Scientists grow bone from human embryonic stem cells

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As people live longer, repairing or regenerating human tissues has become an ever-more critical issue. Just in the past decade alone, human stem cells are emerging as powerful tools for tissue regeneration, as they can differentiate into many diverse specialized cell types as well as self-renew to produce more stem cells. And now they are used to study bone development, build models of disease, and establish new clinical modalities for treating large bone defects.

In a study published this week in the online Early Edition of *PNAS* (*Proceedings of the National Academy of Sciences*), researchers at Columbia University's School of Engineering and Applied Science, led by Gordana Vunjak-Novakovic, Mikati Foundation Professor of Biomedical Engineering, have shown, for the first time, that human embryonic stem cells can be used to grow bone tissue grafts for use in research and potential therapeutic application.

"This is the first demonstration that human embryonic stem cells can be directed to form compact, stable, living bone in sizes sufficient for future studies and eventually clinical applications," says Vunjak-Novakovic, who is also professor of medical sciences, vice chair of the Department of Biomedical Engineering, and director of the Laboratory for Stem Cells and Tissue Engineering.

In this study, Vunjak-Novakovic and her team, with former postdoctoral student Darja Marolt as a lead author, used a "cell-instructive" environment that they engineered by using a specialized scaffold that induced bone formation, and a bioreactor that perfused fluid through the forming tissue to maintain cell viability. Marolt is now a New York Stem Cell Foundation-Helmsley Investigator.

“We were happy to find that these versatile human cells consistently made compact bone tissue large enough to repair centimeter-sized defects,” says Vunjak-Novakovic. “This engineered bone tissue developed, remodeled, and connected to the vascular supply of the host, without a single incidence of tumor growth.”

Vunjak-Novakovic and her team are focused on three separate but related areas of research. They want to grow living bone grafts with a wide range of sizes, shapes, structural, and mechanical properties suitable for clinical use. In addition, she says that embryonic stem cells are a “perfect” model to study development, and to learn how the cells commit to specific paths leading into the formation of specific organs, and thus gain specific functions. “The engineered bone resembles some aspects of the environment in vivo,” she adds, “and it enables us to study bone development under biologically sound yet controllable conditions.”

The team is also planning to use engineered bone to build models of disease. Marolt has already worked on in vitro studies of drugs using the engineered bone model, and Vunjak-Novakovic’s laboratory is now using this model system to study the formation and metastasis of bone tumors.

“I really love tissue engineering,” says Vunjak-Novakovic, “because of the complexity of the problems we study and the prospects to help us live longer and better, by providing ‘spare parts’ for our tissues and organs. It’s thrilling to see that some of the greatest young talent is attracted to this tissue engineering and regenerative medicine, with Dr. Marolt being a prominent example. The advanced technologies we are developing and the progress being made with human stem cells are instrumental for this exciting work to get to the next level."

More information: www.pnas.org/content/early/201 … /1201830109.abstract

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