Advancements in Genetic Engineering

Editorial

# For the preservation of genome stability, there is an interaction between DNA replication stress, chromatin dynamics, and DNA-damage response

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DNA replication is a highly controlled process in eukaryotic cycling cells that is required for the correct and accurate duplication of the entire genome. Individual replication origins initiate bidirectional replication forks, which each involve "licencing" prior to S-phase entry, which is accomplished by a combination of replication initiation proteins that help chromatin preparation for replication. DNA replication stress is caused by disruptions in DNA replication progression and the resulting development of stalled replication forks, which can compromise genome stability. Replication fork stalling can be resolved by fork resumption processes during S-phase progression, resulting in a coordinated replication checkpoint. If a fork cannot be restarted or rescued, it will become inactive and eventually fail. Fork recovery is dependent on the existence of the impediment, and failures in this process can result in chromosomal instability and oncogene activation, which can lead to cancer.

DNA double-strand breaks (DSBs) are created when forks collapse, triggering DNA damage response (DDR) pathways. In the presence of daughter-strand gaps, which accumulate and trigger a damage response, as well as a cell cycle arrest in G2/M process, such pathways can be triggered The DDR entails the recruitment of proteins that stabilise the replication fork and transmit a stress signal, triggering cell cycle arrest and allowing time for the replication fork to restart . The interplay between DNA replication and DNA repair is complex, and chromatin structure and remodelling play a critical role in their management in this context..

The organisation of chromatin is maintained by specific proteins, maintaining a healthy cell. We focus on how the appropriate chromatin landscape and epigenetic status are replicated in response to DNA replication stress in this study of recent developments in the relationship between DNA replication stress and DDR pathways. Replication stress's pathological implications have recently been studied elsewhere.

The replisome, a multi-protein complex formed by a helicase that unwinds DNA, DNA polymerases that synthesise the leading and lagging strands, and a primase that generates short primed sites to initiate DNA synthesis on both strands, makes up the eukaryotic DNA replication machinery. During and after replication, the replisome must coordinate its actions with cohesin rings, which hold sister chromatids paired. Multiple replisomes are involved in the replication of eukaryotic chromosomes. The existence of various impediments (e.g., DNA lesions, secondary DNA structures, RNA polymerases, protein-DNA complexes, and so on, see 3.2) that cause replication fork slowing or stalling is known as DNA replication stress. Cells react to these conditions by triggering a complex DNA replication stress response, the mechanism of which in mammalian cells is still unknown. Forks that have been stalled can be resolved in one of two ways.

Stalled replication forks activate a DNA replication stress response, which recruits proteins to stabilise the replication fork and sends a stress signal, halting the cell cycle and allowing fork restart, as previously mentioned. Cells are at a high risk of experiencing genome instability when they are under replication stress. As discussed in the previous section of this study, cellular pathways involving chromatin remodelling help to maintain genome integrity by collaborating with processes that promote fork protection/stabilization, repair, reversal, and restart. Exonucleases are generally prevented from degrading stalled forks by the concerted action of factors involved in DNA repair and replication.