Research on stem cells in Switzerland

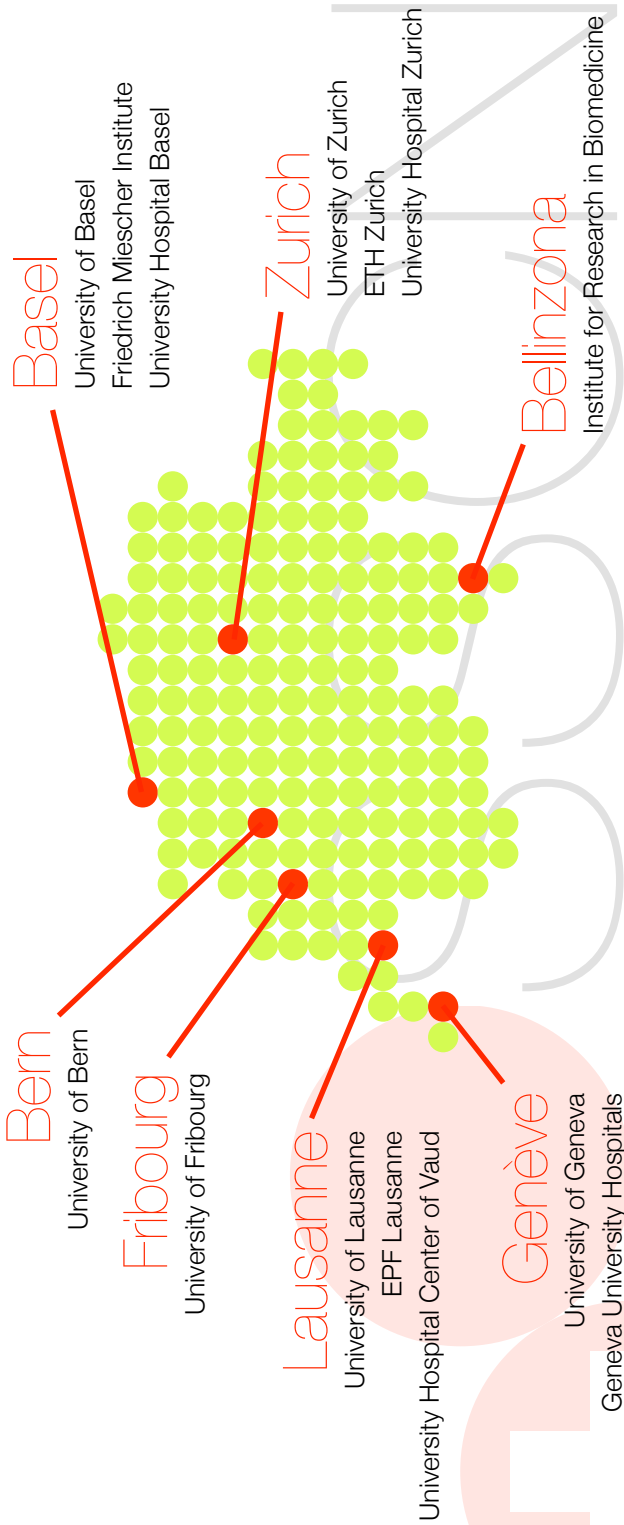
Understanding the biology of stem cells is essential for any rational use. Today, scientists in Switzerland are hard at work to decipher the function and regulation of stem cells in oncological, developmental, pathological, regenerative and ageing processes. Various kinds of stem cells from different species are used, including those from humans, mice, fish, flies, worms and hydra. The technologies used in stem cell research encompass cell culture, clonal analysis, molecular biology, genetic analyses, imaging and microsurgery. In addition, scientists and clinicians have a long-standing interest in translating basic knowledge into clinical application. The elucidation of how stem cells induce regeneration and repair will provide the bases for sound, novel approaches for treating many debilitating and life-threatening conditions.

The legal use of stem cells in Switzerland

Switzerland is the only country where the use of embryonic stem cells was approved by direct popular vote. Since March 2005, the government has legalized both the importation and the derivation of human embryonic stem cell lines from surplus in vitro fertilized embryos for research purposes. Research projects can only be started after approval by the federal commission. However, therapeutic cloning, resulting from the transfer of an adult human cell nuclei belonging to a patient into an enucleated oocyte from a woman donor, to provide new tissue for the patient, is not allowed. Towards a completely different purpose, the similar strategy to produce developing human embryos for reproductive cloning is strictly forbidden and scientifically proscribed.

the Swiss Stem Cell Network (SSCN)

The SSCN is a non-profit group of scientists and clinicians active in the field of stem cells in Switzerland. The SSCN started in 2004 and was designed to foster interactions among scientists, and between scientists and society, to advance the discovery of basic mechanisms of embryonic and adult stem cell functions in human and all model systems, to encourage and support young scientists, minorities and women in science, to provide the public at large with an informed and first hand view of current stem cell research, and to discuss important scientific and ethical issues arising from stem cell research. The SSCN does not support reproductive cloning.



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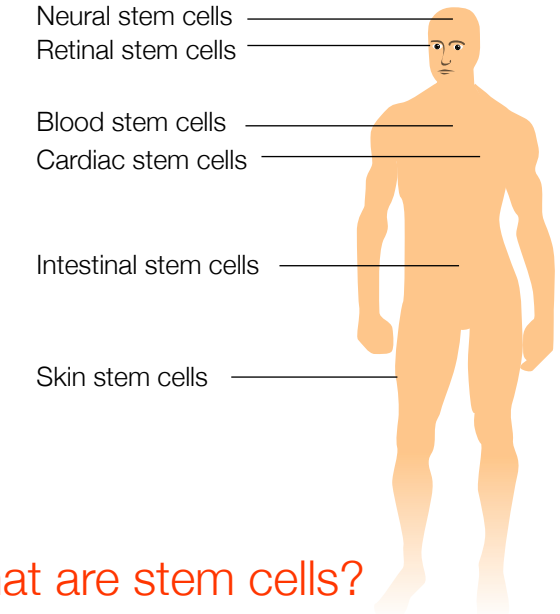

What are stem cells?

Stem cells are rare key cells with special properties: self-propagation or self-renewal, and multipotentiality, which is the ability to give rise to different kinds of cell types such as muscle, brain and skin. During their development, embryos produce different cell types that eventually make up the adult. In adulthood, the rare stem cells that persist in many organs all through life, are involved in tissue maintenance and, in some cases, organ regeneration. Stem cells therefore generate new tissue in the appropriate context while self-renewing themselves and thus maintaining the possibility of future regeneration. Stem cells, in their various forms, hence offer important possibilities to treat a wide variety of pathological conditions including diabetes, strokes, paraplegia or blindness.

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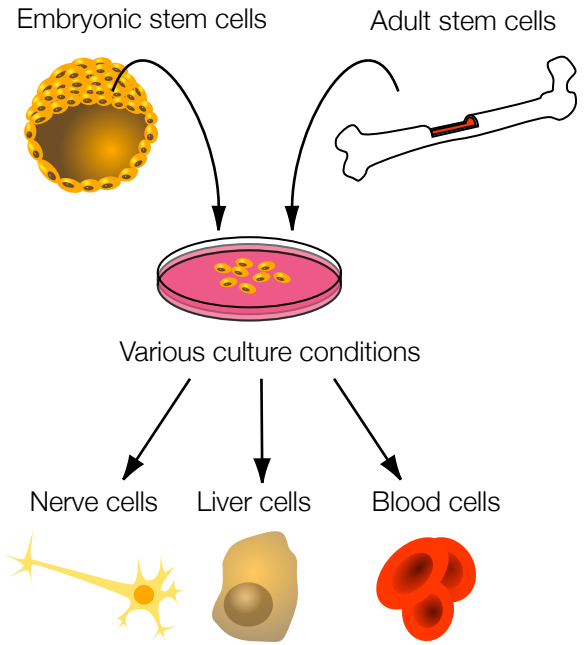
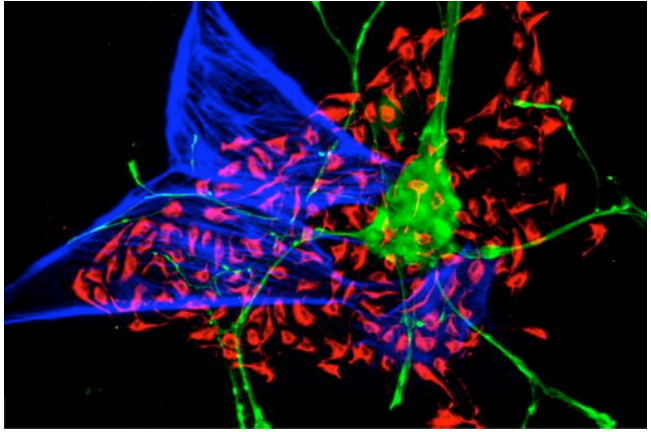
Embryonic and adult stem cells

Embryonic stem cells can be derived from very early embryos a few days after conception. In older fetuses, stem cells appear to have lost their totipotentiality and are already engaged in the formation of specific cell types dedicated to forming organs, such as brain, skin, muscles, bones, intestine, liver, blood… At birth, the blood that remains in the umbilical cord and placenta is a valuable source of stem cells. Adult stem cells can be extracted from adult tissues, namely bone marrow, skin, brain, retina, muscles, vessels. Stem cells for blood (hemotopoietic stem cells) are found in the bone marrow and were first described in the 1960's. Other kinds of adult stem cells, such as those in the adult brain, have been discovered in the last decade. Nevertheless, adult stem cells are very rare, difficult to maintain in culture and appear to be more restricted than embryonic stem cells, which emphasizes the importance of considering all sources of stem cells for future biomedical applications.

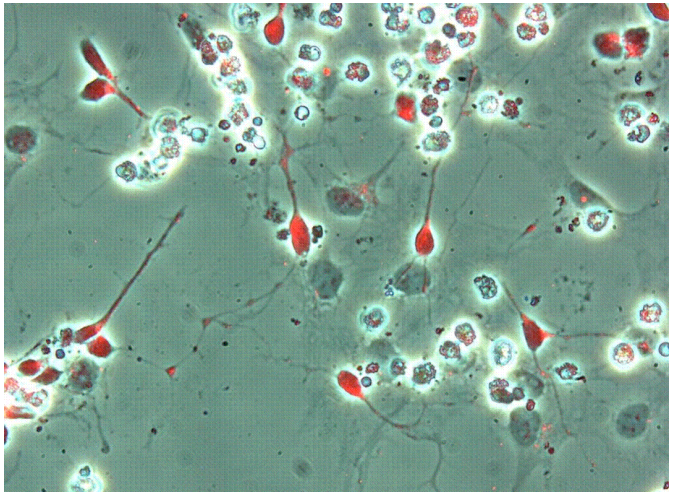




Stem cells have the capacity to generate many different cell types of our body. In the example shown here, a single stem cell has given rise to cells of the nervous system (red and green) as well as to muscle cells (blue).

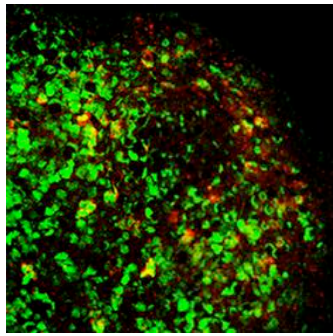
Stem cells in medicine today

Two kinds of adult stem cells are already in the clinics: Blood stem cells and skin stem cells. Hematopoeitic (blood) stem cells induce bone marrow recovery when transplanted into leukemic patients following chemotherapy. Skin stem cells grown in vitro allow for the reconstruction of the skin in severely burnt patients. These two types of applications have been in the clinics for many years and have dramatically improved the survival and the comfort of patients. Other types of stem cells are being designed, including possible beneficial effects to repair cardiac injury and neurodegeneration. These last approaches are in their infancy and their validity still needs be confirmed.



Neurons generated in cell culture express a photoreceptor-specific protein (red cells).

Stem cells and regenerative medicine



Head regeneration in hydra

In the future, it is possible to expect that the manipulation of stem cells, either pharmacologically or genetically, may lead to repair of diseased tissues. For example, diseases provoking blindness are due to a loss of the photoreceptor cells in the retina. Retinal stem cells could be a source to replace lost photoreceptors and in consequence to restore vision. But stem cells are also an important tool for the development of screening systems to identify new drugs that promote the survival of highly specialized cells. These decisive steps can only be reached through rigorous stem cell science, avoiding quick promises and simplistic answers.

Stem cells in cancer

A pressing reason to study stem cells is their perversion and function in cancer. Today cancer has become one of the leading causes of death in industrialized countries at peace. Importantly, 90% of people who die from cancer, die from metastatic tumors. In contrast to normal tissues and their normal stem cells, cancers also seem to harbor aberrant stem cells named cancer stem cells. Recent discoveries indicate that the recurrence of tumors after radiation or chemotherapy, as well as their metastatic potential is due to a small number of cancer stem cells. Identifying, targeting and destroying these cells, which are largely untouched by conventional treatments, is thus paramount in the development of novel and efficient anti-cancer therapies.