

**CHIASMA INTERFERENCE AND THE "DYNAMIC UNWINDING" MODEL OF GENETIC RECOMBINATION**

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A recent paper<sup>1</sup> discussed a model of recombination<sup>2</sup> in which hybrid DNA forms by illegitimate pairing between intact DNA strands from the two chromatids involved in the recombination event. Illegitimate pairing was envisaged to be an error situation which could be corrected by strand breakage in two ways. A single break in each of the strands concerned would result in a classical chiasma containing regions of hybrid DNA, whereas if two breaks occurred in one strand of each chromatid hybrid regions would be formed in them but without a coincident chiasma. It was suggested that the illegitimate pairing was made possible by unwinding events in the two chromatids producing complementary single stranded regions. It being supposed that rapid unwinding-rewinding cycles of short, randomly located, segments of the DNA helix form a flux that is a normal part of the dynamic environment of the cell. Since it was envisaged that unwinding of a particular region was accompanied by overwind of the helix on either side an explanation for positive chiasma interference emerged. It would be expected that the overwind would usually be released by the almost immediate rewinding of the unwound segment. However, in the case where adjacent chromatids unwind the same region to release complementary single strands which cross-pair the situation will be stabilised, the overwind will persist and will reduce the likelihood of further unwinding events in the vicinity. The model consequently provides a natural explanation for positive chiasma interference, but in this form it does not account for the lack of interference between chiasmata and achiasmate conversion events<sup>3, 4, 5</sup>. The two alternative pathways for resolving illegitimate pairing must

therefore be distinguished from one another in some way so that they are used at different times for if those events which are not to produce chiasmata can be repaired immediately while those that are to form chiasmata are not repaired until a later stage of meiosis then the former would be essentially free of interference (the overwind which causes interference being released before it can have significant effect on the occurrence of further unwinding events) while the latter would exhibit this feature. FOGEL and HURST<sup>4</sup> suggested that a difference in the time at which resolution occurs might be the cause of the difference in the interference pattern but, without offering any explanation of interference, their interpretation was essentially that the chiasma must be formed first in order to generate interference – this is the reverse of the sequence of events postulated here.

The prime cause of the difference in behaviour may well be the configuration assumed by the DNA when it unwinds and pairs illegitimately. Since the model involves pairing with all four parental strands intact the illegitimately paired segments cannot be helically wound<sup>6</sup>. The strands will not be as fully stabilised as they would be in a base-paired helix so configurational changes could be profound. There may thus be two alternative states: a largely unaltered state which can be rapidly restored by "patrolling ligases" which nick the same strand at opposite ends of the illegitimately paired region and thereby free the entangled molecules to form hybrid helices without a chiasma; and a grossly deformed state which presents a more serious problem to the DNA repair system and must await the appearance of a more sophisticated complex which cuts the strands in such a way as to allow chiasma

formation. A plausible geometrical difference between the two states would be the pucker of the deoxyribose ring, the different forms of which are responsible for the contrasting geometrical configurations of the DNA A and B helices<sup>7</sup>. If the ring maintains the *C2-endo* configuration rewinding into the B-conformation could follow spontaneously as the strands were cut. On the other hand if the strands relaxed to the *C3-endo* configuration the initial stages of the repair process would be much more active, the strands having to be constrained to adopt a different geometrical configuration as well as being cut. This process might involve the expenditure of energy and may well require too that each strand be broken only once (so that at the terminus of each illegitimately paired region continuity of structure is provided by the intact strand) and thereby gives rise to the peculiar distribution of strand breaks which results in chiasma formation.

It has long been supposed that recombination events of the conversion type arise by excision-repair of base mismatch in hybrid DNA. It is implicit in this interpretation of interference that recombination as a whole is a secondary phenomenon resulting from the correction of errors in the organisation and structure of DNA. A specific prediction of the model is that the repair system which gives rise to achiasmate events should be quite distinct from that which generates chiasmata.

## References

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