

Analysis of a PCNA-Binding Site in Diverse Protein Families

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Proliferating Cell Nuclear Antigen (PCNA) is a major factor in DNA replication, DNA repair and cell cycle control mechanisms. It is found in two of the three major domains of life: Archaea and Eukarya. PCNA is an accessory for DNAprocessive proteins, such as DNA polymerases, DNA-repair proteins etc. Several PCNA-binding proteins were shown to bind PCNA in a competitive manner, suggesting a common binding site for these proteins on PCNA, hence a common PCNA-binding motif in these proteins. One of these PCNA-binding proteins is the cell-cycle control protein p21Cip1. A synthetic peptide derived from human p21 Cip1 was co-crystallized with PCNA. This offered an insight to the interaction between PCNA and the proteins that bind to it. The sequence motif of the PCNAbinding site that is shared among p21 Cip1 and other proteins was termed: p21-like PCNAbinding site. A sequence pattern for this motif was offered: Q-x-x-h-x-a-a, where 'x' is any amino acid, 'h' is a hydrophobic residue and 'a'

is an aromatic residue. This sequence pattern is used for searching for new PCNA-binding proteins. However, a search with this pattern gives a large number of unranked hits that includes many false hits. Thus, identifying true hits is very difficult. Multiple sequence alignments are well documented to be superior to pattern and single-sequence queries in database searches.

We present here a block alignment based method for identifying PCNA-binding proteins. The method has better sensitivity (identifying true hits) and selectivity (avoiding false hits) then pattern and sequence searches. We identified new PCNA-binding sites in several families, including some not even known to bind. Some of the sites appear in a different sequence context then known PCNA-binding sites. Our analysis also allows us to study the convergent evolution of these sites and the effect of various selection pressures on them.