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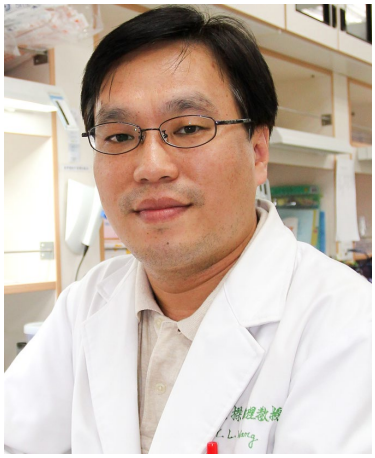
Hosted by A/P Henry Mok

Curcumin-carbon quantum dots inhibit JEV infection by binding viral particles



By Robert YL Wang

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Japanese encephalitis is a mosquito-borne disease transmitted by Japanese encephalitis virus (JEV) that is widespread in Asia and the Western Pacific. Currently, there is no effective treatment for Japanese encephalitis. In recently years, many phytochemicals have been widely used as therapeutic agents to inhibit viral infections, including curcumin. Curcumin is a compound extracted from the roots of Curcuma longa, and has been reported to have antiviral and anti-inflammatory activity. However, its high cytotoxicity and very low solubility limit its biomedical applications. In my presentation, we synthesized Curcumin carbon quantum dots (Cur-CQDs) by mild pyrolysis-induced polymerization and carbonization, resulting in higher water solubility and lower cytotoxicity, and excellent antiviral activity against JEV infection. We observed that Cur-CQDs effectively bind to the E protein of JEV and prevent the viral entry into the host cell. In addition, a mutant strain of JEV evolved after continued treatment with Cur-CQDs. Using transmission electron microscopy, bio-layer interferometry and molecular docking analysis, we observed that the S123R and K312R mutations in the JEV E protein play a key role in binding Cur-CQDs. Residues S123 and K312 are located in structural domains II and III of the E protein and are responsible for binding to receptors and fusing with the cell membrane. Furthermore, in vivo infection experiments demonstrated that Cur-CQDs can significantly inhibit JEV infection in vivo. In summary, our results suggest that the flaviviral E protein represents a potential target for the development of CQD-based inhibitors to prevent or treat viral infections.

Robert Wang received his PhD. In Microbiology and Biochemistry from the National Taiwan University in 2002, and worked at the University of Texas Medical Branch and University of Kentucky, USA, for his postdoctoral work, where he research interest switched to molecular virology. In 2009, he started his career at Chang Gung University (CGU), Taiwan. Over the past 4 years, he have been developing curcumin quantum dots for the treatment of enterovirus 71 infection with Prof. Chi-Ching Huang's team at Ocean University in Taiwan. Compared to the insoluble nature of curcumin, Cur-CQD is more than 100 times more water soluble and its viral inhibitory effect is more than 1000 times greater. The research results were published in the June 2019 issue of Small, a leading international journal covering mostly advanced materials applications in nanotechnology, with an impact factor of 15.15, making it an internationally recognized journal of high quality for nanomaterials. The results of this study also provide a novel concept of natural herbal bioactive carbon; by converting the herbal natural active molecules into active carbon in excess state, the polymerized natural molecules will self-assemble on the surface of the active carbon, and these high-density polymerized natural substances can greatly enhance their antiviral and antibacterial bioactivities, as well as their antioxidant and anti-inflammatory effects.