How can two homologous needles find each other in the genomic haystack?

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Homologous recombination is a universal DNA repair mechanism that faithfully restores genomic integrity following DNA double strand breaks. Decades of research have unraveled many of the details concerning the transfer of information between two homologous sequences. By contrast, the processes by which the interacting molecules initially colocalize are largely unknown. Is homologous pairing the result of a damage-induced genome-wide homology search, or is it an enduring and general feature of the genomic architecture that facilitates homologous recombination whenever and wherever damage occurs? We will present recent studies shedding new light on the pattern of homologous pairing in different phyla using the yeast paradigm as a reference point. We will then discuss the implications reaching far beyond the range of DNA repair alone.