A Comparative Bioinformatic Analysis of the Protein-Protein Interaction Networks of the Archaea

Cathy Derow [(1)] and David Fell[(1)]

(1) Oxford Brookes University, Gipsy Lane, Headington, Oxford OX3 0BP

Protein-protein interactions (PPIs) lie at the heart of biological processes. Protein-protein interaction networks (PPINs) as investigated so far, have been found to be scale-free, small-world, with similar network diameters, and to display similar levels of hierarchical organization. Highly connected proteins, known as ‘hubs’, are thought to be more likely than other proteins to be necessary for viability and to have higher levels of disorder in their structures. The necessity for viability is thought to relate to the greater perturbation to the network caused by their elimination, including a greater increase in the diameter of the network. The scale-free nature of PPINs is thought to make these networks robust to the loss of randomly selected proteins, as these are less likely to be highly connected, but vulnerable to attacks on hubs.

The Archaea are of interest, as while prokaryotic, they are more closely related to eukaryotes in many ways than to bacteria. Their properties have led to the proposal that they constitute a distinct Third Kingdom of Life, although this is disputed. One unifying feature of the Archaea seems to be an ability to survive energetic stress and understanding their PPINs may aid understanding how they do this.

This study aims to determine the network properties of archaeal PPINs. These properties will be compared to those of eukaryotic and bacterial PPINs. This study could contribute to the understanding of these unique organisms and help to decide whether the Archaea constitute a distinct Third Kingdom. The findings from this investigation could help elucidate the nature of evolution and which network properties of PPINs are universal and essential for life.

This research is relevant to exobiology as many Archaea are extremophiles able to live under harsh conditions, which are thought to prevail on many other planets. Thus extremophiles may provide insight into the types of life which might be found on other planets. In addition, Archaea may contaminate spacecraft and this research could help in finding ways to reduce or eliminate such contamination to support planetary protection programs. Archaea may also have biotechnological applications as yet unharnessed and this makes understanding them valuable.