

Interview with Mitsuko Sugano, Senior Fellow, Corporate Research & Development Center, Toshiba Corporation

Toshiba Applying Nanotechnology in Search of Medical Remedies

By Japan SPOTLIGHT

Toshiba Corporation has a technological edge not only in IT but also in nanotechnology, as its principal products, infrastructure services, are today increasingly dependent upon devices or materials on an atomic, molecular and super molecular scale. With this technology, Toshiba can expand its R&D efforts in contributing to other businesses or even public policy. Health care is one of those areas.

We interviewed Mitsuko Sugano, senior fellow of the Corporate Research and Development Center of Toshiba Corporation and a leading scientist in their entrepreneurial project to apply nanotechnology to medical remedies.

(Interviewed on Aug. 7, 2020)

Self-Introduction

JS: First, could you please tell us about your career and the background of your project?

Sugano: I am a specialist in biology and have been working on a wide range of research projects for Toshiba involving the use of molecular biology. One example is research on technology to detect harmful materials in the environment.

Our newly developed “Tumor-Tropic Liposome” which we announced on May 29, 2020 is a gene therapy technology delivering therapeutic genes developed by Shinshu University and containing “biodegradable liposomes” – nano-sized capsules developed by Toshiba – to cancer cells precisely and efficiently.

The background to the development of this technology is that cancer has been the leading cause of death in Japan for many years and the number of patients and fatalities continues to increase. A variety of remedies have been discovered and tried and the survival rate of cancer patients is increasing. However, the existing remedies’ effects are limited and a new remedy is required for cancers difficult to cure by surgery or medicine. One candidate for such a remedy is gene therapy.

Gene therapy is a remedy that needs extremely fine tuning, as it works on cancer cells by delivering genes to those cells with the aim of restoring their functions and strengthening them.



Mitsuko Sugano

“Tumor-Tropic Liposome”

JS: Could you explain the characteristics of your “Tumor-Tropic Liposome” technology?

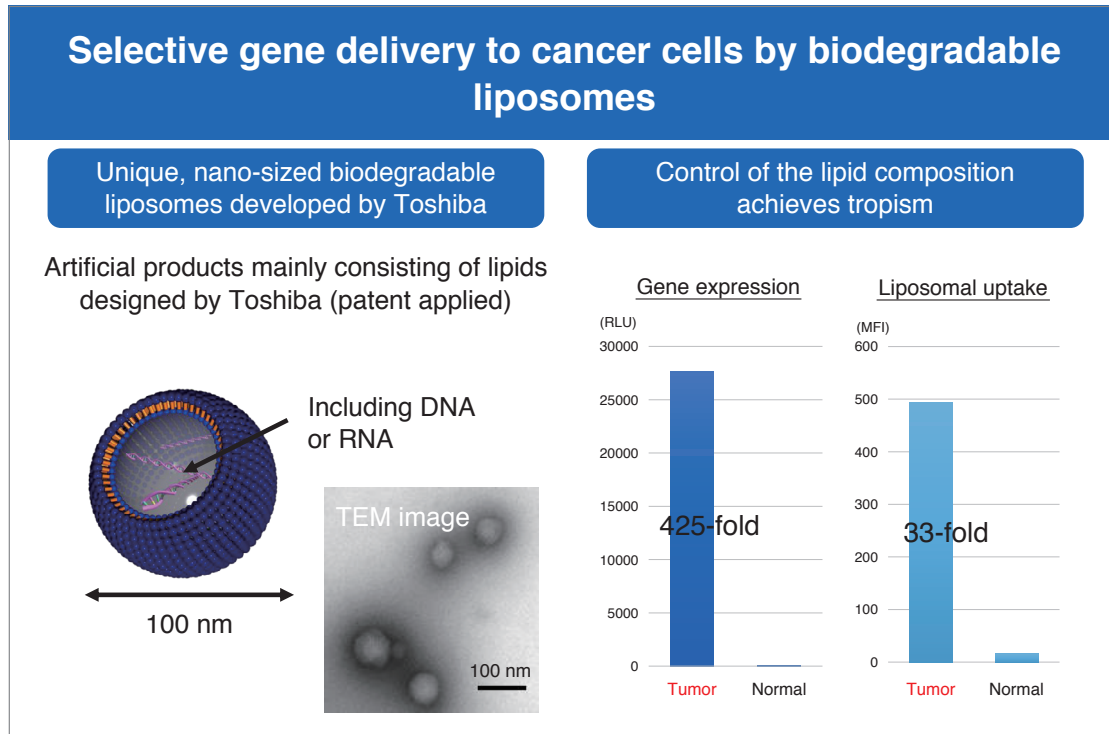
Sugano: What is most important in the application of gene therapy for cancers is to find a technology for selectively introducing therapeutic genes into cancer cells and not into normal ones. Precise delivery of therapeutic genes to the targeted cells would lead to an effective remedy.

The core element of Toshiba’s biodegradable liposome is a nano-capsule mainly consisting of lipids, devised with our own unique technology. This is a capsule about 100 nanometers in diameter made out of lipids and this uniform-sized capsule can contain genes. Liposome itself has already been used for many years. We showed that optimizing the composition of lipids enhances the probability of introducing therapeutic genes into the cancer cells selectively. Our newly developed nano-capsule is completely a chemically synthesized product and as such it is a safer and more efficient gene delivery technology than any other technology used via a virus for the transfer of therapeutic genes in gene therapy so far.

Shinshu University and Toshiba started joint research on the utilization of biodegradable liposomes for delivery of therapeutic genes without using a virus. We achieved 33-fold delivered genes and 425-fold gene expression in therapeutic gene delivery to T-cell tumors (T-cell acute lymphocytic leukemia), one of the cancers, as great as in delivery to normal T-cells (*Chart 1*). In short, we confirmed that our new technology would create a great difference

CHART 1

Newly developed “Tumor-Tropic Liposome”



Source: 2020 Toshiba Corporation

within the targeted cells.

In Shinshu University they had an experiment by using mice with human T-cell tumors transplanted. In one group of mice, they injected biodegradable liposomes containing cancer cell-killing genes throughout their bodies through veins. Photos of the heat maps and a graph showing the increase in cancer days after liposome infusion (*Chart 2*) show very little increase in cancer in the group with liposome infusion until 13 days afterwards, and also show tumor progression significantly suppressed even 21 days afterwards, compared with the control group. We presented this result at a meeting of The American Society of Gene and Cell Therapy 2020 on May 13 in 2020.

In our joint research, we proved that elaborated control of lipid composition enables selective gene delivery to cancer cells. Encouraged by this success, we would like to continue our joint R&D to promote further improvements in gene therapy.

JS: Could you tell us how this collaborative research with Shinshu University started?

Sugano: Toshiba had been working on R&D for biodegradable liposomes for several years and thinking about its application in health care, but we feared that achieving medical remedies might be out of our reach and we hesitated to explore that possibility of its

medical application. We were lucky to be introduced by chance to Prof. Yozo Nakazawa at Shinshu University, one of the most distinguished and well-known experts on gene therapy without using a virus, and he became interested in our biodegradable liposome technology. That's how our collaborative research began.

JS: With this new technology, do you think cancer can be overcome?

Sugano: Gene therapy is still in the development stage and needs to be much improved from now on. But with further efforts to advance our technology, we would like to help enhance the options for remedies for patients, in particular those suffering from cancers difficult to cure.

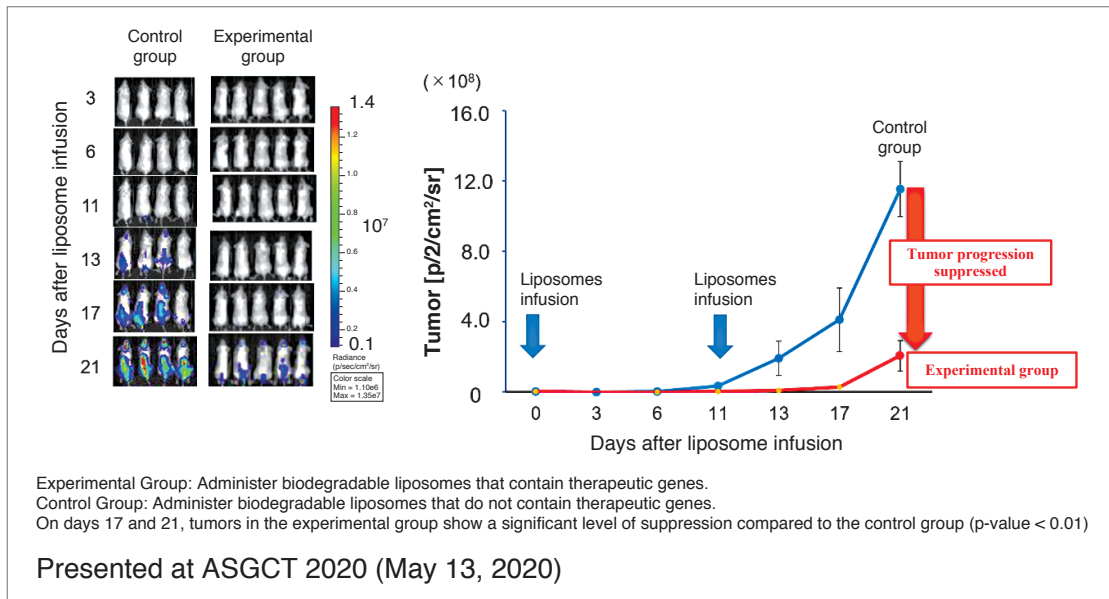
Home Appliances & Healthcare

JS: Toshiba is generally well known as an infrastructure service company. How do you relate your biotechnology business to Toshiba's main business?

Sugano: Toshiba defined precision medicine as a promising growth business towards 2023 in our “Toshiba Next Plan”, our mid-term

CHART 2

Verification of effects of tumor-tropic liposomes on mice bearing T-cell tumors



Source: 2020 Toshiba Corporation

business strategy published in 2018. Toshiba was originally competitive in technologies like nanomaterials and AI and we have been actively working on R&D to apply them to the medical and healthcare business. In the R&D of biodegradable liposomes, we have tried a wide range of nanomaterials to create nano-capsules. In this process, we have taken advantage of AI's function of mechanical learning. I believe that AI is now a powerful tool that can speed up R&D, and also that collaboration between AI and medical technology will lead to technological progress in the medical and healthcare business.

JS: Can biodegradable liposomes be referred to as one of the most advanced technologies in Japan?

Sugano: Yes. We are pursuing the most advanced technological research in the sense that selective gene delivery to cancer cells could be achieved without using a virus.

JS: Do you have a plan for collaborative research or a business partnership with an overseas research institute in this area?

Sugano: We do not have any particular plan yet. However, seeing that there are more publicly authorized technologies for gene therapy overseas than in Japan, we are thinking about pursuing the possibility of joint research with an institute in another country.

JS: With the positive outcome of joint research with Shinshu University, are you planning to promote its practical application or production on a large scale? What issues would you need to tackle in the future?

Sugano: The outcome of our current experiments has only shown the result of gene delivery twice to cancer cells by biodegradable liposomes. We need to investigate the dose and times of delivery. In addition, since the new lipid used for this experiment is a chemically synthesized product which has not existed before, we need to confirm its safety over the long term for clinical use and find out what types of cancers it can be most effectively applied to.

JS: As the aging of society continues in Japan, I believe the medical and healthcare business has great potential to grow.

Sugano: Yes, I think that is true. We believe that technological development in the medical area will be crucial for resolving various social issues. We are not a pharmaceutical company, but we would like to make a good contribution to overcome a wide range of social challenges, including aging, by providing precision medicine such as biodegradable liposomes for a variety of goals.

JS

Written with the cooperation of Naoko Sakai who is a freelance writer.