

Chapter 14

Quantitative Aside 14.1--Unwinding the DNA

As replication proceeds, the helix is unwound. As discussed, this introduces supercoils into the DNA. If the molecule had a free end, it would rotate due to the unwinding. In fact, the original conception of DNA topoisomerase was a molecular swivel that provides such a “free” end. We can ask the question: If the DNA had a “free” end, how fast would it be rotating?

First we need to know the rate of fork movement. This has been measured both in vitro and estimated in vivo. The in vitro rate is about 750 nt/sec, which agrees well with the in vivo estimate of about 1000 nt/sec. Second, we already know that 10 base pairs occur in one turn of the helix, so we can do the calculation easily:

rate of fork = 1000 nt/sec
unwinding 10 bp will cause 1 rotation
so rotations per minute should be:
rotations per minute =
$$\frac{(1000 \text{ nt/sec})(1 \text{ rotation}/10 \text{ nt})(60 \text{ sec}/1 \text{ min})}{6000 \text{ rotations/min}}$$