Rapid Detection and Inactivation of SARS-CoV-2 with Bio-Conjugated Nanomaterial

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The purpose of this project is to develop a bio-conjugated nanomaterial to rapidly detect COVID-19 and to block the binding of the spike protein from SARS-CoV-2 to the ACE-2 receptor on the host cell. The gold standard, RT-PCR, is currently the ultimate diagnostic method for the detection of SARS-CoV-2. Since PCR method needs 1-3 days to detect the disease, treatment options cannot be initiated immediately. There is a need for the development detection method that can provide results in a few minutes to control this outbreak. A rapid naked eye colorimetric detection method is developed using gold nanoparticles. Gold nanoparticles have unique size dependent optical properties. COVID-19 anti-spike antibodies are attached to gold nanoparticles using amide coupling reagents. The color of anti-spike antibody attached gold nanoparticle changes in the presence of the COVID-19 antigen, indicating an antibody-antigen binding interaction from the aggregation of GNPs. This provides a fast (5 min) naked eye colorimetric detection method for COVID-19. Although mortality rate is very high for COVID-19, data also indicates that around 42% of infected individuals are asymptomatic, which indicates that SARS-CoV-2 can also be controlled by the human's innate immune system. Based on this fact, human host defense peptides HNP1, LL-37 are used for blocking virus infections in this study. HNP1, LL-37 are conjugated with graphene oxide quantum dots. Interaction of pseudotyped baculovirus with SARS-CoV-2 delta variant spike protein and ACE-2 on HEK-293T cells is measured using fluorescence imaging. LL-37 and HNP1 peptides attached GQDs block virus infection with 100% efficacy.