E. coli packs a punch - an intestinal insight from ISIS

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The cells of E.coli bacteria are surrounded by a protective membrane. In this membrane are proteins (OmpF) which allow food into the cell. The antibacterial toxin Colicin N uses OmpF to penetrate into the cell and kill it. Neutron science has given us a picture of how this happens. Credit: J Lakey, Newcastle University

Recent studies at the ISIS neutron source, the Science and Technology Facilities Council's world leading research centre, have given a new insight into how E. coli bacteria, often associated with food poisoning (and sometimes found in turkey), kill each other in the evolutionary competition for food and space. This breakthrough could be fundamental in developing new ways to treat illnesses such as food poisoning or meningitis.

Commonly found in the intestines of humans and animals, E. coli is normally considered to be a 'helpful' bacterium that aids digestion. However, it can also cause vomiting and diarrhoea, and can be a serious illness for young children, the elderly and those with vulnerable immune

systems. In 2010, 793 incidents of the O157 strain of E. coli were recorded by the Health Protection Agency, but this is thought to only represent a fraction of actual cases because most go unreported.

Discovering how antibacterial proteins attack harmful bacteria is important for establishing new methods of drug delivery. Antibacterial proteins often have to travel across a waterproof cell membrane to reach their target. E. coli bacteria use a similar mechanism when attacking each other so it makes a good comparable study for observing this behaviour.

A bacterial cell is surrounded by a cell membrane that acts as a barrier to hold nutrients and cell components inside, and protect the cell from attack. The E. coli membrane is particularly difficult to pass through as it is a hydrophobic double layer making it twice as hard for the intruders to penetrate. To penetrate these barriers, E. coli bacteria secrete toxic proteins called Colicins. Just one Colicin can be enough to kill an E. coli bacterium – this is no mean feat as the E. coli bacterium is 400,000 times heavier than the Colicin protein.

For the first time, experiments carried out at ISIS by a team from Newcastle University and funded by the Wellcome Trust have revealed a 'side view' of the process that one type of Colicin (Colicin N) uses to kill E. coli bacteria. The experiments allowed the progress of the Colicin N to be followed as it travelled through the membrane. More conventional study methods only allow a surface-view of the membrane. Colicin N specialises in punching a hole through the inner membrane of its target E. coli bacterium. Normally Colicin N would not be able to do this because it is too big to fit through the narrow food-entry pores in the outer membrane of the E. coli. Results from these experiments have discovered that Colicin hijacks the pore-forming protein Ompf in the outer membrane of the bacteria and then squeezes down the side to reach the inner membrane which it then attacks.

"Neutron scattering techniques were able to show us the insertion of Colicin N into the hydrophobic membrane. Using neutrons allowed us to get a side view of the process, which is important when following proteins across a barrier" said Jeremy Lakey, Professor of Structural Biochemistry at Newcastle University.

Professor Lakey and his team plan to conduct further studies at ISIS to observe later stages of the process. The results of this research (published in the Journal of Biological Chemistry) will be used to develop new, more effective ways to treat life-threatening illnesses and ultimately help save lives.

Provided by Science and Technology Facilities Council

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