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Innovative Decontamination Solutions

Why measure protein quantity when looking for contamination?

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HTM0101 states that surgical instruments are to be cleaned and disinfected once the protein contamination has reached a certain level (5ug per side of the instrument).

The aim of this article is to provide a review on protein contamination. In order to progress in the field of decontamination, it is in our best interest to gather this information.

I will first introduce, as a gentle reminder, what proteins are and what they do; then I'll move on to the relation of current medicine in use with proteins and finally talk about biological contamination.

What are proteins?

The everyday word "protein" usually refers to a type of nutrient found in fish, red meat, eggs … however, these "protein rich" foods actually contain essential amino acids for your body to synthesise proteins. Amino acids are building blocks for proteins, and proteins are the biological entities that achieve all functions in an organism – human, animal, bacterium, etc.

Proteins can be seen as workers that provide specific functions for their factory (organism). These functions that cells and viruses do are: communication (intra/extracellular signalling), movement (cell migration), digestion (through enzymes), multiplication (cellular division, budding …), structural support (skeleton of the organism), feeding, killing and others.

To have an idea of how small proteins are, here is an order of magnitude: a mammalian cell (10um) is roughly 10 times bigger than a bacterium (1um) which is 10 times bigger than viruses (100nm); and viruses are 10 times bigger than proteins (10nm). This means that a human cell is 1000 times bigger than a protein. A standard microscope would not be able to detect a protein (you would need an electron microscope to do so).

There is a vast amount of proteins in the human body. A human cell would have 10^9 proteins on average, and there are roughly 10^{12} cells in the human body. While this is an extensive amount of proteins in your body, they all work in harmony towards homeostasis.

Medicine and proteins

Understanding the function of proteins is crucial when treating diseases. The drugs developed for therapy, act directly on proteins' function. For example, cancer therapy will include chemicals that specifically bind/recognise/remove oncogenic proteins. It is known that cancer cells won't stop multiplying; this is why researchers have developed drugs that target proteins which enable cellular division (El-Arabey A.A et al 2018) (Wijdeven, R.H et al 2016).

Another example - The HIV treatment is directed towards the viral proteins, preventing the virus from infecting more cells, preventing it from inserting its genetic code into the host DNA and ultimately, preventing the virus from multiplying (Keola K. Beale et al 2000) (Zhao S. et al 2018).

Genetic diseases result in an imbalance in the human body because of a surplus or a lack of a specific protein. Type I diabetes for example, is a genetic malfunction resulting in the lack of insulin (a protein).

Proteins are either the cause or the effect of a disease and are in most cases implicated in their treatment.

Biological Contamination

Although there are very few records of cross contamination of reusable surgical tools from one patient to another, they still exist and constitute a big issue in health care systems (Southworth P.M. 2014). Biological contamination can come from any foreign body being introduced into an organism and interfering with the wellbeing of the host. The contaminant could be a bacterium, which is a factory of its own (with its own set of workers), which can be found inside or outside a human cell. Viruses are a bundle of proteins with no factories, which is why they need to infect a cell to unload their workers (proteins) in order to survive and multiply. A contamination can also come from a simple protein introduced, thus activating a defence mechanism from the host. Infections acquired in theatres would be prevented if all proteins were controlled and removed from the surgical tools.

This is why the decontamination standards are moving toward the detection of protein, but also why new technologies are focused on the protein detection and removal.

Future

Looking at residual proteins is the right direction for decontaminating surgical instruments. The research should continue in this field, trying to detect and remove proteins from different surfaces. There might be a time where the detection can be specific to the point of knowing the identity of proteins left over (this can be achieved like for example a pregnancy test - through antibodies). This information would allow us to know which organism it came from and help us track down the contamination (whether it is human, bacterial or viral proteins along with its function).

This article was written to reinforce the need of protein detection in Decontamination Units and confirming the direction the standards are leaning towards, which is the importance of screening and removing proteins from reusable surgical instruments.

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