AUSTRALIAN SOCIETY FOR BIOPHYSICS

Abstract: 178P

Imaging changes to the membranes of live fungal cells caused by exposure to gold nanoparticles

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Nanomaterials have been extensively investigated for a wide range of biomedical applications including as antimicrobial agents, drug delivery vehicles, and diagnostic devices among many other potential uses. In general, one commonality between these varied uses is the necessity for the nanoparticle to interact with or pass through the cellular membrane to be useful. Nanomaterials have been known to interact with cellular membranes in many different ways including permeating through the membrane, adhering to and forming aggregates on the surface to the membrane, and becoming absorbed within the membrane bilayer itself. These interactions can cause changes to the integrity of the membrane, however, the precise mechanisms underpinning such interactions remain poorly understood. Here we investigate the interaction between nanoparticles and cellular membranes, specifically the interactions between 100 nm gold nanoparticles (AuNPs) and the membrane of *Candida albicans* fungal cells were studied using a range of different microscopy techniques including atomic force microscopy (AFM), confocal laser scanning microscopy (CLSM), scanning electron microscopy (SEM), transmission electron microscopy (TEM), and infrared microscopy (ATR-FTIR), examples of the microscopy images obtained can be seen in figure 1. In most cases, particles were adhered onto the surface of cells, although instances of particles within the cell and absorbed within the membrane were also seen. Noticeable changes to the physical composition of the membrane were also observed particularly, there was a measurable increase in the stiffness of the cell membranes after AuNPs were introduced and PCA analysis of the IR data showed significant differences in peaks associated with phospholipids and proteins before and after exposure to AuNPs.

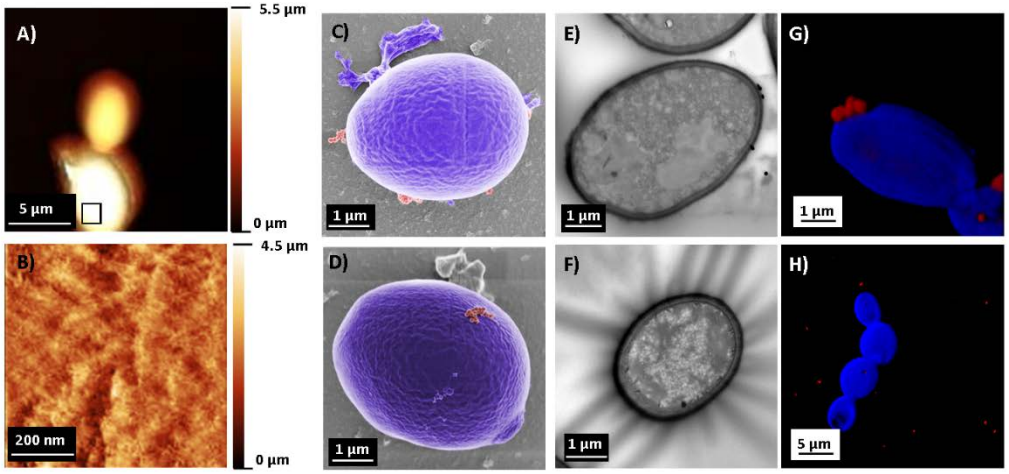

Figure 1: Microscopy images of interactions between AuNPs and *C. albicans* cells **A)** AFM image of whole cells **B)** AFM image of cell membrane **C)** and **D)** coloured SEM images of *C. albicans* cells (blue) and AuNPs (red) **E)** and **F)** TEM images of *C. albicans* cells and AuNPs **G)** and **H)** CLSM images of *C. albicans* cells (blue) and AuNPs (red)