【Grant-in-Aid for Scientific Research(S)】
Integrated Science and Innovative Science (Comprehensive fields)

Title of Project : Development of a Nano-Micro Platform for Tissue Engineering Applications

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Research Area : Biomedical Engineering - Biomedical engineering/Biological material science

Keyword : Medical micromachines, nanomachines

【Purpose and Background of the Research】

Tissue engineering is a research field thriving at an immense speed globally. However, most research concentrates only on the cellular level, such as establishing stem cell lines and investigating differentiation inducing techniques. In order to boost tissue engineering to a clinically applicable level, it is inevitable for tissue regeneration technologies to be developed, not at the cellular level, but at the tissue/organ level. Still, to regenerate 3-dimensional tissue with thicknesses ranging in the mere millimeter scale remains too high a challenge.

We aim to contribute to the field by integrating originally developed root technologies such as 3-D nano-fabrication, micro-actuators, super-small force sensing, and nano-functional materials (Fig. 1).

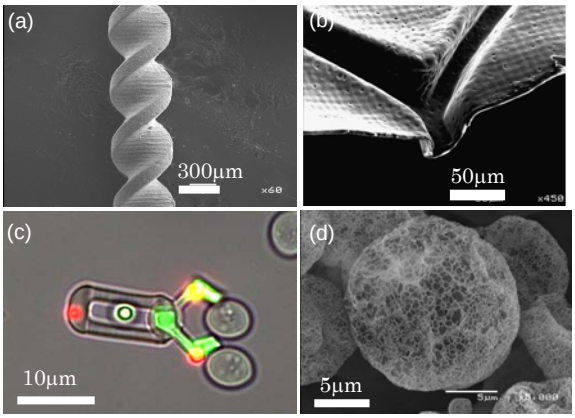

Figure 1. Originally developed root technologies (a) Magnetic micro-machine (b)Biodegradable membrane micro-channel (c)Optically-driven cell manipulating robot (d) Biodegradable nanofiber capsule.

【Research Methods】

The tissue engineering platform to be developed is composed of 3 differently scaled classes: mm, μm and nm. The largest class will be a cell culture chip no larger than a square centimeter containing a culturing chamber, medium providing vessels, heat and CO_2 control units. The middle class will be a micro-channel network placed within the culturing chamber. The micro-channels will function as an inlet for gene transfection and differentiation inducement. The lowest class will be a nano-actuator that can apply stimuli to individual cells enabling the inducement of differentiation via mechanical stimuli. Accordingly to the above three classes, single cells to mass tissue can be controlled, and inducing differentiation along with 3-D tissue culturing will be realized.

【Expected Research Achievements and Scientific Significance】

The described tissue engineering platform aims to regenerate multiple functioning 3-D tissues. As it being a basic technology, the formation of intellectual property and the origination of new industries / venture businesses can also be expected.

For future plans we are aiming to develop clinically functional, implantable tissues through thorough animal experiments. By combining conventional stem cell technology with the tissue engineering platform we pursue a radical solution to the chronicle problem of lacking donors seen in transplantation medicine today.

【Publications Relevant to the Project】

- K. Kobayashi, K. Ikuta, Three-dimensional magnetic microstructures fabricated by microstereolithography, Appl. Phys. Lett., 92, 262505 (3pp), 2008
- A. Yamada, F. Niikura, K. Ikuta, A three-dimensional microfabrication system for biodegradable polymers with high resolution and biocompatibility, J. Micromech. Microeng., 18, 025035 (9pp), 2008
- M. Ikeuchi and K. Ikuta, Membrane Micro Emboss (MeME) Process for 3-D Membrane Microdevice, Micro Electronic and Mechanical Systems, IN-TECH, pp.1-14, 2009

【Term of Project】 FY2010-2014

【Budget Allocation】 167,200 Thousand Yen

【 Homepage Address and Other Contact Information】

http://www.keisu.t.u-tokyo.ac.jp/lab/lab_ipc/ikutalab.htm