



In vitro gametogenesis refers to the process of generating functional eggs or sperm in laboratory setting from isolated germ cells or induced Pluripotent stem cells (iPSC). This technology has immense potential for reproductive biology, breeding conservation and clinical applications. additionally, IVG could be used to create gametes from human iPSC which would enable the creation of 'artificial eggs' or artificial sperm', offering new opportunities for fertility treatments.



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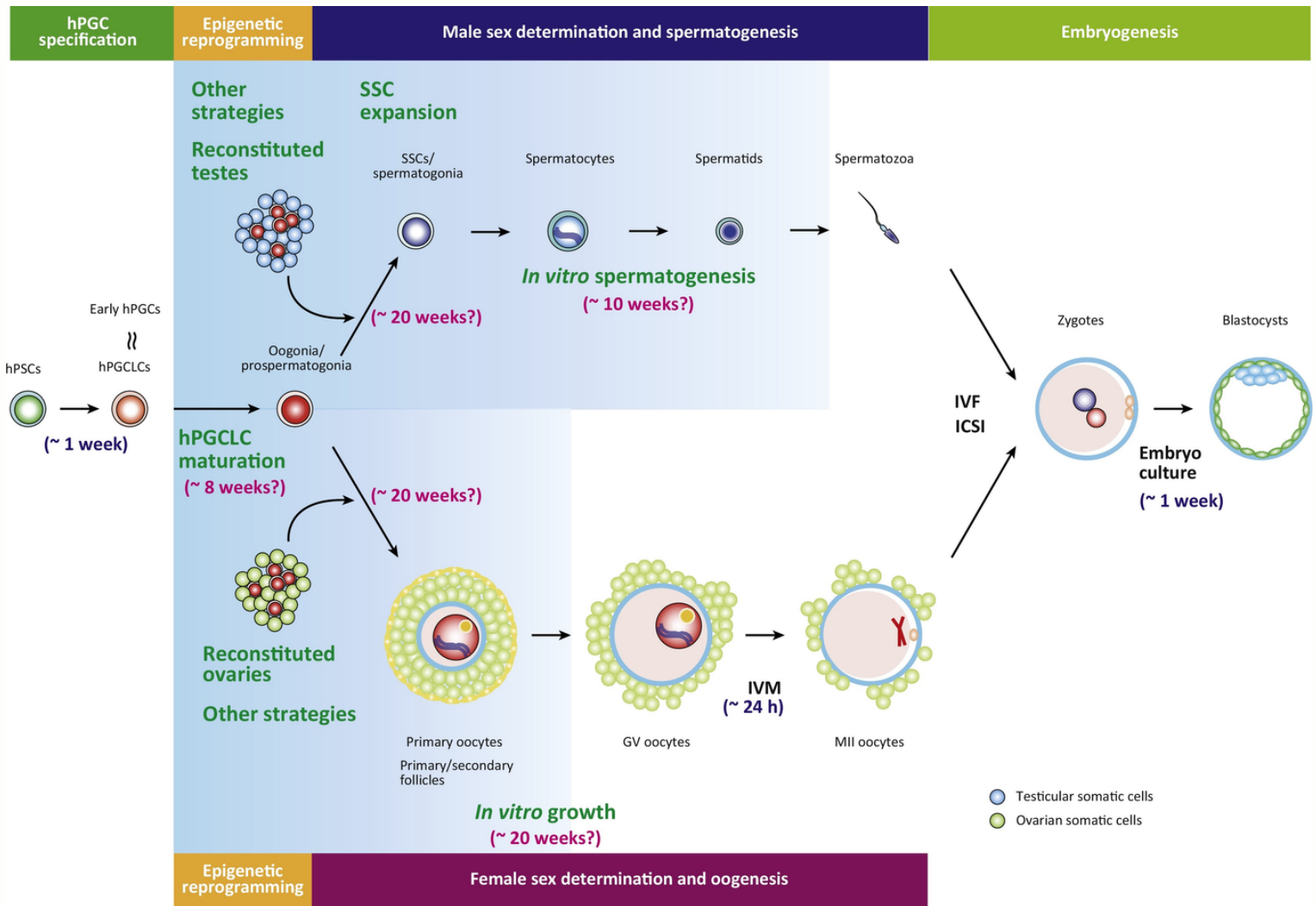
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## Introduction

In first few years of this century, researchers made headlines after deriving in vitro gametes - reproductive cells - from mice. Further work produced live offspring, demonstrating reproductive viability of these cells. In the research setting, IVG could improve current understanding of gametogenesis (gamete development) and various factors contributing to infertility. Knowledge gained from such research not only is valuable in and of itself, but also has the potential to lead to tangible clinical benefits, such as reduced infertility rates. While not nearly as advanced, the research on human cells suggests that in vitro gametogenesis may one day be possible with humans.

## Techniques

Three main techniques for creating IVD (In vitro derived) gametes have been described in the literature. The primary difference among these techniques relates to the source of stem cells used to derive the IVD gametes. These sources include (1) induced pluripotent stem cells, (2) embryonic stem cells (ESCs) from cloned embryos, and (3) ESCs from in vitro fertilization (IVF) embryos.



Trends in Molecular Medicine

Figure. 1 : Generation of artificial Gamete and embryo from induced pluripotent stem cells.

Creating IVD gametes from induced pluripotent stem cells (iPSCs) involves genetically reprogramming a somatic cell (e.g. skin cell) from one of the prospective parents to become iPSCs, and differentiating these iPSCs into IVD gametes, which can be combined with other IVD gametes (or non-IVD gametes) in vitro. IVD gametes can also be created from ESCs taken from cloned embryos created using somatic cell nuclear transfer.

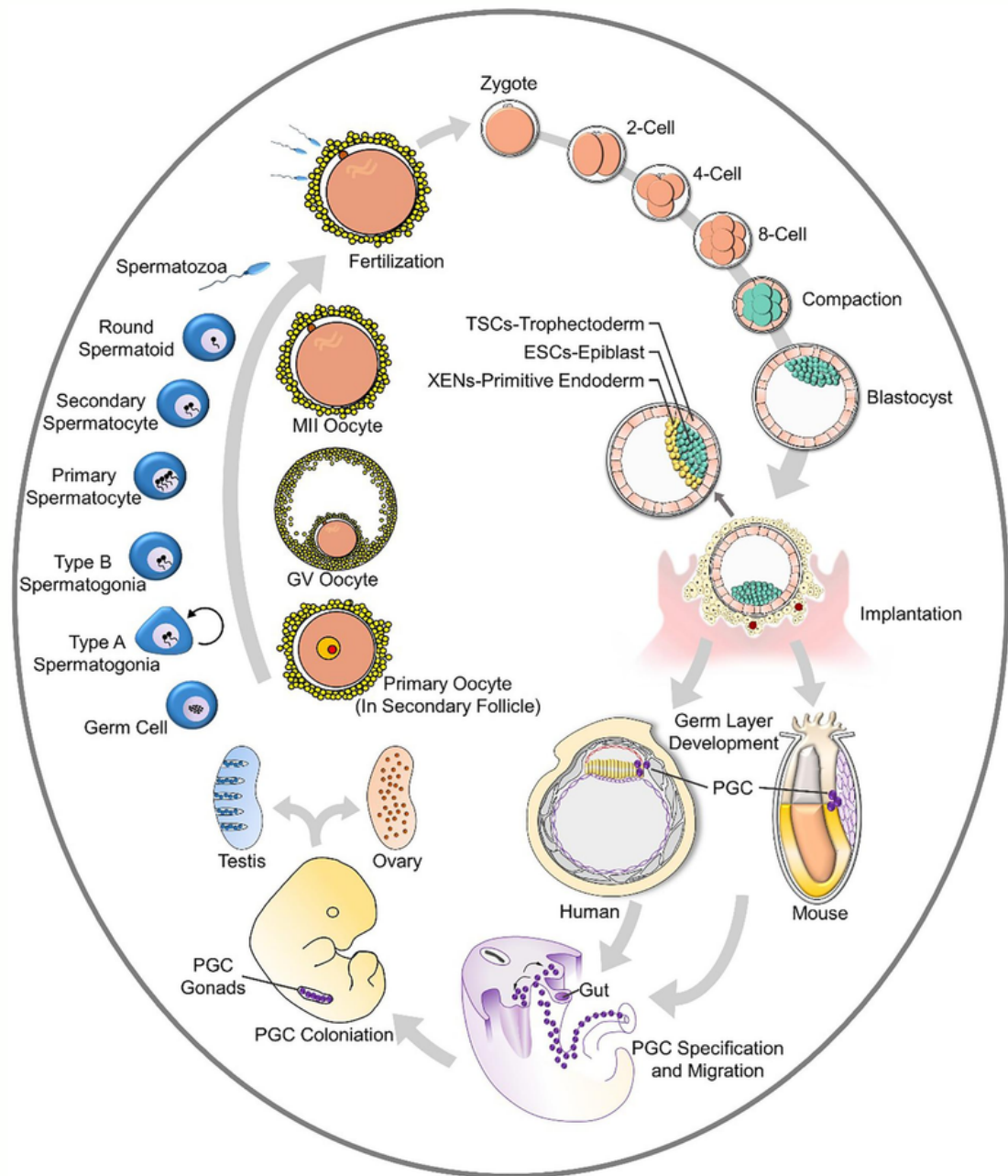


Figure. 2 : Generation of artificial Gamete and embryo from embryonic stem cells derived from preimplantation embryo.

Finally, IVD gametes can be derived from ESCs taken from embryos created through IVF. This approach avoids some of the technical challenges associated with the other two methods. The IVD gamete from one prospective parent would be combined in vitro with a non-IVD gamete from the other prospective parent.

## Clinical applications

- Our understanding of human embryogenesis was obtained from animal embryo models and Human in vitro fertilization. But now with the help of in vitro gametogenesis, Researchers have generated embryoids, blastoids and gastruloids in vitro, thus it is possible to uncover complex events and establish key developmental principle in a detailed and highly quantitative manner.
- **IVG for opposite-sex reproduction** : Nowadays, IVF is most commonly used method to treat infertility but some people lack the internal capacity to produce any gametes or lack so few functioning gametes that establishing a pregnancy is nearly impossible. IVG will provide a novel treatment for such cases.
- **IVG for same sex reproduction** : Compared with alternative family-building options currently available to same sex couple, IVG is unique as it could enable both partners to be the genetic parents of the resulting child. This benefit would apply to both same-sex male and female couples.

## References

1. Notini L, Gyngell C, Savulescu J. Drawing the line on in vitro gametogenesis. *Bioethics*. 2020;34:123–134. <https://doi.org/10.1111/bioe.1267>.
2. Luo Y and Yu Y (2022) Research Advances in Gametogenesis and Embryogenesis Using Pluripotent Stem Cells. *Front. Cell Dev. Biol.* 9:801468. doi: 10.3389/fcell.2021.801468.
3. Ishii, T., & Saitou, M. (2017). Promoting in vitro gametogenesis research with a social understanding. *Trends in Molecular Medicine*, 23(11), 985–988; Segers, S., Mertes, H., de Wert, G., Dondorp, W., & Pennings, G. (2017). Balancing ethical pros and cons of stem cell derived gametes. *Annals of Biomedical Engineering*, 45(7), 1620–1632.
4. Bredenoord, A. L., & Hyun, I. (2017). Ethics of stem cell-derived gametes made in a dish: Fertility for everyone? *EMBO Molecular Medicine*, 9(4), 396–398.
5. Padubidri, V. G., & Daftary, S. N. (2015). Infertility and sterility. In V. G. Padubidri & S. N. Daftary (Eds.), *Shaw's textbook of gynaecology* (16th ed., pp. 237-262). New Delhi, India: Elsevier.
6. Nicholas Wade, Pennsylvania Researchers Turn Stem Cells to Egg Cells, *NEW YORK TIMES*, May 2, 2003, at A28; Sylvia P. Westphal, Embryonic Stem Cells Turned into Eggs, *NEW SCIENTIST* (May 1, 2003).
7. Cesar Palacios-Gonzales et al., Multiplex Parenting: IVG and the Generations to Come, 40 *J. MED. ETHICS* 752 (2014).
8. Rivron, N. C., Frias-Aldeguer, J., Vrij, E. J., Boisset, J.-C., Korving, J., Vivié, J., et al. (2018). Blastocyst-like Structures Generated Solely from Stem Cells. *Nature* 557, 106–111. doi:10.1038/s41586-018-0051-0
9. Tomaselli, S., Megiorni, F., Lin, L., Mazzilli, M. C., Gerrelli, D., Majore, S., et al. (2011). Human RSP01/R-Spondin1 Is Expressed during Early Ovary Development and Augments  $\beta$ -Catenin Signaling. *PLoS One* 6, e16366. doi:10.1371/journal.pone.0016366

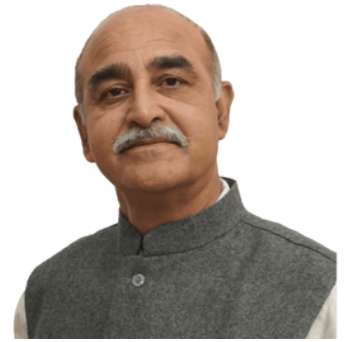
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## MESSAGE FROM EXECUTIVE DIRECTOR

PROF.DR. (COL.) CDS KATOCH, AIIMS RAJKOT

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I heartily congratulate the Department of Anatomy for bringing this informative newsletter on the anatomical explanation of In vitro gametogenesis. My best wishes to the entire team.



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