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Embryonic Stem Cells

By Richard Mollard

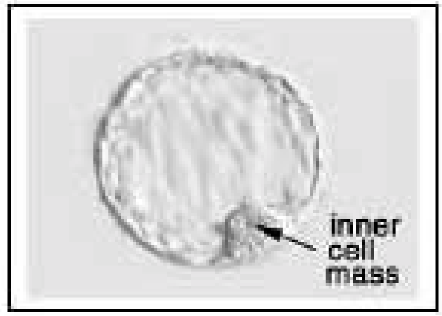
Human embryonic stem (ES) cells are cultured cell lines derived from the inner cell mass of the blastocyst that can be grown indefinitely in their undifferentiated state, yet also are capable of differentiating into all cells of the adult body.

The blastocyst, source of human embryonic stem cells:

The most versatile type of stem cell is the embryonic stem cell. This cell is distinct from the stem cells found within the adult body, as it can only be derived from cells found in the embryo. During development, at 5-6 days, the human fertilized egg grows into a ball of cells known as the blastocyst. The blastocyst will develop through a number of other embryonic stages before becoming a fetus. Embryonic stem cell research is undertaken on cells derived from the inner cell mass (see image above) of blastocysts that have developed from fertilized eggs following *in vitro* fertilization. If the blastocyst would be implanted back into the mother for pregnancy, it could develop into a fetus and then a new born baby.

Because not all eggs will fertilize and develop properly into blastocysts during an *in vitro* fertilization procedure, more eggs are fertilized than are required in order to maximize the chances of having a successful pregnancy. Those blastocysts that are not implanted for pregnancy are usually frozen for future use by the couple who produced them, or are ultimately discarded. It is these discarded blastocysts that have been used to derive human embryonic stem cells in the laboratory, after approval of the donors and oversight by the appropriate institutional review boards or ethics committees.

Once embryonic stem cells have been established in culture, they can be propagated and even amplified for a long time, without loosing their true stem cell character and potential.



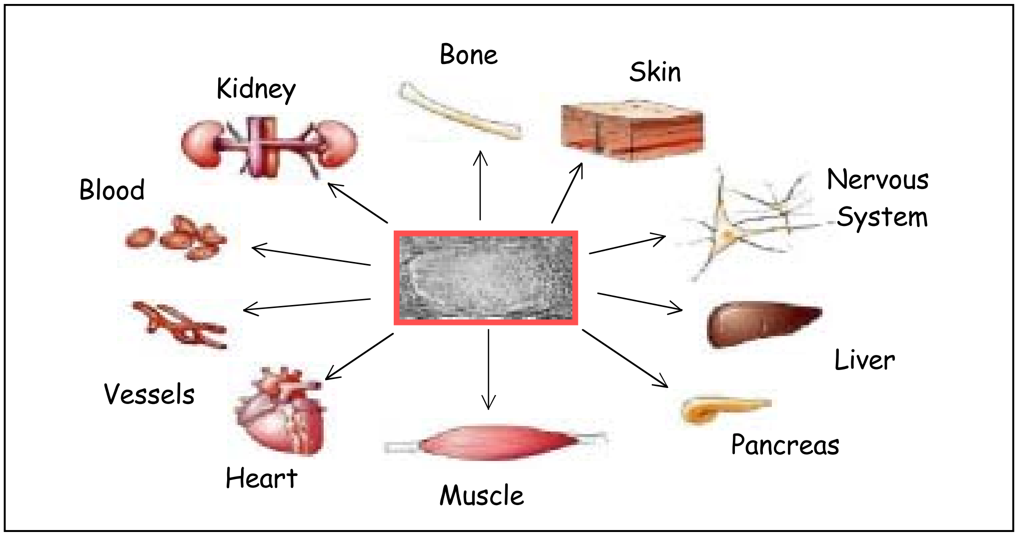
Blastocyst: 5-6 days after fertilization, the egg develops into the cell ball pictured in the image, which is called blastocyst by developmental biologists. At the depicted stage the ball is hollow, consisting of an envelope of cells, surrounding the inner cell mass (ICM) from which the embryonic stem cells are gathered.

The value of embryonic stem cells for research and therapy:

The most remarkable feature of embryonic stem cells is their ability to retain the developmental capacity to generate all functional adult cell types. Culture methods have been developed to turn embryonic stem cells into brain, heart, muscle cells, blood cells, blood vessels, skin, islet cells and bone cells.

It is therefore anticipated that research with embryonic stem cells will help to discover the factors necessary for regeneration and repair of tissues. Researchers hope to be able to coax embryonic stem cells, and maybe also adult or cord blood stem cells, into producing cells and tissue for replacement therapies for treating disorders such as Parkinson's disease, heart attacks, blood disorders and diabetes.

It is also hoped that stem cells could be used to grow entire hearts, livers and even kidneys, thus relieving the alarming shortfall of organ donors. However, for this scientists will have to develop culture techniques that allow three-dimensional growth of complex structural and functional entities, such as entire organs.



Potential of human embryonic stem cells. Embryonic stem cell colonies such as depicted in the middle could potentially one day be grown in culture to the depicted organs and more. While to date many differentiated cell types have been grown from embryonic stem cells, culture conditions need more refinement before entire organs could possibly be grown in culture.

How these new therapies will be best achieved is still open to debate. One area of investigation is to learn how to instruct embryonic stem cell in culture to produce the desired cell type for introduction into, and treatment of, the affected tissue. Alternatively, adult stem cells that reside within the affected organs themselves may be directly stimulated to replace damaged cells in the affected organ.

Finally, adult stem cells such as hematopoietic or neural stem cells, can be isolated in culture, treated and then reintroduced back into the body to repair or replace the damaged tissue.

Scientists continue to obtain valuable information about each stem cell type and the final choice may depend upon the specific disease or disorder.

However, embryonic stem cells remain the only stem cell type demonstrated to produce all of the approximately different 200 cell types found within the adult body, and the only stem cell type for which routine genetic engineering protocols have been developed. For these reasons, they remain an extremely important resource for researchers to study.

Richard Mollard, Ph.D., is an embryonic stem cell specialist at the Institute of Reproduction and Development at the Monash University in Australia.