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News & Comments

A Study Reveals how Zebrafish can Heal Damaged Heart

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Lack of oxygen damages heart muscle cells (cardiomyocytes) and causes them to die off after a heart attack if they are not treated quickly enough. As scar tissue develops, the heart cannot pump effectively because new cardiomyocytes cannot be produced. The zebrafish, which can regenerate organs, including its heart, is an example of a lower vertebrate that can regenerate organs. After sustaining a heart injury, zebrafish can regrow up to 20 percent of their one-millimeter-sized hearts within two months. Cardiomyocytes, which make up the heart muscle in humans, cannot regenerate like those in zebrafish.

In an attempt to figure out how zebrafish do it, Professor Jan Philipp Junke and the team simulated myocardial infarction injuries in the hearts of their zebrafish. Cell lineage trees and single-cell analyses were used to track cardiomyocyte regeneration. They found that the immediate response to the injury was similar. Fish, however, carry on the process after that point, while humans stop at that point. They form new cardiomyocytes, which are capable of contracting.

Interestingly, this study shows that zebrafish heart regeneration is conducted by connective tissue cells called fibroblasts, which produce proteins that act as repair signals. This discovery follows other promising efforts in regenerative medicine, such as cell-based therapies and drugs mimicking zebrafish molecules that can replace or repair damaged hearts. They then extracted genomic information from individual cells in the damaged hearts of zebrafish using single-cell sequencing techniques. In this study, three types of fibroblasts entered a temporary activation state, switching on genes encoding muscle-building proteins, such as collagen XII, which promotes connective tissue growth. upon silencing these genes, the zebrafish could no longer regenerate heart tissues.

It has been shown in zebrafish research that inflammatory cells called macrophages are quick to respond to heart attacks and necessary for heart regeneration, in addition to fibroblasts. In this study, the researchers used single-cell sequencing techniques to locate heart cells sending out regenerative signals. The study sheds light on the biological processes that occur following a heart attack, insights that may one day help prevent subsequent heart attacks that become riskier as time goes on.

KEYWORDS

Cardiac regeneration, tissue regeneration, zebrafish, cardiomyocytes, myocardial infarction, systems biology, regeneration, heart muscle cells, repair damaged heart, fibroblasts, research