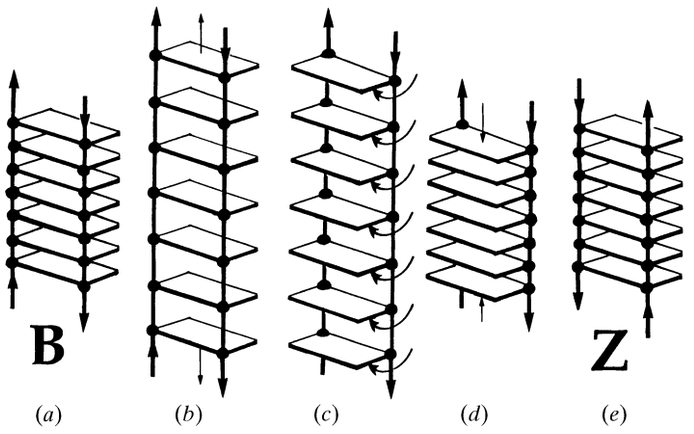

Fig. 23.3.3.6. Interconversion of a B to a Z helix. Because the strands have opposite directions in B (*a*) and Z (*e*), interconversion must involve opening up the helix (*b*), flipping each base pair to the other side (*c*), and re-stacking base pairs (*d*). (*d*) and (*e*) are identical upon rotation about a vertical axis.

pulled apart, as in part (*b*), and each base pair swung around to the opposite side of the backbone 'ladder' [part (*c*)]. This would automatically lead to *syn* conformations at both ends of the base pair, as drawn in Fig. 23.3.3.4(*b*). Returning pyrimidines to an *anti* conformation would create the zigzag backbone chain (Fig. 23.3.3.4*c*). Base pairs can then be re-stacked, as in parts (*d*) and (*e*) in Fig. 23.3.3.6 (which differ only by rotation of the entire helix about the vertical), to yield the backbone geometry of a Z helix. This is the simplest interconversion and one which was recognized and proposed in the very first Z-DNA structure paper (Z1). Other alternatives have been suggested, involving breaking individual base pairs, swinging the bases independently around their backbone chains, and re-forming the pairs. But one kind of special mechanism or another must be invoked if a B-to-Z interconversion is to be achieved.

23.3.3.7. *'Watson–Crick' Z-DNA*

Ansevin & Wang (1990) have proposed an alternative left-handed double helix, with many of the properties of Z-DNA, but possessing the same backbone chain orientations as A- and B-DNA. With such a helix, a B-to-Z conversion would require only a twisting of the duplex about its axis – no separation of bases or unpairing, and no pulling apart of the stack. Ansevin & Wang did not challenge the X-ray crystal structure analyses of short Z-DNA oligomers. Instead, they suggested that Z-DNA was globally the most stable form, adopted in short oligomers where chain unravelling and rearrangement is easy, but that their 'Watson–Crick' Z-DNA or Z(WC)-DNA was the structure that was actually produced by *in vitro* or *in vivo* manipulations of long DNA duplexes. They noted that most solution measurements focus on only two characteristics of the DNA: left-handedness and a dinucleotide repeat, both shared by Z-DNA and Z(WC)-DNA.

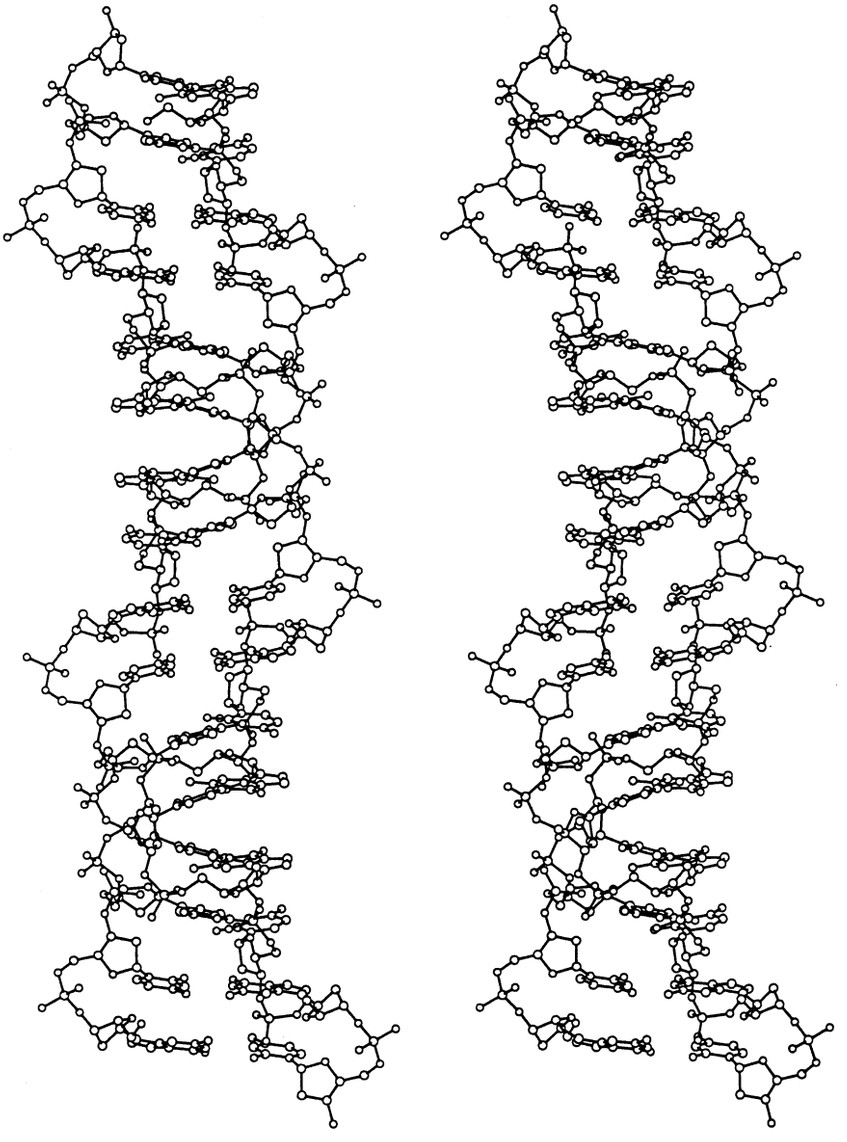

Fig. 23.3.3.7. Z(WC)-DNA, or 'Watson–Crick Z-DNA', a proposed left-handed, zigzag, alternating purine/pyrimidine helix with many of the properties of Z-DNA, but with the backbone chain sense found in A- and B-DNA (Ansevin & Wang, 1990). Coordinates courtesy of Allen T. Ansevin.

The Z(WC) helix is shown in Fig. 23.3.3.7, and a different stereo view appears as Fig. 7 of Dickerson (1992). Like Z-DNA, it is left-handed, with a deep minor groove and shallow major groove. Cytosines with *anti* glycosyl bonds and guanines with *syn* bonds alternate along each backbone strand. However, sugar puckering is reversed: cytosines are C3′-*endo*, while guanines are C2′-*endo*. In Z-DNA, the backbone chain runs parallel to the helix axis past G, and at right angles to the axis past C. In Z(WC)-DNA, this is reversed: parallel to the helix past C, and at right angles past G. Because of efficient stacking of base pairs, the logical two-base-pair structural unit in Z-DNA is $^{5'}$C–G$^{3'}$; in Z(WC)-DNA it is $^{5'}$G–C$^{3'}$. One such unit is clearly visible in the centre of Fig. 23.3.3.7. This behaviour is reflected in local twist angles:

Helix	C–G	G–C	Sum
Z-DNA	−8°	−52°	−60°
Z(WC)-DNA	−70°	+10°	−60°

references