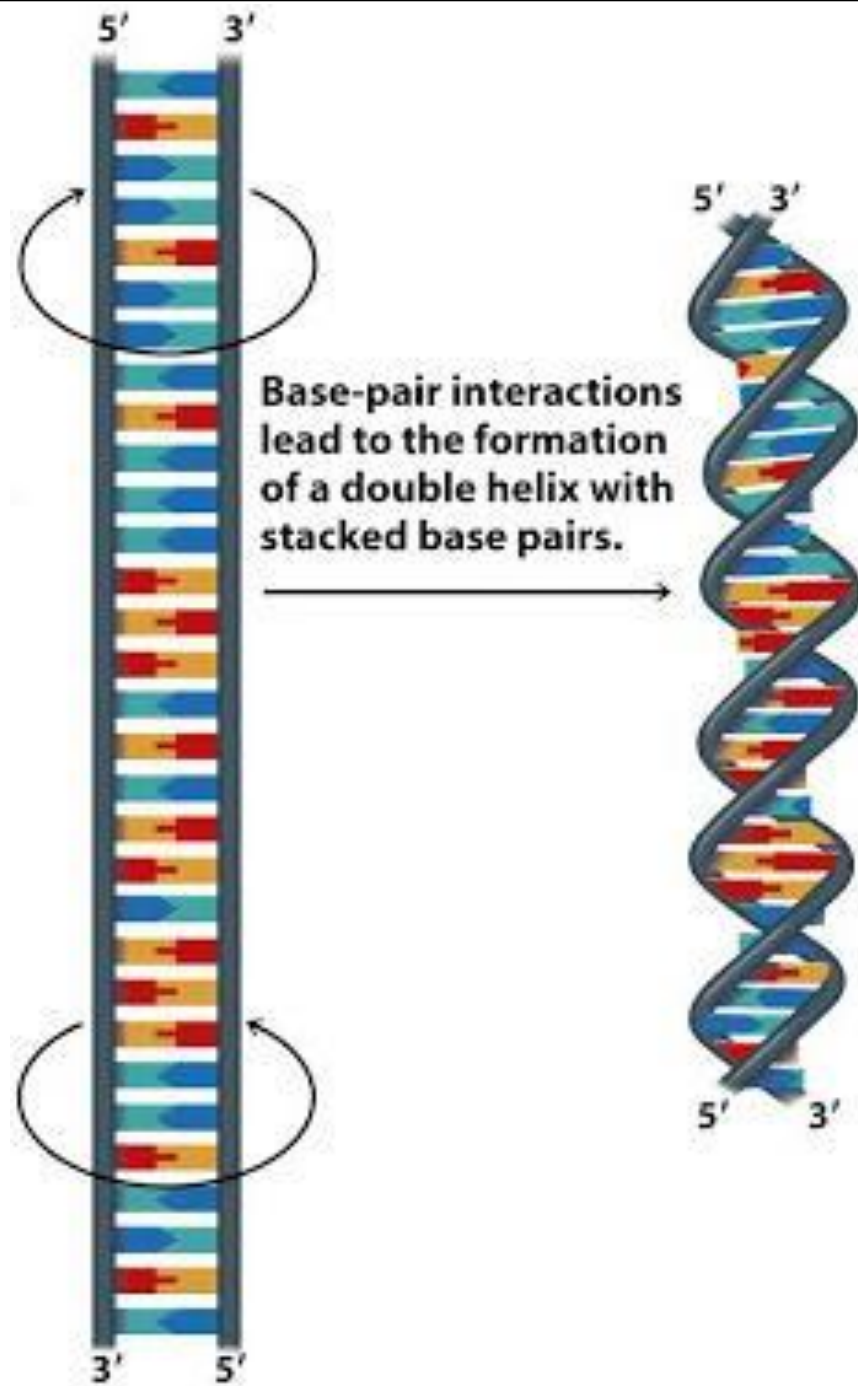
# Z-DNA

- Important structural features of B-DNA are given below:
- The Z-DNA is a left handed helical structure.
- The double helix winds in a zig-zag pattern.
- The helical diameter of Z-DNA is 18 Å.
- The total height of a helix turn is 44 Å.
- The nucleotide pairs in Z-DNA occur as nucleotide dimers.
- Each helical turn of Z-DNA contains 12 nucleotides (6 dimers).
- The helical turn per base pair in Z-DNA is  $9^{\circ}$  for pyrimidine – purine step and  $51^{\circ}$  for purine – pyrimidine step.

# Z-DNA

- The distance between each nucleotide is 7.4 Å.
- Z-DNA possesses a more or less flat major groove.
- The minor groove in Z-DNA is narrow and deep.
- Z-DNA has a solid core at the center.
- The sugar pucker is C2' endo for pyrimidine and C3' endo for purines.
- The glycosidic bond conformation is anti- for pyrimidines and syn- for purines.





# A comparison of A-DNA, B-DNA and Z-DNA

|                                         | A-DNA           | B-DNA           | Z-DNA                             |
|-----------------------------------------|-----------------|-----------------|-----------------------------------|
| Helix turn                              | Right handed    | Right handed    | Left handed                       |
| Helical diameter                        | 26 Å            | 20 Å            | 18 Å                              |
| Height of helical turns (helical pitch) | 28.6 Å          | 34Å             | 44Å                               |
| Number of base pairs per helical turn   | 11.6            | 10              | 12 (6 dimers)                     |
| Helical twist per base pair             | 31 <sup>0</sup> | 36 <sup>0</sup> | 9 <sup>0</sup> or 51 <sup>0</sup> |

# A comparison of A-DNA, B-DNA and Z-DNA

|                                                             | A-DNA            | B-DNA           | Z-DNA                                           |
|-------------------------------------------------------------|------------------|-----------------|-------------------------------------------------|
| Distance between each base pair<br>(helical rise/base pair) | 2.9 Å            | 3.4 Å           | 7.4 Å                                           |
| Base tilt to the normal helical axis                        | 20°              | 6°              | 7°                                              |
| Major grove                                                 | Narrow and deep  | Wide and deep   | Flat major groves                               |
| Minor grove                                                 | Wide and shallow | Narrow and deep | Narrow and deep                                 |
| Ribose sugar conformation                                   | C3' endo         | C2' endo        | C2' endo for pyrimidine and C3' endo for purine |
| Glycosidic bond conformation                                | Anti-            | Anti-           | Anti- for pyrimidine and Syn- for purine        |

**THANK YOU**