Molecular mechanisms of DNA repair in bacteria

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DNA, which encodes genetic information, is continuously subject to chemical changes, or damage, that can distort this information. All life forms have mechanisms to repair DNA. Two primary repair pathways are nucleotide excision repair (NER) and homologous recombination (HR). NER is responsible for removing helix-distorting lesions with various chemical structures, while HR uses homologous DNA sequences to repair particularly harmful lesions, such as double-stranded DNA breaks.

In bacteria, the UvrA protein serves as the damage sensor in NER. We reported the first structure of UvrA in complex with DNA, revealing that the protein detects DNA distortions rather than the damage itself [1]. Later, we proposed a model in which UvrB, the second protein in the NER pathway, is recruited by UvrA to scan the DNA and confirm the presence of the lesion [2].
A critical step in bacterial HR is the formation of a RecA protein filament on single-stranded DNA. This filament searches for homologous DNA and its formation is facilitated by a complex of three proteins: RecF, RecO, and RecR. We reported the structure of the RecFOR-DNA complex, which showed how it identifies the junction between single- and double-stranded DNA, where RecA filament formation occurs [3].
When homologous sequences hybridize, they form four-way DNA structures known as Holliday junctions (HJs), which must be resolved by the specialized nuclease RuvC in bacteria. We determined the structure of RuvC in complex with HJs [4] and explained its molecular mechanism, especially how the protein recognizes its target sequence and coordinates the two cuts required for HJ resolution [5].
References
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