AHB White Paper, June 2023:

OPPOSING LABORATORY MANUFACTURE OF CHILDREN FROM GAMETE-LIKE CELLS

INTRODUCTION

Research on the manufacture of egg-like and sperm-like cells for the purpose of producing laboratory-crafted human children is proceeding rapidly. The objective is to turn ordinary body cells of prospective parents into artificial eggs and sperm. Though ostensibly developed to facilitate reproduction in individuals for whom this capability is impaired or unavailable, the use of laboratory produced eggs and sperm represent an opening for the routine production and commercialization of "designer babies."[1] These are individuals whose hereditary components are technologically modified to meet one or more specified objectives.

Researchers refer to creating eggs and sperm (gametes) in the laboratory as *in vitro* gametogenesis or IVG. The experimental process begins with "somatic" or body cells, e.g., from adult blood or skin. These cells are not those that evolved to produce gametes during embryonic development. The somatic cells are modified with extra DNA or RNA, or by exposing them to proteins or drugs, which has the effect of turning some of them into induced pluripotent stem cells (iPSCs). The iPSCs are next exposed to other biomolecules or drugs, to convert them into cells resembling the specialized cells of the body, such as eggs or sperm.

[1] Newman, Stuart, "Our Assembly-Line Future?," *CounterPunch*, July 31, 2018, https://www.counterpunch.org/2018/07/31/our-assembly-line-future/

Molecular tests of artificially differentiated cells invariably show them to be not identical to their natural counterparts (also see below).[2]

Promoters suggest that IVG would make it possible for medically infertile people to have biologically related children without seeking authentic eggs or sperm from a donor. Additionally, advocates for the technology's clinical use argue that it will help people have biologically related children who are not medically infertile but who could be considered "socially" infertile. This category would include same sex couples or gay individuals as well as people past the age of viable medical reproduction.[3] The technology would also make it possible for a fertile person wanting to become a single parent of a biologically related child to do so without gametes (egg or sperm) donated by an identifiable second person (solo IVG).

If it works, the technology will also make it possible to assist a "uni-parent" to reproduce; that is, a person from whom both synthetic eggs and sperm are derived. There are also possibilities for assisting "multiplex parenting" where more than two individuals want to have genetic ties to a single child.[4] For all these categories, the preferencing of genetically related children over adopted children is implicit.

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[2] Vaughan-Jackson, Alun, Szymon Stodolak, Kourosh H. Ebrahimi, Cathy Browne, Paul K. Reardon, Elisabete Pires, Javier Gilbert-Jaramillo, Sally A. Cowley, and William S. James. 2021. "Differentiation of human induced pluripotent stem cells to authentic macrophages using a defined, serum-free, open-source medium." *Stem Cell Reports* 16 (7):1735-1748. doi: https://doi.org/10.1016/j.stemcr.2021.05.018; Chen, SW., Wong, YH. (2023). Directed Differentiation of Human iPSCs into Microglia-Like Cells Using Defined Transcription Factors. In: Huang, YW.A., Pak, C. (eds) Stem Cell-Based Neural Model Systems for Brain Disorders. Methods in Molecular Biology, vol 2683. Humana, New York, NY. https://doi.org/10.1007/978-1-0716-3287-1_5

[3] See, for example, Emily Witt, "The Future of Fertility: a new crop of biotech startups wants to revolutionize human reproduction," *The New Yorker*, April 17, 2023. https://www.newyorker.com/magazine/2023/04/24/the-future-of-fertility

[4] See Day 1 presentation by Paula Amato of Oregon Health and Sciences University

The technology, should it find its way into fertility clinics, may reduce the number of donor gametes that are necessary, but it is likely to vastly increase the need for women to serve as surrogates, especially for same-sex males seeking to reproduce genetically, until the creation of artificial wombs, currently an actively researched prospect, becomes a reality.[5] Proponents of IVG, acknowledging the health risks and discomfort associated with egg extraction, count as a benefit the expected reduced demand for women's eggs. They fail to note, however, that for many decades the fertility industry ignored calls for it to include health warnings on advertisements seeking young women to supply eggs and to investigate the long-term health risks for egg donors by establishing a national health registry.[6] This does not bode well for how the increased number of surrogates would be targeted, especially in impoverished and patriarchal countries where patterns of coercive paternalism work against the ability of women to consent freely to function as surrogates.

From April 19-21, 2023, The US National Academies of Sciences (NAS) held a three-day workshop titled, "In Vitro Derived Human Gametes as Reproductive Technology: Scientific, Ethical, and Regulatory Implications: A Workshop"[7]. This paper offers a critique of that NAS workshop.[8]

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[5] Ibid.

[6] http://www.humanebiotech.org/sign-egg-donor-petition

[7] https://www.nationalacademies.org/event/04-19-2023/in-vitro-derived-human-gametes-as-a-reproductive-technology-scientific-ethical-and-regulatory-implications-a-workshop?i=_w2WaLdVBmoX8Qhu35lMHUiFdk-doqH7

[8] See also: Katie Hasson, "Lab-Made Gametes Takes Center Stage," *BioPolitical Times*, 05.16.23: https://www.geneticsandsociety.org/biopolitical-times/lab-made-gametes-take-center-stage

It observes that there was no sustained discussion at the workshop about *whether* clinical application of this exotic technology should be allowed. Instead, the event's unquestioned presumption was that the technology would advance to clinical use. While some invitees evinced concerns about moving forward with this technology, no one put forth a vigorous challenge to employing gametogenesis in fertility clinics. Some debate may have occurred in break-out sessions, but the proceedings of those were not shared with the public. In the plenary sessions, however, no one articulated significant opposition to the idea that commercial laboratories should be permitted to manufacture synthetic embryos for implantation and eventual birth. Analysis of workshop deliberations suggests that, confined by structure and topical framing, while reservations about IVG may have been aired they were not debated. Based on the state of the relevant science and the lack of any pressing health need, this paper concludes that IVG for reproductive purposes should be strongly opposed.

CORRALLING CAUTIONS AND SETTING THE AGENDA

The framing of the workshop's agenda and labelling of its subsections discouraged consideration of *whether* synthetic gametes should be used to create functionally equivalent human embryos for implantation.[9] Indeed, Yale University reproductive scientist Hugh Taylor enthused early on that, impressed by how quickly the field was evolving, he was confident that it was not a matter of 'if' this technology would be available for clinical practice but 'when.' He speculated that availability of dozens, hundreds, or even thousands of embryos would increase

[9]National Academies, Agenda for workshop on In Vitro Derived Human Gametes.: Scientific, Ethical, Regulatory, Legal and Clinical Implications: A Workshop, April 19-21 https://www.nationalacademies.org/documents/embed/link/LF2255DA3DD1C41C0A42D3BEF0989ACAECE3053A6A9B/file/DA5ED106FF2081C69862FF4741D440B29583B2E3B06E?noSaveAs=1

opportunities for expanding embryo screening. That creating large numbers of embryos makes it possible to select for "desirable" traits was acknowledged as problematic, but did not dampen enthusiasm for moving forward.[10] Boosters of the technology must have been gratified to hear Peter Marks, director of the Center for Biologics Evaluation and Research of the Food and Drug Administration (FDA), share with them the advice he likes his staff to offer lawmakers: "[y]ou're not going to put the genie back in the bottle. It's going to progress, whether it progresses here in the US or elsewhere. If we don't get into this…you're just putting ourselves behind the 8 ball of [not] being able to take some leadership in making sure it's done correctly." No one rejoined that the US could alternatively take leadership in curtailing its progress and avert a global scramble to the ethical bottom. Indeed, as the workshop wound down, Stanford Law Professor and bioethicist, Hank Greely, had heard nothing to dissuade him from the optimistic view that it was a matter of, "when this ultimately gets adopted."

The agenda's printed objectives for the social, ethical, and legal consideration of IVG and for how to engage the public, channeled critique into categories that presumed that fertility clinics would, eventually, offer IVG. Operative concepts included imagining pathways to clinical trials, facilitating governance of the technology, identifying challenges to securing equitable patient access, identifying "stakeholders," and highlighting best practices.

[10] Hugh Taylor, MD. Yale University, past president of (American Society for Reproductive Medicine) ASRM https://www.nationalacademies.org/documents/embed/link/LF2255DA3DD1C41C0A42D3BEF0989ACAECE3053A6A9B/file/D6E1AB97133CA53B50915EF694553F8AAAB166467CDE?noSaveAs=1.

During discussions, concerns were raised about how IVG amplified the possibility of eugenic outcomes, and was likely to exacerbate social inequities, especially in the global south where the demand for women to serve as surrogates would increase. There was also mention of the importance of ensuring safety for children born in this way. Notwithstanding all this, no one argued that ethical concerns about IVG were of a sufficient magnitude to support calls for a moratorium, a ban, or a prohibition of any aspect of IVG. A few non-scientist attendees lamented the lack of a presentation from a disability rights perspective, the intended panelist having cancelled owing to health concerns. Perhaps a more powerful consideration of how eugenic proclivities inhere in the very idea of IVG would have emerged had the cancellation not occurred.

Some concern was expressed about how the "genetic essentialism" of IVG carried an implied devaluing of children born using donor gametes. Yale Law School lecturer, Katherine Kraschel, noted that the gay community is not a monolith. Where some might welcome opportunities to have biologically related children as do their heterosexual counterparts, others, with an eye to challenging entrenched values, may be discomfited by the devaluing of children conceived using donor gametes.[11] But no one made a sustained case for how this technology, marketed as preferencing the desirability of biologically related children, socially de-values adopted children, whether to gay or straight families, around the globe. Their status was implicitly sub-texted by gametogenic promoters as a substandard substitute for "the real thing."

[11] On the questions of whether IVG is actually a boon for LGTBQ families see, Darnovsky, Marcy, "Bioengineered Gametes: Techno-Liberation of Techno-Trap," *BioPolitical Times* 08.26.2020: https://www.geneticsandsociety.org/biopolitical-times/bioengineered-gametes-techno-liberation-or-techno-trap

Only briefly referenced but not discussed much less debated, is that embryo selection at the scale expected *is* eugenics. Moreover, manipulative intervention to bring about traits (in addition to those already offered through conventional prenatal selection in reproductive markets, such as sex, eye color, and presumed life prospects) will be unavoidable given the inherent commodification of the enterprise. Eugenics is not a possibility that can be avoided. It is inherent in the undertaking and is already underway. [12]

CONFLICTS OF INTEREST

Biographies of presenters listed academic affiliations and scientific institutional or science society affiliations. None, however, listed bio-companies that scientists either founded or with which they were affiliated. Similarly, the biographical summaries of legal-bioethical presenters, some of whose presentations were clearly facilitating moving the technology into clinical use, listed no connections to named commercial bio-labs. Once the workshop was underway, a few presenters made disclosures of their corporate ties or funding sources.[13] How these might function to compromise neutral analysis of the technology was also not discussed. One funder of the workshop itself was also a funder of ongoing IVG research.[14] There was no assessment of

[12] IVG also ramps up possibilities for the controversial use of polygenic risk scores to predict social success. See, Ball, Philip, "Polygenic screening of embryos is here but is it ethical," *The Guardian*,10.17.2021 https://www.theguardian.com/science/2021/oct/17/polygenic-screening-of-embryos-is-here-but-is-it-ethical and Shanks, Pete, "ACMG: Do Not Use Polygenic Risk Scores for Embryo Selection," 03.21.2023, https://www.geneticsandsociety.org/biopolitical-times/acmg-do-not-use-polygenic-risk-scores-embryo-selection

[13] Dr. Ari Brivanlou of Rockefeller University, for example, disclosed that he is also a Cofounder of Rumi Scientific which deals directly with clinical applications of the kind of work they do; Lawyer-bioethicist Alta Charo sits on the boards or advises bio-companies that are developing the technologies e.g., Conception BioSciences; Paula Amato, President elect of ASRM, receives funding from Open Philanthropy which also funded the workshop.

[14] Open Philanthropy, a funder of the National Academies Workshop also funds research by Paula Amato and Katsuhiko Hayashi, for example.

how those who stand to profit lavishly from the normalization of commercially produced gamete-like cells might be compromised as presumed sources of balanced social and ethical analysis of the technology. There was no recognition that clinicians operate as part of a multi-billion-dollar IVF industry that constitutes a massive global profit-focused concern. *Fortune Business Insights*, which conducts market studies of global businesses, reports that the global market for *in vitro* fertilization is estimated to reach USD 36.39 billion by 2026.[15] The American Society for Reproductive Medicine (ASRM), a self-described professional society, possesses powerful and operational lobbying capacity. One workshop conferee was its president-elect. Another, also a member of the planning committee, was an ASRM past president. A balanced analysis of IVG might include their points of view and input. But to avoid explicitly discussing the influence such connections may have on the conference framing, structure, and proposed policies suggests that disclosure of a conflict of interest is considered by the NAS to magically neutralize the effects of its possession. Registering any concern to the contrary did not appear to be an option.

REGULATORS OR MIDWIVES?

Whereas the workshop format limited critical discussion, there was ample space for considering whether and how IVG could be shepherded into socio-legal acceptance and clinical use given the current regulatory landscape. This calls into question what it is that constitutes the role and social function of the National Academy of Sciences, Engineering and Medicine (NAS.) Is it

[15] *Fortune Business Insights*: "In Vitro Fertilization Market Size, Share & Industry Analysis, By Type (Conventional IVF, and IVF with ICSI), By Procedure (Fresh Non-donor, Frozen Non-donor, Fresh Donor, and Frozen Donor), By End User (Hospitals, and Fertility Clinics) and Regional Forecast, 2019-2026"
https://www.fortunebusinessinsights.com/in-vitro-fertilization-ivf-market-102189

meant to function as advocate for controversial technology? The self-described *raison d'être* of the NAS is to, "provide independent, objective advice to inform policy with evidence, spark progress and innovation, and confront challenging issues for the benefit of society."[16] The workshop on IVG, however, was less an independent, objective consideration of the scientific, regulatory, and ethical implications of reproductive use of gametogenesis, than a brainstorming opportunity to think through what it would take to assist IVG into becoming a legally accepted, societally normalized feature of clinical practice.

Scientists summarized their research, explaining how they are learning to make and mature gametes (actually, gamete-like cells) from stem cells, and they related what limitations they have encountered, given scientific, ethical, and regulatory constraints. In response, bioethical techno-boosters energetically shared advice on how to overcome obstacles to moving forward. This included speculating on how to skirt regulations and gain FDA approval by redefining terms and potentially parsing the creation of IVG embryos as not involving eggs and sperm, per se, but 'manufactured products'.

Harvard Law professor and bioethicist Glenn Cohen asked scientists what questions they needed answered to "get their experiments off hold." Alta Charo is Professor Emerita of Law and Bioethics at the University of Wisconsin. After disclosing several conflicts of interests (including serving as a paid consultant to Conception Bioscience, whose CEO was also

[16] https://www.nationalacademies.org/about#:~:text=The%20National%20Academies%20of%20Sciences,for%20the%20benefit%20of%20society.

presenting at the workshop) her presentation and Q & A discussion analyzed the Dickey-Wicker Amendment, and a 2016 budgetary rider that prohibits federal funding of, "research in which a human embryo is intentionally created or modified to include a heritable genetic modification."[17] Would this apply to embryos made from IVG gametes? The language is, Charo advised, susceptible to multiple interpretations. But the original motivation behind the language would preclude it being liberally interpreted: "You might get away with the current language, you could have an interpretation that gives you the freedom, but I'd say that there's an excellent chance that at the state and federal level, somebody's going to catch on and pass something else that clarifies that this, too, is not allowed."

Matt Krisiloff, CEO and Cofounder of Conception Bioscience, (and patent applicant) suggested that it could be argued that gametogenesis was less manipulative than other technologies, adding later that it might be possible to designate it as therapy and thereby evade prohibitions.

Peter Marks, director of the Center for Biologics Evaluation and Research of the FDA, fielded the question as to whether IVG embryos could be regulated as standard commercial biological products? Would the 12-year exclusivity period apply? Or would this be considered more of a

[17] "[The] Dickey-Wicker Amendment…has been passed annually within the federal budget for the US Department of Health and Human Services since 1995, prohibiting scientists from obtaining funding for human embryo research work from the US NIH…The Dickey-Wicker Amendment…specifically bans federal funding for "*the creation of a human embryo or embryos for research purposes or research in which a human embryo or embryos are destroyed, discarded, or knowingly subject to risk of injury or death*," including developing hESC lines. The amendment only applies to federal funding and does not affect R&D funded by state or local governments or private institutions." Mathews, Kristin RW and Morali, Daniel, "National human embryo and embryoid research policies: a survey or 22 top research-intensive countries," *Regenerative Medicine* Vol. 15 No. 7 https://www.futuremedicine.com/doi/10.2217/rme-2019-0138

human cell/tissue product? Marks responded that, "You'd like to refer to it as a cell or tissue product but given how it's made, it's more manipulated than that....The reasons why I love what I do is that you'd probably have to find another pathway or adapt another pathway to make things work here. The concept of a human embryo having 12-year exclusivity is 'off the rocker.' But we've had to do worse…I never thought we'd be regulating human stool, and I'm doing that right now. So, we'll find a way to adapt. We'd obviously have to do it in a humanistic way because, at the end of the day…you don't want these children…you don't want somebody to be growing up and feel like they were…figure out some nice name for new product - that that's what they were. We'd want to figure out a way that would make this humanized." There is an irony in fretting over how not to dehumanize non-existing future children while ignoring the present devaluing, if not dehumanization, of people with disabilities, adopted people, people born of donor gametes, and children of some ethnic groups who, owing to their disproportionate representation among the poor, do not participate in reproductive technologies.

No one questioned why it was appropriate for a representative of the FDA to be counseling IVG promoters concerning what it will take, in terms of defining terminology, to see the technology approved in advance of public consideration of whether it should be approved. Quite the contrary, bioethicist Hank Greely counseled Marks that he might want to think about ways of expediting the approval process.

Johns Hopkins bioethicist, Jeffrey Kahn counseled that when seeking approval, promoters might get traction with legislators if they talked about the issue of competitive leadership. Peter

Marks agreed: talking about advanced technology leaving our shores gets some people "woken up."

Near the end of the workshop, UCLA stem cell biologist Amander Clark admitted that,
"It makes me very nervous to think of a [human] embryo as a manufactured product." But this comment immediately followed her approvingly anticipating that "…we will be manufacturing a gamete that is then used to generate an embryo." The cognitive dissonance is striking. How can an entity, constituted in a laboratory from manufactured gametes, not itself be a manufactured product? Either way, the terminological gymnastics of IVG advocates lands them on shaky ground. On the one hand, declaring the lab manufactured entity to be an embryo makes for an easier sell to potential parents who do not wish to burden their child with the stigma of being a product; on the other hand, declaring the entity to be a product could, arguably, avoid triggering federal funding prohibitions which applies to embryos (see above and footnote 17).

There is another key aspect concerning terminology that the NAS workshop overlooked: scientist-entrepreneurs are not manufacturing true gametes but, rather, "gamete-like" cells. The administrators and bioethicists at the NAS meeting went along with the scientist-entrepreneur business principals in referring to IVGs as gametes: i.e., eggs and sperm. Relevant to this is that IVG research is part of a larger program of scientific investigation devoted to deriving cells of all types from laboratory-engineered "induced pluripotent stem cells" or iPSCs. Scientists working in this area, both outside and inside the reproductive context, continually acknowledge that differentiated cells derived from IPSCs only resemble the real

thing. They fall short in ways that can be measured genetically. Much of the field of IPSC research is devoted to bringing the gene expression profiles of experimental products in line with *in vivo*[18] cell types. By this criterion the engineered cells that give rise to IVGs are "germ cell-like cells," not actual germ cells. [19]

The acceptance by clients (potential parents) of this procedure will depend on their being seduced into thinking there is no difference between gamete-like cells and actual gametes. It is possible that there will be no way to produce completely normal gametes by these methods. There is a range of variations among normal gametes and there will be a different range for IVGs. There will be an overlap, but when hundreds of expressed genes are at issue (which is likely to be the case) normality cannot be rigorously defined. The criteria for calling something an egg or sperm cell are likely to be arbitrary and nonrigorous.

OPPOSING LAB-MANUFACTURED HUMANS

The most compelling reason to move forward with reproductive gametogenesis, declared Hank Greely, is that those who desire to have a biological child but cannot are suffering; because they are suffering, they deserve to be helped. The only good reason not to move ahead, he asserted, would be lack of safety guarantees. His framing went unchallenged at the workshop: any other ethical hesitations offered at the conference lost standing as justifications for curtailing the technology.

[18] *In vivo* refers to a process that takes place inside a living organism, as opposed to test tubes culture dishes.
[19] See, for example, Seita Y, Hwang YS, Sasaki K. "Reconstitution of Human Prospermatogonial Development from Human-Induced Pluripotent Stem Cells." *Methods Mol Biol*. 2023; 2656:145-159. doi: 10.1007/978-1-0716-3139-3_8. PMID: 37249870. https://pubmed.ncbi.nlm.nih.gov/37249870/

There is, of course, good reason to be concerned about safety. At what point can a child resulting from a synthetic embryo be considered safe from unintended consequences? The definition, health, and suitability for reproduction of authentic gametes depend on hundreds of thousands of factors whose coordinated function has been refined over millions of years of evolution. There is no way to test exhaustively if an IVG cell, concocted from a somatic cell in the lab, fulfills these criteria. While they can be used in fertilization and possibly yield something that looks like a normal embryo, how can its lack of procedure-introduced anomalies be confirmed? What are the criteria for determining safety? Over how many generations?

Conferees recognized the difficulties of tracking these human experiments, i.e., children born from IVG. Parents could give their consent to following the fate of their own children. But, at some point, the children themselves would need to give consent. And what about those children's children? How many generations need to be tracked before IVG can be considered safe? Is intergenerational consent possible? If such human experimentation fails and children down the road are found to have developmental anomalies or impairments, who along the chain of production would be liable? If experimentation is not controlled (in the sense of comparative treatments with critical factors omitted), if accountability is impossible, is the program ethical? Enthusiasts were troubled but not deterred by the difficulties of long-term tracking of generations of children. The question of whether one can conduct a rigorous on-going scientific experiment without adequate data collection went unanswered. The even

more fundamental questions of whether one can ethically experiment on prospective humans, the human gene pool, the human species, and with evolution itself went unasked.

CONCLUSION: WHO WANTS SYNTHETIC EGGS AND SPERM?

The National Infertility Association, RESOLVE, is a patient advocacy group for medically infertile people seeking to build families. When its representative at the workshop was asked if her clients were seeking synthetic gametes she replied, somewhat reluctantly, that they were not. Her answer opened an inquiry that was inadequately considered. But at a later session, University of Cape Town Professor of Sociology, Amrita Pande, asserted that, "demand for many things can be created…its not just about supply meeting demand…". The observation begs questions: who, right now, *is* asking for IVG and what does it tell us?

Conception Bioscience is a company working to develop egg-like cells to be fertilized, implanted, and gestated. Its CEO Matt Krisiloff, mentioned above, reported that his company is often contacted by people wanting to have biological children. Such desires represent potential demand. IVG boosters in attendance shared ideas on undertaking patient advocacy to stimulate market demand, including selecting the most appealing first human experiment candidate to trigger sympathetic appeal (proposed as a young, female cancer survivor.) But, at present, there is scant call for synthetic eggs or sperm from medically infertile people seeking to have a child.

By contrast, entrepreneurial scientists with patent applications want *in vitro* gametes. Venture capitalists want them. IVF industry clinicians, in anticipation of an assumed demand, want them. Privately funded companies, like Conception Bioscience, which came into existence to capitalize on the expectant emerging disease category of the "socially infertile," want them. Anyone with the incentive to invest in the technology wants them. And this raises a question: should individuals and contingents with such financial motivations be leading the opening volley on whether society should experiment so dramatically with the human species and, while doing so, embrace the ultimate human commodification: children.

Much disliked by techno boosters is the 1997 dystopian film *Gattaca*, describing as it does a future where, through freely-chosen genetic selection, society has devolved into eugenic classes, the genetic "haves" and "have nots" (the movie's "valids" and "invalids). In 2015, a *Nature* editorial counseled its professional readers not to participate in discussions of the film, and a science writer for the *NY Times* called for "an international ban on invoking" it.[20] Similarly, at the NAS workshop, Alta Charo prefaced her remote presentation with the off-hand instruction to colleagues in the room that it's a good idea to avoid engaging the topic of eugenics.[21]

In *The New Yorker's* coverage of startup companies behind gametogenesis, "The Future of Fertility," Emily Witt quotes Hank Greely predicting that, "…in the next twenty to forty years sex

[20] See, Stevens, Tina and Newman, Stuart, *Biotech Juggernaut: Hope, Hype and Hidden Agendas of Entrepreneurial BioScience* (New York: Routledge 2019) p. 118).
[21] This admonition does not appear in the edited recorded version.

will no longer be the method by which most people make babies ("among humans with good health coverage," he qualified). No wonder promoters of genetic reproductive technologies advise not talking about eugenics or its film avatar, *Gattaca*. If Greely's prediction is correct, the film's prescience (along with that of Aldous Huxley's equally dystopian 1931 novel *Brave New World*) would be amply supported. While estimates vary, IVG users would be implanting their fabricated embryo after selection for experimental successful (suitable traits, lack of evident errors) from scores or hundreds of similar ones. This would be assembly line eugenics, with predictable social effects.[22]

The NAS workshop on IVG was an occasion for interested parties to think through what it will take to enable IVG to become a legally accepted, societally normalized feature of clinical practice – an option on fertility clinics' menu of services. The gathering was structured to dissipate the impact of objections to using IVG to create fabricated embryos for implantation and gestation. Rather than offering a balanced assessment of what is at stake for humanity should gametogenesis be clinically employed, the conference functioned to fine-tune public lobbying for normalization of an exotic and controversial technology. Advocates of the technology suggested instituting public outreach programs. Programs could include science museums for children that introduce them to eggs, embryos, and IVG; outreach should instill a degree of scientific literacy, pitched to a grade-school level, and sympathetically packaged. But there was no mention of teaching about the always-present risks of powerful technologies, or

[22] See UC Davis Professor of Law Lisa Ikemoto's presentations and Q & A regarding access and cost issues.

the need for social-science literacy, one that takes seriously critical considerations that advocates at the workshop did not see fit to engage.

The concept of the "technological imperative" is that new technologies, considered useful by their promoters, will inevitably be developed and applied. Even so, public debate fittingly ensues as to *whether* chatbots are conscious, *whether* AI paintings are art, or *whether* the imitative properties of lab-manufactured meat warrants the nutritive deficits required to accomplish them. Elite science society meetings should not obscure the fact that manufacturing synthetic embryos will blur the boundaries between humans and objects and, further, provide an incentive for "quality control" that develops, inexorably, into a platform for eugenics.[23]

CALIFORNIA CODA

Technologies can stray far afield from their originally approved contexts. Conception Bioscience's Matt Krisiloff explained, for example, the choice of California for its corporate base: it is a state that permits the creation of embryos. But California did not legalize the creation of embryos to enable manufacturing them, up to scale and on demand, to create children. Rather, California permitted creating embryos to facilitate researching embryonic stem cells to assist in finding cures for an array of diseases. Will a company be able to secure an enabling

[23] Newman, Stuart, "Our Assembly-Line Future?," (op. cit., ref. 1)

environment when the originating approval was for an entirely different reason? Should it be allowed to? Just how far can technologies be allowed to stray from their original contexts.[24]

California has a lot at stake in getting the answer right. It may be a state that permits the creation of embryos but it is also a state that acknowledges its own shameful role in promoting 20th century eugenics. In March 2003, Governor Gray Davis apologized to all those affected by California's eugenics movement.[25] In June 2003, the California Senate passed Senate Resolution SR 20 acknowledging that: "The goal of the eugenics movement of the twentieth century was racial betterment through the elimination of hereditary disorders or genetic defects by means of sterilization, selective breeding, and social engineering." It urged all citizens to become familiar with the history of the eugenics movement and resolved that: "this resolution addresses past bigotry and intolerance against the persons with disabilities and others who were viewed as "genetically unfit" by the eugenics movement…" [26] There has been sustained effort to compensate the victims of state sponsored eugenics.[27] Additionally, in 2018, faculty at the University of California, Berkeley uncovered that the university was receiving ongoing research funding from the Genealogical Eugenics Institute Fund. The funds were frozen, and in 2020 its payouts were repurposed to educate the campus community and the public about eugenics' cruel history.[28]

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[24] Could gametogenic development be put in the service of global defense departments' calls for "human augmentation" for military purpose? See, Ministry of Defence, "Human Augmentation – the Dawn of a New Paradigm."https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/986301/Human_Augmentation_SIP_access2.pdf

[25]Ingram, Carl, "State Issues Apology for Policy of Sterilization," *Los Angeles Times*, March 12, 2003. https://www.latimes.com/archives/la-xpm-2003-mar-12-me-sterile12-story.html

[26] https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=200320040SR20

[27] https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200AB3052

[28]Manke, Kara, "Berkeley Public Health announces plans to rename, repurpose former eugenic fund," *Berkeley News,* October 26, 2020.

Promoters of technologies with eugenic capacity often attempt to distinguish between state sponsored eugenics, on the one hand, and the mere aggregation of choices made in a free market, on the other. The distinction is disingenuous. Twentieth century eugenics is replete with examples of "Fitter Family Contests".[29] What could be more free market than competition? As public debates on reproductive gametogenesis get underway, California needs to consider its leadership role. Will it undo the singular moral impact of denouncing its infamous leadership in 20th century eugenics only to launch a new chapter, leading the nation in 21st century techno-eugenics?

Sign: International Declaration Against Legalization of Human Genetic Modification

https://coalitionstopdesignerbabies.net

https://news.berkeley.edu/2020/10/26/berkeley-public-health-announces-plans-to-rename-repurpose-former-eugenics-fund/

[29]Uenuma, Francine, "'Better Babies' Contests Pushed for Much-Needed Infant Health but Also Played Into the Eugenics Movement," *Smithsonian Magazine*, January 17, 2019. https://www.smithsonianmag.com/history/better-babies-contests-pushed-infant-health-also-played-eugenics-movement-180971288/