IBN Discovers Human Neural Stem Cells with Tumor Targeting Ability – A Promising Discovery for Breast Cancer Therapy

Singapore, April 20, 2012 – Could engineered human stem cells hold the key to cancer survival? Scientists at the Institute of Bioengineering and Nanotechnology (IBN), the world’s first bioengineering and nanotechnology research institute, have discovered that neural stem cells possess the innate ability to target tumor cells outside the central nervous system. This finding, which was demonstrated successfully on breast cancer cells, was recently published in leading peer reviewed journal, *Stem Cells*.

Despite decades of cancer research, cancer remains a leading cause of death worldwide, accounting for 7.6 million deaths in 2008, and breast cancer is one of the most common causes of cancer deaths each year. In Singapore, more than 1,400 women are diagnosed with breast cancer and more than 300 die as a result of breast cancer each year. The high fatality rate of cancer is partially attributed to the invasive ability of malignant tumors to spread throughout the human body, and the ineffectiveness of conventional therapies to eradicate the cancer cells.

A team of researchers led by IBN Group Leader, Dr Shu Wang, has made a landmark discovery that neural stem cells (NSCs) derived from human induced pluripotent stem (iPS) cells could be used to treat breast cancer. The effectiveness of using NSCs, which originate from the central nervous system, to treat brain tumors has been investigated in previous studies. This is the first study that demonstrates that iPS cell-derived NSCs could also target tumors outside the central nervous system, to treat both primary and secondary tumors.

To test the efficiency of NSCs in targeting and treating breast cancer, the researchers injected NSCs loaded with a suicide gene (herpes simplex virus thymidine) into mice.
bearing breast tumors. They did this using baculoviral vectors or gene carriers engineered from an insect virus (baculovirus), which does not replicate in human cells, making the carriers less harmful for clinical use. A prodrug (ganciclovir), which would activate the suicide gene to kill the cancerous cells upon contact, was subsequently injected into the mice. A dual-colored whole body imaging technology was then used to track the distribution and migration of the iPS-NSCs.

The imaging results revealed that the iPS-NSCs homed in on the breast tumors in the mice, and also accumulated in various organs infiltrated by the cancer cells such as the lung, stomach and bone. The survival of the tumor-bearing mice was prolonged from 34 days to 39 days. This data supports and explains how engineered iPS-NSCs are able to effectively seek out and inhibit tumor growth and proliferation.

Dr Shu Wang shared, “We have demonstrated that tumor-targeting neural stem cells may be derived from human iPS cells, and that these cells may be used in combination with a therapeutic gene to cripple tumor growth. This is a significant finding for stem cell-based cancer therapy, and we will continue to improve and optimize our neural stem cell system by preventing any unwanted activation of the therapeutic gene in non-tumor regions and minimizing possible side effects.”

“IBN’s expertise in generating human stem cells from iPS cells and our novel use of insect virus carriers for gene delivery have paved the way for the development of innovative stem cell-based therapies. With their two-pronged attack on tumors using genetically engineered neural stem cells, our researchers have discovered a promising alternative to conventional cancer treatment,” added Professor Jackie. Y. Ying, IBN Executive Director.

Compared to collecting and expanding primary cells from individual patients, IBN’s approach of using iPS cells to derive NSCs is less laborious and suitable for large-scale manufacture of uniform batches of cellular products for repeated patient treatments. Importantly, this approach will help eliminate variability in the quality of the cellular products, thus facilitating reliable comparative analysis of clinical outcomes.

Additionally, these iPS cell-derived NSCs are derived from adult cells, which bypass the sensitive ethical issue surrounding the use of human embryos, and since iPS cells are developed from a patient’s own cells, the likelihood of immune rejection would be reduced.

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Figure: In vivo imaging to demonstrate the tumor tropism of human iPS cell-derived neural stem cells (NSCs) in normal mice (without tumor) and in mice with tumor (4T1) using the dual-colored whole body imaging technology (DiR near-infrared fluorescence and bioluminescence imaging).

References:


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About the Institute of Bioengineering and Nanotechnology
The Institute of Bioengineering and Nanotechnology (IBN) was established in 2003 and is spearheaded by its Executive Director, Professor Jackie Yi-Ru Ying, who has been on the Massachusetts Institute of Technology's Chemical Engineering faculty since 1992, and was among the youngest to be promoted to Professor in 2001.

In 2008, Professor Ying was recognized as one of “One Hundred Engineers of the Modern Era” by the American Institute of Chemical Engineers for her groundbreaking work on nanostructured systems, nanoporous materials and host matrices for quantum dots and wires.

Under her direction, IBN conducts research at the cutting-edge of bioengineering and nanotechnology. Its programs are geared towards linking multiple disciplines across engineering, science and medicine to produce research breakthroughs that will improve healthcare and our quality of life.

IBN’s research activities are focused in the following areas:

- **Drug and Gene Delivery**, where the controlled release of therapeutics involve the use of functionalized polymers, hydrogels and biologics for targeting diseased cells and organs, and for responding to specific biological stimuli.

- **Cell and Tissue Engineering**, where biomimicking materials, stem cell technology, microfluidic systems and bioimaging tools are combined to develop novel approaches to regenerative medicine and artificial organs.

- **Biodevices and Diagnostics**, which involve nanotechnology and microfabricated platforms for high-throughput biomarker and drug screening, automated biologics synthesis, and rapid disease diagnosis.

- **Pharmaceuticals Synthesis and Green Chemistry**, which encompasses the efficient catalytic synthesis of chiral pharmaceuticals, and new nanocomposite materials for sustainable technology and alternative energy generation.

IBN’s innovative research is aimed at creating new knowledge and intellectual properties in the emerging fields of bioengineering and nanotechnology to attract top-notch researchers and business partners to Singapore. Since 2003, IBN researchers have published over 769 papers in leading journals.

IBN also plays an active role in technology transfer and spinning off companies, linking the research institute and industrial partners to other global institutions. The Institute has a portfolio of over 695 patents/patent applications on its inventions, and welcomes industrial and clinical partners to collaborate on and co-develop its technologies. IBN has successfully commercialized 33 patents/patent applications.

IBN's current staff and students strength stands at over 150 scientists, engineers and medical doctors. With its multinational and multidisciplinary research staff, the Institute is geared towards generating new biomaterials, devices, systems and processes to boost Singapore's economy in the medical technology, pharmaceuticals, chemicals, consumer products and clean technology sectors.

IBN is also committed to nurturing young talents. Besides the training of PhD students, IBN has a Youth Research Program (YRP) for students and teachers from secondary schools, junior colleges, polytechnics, and universities. Since its inception in October 2003, IBN’s YRP has reached out to more than 54,000 students and teachers from 286 local and overseas schools and institutions. Over 1,500 students and teachers have completed research attachments at IBN for a minimum period of four weeks.

For more information, please visit: [www.ibn.a-star.edu.sg](http://www.ibn.a-star.edu.sg).