

5.1 Preimplantation Genetic Testing (PGT)

The Procedure and its Uses

Techniques of **preimplantation genetic testing (PGT)** aim “to identify genetic defects in embryos created through IVF [in vitro fertilization] before transferring them to the uterus.” (1) After testing, only unaffected embryos are transferred to the uterus for implantation and pregnancy. (2) There are two types of preimplantation genetic testing: *preimplantation genetic diagnosis* and *preimplantation genetic screening*.

In the case of **preimplantation genetic diagnosis (PGD)**, one or both of the genetic parents has a genetic abnormality and testing is performed to determine if that abnormality has been transmitted to the egg or embryo. (3) PGD can be used to detect such genetically based diseases as cystic fibrosis, Tay-Sachs, sickle cell anemia, Huntington disease, hemophilia and muscular dystrophies. (4) PGD can also be used to identify genetic mutations, like BRCA-1, which increase the risk of developing a disease. (5) A couple using IVF because of infertility may add PGD to the IVF procedure. (6) Some couples may choose IVF with PGD precisely to avoid having children with a genetic disease. (7)

In the case of **preimplantation genetic screening (PGS)**, the genetic parents are known or presumed to be chromosomally normal but their embryos are tested for aneuploidy (an extra or missing chromosome). (8) This knowledge is considered important because embryonic aneuploidy is a major cause of the failure of embryos to implant and of early miscarriage. (9) The goal is to reduce the failure rate of IVF by transferring only chromosomally normal embryos to the uterus. (10) Indications for PGS include advanced maternal age, a history of recurrent pregnancy loss, severe male factor infertility, or a prior pregnancy with chromosome abnormality. (11)

PGD and PGS are carried out by biopsy of the embryo (12) or of the polar bodies extruded by the egg as it develops (13). It should be noted that both testing procedures are tied to the procedure of in vitro fertilization.

The scope of preimplantation genetic testing has expanded beyond its original purpose. PGD can be used for preimplantation human leukocyte antigen (HLA) matching (14) of “savior siblings” (15):

PGD can also help couples who have a child with diseases such as leukemia and who need a hematopoietic cell transplant. Often there are no matches for the child among the family, and the parents were planning on having more children. In this case the couple can go through IVF and have the embryos undergo HLA typing. Embryos that are an HLA match with the child with the disease can be transferred. Cord blood from the IVF pregnancy can then be used for transplant to the affected sibling. (16)

Or again, the sex of the embryo can be determined through PGD or PGS, and some have used these procedures to engage in “sex selection” of embryos for parental preference, e.g., in order to have a balanced family of both male and female children. (17) Indeed, it has been speculated that PGD could be used to create “designer babies,” selecting against such traits as obesity or

hyperactivity or selecting in favor of such desirable traits as intelligence, beauty, or athletic ability. (18)

Moral Assessment

Preimplantation genetic testing, whether preimplantation genetic diagnosis or preimplantation genetic screening, is not morally permissible.

First, the technologies of preimplantation genetic diagnosis and preimplantation genetic screening are tied to the procedure of in vitro fertilization, which itself is not morally permissible (see section 2.3). (19)

Further, preimplantation genetic testing can be followed by discarding embryos with unwanted traits (20), which is the destruction of human life. (21) Some see preimplantation genetic testing as an attractive alternative to prenatal testing during pregnancy because it avoids difficult decisions about terminating an established pregnancy. (22) However, in the Catholic tradition, the embryo is regarded as a human being from the time of conception/fertilization so that preventing the implantation of embryos or destroying them is regarded as an abortion. (23)

Moreover, as pointed out in the Vatican Congregation for the Doctrine of the Faith's *Instruction Dignitas Personae on Certain Bioethical Questions*, preimplantation diagnosis expresses an unacceptable eugenic mentality and discriminatory attitude towards human beings with diseases or disabilities:

Preimplantation diagnosis is therefore the expression of a *eugenic mentality* that "accepts selective abortion in order to prevent the birth of children affected by various types of anomalies. Such an attitude is shameful and utterly reprehensible, since it presumes to measure the value of a human life only within the parameters of 'normality' and physical well-being...

Dignity belongs equally to every single human being, irrespective of his parents' desires, his social condition, educational formation or level of physical development. If at other times in history...discrimination was practiced on the basis of race, religion or social condition, today there is a no less serious and unjust form of discrimination which leads to the non-recognition of the ethical and legal status of human beings suffering from serious diseases or disabilities....Such discrimination is immoral... (24)

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Notes

1. ARC Fertility, *ARC Fertility Articles: Preimplantation Genetic Testing*. <https://www.arcfertility.com/preimplantation-genetic-testing>. Accessed April 2019.
2. Molina B. Dayal and Richard Scott Lucidi, *Preimplantation Genetic Diagnosis* (August 29, 2018). Medscape. <https://emedicine.medscape.com/article/2734150-overview>. Accessed April 2019.
3. *Ibid.*, ARC Fertility, *ARC Fertility Articles: Preimplantation Genetic Testing*.
4. Dayal and Lucidi, *Preimplantation Genetic Diagnosis*.
5. *Ibid.*; Karen Appoid, *Preimplantation Genetic Diagnosis How Should Labs Grapple with Ethics?* (Jan. 1, 2014). American Association for Clinical Chemistry. <https://www.aacc.org/publications/cln/articles/2014/january/preimplantation>, accessed April 2019.
6. Overlake Reproductive Health, *Pre-Implantation Genetic Testing (PGD/PGS)*. <https://fertileweb.com/reproductive-medicine/pgd>. Accessed April 2019.
7. The Regence Group, *Medical Policy Manual: Preimplantation Genetic Testing* (May 1, 2018). <http://blue.regence.com/trgmedpol/geneticTesting/gt18.pdf>. Accessed April 2019.
8. Ohio State University Health Plan, *Preimplantation Genetic Diagnosis and Screening Policy* (7/2018) at <https://osuhealthplan.com>, accessed April 2019; Dayal and Lucidi, *Preimplantation Genetic Diagnosis*; New Hope Fertility Center, *Preimplantation Genetic Screening* at <https://www.newhopefertility.com/genetic-testing/ivf-genetic-testing>, accessed April 2019.
9. Genetics & IVF Institute, *Preimplantation Genetic Diagnosis* at <https://www.givf.com/geneticservices/pgdtestoptions.shtml>, accessed April 2019; Appoid, *Preimplantation Genetic Diagnosis How Should Labs Grapple with Ethics?*.
10. Dayal and Lucidi, *Preimplantation Genetic Diagnosis*; Paul R. Brezina, Raymond W. Ke, and William H. Kutteh, “Preimplantation Genetic Screening: A Practical Guide,” *Clinical Medicine Insights: Reproductive Health* 7 (2013): 37-42.
11. Genetics & IVF Institute, *Preimplantation Genetic Diagnosis*; Dayal and Lucidi, *Preimplantation Genetic Diagnosis*.
12. After embryos are created through IVF, embryo biopsy takes place either after 3 days of development (cleavage stage) or after 5 or 6 days of development (blastocyst stage). (Brezina, Ke, and Kutteh, “Preimplantation Genetic Screening: A Practical Guide.”) Cleavage stage biopsy “takes place after the first few cleavage divisions when the embryo is composed of six to eight cells (i.e., blastomeres).” (The Regence Group, *Medical Policy Manual: Preimplantation Genetic Testing*.) Biopsy involves “aspiration of one and sometimes two blastomeres from the embryo” followed by genetic analysis of them (*ibid.*). At the blastocyst stage, the embryo has about 100 cells, and three to ten cells from the outer layer of the blastocyst (i.e., trophectoderm cells) are sampled for analysis (*ibid.*).
13. Polar bodies are byproducts of the egg undergoing the process of meiosis. (Markus Montag, Maria Koster, Thomas Strowitzki, and Bettina Toth, “Polar Body Biopsy,” *Fertility and Sterility* 100/3 (Sept. 2013): 603-7 at 603.) Specifically:

The diploid chromosome set of the oocyte [egg] is reduced to a haploid chromosome set shortly before ovulation by completion of the first meiosis. One set of chromosomes remains in the oocyte, while the second chromosome set is expelled from the cytoplasm with formation of the first polar body. The penetration of a sperm is followed by the second meiosis. The doublethreaded chromosomes divide further into chromatids and one chromatid set is expelled with formation of the second polar body. ...The polar bodies are of no proven significance for further embryonic development and are available for diagnostic purposes. (Katrin van der Ven, Markus Montag, and Hans van der Ven, "Polar Body Diagnosis – A Step in the Right Direction?" *Deutsches Arzteblatt International* 105/11 (March 2008): 190-96.)

For the procedure of polar body biopsy, eggs are obtained in a standard IVF protocol, and the first polar body can be removed. After ICSI (introcytoplasmic sperm injection), the second polar body forms and can be removed. Or both polar bodies can be removed together for analysis. (Anver Kuliev and Svetlana Rechitsky, "Polar body-based preimplantation genetic diagnosis for Mendelian disorders." *MHR: Basic science of reproductive medicine* 17/5 (May 2011): 275-85; Montag, Koster, Strowitzki, and Toth, "Polar Body Biopsy"; Katrin van der Ven, Markus Montag, and Hans van der Ven, "Polar Body Diagnosis – A Step in the Right Direction?") Analysis of the polar bodies provides indirect evidence of the genetic constitution of the egg. (Katrin van der Ven, Markus Montag, and Hans van der Ven, "Polar Body Diagnosis – A Step in the Right Direction?") For example, "if a woman is heterozygous for an autosomal-recessive disease, a polar body having the mutant allele should be complemented by a primary oocyte presumed to have the normal allele." (Lee P. Shulman and Sherman Elias in Emery and Rimoin's *Principles and Practice of Medical Genetics* (2013) 26.8 in *Science Direct* at <https://www.sciencedirect.com/topics/neuroscience/polar-body>, accessed April 2019). On the other hand, "if the polar body was determined not to carry the mutant allele, the oocyte would contain the mutant allele...". (*Ibid.*) Or again, "if the first polar body failed to show a chromosome 21, the oocyte would be presumed to have two 21 chromosomes, and hence, the zygote would have trisomy 21." (*Ibid.*) Only embryos from genetically normal oocytes (eggs) are allowed to develop. (Kuliev and Rechitsky, "Polar body-based preimplantation genetic diagnosis for Mendelian disorders.")

14. Dayal and Lucidi, *Preimplanation Genetic Diagnosis*; ARC Fertility, *ARC Fertility Articles: Preimplantation Genetic Testing*; Genetics & IVF Institute, *Preimplantation Genetic Diagnosis*;

15. Appoid, *Preimplantation Genetic Diagnosis How Should Labs Grapple with Ethics?*.

16. ARC Fertility, *ARC Fertility Articles: Preimplantation Genetic Testing*.

17. Dayal and Lucidi, *Preimplanation Genetic Diagnosis*; ARC Fertility, *ARC Fertility Articles: Preimplantation Genetic Testing*.

18. Overlake Reproductive Health, *Pre-Implantation Genetic Testing (PGD/PGS)*; Appoid, *Preimplantation Genetic Diagnosis How Should Labs Grapple with Ethics?*.

19. Cf. Vatican Congregation for the Doctrine of the Faith, *Instruction Dignitas Personae on Certain Bioethical Questions*, no. 22: "Preimplanation diagnosis -- connected as it is with artificial fertilization, which is itself always intrinsically illicit...". Available at

<http://w2.vatican.va> > English > Roman Curia > Congregations > Doctrine of the Faith > Documents. Accessed 2019.

20. Overlake Reproductive Health, *Pre-Implantation Genetic Testing (PGD/PGS)*; American Pregnancy Association, *Preimplantation Genetic Diagnosis (PGD) Benefits & Concerns* at <https://americanpregnancy.org/infertility/preimplantation-genetic-diagnosis>, accessed April 2019.

21. Cf. Vatican Congregation for the Doctrine of the Faith, *Instruction Dignitas Personae on Certain Bioethical Questions*, no. 22: "...in this case, the diagnosis before implantation is immediately followed by the elimination of an embryo suspected of having genetic or chromosomal defects, or not having the sex desired, or having other qualities that are not wanted. Preimplantation diagnosis...is directed toward the *qualitative selection and consequent destruction of embryos*, which constitutes an act of abortion."

A special note is in order regarding polar body biopsy. Fertilization is not instantaneous but "a sequence of events that begins with the contact of a *sperm* (spermatozoon) with a *secondary oocyte* (ovum) and ends with the fusion of their *pronuclei* (the haploid nuclei of the sperm and ovum) and the mingling of their chromosomes to form a new cell"; thus "this fertilized ovum, known as a *zygote*, is a large diploid cell that is the beginning, or *primordium*, of a human being." (Keith L. Moore, *Essentials of Human Embryology* (Toronto: B.C. Decker Inc., 1988), p. 2. <https://www.princeton.edu/~prolife/articles/embryoquotes2.html>. Accessed April 2019.) Because "polar body biopsy takes place before the fusion of the pronuclei" (Katrin van der Ven, Markus Montag, and Hans van der Ven, "Polar Body Diagnosis – A Step in the Right Direction?"), this procedure has been described as "a preconception diagnostic technique" (*ibid.*) and as "pre-embryonic diagnosis" (Kuliev and Rechitsky, "Polar body-based preimplantation genetic diagnosis for Mendelian disorders"). Even if one accepts this point of view, there are still moral problems with polar body biopsy in terms of its dependency on in vitro fertilization.

22. Dayal and Lucidi, *Preimplantation Genetic Diagnosis*; the Regence Group, *Medical Policy Manual: Preimplantation Genetic Testing*; Genetics & IVF Institute, *Preimplantation Genetic Diagnosis*.

23. See note 21 above. See also United States Conference of Catholic Bishops, *Ethical and Religious Directives for Catholic Health Care Services*, 6th ed. (2018), no. 45. <http://www.usccb.org/about/doctrine/ethical-and-religious-directives>. Accessed July 2019.

24. Vatican Congregation for the Doctrine of the Faith, *Instruction Dignitas Personae on Certain Bioethical Questions*, no. 22.