Healing heart attack victims, one cell at a time

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Researchers have determined that cells in the human heart develop into adulthood by looking at the amount of carbon 14 in the atmosphere from above-ground nuclear testing in the 1950s and 1960. Illustration by Mattias Karlén, Karolinska Institute

(PhysOrg.com) -- By using the amount of carbon 14 in the atmosphere from above-ground nuclear testing in the 1950s and 1960, researchers have determined that cells in the human heart develop into adulthood.

But as humans age, the percentage of new heart cells decreases

markedly. By age 25, renewal of heart cells gradually decrease from 1 percent turning over annually to .45 percent by the age of 75. About 50 percent of the heart cells a human is born with will regenerate during a lifetime.

Myocardial damage often results in chronic heart failure because of the loss and insufficient regeneration of heart cells. But this new finding may mean that patients, who have suffered myocardial damage as a result of a heart attack, may have some good news.

Lawrence Livermore National Laboratory scientist Bruce Buchholz with colleagues from the Karolinska Institute, Université Claude Bernard Lyon, Lund University and Lund University Hospital, found that cells in a human heart can develop into adulthood and the age of heart cells is, on average, six years younger than the individual.

Using the Laboratory's Center for Accelerator Mass Spectrometry, Buchholz measured the amount of carbon 14 in DNA to establish the age of caridiomyocytes (cardiac muscle cells) in humans.

Carbon 14 atmospheric concentration levels remained relatively stable until the Cold War, when above-ground nuclear bomb tests caused a sharp increase, or peak, which decreased slowly after the end of above-ground testing in 1963. This spike in carbon 14 in the atmosphere serves as a chronometer of the past 55 years.

Because DNA is stable after a cell has gone through its last cell division, the concentration of carbon 14 in DNA serves as a date mark for when a cell was born and can be used to date cells in humans.

The team determined the ages of heart cells by determining the time at which the sample's carbon 14 concentration corresponded to the atmospheric concentration. Buchholz found that people born around or

after the nuclear bomb tests corresponded to atmospheric concentrations several years after the subjects' birth, indicating substantial postnatal DNA syntheses.

"By analyzing individuals born at different times before 1955, it is possible to establish the age up to which DNA synthesis occurs, or whether it continues beyond that age," Buchholz said.

In the study, carbon 14 concentrations were elevated in subjects compared to those people born up to 22 years before the beginning of nuclear bomb tests.

"DNA of myocardial cells is synthesized many years after birth, indicating that cells in the human heart do, in fact, renew into adulthood," Buchholz said. "At the age of 50, 55 percent of the heart's cells remain from the time around birth and 45 percent have been generated later."

Cardiac muscles have a striated appearance and their contraction in the heart propels blood from the atria and ventricles to the blood vessels of the circulatory system.

The limited recovery in humans after a heart injury, such as a heart attack, demonstrates failing regeneration of heart cells. But the team concluded that the renewal of heart cells, as indicated by the mixing of carbon 14 in the DNA, suggest that the development of pharmacological strategies to stimulate this process may be a rational alternative or complement to cell transplantation strategies for heart cell replacement.

The research appears in the April 3 edition of the journal *Science*.

Source: Lawrence Livermore National Laboratory