

RAMAN SPECTROSCOPY FOR HEALTH, PRESYMPTOMATIC AND MEDICAL ANALYSES

Pradjna N. Paramitha, Rheta Elkhaira, Bibin B. Andriana, Keita Iwasaki and Hidetoshi Sato

School of Biological and Environmental Sciences, Kwansei Gakuin University, 1 Gakuen Uegahara, Sanda, Hyogo 6691330 Japan
E-mail: hidesato@kwansei.ac.jp

Your photo

One of the most important purposes of science is “prediction.” When scientists meet a new phenomenon, they observe its reaction, measure its contents, and try to figure out the principles that govern the phenomenon. Mathematics is often used to express the principles for utilizing the phenomenon for the benefits of humanity. Consequently, mathematical expression is expected for prediction, especially in biology. One of the most known techniques for prediction of life is genetic analysis and control. Although the genetic information is highly correlated with the phenotypes of life forms, it is not easy to predict the real biological phenomena only by the genetic information because they are strongly affected by their life history and environments. Moreover, it is extremely difficult to make any genetical modification to most of organisms, except cultured cells, indicating that while it is possible to predict life through the genetic means but is difficult to control it. Hence, we need technology that can objectively express living organisms in front of us using values based on their molecular information. In contrast, Raman spectroscopy is one of the few tools that can be applied for quantitative analysis of intact lives. It is no matter how the analytical target lives, Raman spectroscopy reflects its molecular composition and converts it into spectral information. Multivariate analysis, often described in linear algebra, is used to extract useful information from the spectra. Furthermore, it provides prediction models for analysis of unknown samples. Hence, Raman spectroscopy is able to be a complementary technique of the genomics for prediction of lives.

The purpose of the present study is to explore the viability of Raman spectroscopy in prediction of live phenomena for intact tissues and/or cells. Here, we introduce Raman spectroscopic applications in virus detection and quantitative analysis of fats. Figure 1 depicts a scheme of the viral analysis. Since various animals, even bacteria, have their specific viruses, it is not easy to find out and determine only human infectious viruses from such a large variation of viruses by data analysis. Instead, we use human cultured cells to screen the human infectious viruses. When the human infectious virus invades the human cell, it induces reactions of the cell and, consequently, molecular compositional changes which is able to be detected by Raman spectroscopy. The result showed that the cell has a quick response to the virus invasion within 3 hours. According to previous studies for virus reproduction in a cell, the molecular changes observed in the infected cells are not due to the

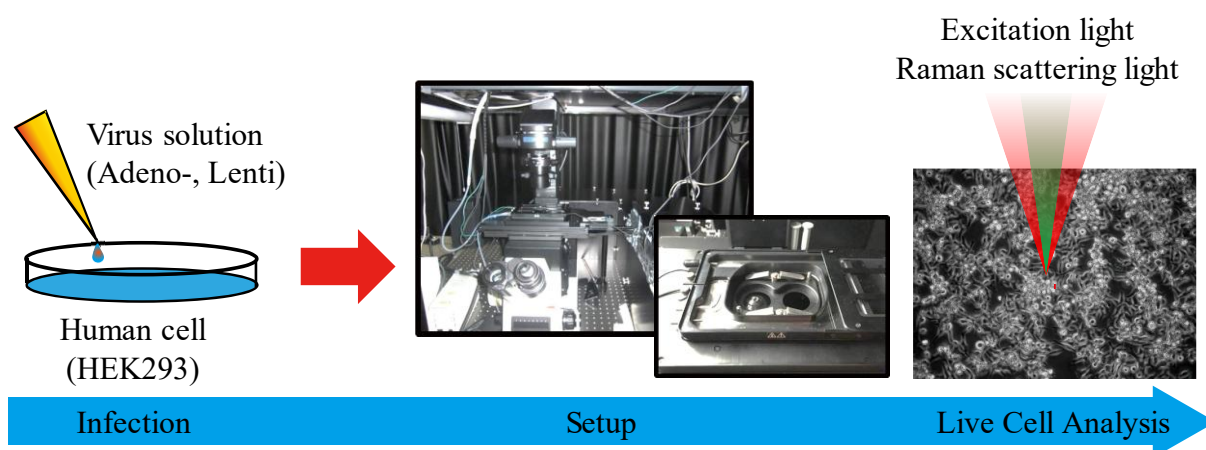


Fig. 1 The scheme of the real-time detecting of human infectious virus.

materials generated during the viral propagation processes because it is too early for the protein productions due to the virus. It suggests that a body cell has a detecting system for virus invasion. The present study demonstrates that the human cultured cell with Raman monitoring is able to predict the existence of human infectious virus in a several hours in advance to any human infection.

Figure 2 shows a scheme of fat circulation in a body. Fats are taken from food and are also synthesized in our body. When there is excess fat in a body, some of the fats are accumulated in liver. The accumulated fats in liver lead non-alcoholic fatty liver disease (NAFLD) and non-alcoholic steatohepatitis (NASH), which may progress to hepatic cancer. We have assumed that if we could measure the spectra of fat layer beneath the skin noninvasively, and if we could analyze the fatty acyl group composition quantitatively,

it would be possible to apply Raman spectroscopy for prediction of disease. We have developed a ball lens top hollow optical fiber Raman probe (BHRP) for subsurface Raman measurements. Hamsters that are treated special diets of tricaprinn and trilinolein were measured with BHRP. The hamsters are sacrificed every 2 weeks and their fat is analyzed by gas chromatography (GC) as well as Raman spectroscopy. The result indicated that the linoleic acid group had a subcutaneous accumulation rate approximately 10 times higher than that of the capric acid group, suggesting that the adipocytes like to accumulate the linoleic acid. In contrast, a liver model cell, HepG2, is used to study the accumulation rate of fatty acids in liver. The results suggested that the liver cell induces apoptosis when it is cultured with excess concentration of linoleic acid. These results shows a contradiction in fatty acid metabolism in the body, and suggest that noninvasive analysis of fatty acid composition in body will be an important indicator for health management.

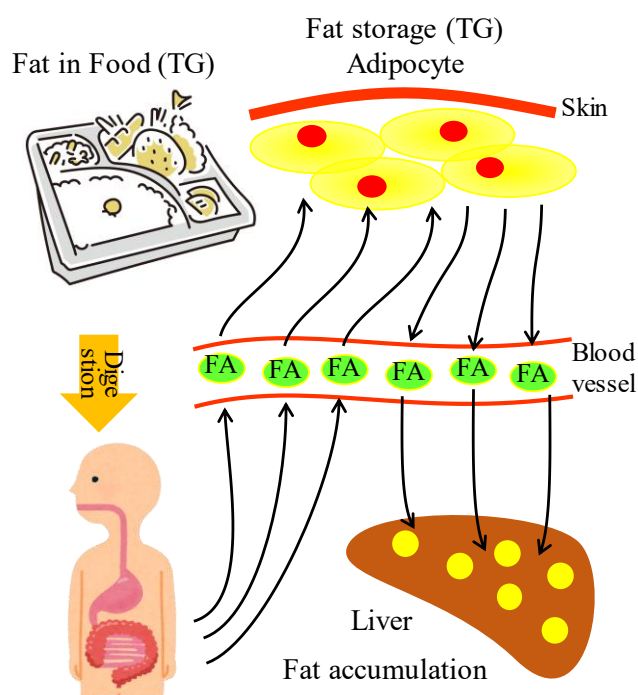


Fig. 2 Scheme of fat circulation in body.

References

- K. Moor, et al.:** Early detection of virus infection in live human cells using Raman spectroscopy, *J. Biomed. Opt.* **23**, 097001-1-7. 2018.
- R. Elkhaira, et al.:** Study on Real Time Response of Live Cells to Lentivirus Infection Monitored by Raman Spectroscopy, *Spectrochim. Acta A Mol. Biomol. Spectrosc.* **343**, 126535-1-10. 2025.
- P. Meksiarun, et al.:** Non-invasive quantitative analysis of specific fat accumulation in subcutaneous adipose tissues using Raman spectroscopy, *Sci. Rep.*, **6**, 37068-1-8. 2016.
- P. N. Paramitha, et al.:** Raman study on lipid droplets in hepatic cells co-cultured with fatty acids, *Int. J. Mol. Sci.*, **22**, 7378-7391. 2021.