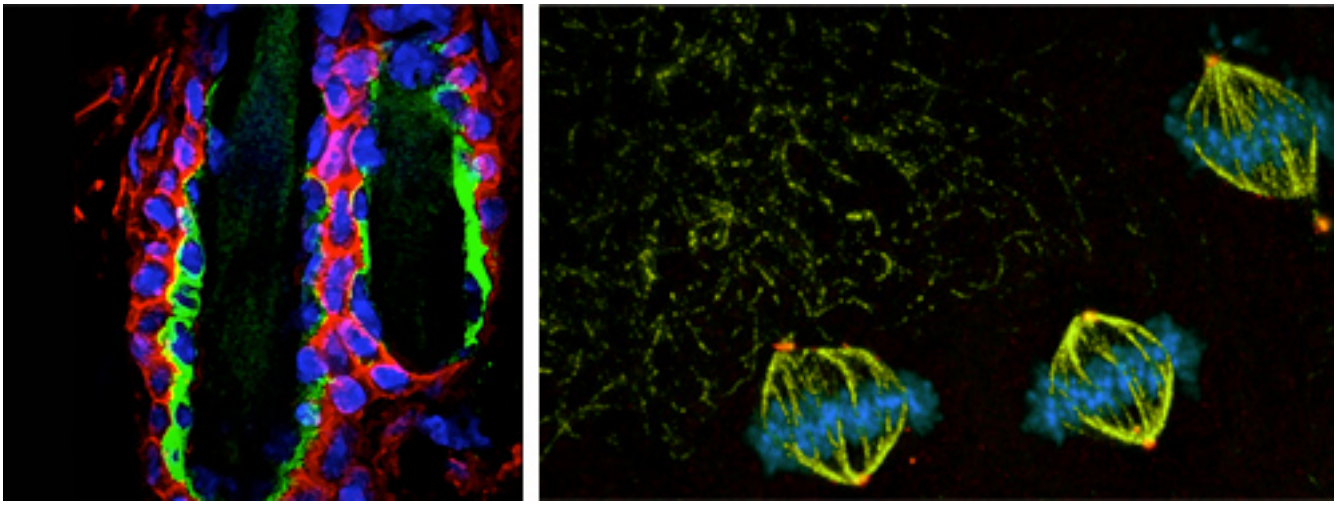
the Pontifical Academy of Sciences

New Developments in Stem Cell Research: Induced Pluripotent Stem Cells and their Possible Applications in Medicine

Working Group



The concept of stem cell goes back to the discovery, in the early 1960s, of the mechanisms through which blood cells, whose life span is short, are constantly renewed. It was shown that this is achieved by a small number of undifferentiated pluripotent progenitor cells, present in the bone marrow, that are endowed with the capacity to self renew. Cells with such characteristics were subsequently found in practically all tissues of the adult body that are permanently rejuvenated in the majority of multicellular organisms. In some primitive species, such as the flatworm Planaria, stem cells present in the adult make the animal able to multiply asexually. A major breakthrough in this field was the demonstration that the cells of the early mammalian embryo are endowed with stem cell properties that can be captured and maintained indefinitely in culture. It appeared that the embryonic stem cells that were obtained by this technique, named ES (Embryonic Stem) cells, constituted an inexhaustible source of pluripotent cells. The double capacity of stem cells to self renew in an undifferentiated state while being able to yield a large diversity of cell types in their progeny, was recently shown to be under the control of defined genes. This has recently led to a second breakthrough: the possibility ‘to turn the old into the young’, that is, to convert differentiated cells of an adult into cells that have most of the characteristics of the pluripotent cells of an embryo. The so-called iPS cells (induced Pluripotent Stem cells), have, since 2006, opened new avenues of research in Cell and Developmental Biology and also new hopes in regenerative medicine. Basic and applied research on the different types of stem cells is of major interest for several reasons. First they will contribute to enlighten some of the most critical biological problems

such as the mechanisms underlying cell differentiation, the maintenance of the differentiated state, the intimate relationships between cell differentiation and proliferation, as well as the deregulation of these processes in cancer. One can also expect that the capacity to re-programme already differentiated cells via the iPS cell technology will make it possible to use – for therapy – the cells of the patient. This will have the advantage of avoiding the use of the 'controversial' ES cells derived from human embryos and the immune rejection of the transplant. Thanks to these new discoveries, novel opportunities will very likely be available to improve the life of human beings. This is why the Council of the Academy decided that the most recent scientific developments in this exciting field of research should be expounded to the Academy by PAS Academicians together with the most prominent international specialists and subjected to in depth discussion. In fact, I think it is important that society leaders be aware of the extraordinary progress that has been accomplished during the last year with a better understanding of the identity of iPS cells and the new possibilities offered by the reprogrammation of adult, differentiated cells.

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