Scientists reveal DNA-enzyme interaction with first ever real time footage

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For the first time scientists have been able to film, in real time, the nanoscale interaction of an enzyme and a DNA strand from an attacking virus. Researchers from the University of Cambridge have used a revolutionary Scanning Atomic Force Microscope in Japan to produce amazing footage of a protective enzyme unravelling the DNA of a virus trying to infect a bacterial host.

The research, funded by the Biotechnology and Biological Sciences Research Council (BBSRC), will improve our understanding of how enzymes interact with DNA at a nanoscale but also has marked implications for scientists studying DNA repair, and could help in the search for cancer treatments.

Working with researchers in Edinburgh, Japan and India, the Cambridge team used a state-of-the-art microscope, only three of which exist in the world, and a technique known as fast-scan atomic force microscopy (AFM). Before now, scientists could only make assumptions as to how proteins and DNA interact based on indirect evidence but this new window on a fundamental biological process gives them the opportunity to view how the interaction actually occurs.

Dr Robert Henderson, who led the Cambridge research, explains: “This is the first time that such a process has been seen in real time. To be able see these nano-mechanisms as they are really happening is incredibly exciting. We can actually see the enzyme ‘threading’ through a loop in the virus’s DNA in order to lock on to and break it, a process known as

DNA cleavage.

“The microscope and new techniques give us a clear view of the molecular interactions between proteins and DNA that we could only previously interpret indirectly. The indirect methods require scientists to make assumptions to interpret their data, and video footage like this can help to provide a more direct understanding of what is really happening.

“Standard technology for filming on this scale can only produce one image frame every 8 minutes. However, our new work allows one frame per 500 – or fewer, milliseconds.”

The footage shows a bacterial type III restriction enzyme attaching itself to the DNA of a virus, in order to break the DNA before the virus has the chance to infect the bacterium. However, this could also provide a model for understanding how other enzymes and DNA, in any type of organism, including humans, interact.

“This helps us understand how enzymes recognise which bit of a DNA strand to latch onto, which is important in understanding how proteins repair damaged DNA. In the long term, this could help in the search for cancer treatments, as cancer sometimes occurs where DNA is damaged but enzymes do not behave correctly in order to repair it.”

Steve Visscher, interim BBSRC Chief Executive, said: “BBSRC strongly supports the development of new tools and resources and this study clearly highlights the significance of cutting-edge technologies to bioscience research. It is essential that bioscientists can draw upon technologies from the physical and engineering sciences to improve their understanding of biological processes.”

The film is available to view at:
http://www.bbsrc.ac.uk/media/pressreleases/video_enzyme_unravelling_

dna.html

Source: Biotechnology and Biological Sciences Research Council