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Human pluripotent stem cells: derivation and applications

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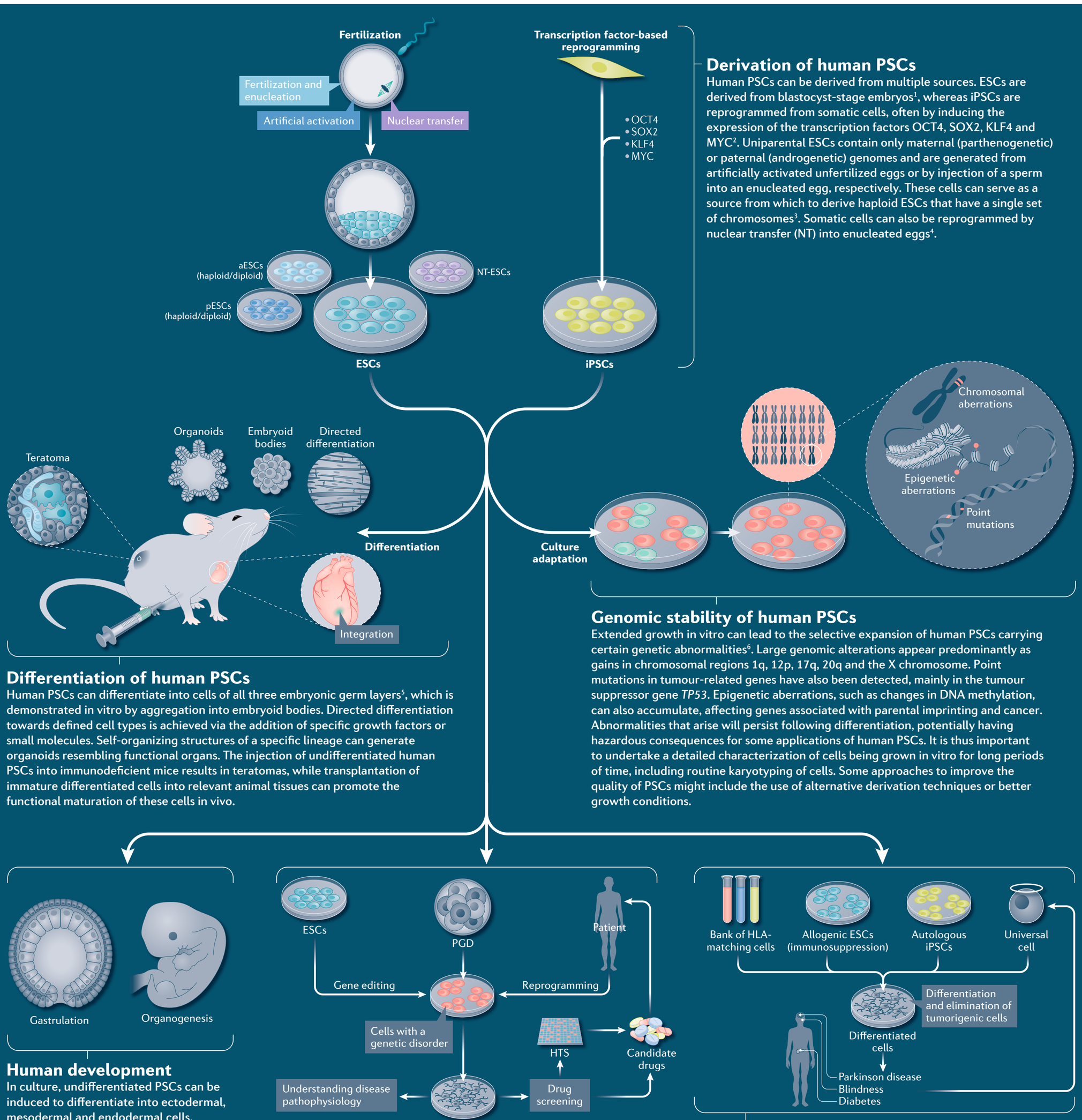
The two main human pluripotent stem cell (PSC) types are embryonic stem cells (ESCs) and induced pluripotent stem cells (iPSCs), both of which can differentiate in vitro into cells comparable to those arising from any of the three embryonic germ layers. In vivo, after transplantation into animals, these cells can form teratomas comprising various cell lineages, or integrate as functional cells into specific tissues. Human PSCs can acquire epigenetic and genetic aberrations, typically in specific chromosomal hot spots and in cancer-associated genes. Human PSCs have a wide range of applications related to the study of early human development, disease modelling and regenerative medicine. Multiple human disorders can now be modelled using cells derived from human PSCs and grown in monolayers, spheroids or organoids. These cell cultures are used for the discovery of therapeutics by applying high-throughput screening (HTS) or candidate medication approaches. Cells derived from human PSCs are also in clinical trials as treatments for various human disorders.



Glossary and abbreviations

Allogeneic cell transplantation
A form of cell therapy in which cells of a genetically distinct donor are used for transplantation.

Androgenetic (a) cells
Cells carrying only a paternal genome, generated by introduction of sperm into an enucleated egg. For example, androgenetic ESCs (aESCs).

Autologous cell transplantation
A form of cell therapy in which the patient's own cells are used for transplantation.

Blastocyst
An early embryonic structure formed in humans 5 days post-fertilization, comprising an inner cell mass of pluripotent cells, an external layer of trophectoderm cells and a blastocoel fluid cavity.

Cell therapy
An approach to treat human diseases by transplanting functional cells into patients.

Culture adaptation
Alterations arising in a population of cells during prolonged growth in culture, resulting in increased fitness.

Directed differentiation
In vitro differentiation of cells towards a specific cell type by defined culture conditions.

Disease modelling
A strategy to study human diseases using cells that exhibit relevant pathological features.

Embryoid bodies
Sphere-shaped aggregates of pluripotent stem cells undergoing spontaneous differentiation into the three embryonic germ layers.

Embryonic stem cells
(ESCs). Pluripotent stem cells derived from the inner cell mass of blastocyst-stage embryos.

Haploid cells
Cells carrying a single set of chromosomes, in contrast to diploid cells, which contain two sets of chromosomes.

High-throughput screening
(HTS). A method for simultaneously assessing the biological effects of a large set of chemical compounds or genetic alterations.

Human leukocyte antigen
(HLA). The major histocompatibility complex in humans, which is part of the immune system. It encodes cell surface molecules that are specialized to present antigenic peptides to T cell receptors.

Induced pluripotent stem cells
(iPSCs). Pluripotent stem cells derived from somatic cells by a set of reprogramming factors, for example, OCT4, SOX2, KLF4 and MYC (collectively referred to as OSKM).

Organoids
Three-dimensional structures assembled from self-organizing cells that simulate an organ in vitro.

Parthenogenetic (p) cells
Cells carrying only a maternal genome, established by activation of an unfertilized egg; for example, parthenogenetic ESCs (pESCs).

Pluripotent stem cells
(PSCs). Cells capable of indefinite self-renewal and differentiation into all three embryonic germ layers.

Preimplantation genetic diagnosis
(PGD). A test performed on biopsied cells of early in vitro fertilized embryos to determine genetic attributes of the embryo.

Somatic cell nuclear transfer
(SCNT). Introduction of a somatic nucleus into an enucleated egg, resulting in the induction of pluripotent identity and generation of NT-ESCs.

Teratoma
A tumour comprising cells of all three embryonic germ layers.

Tumorigenicity
The competency of a cell to form a tumour.

Universal cells
Genetically modified cells designed to evade immune detection.

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Competing interests
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