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Different forms of DNA- A form, B form, Z form

April 8, 2022 by Sagar Aryal

Edited By: [Sagar Aryal](#)

- The right-handed double-helical **Watson – Crick Model** for B-form DNA is the most commonly known DNA structure.
- In addition to this classic structure, several other forms of DNA have been observed.
- The helical structure of DNA is thus variable and depends on the sequence as well as the environment

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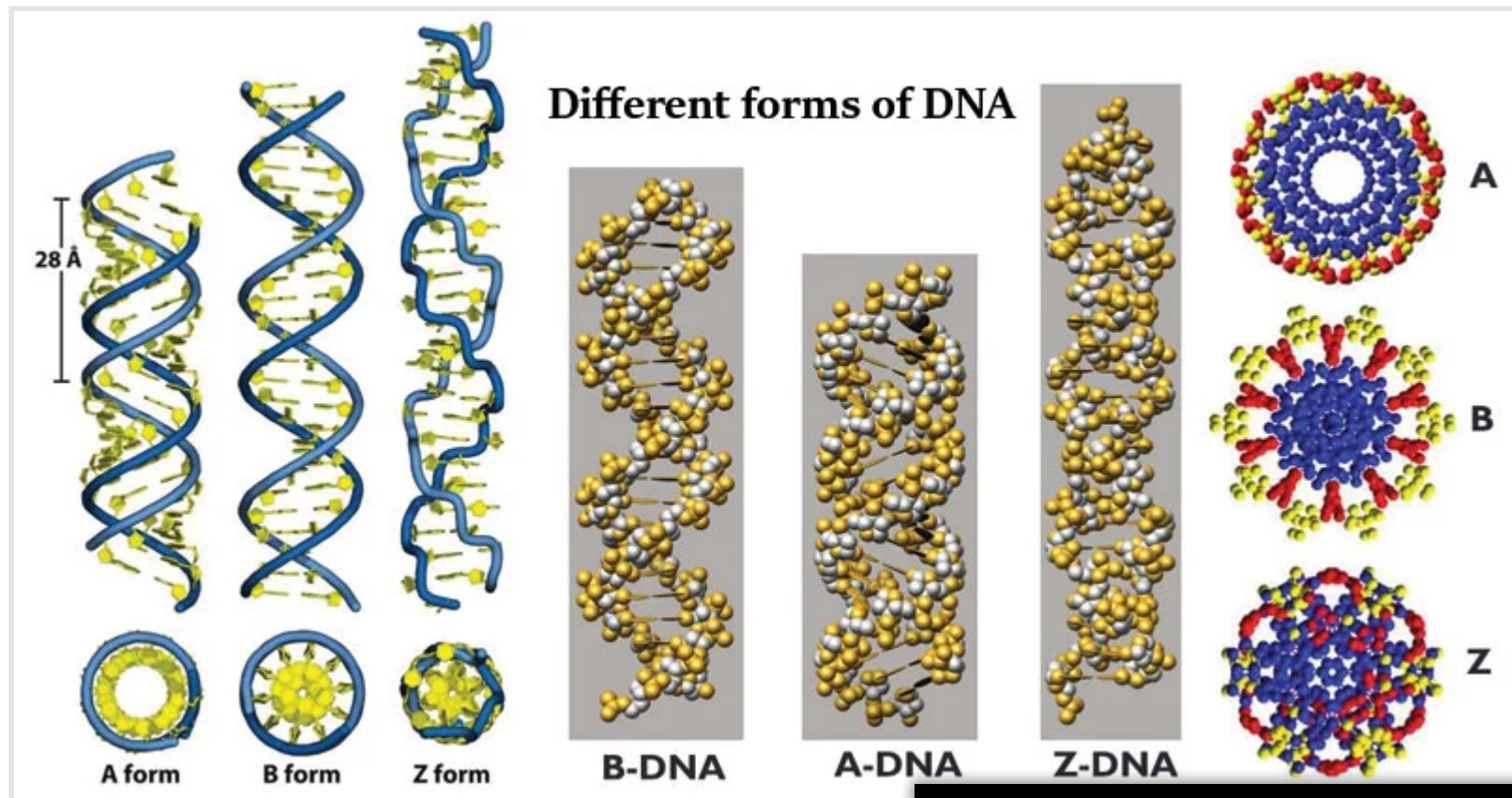


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Why do different forms of DNA exist?

- There is simply not enough room for the DNA to be stretched out in a perfect, linear B-DNA conformation. In nearly all cells, from simple bacteria through complex eukaryotes, the DNA must be compacted by more than a thousand fold in order even to fit inside the cell or nucleus.
- Refined resolution of the structure of DNA, based on X-ray crystallography of short synthetic pieces of DNA, has shown that there is a considerable variance of the helical structure of DNA. A 200-bp piece of DNA can run as if it were more than 1000 bp on an average. The double helix is not the same uniform structure.

The Different Forms of DNA

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B-form DNA

- B-DNA is the Watson–Crick form of the double helix that most people are familiar with.
- They proposed two strands of DNA — each in a right-hand helix — wound around the same axis. The two strands are held together by H-bonding between the bases (in anti-conformation).
- The two strands of the duplex are antiparallel and plectonemically coiled. The nucleotides arrayed in a 5' to 3' orientation on one strand align with complementary nucleotides in the 3' to 5' orientation of the opposite strand.
- Bases fit in the double helical model if pyrimidine on one strand is always paired with purine on the other. From Chargaff's rules, the two strands will pair A with T and G with C. This pairs a keto base with an amino base, a purine with a pyrimidine. Two H-bonds can form between A and T, and three can form between G and C.
- These are the complementary base pairs. The base-pairing scheme :
copy the genetic information.
- 34 nm between bp, 3.4 nm per turn, about 10 bp per turn
- 9 nm (about 2.0 nm or 20 Angstroms) in diameter.
- 34° helix pitch; -6° base-pair tilt; 36° twist angle

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A-form DNA

- The major difference between A-form and B-form nucleic acid is in the conformation of the deoxyribose sugar ring. It is in the C2' endoconformation for B-form, whereas it is in the C3' endoconformation in A-form.
- A second major difference between A-form and B-form nucleic acid is the placement of base-pairs within the duplex. In B-form, the base-pairs are almost centered over the helical axis and further from the central axis and closer to the major groove. The result is a compact core in A-form.
- Right-handed helix
- 11 bp per turn; 0.26 nm axial rise; 28° helix pitch; 20° base-pair tilt
- 33° twist angle; 2.3nm helix diameter

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Z-form DNA

- Z-DNA is a radically different duplex structure, with the two strands coiling in left-handed helices and a pronounced zig-zag (hence the name) pattern in the phosphodiester backbone.
- Z-DNA can form when the DNA is in an alternating purine-pyrimidine sequence such as GCGCGC, and indeed the G and C nucleotides are in different conformations, leading to the zig-zag pattern.
- The big difference is at the G nucleotide.
- It has the sugar in the C3' endoconformation (like A-form nucleic acid) and the guanine base is in the synconformation.
- This places the guanine back over the sugar ring, in contrast to the A-form nucleic acid. Note that having the base in the anticonformation places the base in the major groove and it bonds with the complementary base on the opposite strand.
- The duplex in Z-DNA has to accommodate the distortion of this G nucleotide in the synconformation. The cytosine in the adjacent nucleotide of Z-DNA is in the "normal" C2' endo, anticonformation.

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- Discovered by Rich, Nordheim & Wang in 1984.
- It has antiparallel strands as B-DNA.
- It is long and thin as compared to B-DNA.
- 12 bp per turn; 0.45 nm axial rise; 45° helix pitch; 7° base-pair tilt
- -30° twist angle; 1.8 nm helix diameter

Conditions Favoring A-form, B-form, and Z-form of DNA

- Whether a DNA sequence will be in the A-, B- or Z-DNA conformation
- The first is the ionic or hydration environment, which can facilitate
- A-DNA is favored by low hydration, whereas Z-DNA can be favored
- The second condition is the DNA sequence: A-DNA is favored by ce

whereas Z-DNA can be most readily formed by alternating purine-pyrimidine steps.

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- The third condition is the presence of proteins that can bind to DNA in one helical conformation and force the DNA to adopt a different conformation, such as proteins which bind to B-DNA and can drive it to either A-or Z forms.
- In living cells, most of the DNA is in a mixture of A and B-DNA conformations, with a few small regions capable of forming Z-DNA.

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Other rare forms of DNA

C-DNA

- Formed at 66% relative humidity and in presence of Li^+ and Mg^{2+} ions.
- Right-handed with the axial rise of 3.32\AA per base pair
- 9.33 base pairs per turn

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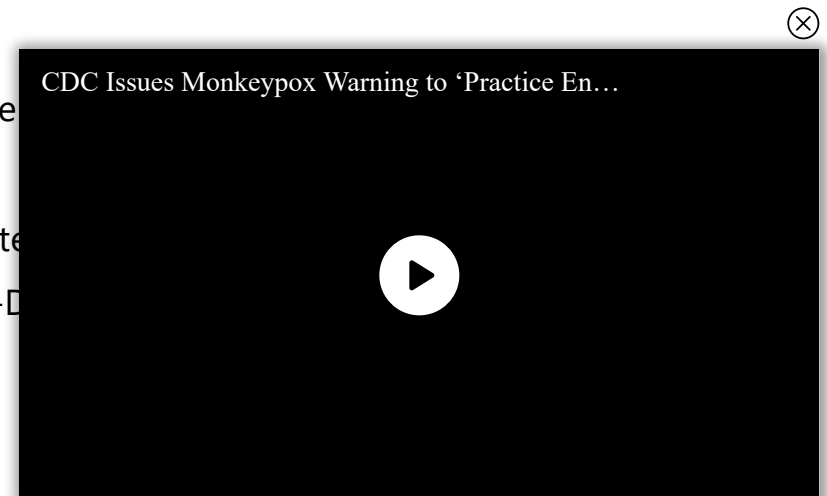
- Helical pitch $3.32\text{A}^\circ \times 9.33^\circ\text{A} = 30.97\text{A}^\circ$.
- Base pair rotation = 38.58° .
- Has a diameter of 19A° , smaller than that of A-&B- DNA.
- The tilt of base is 7.8°

D-DNA

- Rare variant with 8 base pairs per helical turn
- These forms of DNA found in some DNA molecules devoid of guanine.
- The axial rise of 3.03A° per base pairs
- The tilt of 16.7° from the axis of the helix.

E- DNA

- Extended or eccentric DNA.
- E-DNA has a long helical axis rise and base perpendicular to the helix.
- Deep major groove and the shallow minor groove.
- E-DNA allowed to crystallize for a period time longer, the methylated DNA.
- E-DNA is the intermediate in the crystallographic pathway from B-DNA to A-DNA.



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About Author



Sagar Aryal

Sagar Aryal is a microbiologist and a scientific blogger. He attended ...
Nepal, to complete his Master of Science in Microbiology. He worked

Kathmandu, Nepal, from Feb 2015 to June 2019. After teaching microbiology for more than four years, he joined the Central Department of Microbiology, Tribhuvan University, to pursue his Ph.D. in collaboration with Helmholtz-Institute for Pharmaceutical Research Saarland (HIPS), Saarbrücken, Germany. He is interested in research on

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actinobacteria, myxobacteria, and natural products. He has published more than 15 research articles and book chapters in international journals and well-renowned publishers.

8 thoughts on "Different forms of DNA- A form, B form, Z form"

Andy Carter

April 5, 2023 at 10:46 PM

Under C-DNA you say there are 33bp per turn. That should be 9.33bp per turn.

[Reply](#)

Sagar Aryal

April 6, 2023 at 12:17 PM

Thanks, it has been corrected. 😊

[Reply](#)

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BUDHDEV PRAKASH PURTY

July 21, 2021 at 12:20 PM

I was in need of a lot of help but after I got it reading Thanks a lot of

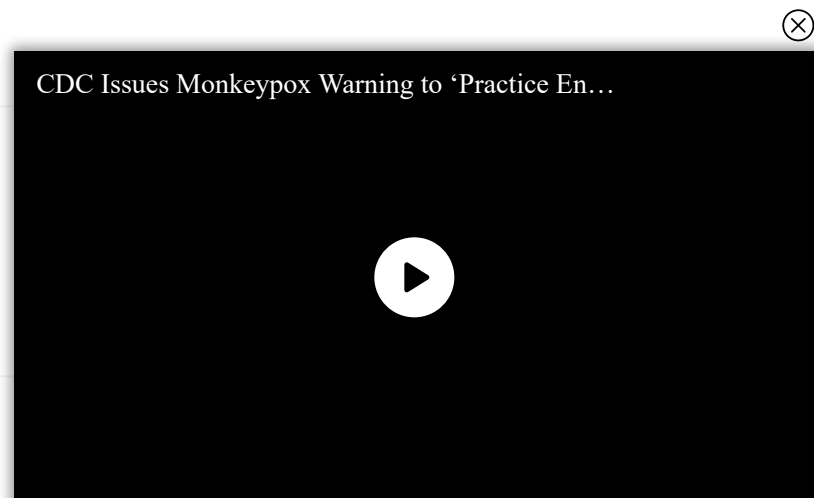
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Ahmed Gharib

May 16, 2021 at 8:12 PM

Do you have PPTs for your syllabus?

[Reply](#)



Vamsi Krishna

October 30, 2020 at 3:14 PM

You are very helpful during the exams

[Reply](#)

Naaz

February 26, 2020 at 4:47 PM

wow...thank you so much ..this is very helpful ...

[Reply](#)

Victor Maliti

August 8, 2019 at 1:06 PM

Educative!

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Ahmed Gharib

May 16, 2021 at 8:13 PM

Very Educative

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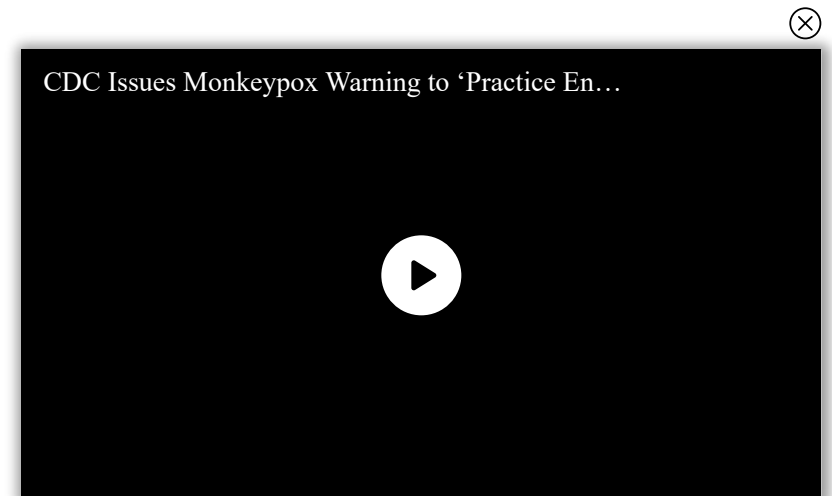
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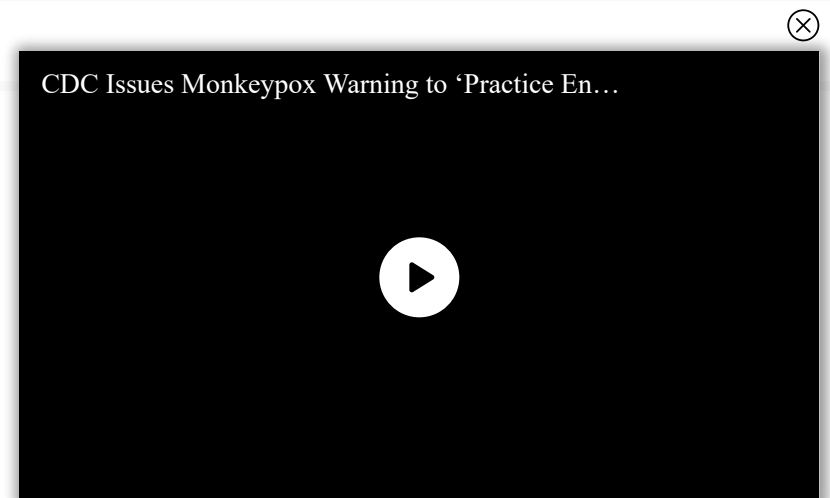
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