FRAMING GERMLINE MODIFICATIONS OF HUMAN EMBRYOS[†]

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THE RELATIONSHIP BETWEEN SCIENCE AND LAW IN GENOME MODIFICATION OF HUMAN EMBRYOS

Throughout the book *Rewriting Nature*,[1] scientist and legal scholar Dr. Paul Enríquez is precise, fair and exacting. With clarity, he explains complex definitions, describes currently unknown factors, and explores limitations on knowledge in the field of genome editing. This commentary will focus on the section of the book that sets forth a framework describing how the law should classify germline modification of human embryos and offers an alternative analysis.[2]

Enríquez states, "once safety and efficacy of select [germline gene editing ("GGE")] interventions are established, which probably will occur at some point in the near future, the government likely cannot categorically ban access to the technology."[3] This statement relies on three areas of interrelated analysis. First, Enríquez presumes that germline modifications will be safe and effective. Next, Enríquez states that the law should be grounded in scientific fact. Lastly, Enríquez concludes that parents will have a right to access genome modification technology based on existing Constitutional principles such as substantive due process, procreative liberty, and familial privacy.[4]

SCIENTIFIC RISKS FROM GENOME MODIFICATION OF HUMAN EMBRYOS

On the first issue, the most significant presumption of the book assumes that safety and efficacy is possible for germline modifications of human embryos. This, in itself, constitutes both a value judgment and an expression of faith. To

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[1] PAUL ENRÍQUEZ, REWRITING NATURE: THE FUTURE OF GENOME EDITING AND HOW TO BRIDGE THE GAP BETWEEN LAW AND SCIENCE (2021).

[2] *Id.* at 330-47.

[3] *Id.* at 332.

[4] *See id.* at 338 (comparing hypothetical right to use GGE—grounded in rights to procreation, parental autonomy, and privacy—to substantive due process rights such as right to interracial marriage)

explain, there is robust scientific literature describing the scientific and technical risks[5] associated with germline modifications of embryos, such as inefficiency,[6] mosaicism,[7] on-target and off-target effects,[8] and how the procedure will translate from animal or embryo models to full term human births. Distinct risks exist pertaining to two current forms of germline modification of human embryos: genome editing[9] and mitochondrial replacement therapy.[10]

To focus on risks associated with genome editing, the first scientific hurdle is inefficiency and whether the procedure works as programmed by making the intended edits.[11]

Another issue is mosaicism, where some cells contain the desired effects and some do not.[12] This can change at different points of development and also vary throughout different tissues, which limits the accuracy of preimplantation genetic diagnosis tests designed to measure efficacy and check for mosaicism.[13]

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[5] Benjamin Davies, *The Technical Risks of Human Gene Editing*, 34 HUM. REPROD. 2104, 2109 (2019) (tracing current call for moratorium on germline editing to "technical and scientific issues, combined with the grave ethical concerns").

[6] Gregorio Alanis-Lobato, Jasmin Zohren, Afshan McCarthy, Norah M. E. Fogarty, Nada Kubikova, Emily Hardman, Mari Greco, Dagan Wells, James M. A. Turner & Kathy K. Niakan, *Frequent Loss of Heterozygosity in CRISPR-Cas9–Edited Early Human Embryos*, 118 PROC. NAT'L ACAD. SCIS., 8 (2021), https://doi.org/10.1073/pnas.2004832117 ("Of the studies that have been conducted, the reported efficiencies of repair with templates in human embryos are very low . . . .").

[7] Maryam Mehravar, Abolfazl Shirazi, Mehboobeh Nazari & Mehdi Banan, *Mosaicism in CRISPR/Cas9-Mediated Genome Editing*, 445 DEVELOPMENTAL BIOLOGY 156, 157-58 (2019) (evaluating positives and negatives of mosaicism, including how mosaicism leads to incorrect genetic evaluations of individuals and interrupts genotypic transmission to offspring).

[8] Eva R. Hoffmann & Ignasi Roig, *Cas9 in Human Embryos: On Target but No Repair*, 183 CELL 1464, 1466 (2020) (discussing harms associated not only with off-target editing of wrong part of genome but with on-target editing that can still lead to harmful effects like chromosome loss).

[9] Katherine Drabiak, *Untangling the Promises of Human Genome Editing*, 46 J.L. MED. & ETHICS 991, 997-99 (2018) (surveying risks including efficiency, predictability, mosaicism, and off-target effects).

[10] Katherine Drabiak, *Emerging Governance of Mitochondrial Replacement Therapy: Assessing Coherence Between Scientific Evidence and Policy Outcomes*, 20 DEPAUL J. HEALTH CARE L. 1, 29-35 (2018) (discussing risks brought up at FDA meeting on mitochondrial replacement therapy including maternal bottleneck, segregation, heteroplasmy, and haplotype incompatibility).

[11] Alanis-Lobato et al., *supra* note 6, at 1 (reporting high frequencies of unintended damage even for on-target edits in early mouse embryos).

[12] Mehravar et al., *supra* note 7, at 156 (defining mosaicism as "the presence of more than one genotype in one individual" which can be caused by natural or manipulative mechanisms).

[13] *See* Drabiak, *supra* note 9, at 998 (warning that such tests "may examine one cell, proclaim the absence of mosaicism, but miss all other cells that do demonstrate mosaicism and inaccurately predict the trajectory of an embryo").

If mosaicism occurs in somatic cells, this can result in serious clinical consequences such as "gross structural abnormalities, major Mendelian disorders, cell and tissue degeneration associated with aging, and death."[14]

An additional risk includes on-target effects and off-target effects.[15] On-target effects refers to when the editing nucleases make unintended cuts or modifications to the target site, while off-target effects are defined as when genome editing process results in modifications to other locations. On-target and off-target effects can activate or deactivate crucial sequences in the genome.[16] Insertions, deletions, or translocations could potentially activate oncogenes related to tumor development or produce unexpected outcomes such as advanced aging.[17]

Other barriers raise additional doubts, such as studies that show a lower percent efficiency in human embryos compared to animal embryos, the low percent of animal model embryos that result in a full-term birth, and the high rate of pregnancy loss and developmental arrest in animal models.[18]

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[14] *Id.* at 998.

[15] Drabiak, *supra* note 9, at 998-99 (cataloging off-target effects and difficulty of detecting them in laboratory settings); Michael Kosicki, Kärt Tomberg & Allan Bradley, *Repair of Double-Strand Breaks Induced by CRISPR-Cas9 Leads to Large Deletions and Complex Rearrangements*, 36 NATURE BIOTECHNOLOGY 765, 765 (2018) (specifically reporting negative effects even for gene editing that targets correct genome, "such as large deletions and more complex genomic rearrangements at the targeted sites"); Fatwa Adikusuma, Sandra Piltz, Mark A. Corbett, Michelle Turvey, Shaun R. McColl, Karla J. Helbig, Michael R. Beard, James Hughes, Richard T. Pomerantz & Paul Q. Thomas, *Large Deletions Induced by Cas9 Cleavage*, 560 NATURE E8, E8 (2018) (questioning study that reported successful genome editing without large on-target deletion events).

[16] *See* Kosicki et al., *supra* note 15, at 770 ("We show that extensive on-target genomic damage is a common outcome at all loci and in all cell lines tested. Moreover, the genetic consequences observed are not limited to the target locus . . . .").

[17] Jacqueline Corrigan-Curay, Marina O'Reilly, Donald B. Kohn, Paula M. Cannon, Gang Bao, Frederic D Bushman, Dana Carroll, Toni Cathomen, J. Keith Joung, David Roth, Michel Sadelain, Andrew M. Scharenberg, Christof von Kalle, Feng Zhang, Robert Jambou, Eugene Rosenthal, Morad Hassani, Aparna Singh & Matthew H. Porteus, *Genomic Editing Technologies: Defining a Path to Clinic*, 23 MOLECULAR THERAPY 796, 802 (2015) (describing tumors that seemed to arise from RAG-mediated translocations in examination of chromosomal abnormalities in mouse); Eric S. Lander, *Brave New Genome*, 373 NEW ENG. J. MED. 5, 7 (2015) ("We remain terrible at predicting the consequences of even simple genetic modifications in mice. One cautionary tale among many is a genetic modification of the *tp53* gene that protected mice against cancer while unexpectedly causing premature aging.").

[18] *See* Uros Midic, Pei-Hsuan Hung, Kailey A. Vincent, Benjamin Goheen, Patrick G. Schupp, Diane D. Chen, Daniel E. Bauer, Catherine A. VandeVoort & Keith E. Latham, *Quantitative Assessment of Timing, Efficiency, Specificity and Genetic Mosaicism of CRISPR/CAS9-Mediated Gene Editing of Hemoglobin Beta Gene in Rhesus Monkey Embryos*, 26 HUM. MOLECULAR GENETICS 2678, 2679 (2017) (identifying poor results in primate gene editing including developmental arrest and pregnancy loss).

The National Academies of Science, Engineering, and Medicine and scientific articles assert each of these setbacks can be corrected with better methods and techniques.[19] Such claims attempt to assuage doubt with proclamations of certainty. Offering statements of belief without supporting evidence, though, constitutes an assertion of *faith* in science rather than *empirical* science. Many peer-reviewed scientific articles pepper words such as "precise," "promising," and "highly efficient" in the abstract, introduction, and conclusion.[20] Proponents repeat this carefully constructed rhetoric in public discussion.[21] What concerns do public discussions omit or downplay?

Importantly, the translation of science into clinical applications rests upon value judgments where scientists and regulatory bodies decide what risks are acceptable and what threshold of uncertainty is tolerable.[22]

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[19] NAT'L ACADS. SCIS., ENG'G & MED., INTERNATIONAL SUMMIT ON HUMAN GENE EDITING: A GLOBAL DISCUSSION 2 (2015), https://doi.org/10.17226/21913 [https://perma.cc/WW65-GEZP] (asserting rapid improvement in gene-editing technology to offset off-target effects and quoting scientist saying, "I am almost certain that we will realize the potential of precision medicine in the next five years . . . ."); INT'L COMM'N ON THE CLINICAL USE OF HUMAN GENOME EDITING, HERITABLE HUMAN GENOME EDITING 90-91 (2020), https://doi.org/10.17226/25665 [https://perma.cc/882P-KXLA] (admitting current inadequacy of genome editing technology, resulting in mosaicism and on-target effects, but suggesting additional research "to refine methods and understand the feasibility and limitations of genome editing"); *see also* Drabiak, *supra* note 9, at 995 (criticizing National Academies for proclaiming high potential accuracy while omitting reasoning for such conclusions which run contrary to current scientific findings).

[20] *See, e.g.*, Hong Ma, Nuria Marti-Gutierrez, Sang-Wook Park, Jun Wu, Yeonmi Lee, Keiichiro Suzuki, Amy Koski, Dongmei Ji, Tomonari Hayama, Riffat Ahmed, Hayley Darby, Crystal Van Dyken, Ying Li, Eunju Kang, A. Reum Park, Daesik Kim, Sang-Tae Kim, Jianhui Gong, Ying Gu, Xun Xu, David Battaglia, Sacha A. Krieg, David M. Lee, Diana H. Wu, Don P. Wolf, Stephen B. Heitner, Juan Carlos Izpisua Belmonte, Paula Amato, Jin-Soo Kim, Sanjiv Kaul & Shoukhrat Mitalipov, *Correction of a Pathogenic Gene Mutation in Human Embryos*, 548 NATURE 413, 413 (2017) (describing correction of mutation with "precise CRISPR-Cas9-based targeting accuracy" in abstract); Lichun Tang, Yanting Zeng, Hongzi Du, Mengmeng Gong, Jin Peng, Buxi Zhang, Ming Lei, Fang Zhao, Weihua Wang, Xiaowei Li & Jianqiao Liu, *CRISPR/Cas9-Mediated Gene Editing in Human Zygotes Using Cas9 Protein*, 292 MOLECULAR GENETICS & GENOMICS 525, 526 (2017) (purporting to show "Cas9-mediated gene editing is highly efficient in human 2PN zygotes" in introduction); Guanglei Li , Yajing Liu, Yanting Zeng, Jianan Li, Lijie Wang, Guang Yang, Dunjin Chen, Xiaoyun Shang, Jia Chen, Xingxu Huang & Jianqiao Liu, Letter, *Highly Efficient and Precise Base Editing in Discarded Human Tripronuclear Embryos*, 8 PROTEIN & CELL 776, 776 (2017) (praising results of human embryo editing as "highly efficient and precise" and "on-target").

[21] *See, e.g.*, NAT'L ACADS. SCIS., ENG'G & MED., *supra* note 19, at 6 (promising new developments that edit genes "at much higher accuracy and efficiency than ever before possible").

[22] *See* Heidi Ledford, *'CRISPR Babies' Are Still Too Risky, Says Influential Panel*, NATURE NEWS (Sept. 3, 2020), https://www.nature.com/articles/d41586-020-02538-4 [https://perma.cc/6LGP-BUL8] (quoting legal scholar Karen Young's point, "They do recognize that even questions of safety and efficacy are ethical questions. . . . What is the

LESSONS FROM THE HISTORY OF SCIENCE

Enríquez distinguishes genomics technology from other applications of science, in particular eugenics. He states that eugenics was not merely bad science, but that it relied on *no science* and was not subject to debate.[23] He refers to failures of science as "deceptive simplicity" where proponents make "impractical and often sensationalist claims."[24] He astutely states, "[W]e must ground legal- and policy-based determinations firmly on scientific facts . . . ."[25]

Based on historical evidence meticulously detailing the eugenics movement, my analysis diverges. Eugenics is one of several examples of a theory that scientists, physicians, and legislators respected as mainstream, established science.[26] Eugenics capitalized on translating knowledge of genetics into social policy and the law. It was part of medical school curricula, endorsed by medical school deans, part of the U.S. Public Health Service marriage certificate program, and translated into involuntary sterilization laws and policies across the country.[27] Such theories seductively whisper what we long to hear: the promise to cure disease, to alleviate distress, and to deliver humane progress through technology.

Eugenics constitutes but one example of misguided and exorbitantly harmful interventions in the history of science and medicine. Throughout history, proponents of multiple theories touted experimental interventions as safe, remarkable, highly effective therapies.[28] These historical mistakes contain similar patterns: miracle promises, definitive assurances of a certain cure, published scientific support, denigration of opposition, and devastating injury. These lessons teach us that science is fiercely contested, but the voices that

appropriate threshold? How many experiments do you have to do? What is accurate enough?").

[23] ENRÍQUEZ, *supra* note 1, at 332-36 (noting that Supreme Court's pro-eugenics decision in *Buck v. Bell*, 274 U.S. 200 (1927), "did not examine any scientific evidence to support its assertion that mental deficiencies are congenital" and disagreeing with "conventional view" that *Buck* was "the result of false science").

[24] *Id.* at 333 ("*Buck*'s ruling is grounded more on deceptive simplicity than on the 'science' of the time . . . ."); *Id.* at 17 (defining umbrella term of "deceptive simplicity").

[25] *Id.* at 336.

[26] Paul A. Lombardo, *Taking Eugenics Seriously: Three Generations of ??? Are Enough?*, 30 FLA. ST. U. L. REV. 191, 208-11 (2003) (cataloging some prime ministers, presidents, scientists, and disability advocates who supported eugenics in its heyday); EDWARD J. LARSON, SEX, RACE, AND SCIENCE: EUGENICS IN THE DEEP SOUTH 21 (1995) (detailing role of eugenics as "the accepted means for explaining human character traits" in Deep South and globally); EDWIN BLACK, WAR AGAINST THE WEAK: EUGENICS AND AMERICA'S CAMPAIGN TO CREATE A MASTER RACE 63-86 (2d ed. 2012) (describing eugenics successful quest for money, organization, and scientific validity).

[27] *See* Lombardo, *supra* note 26, at 208-14.

[28] *See* Katherine Drabiak, *Sacrificing the Public's Health: Conspiracies and Trust in the Scientific Enterprise*, 16 U. ST. THOMAS J.L. & PUB. POL'Y (forthcoming 2022) (focusing on role of medical field in elevating incorrect information as widely accepted fact).

harken dissent, concern, and skepticism are sometimes minimized, dismissed, and forgotten.

A cadre of scientists, health law scholars, and ethicists disagree with the presumption that genome modification of human embryos would someday be safe and effective.[29] Instead, some stakeholders and this commentary conclude the opposite: that it will *never* be safe and effective. Esteemed health law professor George Annas and his colleagues give credence to concerns that germline modifications pose serious risks for both safety and human rights and propose a treaty that would prohibit or criminalize implanting embryos with intentional germline modifications.[30] Evolutionary biologist Stuart Newman notes that germline modifications are "fraught with potential error" because the manipulation of one location impacts the subsequent growth and development of every cell in the body. [31] Finally, some scientists conclude that the genome-wide effect of changing a single allele is unpredictable, and that such a modification could disrupt the pre-existing genome—the very design of the intervention carries significant risk.[32]

TRANSLATING SCIENCE INTO LAW

Enríquez notes that the "current de facto legislative ban" on germline editing based on federal funding restrictions "is merely a temporary fix that cannot adequately address many legal challenges that are looming on the horizon."[33]

[29] Roberto Andorno, Françoise Baylis, Marcy Darnovsky, Donna Dickenson, Hille Haker, Katie Hasson, Leah Lowthorp, George J. Annas, Catherine Bourgain, Katherine Drabiak, Sigrid Graumann, Katrin Grüber, Matthias Kaiser, David King, Regine Kollek, Calum MacKellar, Jing-Bao Nie, Osagie K. Obasogie, Mirriam Tyebally Fang, Gabriele Werner-Felmayer & Jana Zuscinova, *Geneva Statement on Heritable Human Genome Editing: The Need for Course Correction*, 38 CELL PRESS, 351, 352 (2020) (asserting fundamental shortcomings of genome editing such as requiring mass use of *in vitro* fertilization and inability to cure disease in existing persons).

[30] George J. Annas, Lori B. Andrews & Rosario M. Isasi, *Protecting the Endangered Human: Toward an International Treaty Prohibiting Cloning and Inheritable Alterations*, 28 AM. J.L. & MED. 151, 154-78 (2002) ("[M]any believe that . . . inheritable genetic alternations at the embryo level will never be safe because they will always be inherently unpredictable in their effects on the children and their offspring.")

[31] Stuart A. Newman, *Averting the Clone Age: Prospects and Perils of Human Developmental Manipulation*, 19 J. CONTEMP. HEALTH L. & POL'Y 431, 431-63 (2003) [hereinafter Newman, *Averting the Clone Age*]; *see also* Stuart A. Newman, *CRISPR Will Never Be Good Enough to Improve People*, HUFFPOST (Feb. 22, 2017), https://www.huffpost.com/entry/crispr-will-never-be-good-enough-to-improve-people_b_58a90dcbe4b0b0e1e0e20c00 [https://perma.cc/9263-4DSL] ("[E]ven the most precise alteration of a known gene with CRISPR is fraught with uncertainties.").

[32] Newman, *Averting the Clone Age*, *supra* note 31, at 451-52 (claiming that accurate prediction of complex phenotypes "is likely to remain elusive" even under anticipated, improved new models).

[33] ENRÍQUEZ, *supra* note 1, at 337.

He posits that permanent bans cannot withstand Constitutional scrutiny based on his analysis of overlapping doctrine of substantive due process, procreative liberty, and familial privacy, each of which he describes with exceptional detail.[34] In keeping with his precision throughout the text, Enríquez acknowledges that this conclusion hinges upon his lens of Constitutional interpretation.[35] Extending existing precedent, Enríquez asserts that parents should have a right not to simply bear offspring and make children's medical decisions, but a right to bear (presumptively) healthy offspring and create children using certain germline modification techniques.[36]

This commentary offers several alternative points to consider when thinking of the complex legal rights involved here—rights of parents, rights of future children, and the amorphous rights of society that stakeholders must consider when discussing altering the human genome of future generations.[37]

Substantive due process encompasses fundamental liberty interests that define who we are as people to make the most intimate and influential choices, such as medical decisions, whether to marry, and whether to procreate. Each of these categories shapes our life trajectory dramatically. Analyzing how far these rights extend is interwoven with whether we perceive them as negative rights or positive rights. Enríquez asserts that any prohibitions on germline editing would interfere with a right to access the technology and frames it in the context of a right of noninterference.[38] But this seems to be a blurry line that crosses over a mere a right to noninterference. This point of view seeks to fulfill individual goals by relying upon something external, such as technology and third parties to achieve the desired goal of producing a certain type of future child.[39] This

[34] *Id.* at 337-46.

[35] *Id.* at 346-47 (emphasizing importance of "[c]arefully framing an issue for judicial review" to achieve desired results).

[36] *See also id.* at 347 (comparing different likely results for constitutional right to bear children to constitutional right to engineer "designer babies").

[37] Katherine Drabiak, *The Nuffield Council's Green Light for Genome Editing Human Embryos Defies Fundamental Human Rights Law*, 34 BIOETHICS 223, 225-26 (2020) (noting limits of reproductive rights jurisprudence and citing research supporting "the proposition that some rights of children and future children should be held in trust"); Sebastian Schleidgen, Hans-Georg Dederer, Susan Sgodda, Stefan Cravcisin, Luca Lüneburg, Tobias Cantz & Thomas Heinemann, *Human Germline Editing in the Era of CRISPR-Cas: Risk and Uncertainty, Inter-Generational Responsibility, Therapeutic Legitimacy*, 21 BMC MED. ETHICS, 5-7, https://doi.org/10.1186/s12910-020-00487-1 (interrogating ethical dilemmas around second-generation heritable gene editing recipients).

[38] *See* ENRÍQUEZ, *supra* note 1, at 342 (analogizing right to use gene-editing technology with right of noninterference with parental latitude in child upbringing); *see also* Meyer v. Nebraska, 262 U.S. 390 (1923) (recognizing such right in context of choice of language for child's education).

[39] JOHN A. ROBERTSON, CHILDREN OF CHOICE: FREEDOM AND THE NEW REPRODUCTIVE TECHNOLOGIES 38-39 (1994) (conceiving of "negative constitutional right to use a wide variety of reproductive technologies to have offspring"). *But see* Radhika Rao, *Constitutional*

involves a series of trade-offs. Demanding access to certain technologies entails risks to others, encompasses scientific and policy value judgments, and takes it further than simply recognizing the right to be left alone.

Next, procreative liberty constitutes an important right, but it is not boundless. Certainly, we have a natural right to be unencumbered to reproduce or not reproduce.[40] However, choices of reproduction necessarily involve other parties, whether through traditional reproduction or, as we see most acutely, in the permutation of players potentially involved in assisted reproductive technology scenarios. Here, certain jurisdictions in the United States and other nations do delineate boundaries on procreative liberty when one person attempts to induce compliance for his own agenda or impinge upon another person's potentially conflicting right.[41] The law already recognizes certain limits, such as restrictions on surrogacy contracts and imposition of duties of parentage, designed to balance individual procreative liberty with the multiple other interests at stake.[42] Finally, several legal scholars and this commentary maintain that procreative liberty does not encompass the right to use external resources to have a certain type of child, nor the "right" to a biological or genetically related child.[43]

Finally, Enríquez also describes the critical value of familial privacy and the importance of parents as the correct and appropriate medical decision-makers for their children.[44] Parents indeed exercise—rightfully so—wide latitude when making medical decisions for their child.[45] Enríquez asserts this should also

Misconceptions, 93 MICH. L. REV. 1473, 1483-89 (1995) (book review) (pushing back on negative right framework and questioning alleged right's diminishing effect on other constitutional rights).

[40] ENRÍQUEZ, *supra* note 1, at 342-43 (discussing cases and theories vindicating Constitutional guarantees to procreative rights).

[41] *See* Katherine Drabiak, *Infants Born Through Surrogacy Contracts Cannot Be Canceled or Returned*, BILL OF HEALTH (Feb. 8, 2021), https://blog.petrieflom.law.harvard.edu/2021/02/08/surrogacy-contracts-canceled/ [https://perma.cc/3TD5-UV9E] (discussing relationship between reproductive rights and contract rights in surrogacy contracts); *see also* Katherine Drabiak, *Waiving Informed Consent to Prenatal Screening and Diagnosis? Problems with Paradoxical Negotiation in Surrogacy Contracts*, 39 J.L. MED. & ETHICS 559, 562-63 (2011) [hereinafter Drabiak, *Waiving Informed Consent*] (comparing methods states take to manage family and contract law rights, including one state's potential codification of contractual waiver of informed consent during surrogacy).

[42] Drabiak, *Waiving Informed Consent*, *supra* note 41, at 562-63.

[43] Françoise Baylis & Lisa Ikemoto, *The Council of Europe and the Prohibition on Human Germline Genome Editing*, 18 EMBO REPORTS 2084, 2084 (2017) (contesting the right to have a genetically related child); Drabiak, *supra* note 10, at 40 (asserting that alleged right to bear genetically related children "need not be absolute nor demand all technology available without regard to whether the original conception of procreative liberty even encompasses such a right, or how exercising that right would impinge upon the rights of the child"); Drabiak, *supra* note 37, at 225.

[44] ENRÍQUEZ, *supra* note 1, at 339-42.

[45] *See* Katherine Drabiak, *Resolving Physician-Parent Disputes Involving Pediatric Patients*, 20 HOUS. J. HEALTH L. & POL'Y 353, 371-72 (2021).

include the decision to manufacture embryos with certain germline modifications aimed at reducing genetic disease risk to create children.[46] However, this transforms the doctrine of making medical decisions related to conception, during pregnancy, and for existing children into a new and discrete realm. This illustrates a direct example where differences in scientific judgments result in vastly divergent legal conclusions. If we presume that germline modifications raise significant and unknowable risks, then no one, not even a parent, has authority to exercise such power over the rights of a future child. Building upon law professor Dena Davis's theory of a right to an open future, parents may not consent to medical interventions that substantially limit their child's life path.[47]

As an alternative, this commentary asserts that all people should have a right to genomic integrity, defined as a right precluding intentional germline modifications.[48] Originating from human rights principles, this proposed right exists independently of safety or feasibility concerns. Although parents have a variety of rights related to reproductive choices, the law can—and must—draw a bright line to prohibit actions that infringe upon the dignity and rights of the future child.[49] Permitting parents to authorize germline modifications of embryos to create future children violates the physical integrity and developmental trajectory of future persons.

RE-ORIENTING SCIENCE AND LAW

Germline modification of human embryos appeals to precisely what we seek from science and medicine—to cure disease and alleviate suffering. Indeed, the primal yearning to have biological, genetically related children is intense. Yet there are serious and potentially unresolvable safety risks and many other factors driving the technological imperative. Enríquez correctly asserts that we should take decisive action in this arena. However, if we re-examine the scientific evidence, this will lead us to the opposite conclusion: that permitting germline modifications of human embryos is not a right, but instead constitutes a risky proposition for society.

[46] ENRÍQUEZ, *supra* note 1, at 338.

[47] Dena S. Davis, *Genetic Dilemmas and the Child's Right to an Open Future*, HASTINGS CTR. REP., Mar.-Apr. 1997, at 7, 11 (supporting family right to shape children's lives until "that shaping takes the form of a radically narrow range of choices available to the child when she grows up" to protect "the child's future ability to make her own choices about which of the many diverse visions of life she wishes to embrace").

[48] Drabiak, *supra* note 37, at 226 (defining genomic integrity as "a right precluding germline modifications held in trust that vests to the child upon birth").

[49] *See* Françoise Baylis, Marcy Darnovsky, Katie Hasson & Timothy M. Krahn, *Human Germline and Heritable Genome Editing: The Global Policy Landscape*, 3 CRISPR J. 365, 374 (2020) (finding that "substantial majority" of countries have relevant policy documents prohibiting heritable human genome editing, while no surveyed countries explicitly permit heritable human genome editing).