2013 REU Poster: Investigating the Surface Charge of HIV-1 Virus-like Particles Using Plasmonic Nanoparticles

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Investigating the Surface Charge of HIV-1 Virus-like Particles Using Plasmonic Nanoparticles

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Background

In metals, the quanta of oscillations of electrons is referred to as a plasmon. In a situation where two plasmons are nearby, oscillations can occur between the spheres in a process called plasmon coupling. The closer the spheres are to each other, the stronger this force will be. This is the main idea used in plasmon coupling microscopy.

Figure 1. General architectures of quasi-spherical viruses. a) Non-enveloped virus. b) Non-enveloped virus with attachment proteins. c) Enveloped virus with glycoproteins playing the role of viral entry mediators.

Figure 2. (c) Dimer formation leads to a vivid change in color and intensity, which allows detection of assembled plasmon rulers “by eye”. (d) Spectra before and after dimer formation for 42-nm gold particles.

Multi-Spectral Imaging

Figure 3. The following filters have been used for the multi-spectral images: 530, 540, 550, 560, 580, 600, 620, 650. Multiple fields of view of each sample have been imaged using all filter channels, in addition to the fluorescence signal of VLPs. This gives the spectrum in a wavelength range around the gold’s resonance for all the VLPs in each field of view (changing based on the concentration of the sample, usually between 50-100).

Experimental Procedure

PEGylated gold nanoparticles (Figure 4) are prepared by adding 5 mL 10mM Acid PEG to 1 mL 40nm gold nanoparticles (OH PEG may be added in addition in cases of different acid PEG percentages). After sitting overnight, these particles are centrifuged and fixed to volumes of 50 mL. HIV-1 virus-like particles (VLPs) in 1X phosphate buffered saline (PBS) are added to flow chambers and allowed to stick to the surface. After blocking the surface with BSA and incubating for 2 hours at 4°C, the PEGylated GNPs are added to the chamber. They are incubated at 4°C overnight to allow them to stick to the VLPs, as seen in figure 5.

Figure 4. Schematic representing a PEGylated gold nanoparticle. The formula for Acid PEG is: HS-(CH2)11-(EG)6-OCH2-COOH. The formula for OH PEG is the same, except a hydroxyl group replaces the carboxyl group.

Figure 5. TEM (transmission electron microscope) sample showing 100% Acid PEG GNPs on the surface of an HIV-1 VLP.

Data/Results

Figure 6. The surface charge of virus and gold particles is clearly affected by the salt concentration, measured via zeta potential (figure 7).

Figure 7. Zeta potential of GNPs and labeling efficiencies (%VLPs labeled) in GNP/VLP interactions as a function of acid PEG percentage.

Figure 8. Zeta potential of GNPs and labeling efficiencies (% VLPs labeled) in GNP/VLP interactions as a function of salt concentration; a result of 5 runs of the experiment.

Figure 9. Zeta potential of GNPs and labeling efficiencies (%VLPs labeled) in GNP/VLP interactions as a function of acid PEG percentage.

Conclusions/Future Work

There is a clear correlation between surface charge of gold nanoparticles and their interactions with virus particles. The Reinhard lab plans to continue to research this and eventually map the surface charge of the virus particles, which is an important factor in virus-cell interactions.

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References