

Ultrasensitive detection of influenza viruses by glycan biosensors

These days there is a considerable interest to develop devices, which are able to detect various diseases at early-stage with a high speed and reliability to enhance efficiency of subsequent disease treatment. The first step towards this goal is to understand what happens on a cellular level under pathological conditions. Imagine a tiny cell, let's look closer on it and focus on the surface of the cell.

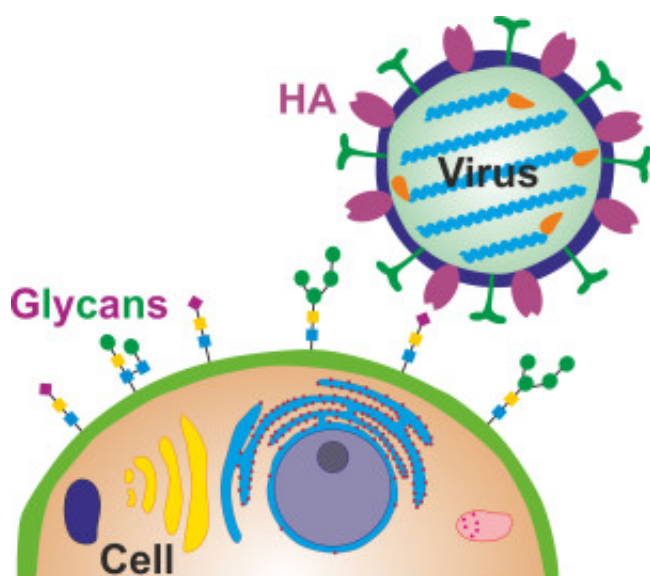


Fig. 1. A scheme showing a typical human cell with various organelles present inside the cell with a “sugary coat” composed of various glycan types deposited on the cellular surface. Glycan terminated with sialic acid (a violet diamond symbol) is essential for interaction of influenza viruses with our cells.

A cell surface is covered with a “sugary coat” of complex sugars called glycans (Fig. 1.), essential for cell-cell communications within our body, but also for interaction between our cells and pathogenic organisms such as bacteria and viruses. There are numerous ways how complex interactions between glycans and viruses could be studied and in our studies we choose to apply biosensors i.e. gold sensors covered by glycan molecules mimicking this “sugary coat” of our cells (Fig. 2.) to detect such interactions.

In our initial study we prepared synthetic glycan surfaces, which were employed to study interaction of glycan surfaces with hemagglutinins (HAs), which are proteins present on the surface of influenza viruses and responsible for initial interaction of influenza viruses with our cells. Specificity

of HA protein is a key element in interaction between viruses and cells. For example influenza viruses infecting birds have HA specifically recognizing glycans present on the surface of avian cells, but not recognizing human cells. As result avian influenza viruses can not infect humans and *vice versa*. In this study, glycans were attached to gold surface and a special detection principle sensing changes in the resistance of the surface after HA binding was applied (Fig. 2.). With higher amount of HA attached to the glycan surface, the higher output response (resistance) of the surface was observed. HAs could be detected in an ultrasensitive way down to a single molecule level and the glycan biosensor designed belongs to the most sensitive devices for detection of isolated HAs.

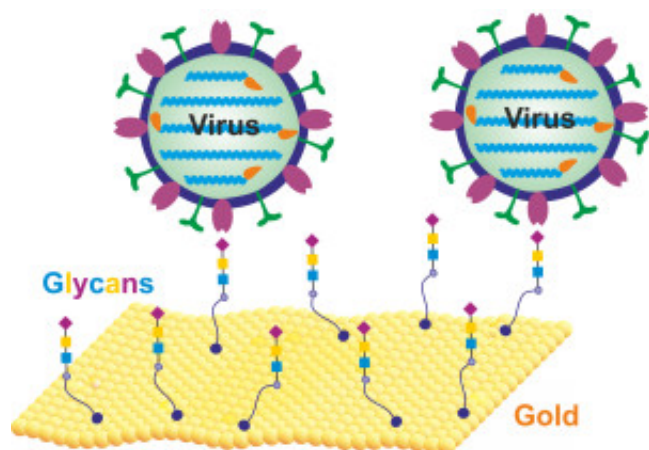


Fig. 2. A scheme of interaction of a glycan biosensor (a gold surface modified by one type of glycan with terminal sialic acid - a violet diamond symbol) mimicking our human cells with intact influenza viruses.

In the following study we focused on detection of intact, but inactivated influenza viruses using the glycan biosensor. The study showed that intact influenza viral particles H3N2 (infecting also humans) could be detected with a high selectivity over other influenza viral particles H7N7 (infecting mainly mammals and poultry), which should not bind to glycan present on the biosensor surface. Moreover, the study revealed that the glycan biosensor belongs to the most sensitive biosensors for analysis of intact influenza viruses with ability to detect as low as 13 viral particles in 1 mL, while a typical aerosol particle can contain up to 1,000 viral particles in 1 mL. Thus, the glycan biosensor could be applied for sensitive detection of various influenza viral strains at early stage of infection spread with a possibility to selectively distinguish influenza viral strains potentially pathogenic to humans.

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Publications

[Ultrasensitive detection of influenza viruses with a glycan-based impedimetric biosensor.](#)

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[An ultrasensitive impedimetric glycan biosensor with controlled glycan density for detection of lectins and influenza hemagglutinins.](#)

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Chem Commun (Camb). 2015 May 1