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Preimplantation Genetic Testing and In Vitro Gametogenesis

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This paper will briefly describe two novel techniques used in conjunction with assisted reproductive technologies like in vitro fertilization (IVF). The first, preimplantation genetic testing (PGT), has been commercially available for several years and is now widely deployed in IVF clinics to detect potential genetic diseases or other anomalies in embryos created in the lab. The second technique, in vitro gametogenesis (IVG), is not yet available for use in humans but likely will be in the next few years. As this paper will explore, both of these techniques have the potential for serious harm, including discriminatory eugenics practices in the first case and a radical restructuring of familial ties and human lineage in the second.

Preimplantation Genetic Testing

PGT is a technique used to test embryos created in a lab via IVF for genetic diseases and other genetic traits. During a typical IVF cycle, in order to increase the chances of producing a viable pregnancy, multiple human embryos—up to six or eight—are produced in the lab. Prior to implanting one or more of these embryos in the woman's uterus, the embryos can be genetically tested. Techniques for doing this, which do introduce some risks to the embryos, were originally developed to screen for genetic diseases. Once genetic anomalies are identified, only apparently genetically healthy embryos are selected for implantation and the opportunity to be brought to birth. Those deemed genetically "unfit" are typically destroyed.

While this method of PGT is sometimes described as a "treatment" for genetic diseases, it is important to note that the method does not actually *treat* an individual affected by a disease. It merely identifies that individual and discards him or her, denying that human being in its earliest stage of development the opportunity for continued existence. In short, PGT doesn't treat or heal maladies; it ultimately destroys the affected embryo altogether.

It is also worth noting that while this technique is often framed in terms of eliminating disease, there are other common uses for PGT. It is frequently employed, for example, for sex selection. This practice is banned in most of the world but not in the United States. Many intending parents, especially those from cultures that tend to disvalue female children, use PGT to ensure they do not become pregnant with a girl. Thus this technique perpetuates discriminatory attitudes and social practices regarding sex. Meanwhile, many in the United States use PGT sex selection precisely because they prefer girls.[1]

As our knowledge of the complex relationships between genes and biological traits advances, PGT could be used not only to eliminate those with diseases or disabilities but to select for "desirable" traits—to produce bigger, faster, stronger, smarter,

1 "One study found that white parents having a first child picked female embryos 70 percent of the time," while "parents of Indian and Chinese descent were more likely to pick boys." Cited by Emi Nietfeld, "The Parents Who Want Daughters—and Daughters Only," *Slate*, May 7, 2024.

or more physically attractive children—or simply children with a particular hair or eye color. Orchid, for example, is a company that provides a "whole genome embryo report" and advertises its service with the tagline "Have healthy babies." Another U.S. company, Heliospect Genomics, offers services that go beyond screening for genetic diseases to predicting human behavior, including IQ screening of embryos at a cost of $50,000—a practice that violates U.K. law but is legally permitted in the United States.[2]

Some misguided ethicists even argue that PGT is a more "responsible" way to produce children and predict that within a few decades most people in developed countries who can afford these services will stop having sex for the purpose of reproduction.[3] While some celebrate this as a technological advance, we should worry about the possibility of creating a dystopian society in which children are "manufactured" using industrial quality-control measures and only those deemed most "fit" are permitted to survive.

PGT revives the dark specter of eugenics: the use of medical technology to eliminate those deemed genetically unfit because of disease, sex, or other "undesirable" traits. While our new "liberal eugenics" may not be top-down or government-mandated—as with forced sterilization in the United States and euthanasia of the "unfit" in Germany during the twentieth century—the same ugly attitudes are manifest in these new eugenic practices. Consumer-driven eugenics is not necessarily less discriminatory against women, men, or those with disabilities than a coercive, government-sponsored eugenics program.

In Vitro Gametogenesis

While it has not yet been perfected in humans, we now have the capability in other mammals to produce gametes—either eggs or sperm—from adult stem cells such as skin cells using techniques of genetic manipulation. The procedure, known as in vitro gametogenesis, involves programming stem cells to differentiate into gametes—sperm or eggs. In 2018, the first human egg cells (though not viable eggs usable for IVF) were created in a lab using this method. In 2024, researchers at Oregon Health Science University developed a more efficient technique in mice that avoids problematic genetic alterations.[4] Many researchers are working on applying these IVG techniques to humans.

This procedure would allow many people who are unable to have genetically related children to do so, including, for example, women of advanced maternal age or women unable to produce viable eggs due to cancer treatment or other medical issues. Such promises make IVG attractive to many prospective parents. More radically, however, because it may be possible to produce eggs from male cells or sperm from female cells, IVG would allow men (or women) in same-sex relationships to have children who are genetically related to both fathers (or both mothers), one of whom would supply an artificial egg and the other the sperm. This would deny children the right to have both a genetic father and mother and dramatically alter our culture's notions of human lineage, motherhood, and fatherhood.

As explained in the previous section on embryonic genetic testing, a typical IVF egg-harvesting cycle can produce at best only about half a dozen eggs, thus limiting the number of embryos that can be created and destroyed in a laboratory. But because the IVG technique uses skin or other easily obtainable cells rather than an invasive procedure, it would permit an *inexhaustible supply* of eggs, and thus would create the potential to easily produce hundreds of embryos in the lab. This technique would amplify the potential for commercial eugenics on a massive scale via "embryo farming," in which hundreds of embryos are tested and only the genetically "strong" or "select" few are allowed to survive.

2 Hannah Devlin et al., "US Startup Charging Couples to 'Screen Embryos for IQ,'" *The Guardian*, October 18, 2024, https://www.theguardian.com/science/2024/oct/18/us-startup-charging-couples-to-screen-embryos-for-iq.

3 See, for example, Stanford law professor Henry T. Greely's book *The End of Sex and the Future of Human Reproduction* (Harvard University Press, 2016).

4 Aleksei Mikhalchenko et al., "Induction of Somatic Cell Haploidy by Premature Cell Division," *Science Advances* 10, no. 10 (2024): 1–11.

IVG would likewise permit other frankly bizarre scenarios, such as the unauthorized use of someone's genetic material to produce offspring who are genetically related to a person who did not consent to have children. The hotel maid who wants to have Brad Pitt's children could merely scrape some skin cells from his pillow and pay a firm to turn these into sperm using IVG, then use that sperm in an IVF procedure.

The deployment of IVG portends a radical refashioning of family structures that could alter the relationships between generations in ways that we can scarcely imagine. Some IVG enthusiasts, for example, celebrate the potential for "multiplex parenting."[5] Suppose four individuals wanted to have a child who was genetically related to all four of them. They could pair up and use IVF to create two embryos in the lab—one related to one pair and the other to another pair in the foursome. Next embryonic stem cells could be extracted from each of those embryos, and through IVG another set of sperm and eggs could be created from those embryos. Those two embryos could be discarded, and the gametes derived from them would be used to create a third embryo, which would then be brought to birth.

All four members of the group would be genetically related to the child; technically, they would be genetic grandparents, not parents. The genetic parents would actually be two embryos that were created and destroyed in the lab. In fact, this cycle of embryonic stem cells to gametes to embryos to embryonic stem cells and so forth could be theoretically repeated as many times as one wanted in a lab—ultimately producing a child with no living genetic relatives, a child whose parents, grandparents, great-grandparents, etc., were all embryos created and destroyed in a lab. The generations would be "compressed" in space and time, and the resultant living human being would be without a meaningful family history or genetic lineage of people who had actually lived full human lives.

Those who are ready to embrace this brave new world of human reproduction seem *incapable* of thinking deeply about the seriously harmful likely effects on children, on the relationship between generations, on family structure, and on an individual's genetic identity. If such a dystopian scenario becomes our reality, we will have turned procreation into a manufacturing process, instrumentalizing human life and discarding—on a massive scale—human lives deemed unfit to exist.

These "Wild West" domains of human reproduction are subject to virtually no regulation at the federal or state level and have been subjected to almost no public discussion or democratic debate. Thoughtful regulatory action is now necessary since these techniques are already available (in the case of PGT) or will soon be available (in the case of IVG) for use on human beings.

5 César Palacios-González, John Harris, and Giuseppe Testa, "Multiplex Parenting: IVG and the Generations to Come," *Journal of Medical Ethics* 40 (2014): 752–58, https://jme.bmj.com/content/40/11/752.

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