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Generation of supercoils in nicked and gapped DNA drives DNA unknotting and postreplicative decatenation

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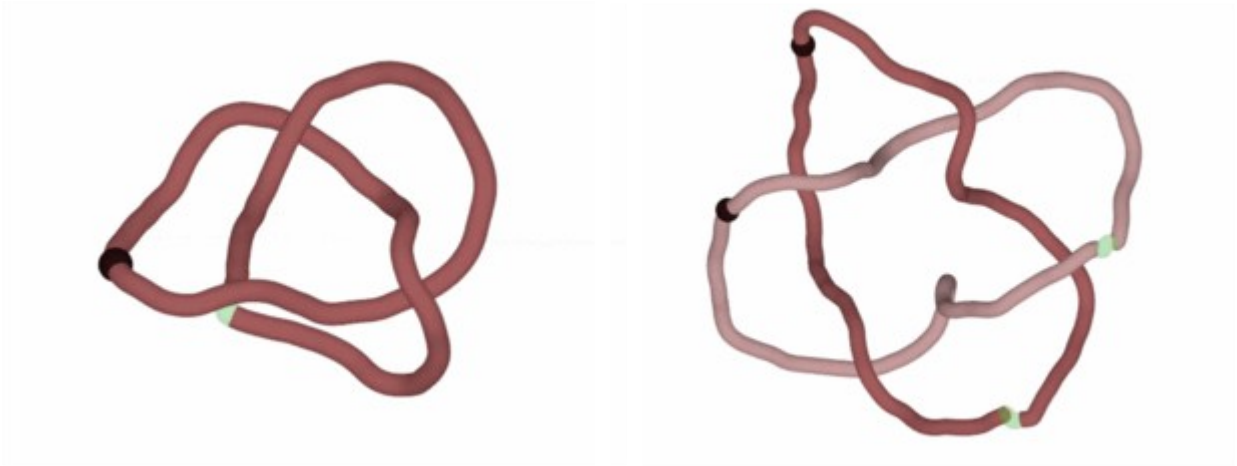
Due to helical structure of DNA the process of DNA replication is topologically complex so that freshly replicated DNA molecules are entangled with each other and are frequently knotted.

For proper functioning of DNA it is necessary to remove all these entanglements. This is done by DNA topoisomerases that pass DNA segments through each other.

So how DNA topoisomerases know where to act, since in highly crowded DNA in living cells random passages between contacting segments would only increase the extent of entanglement.

Unknotting

Decatenation



Model of DNA unknotting and decatenation involving long distance cooperation between DNA gyrase and topoisomerase III. Simulation snapshots illustrating how gyrase (dark bead) that introduces DNA supercoiling and topoisomerase III acting at the site of gaps (semi-transparent region) can act together in the process of DNA unknotting (A) and DNA decatenation (B). To simulate the process of topoIII mediated passages occurring at short gaps we have removed self-avoidance between gaps and the rest of modeled DNA molecules.

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