FUNDING PROGRAM FOR NEXT GENERATION WORLD-LEADING RESEARCHERS

Project Title: Development of fundamental technologies for the realization of taylor-made tissue-engineered cartilage	
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1. Background of research

As the world welcomes the aging society, there is a increasing trend in knee and waist pains within the middle-aged to elderly population. Just alone in Japan, the number of people suffering from such disease is estimated to be over 7 million. Even with the currently medical care, only treatments such as removing the joint cartilage from areas of pain or transplantation of limited durability artificial joints is available. This still does not remove the source of knee and waist pain completely. Therefore, there is much expectations in using autologous tissue-engineered cartilage as a next generation treatment.

2. Research objectives

Theoretically, by utilizing the multipotent stem cells that exist in the matured body, customizable 3D tissue-engineered constructs can be synthesized to completely replace the areas of pain with a perfect fit. Our research goal is to establish robust protocols and technologies for the synthesis of structurally functional tissue-engineered cartilage.

3. Research characteristics (incl. originality and creativity)

3D structurally functional tissue-engineered cartilage is deemed as the next generation articular cartilage to replace the current artificial joints. To develop this next generation articular cartilage, the following technology are necessary. 1.) Apparatus for delivering multiple physical stimulation in order to enhance the maturation of immature tissue-engineered cartilage. 2.) High-speed, wide range and high-precision multi-laser stereolithography technology for the construction of 3D structures. 3.) Apparatus for large-scale production of stem-cell derived micro cartilage blocks. The development of these new technologies and the combination are the novelties in this proposal.

4. Anticipated effects and future applications of research

With the development of the proposed research (i.e. moldable 3D structurally functional tissue-engineered cartilage for full replace) , the quality of life and the welfare of the nation can be increased directly, especially for the middle-aged to elderly population suffering from articular joint diseases. Also, the development of the high-precision, high-speed multi-laser stereolithography technology can be utilized in other non-medical applications as a fundamental technologies for object construction.

-Synthesis of Taylor-Made Autologous Tissue-Engineered Cartilage-

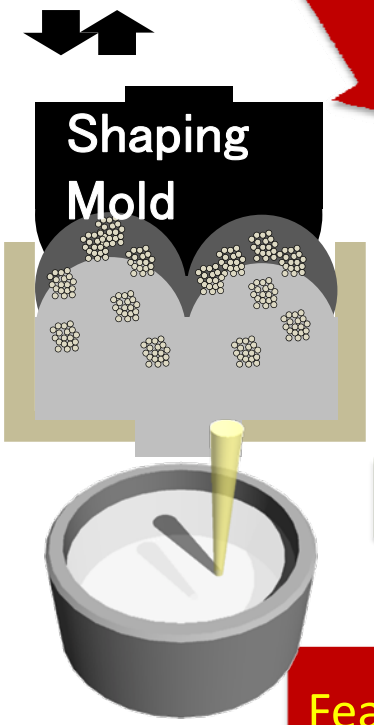
3D Molding Technology

Controlled Stem Cell Differentiation Technology

Feature 2 ; Multi-laser 3D Molding Technology

Feature 3 ; Scaling up stem-cell derived micro tissue units

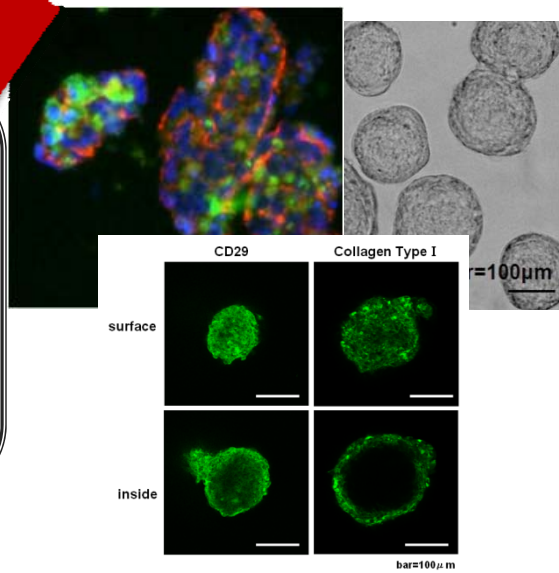
3DTissue Physical Stimulation Apparatus



3D Molding Technology

- Taylor-made (Controllable Shape)
- Anisotropic tissue (Internal Organization

Higher-order structure cartilage
+ Subchondral bone tissue



Squeeze Effect

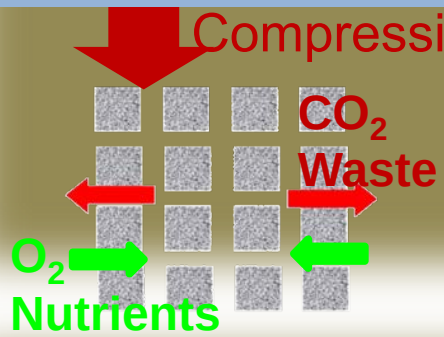
Multiple Physical Stimulation Organization

Feature 1 ; Taylor-made Dynamic Culture Device

Development of large, strong, 3D definable shaped tissue-engineered cartilage

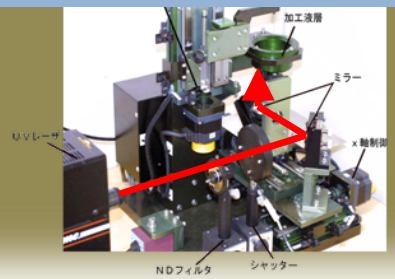
Expected Results

1. Taylor-made Dynamic Culture Apparatus



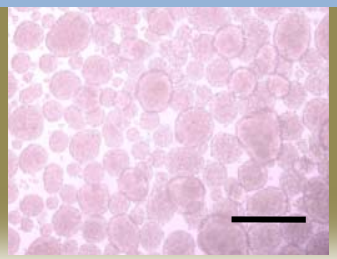
- Substance exchange
- 3D shape of affected area

2. Multi-laser stereolithography



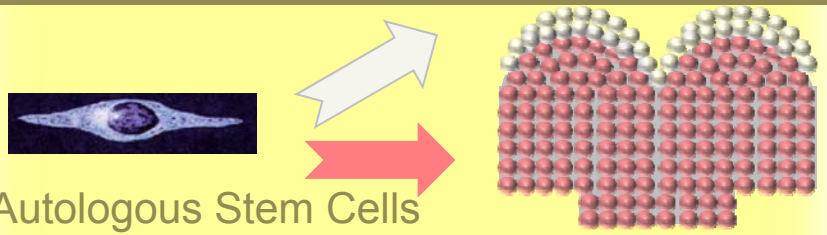
- High speed
- High precision
- Large constructs

3. Micro-tissue unit scale-up apparatus



- Stem Cells
- Large-scale
- Fast

Contribution to life innovation



Autologous Stem Cells
→ 3D Tissue-engineered Cartilage

Unit → 3D struture → Physical stimulation

Large, strong, 3D definable shaped tissue-engineered cartilage

Direct Effects of Civilian Life

- Good QOL
- Resolve caring of the working generation
- **Model organ for disease onset**
  - >Elucidate the mechanism of disease onset
  - >Drug development tool based on SNIP