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USING PRECEDENTS OF JEWISH LAW TO APPROACH CRISPR AND AI

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INTRODUCTION

As the world changes, it is essential to be sensitive to new ethical and theological concerns as they arise and then to strive to be proactive in addressing them. In this way, we can embrace the benefits of new technologies while mitigating potential pitfalls. This article seeks to demonstrate ways in which classic Jewish values can guide us through such uncharted territories. To help show this, I will use Artificial Intelligence in medicine and CRISPR (clustered regularly interspaced short palindromic repeats) gene editing as examples, because they are both rapidly emerging transformative technologies that raise overlapping issues and concerns.

I. ARTIFICIAL INTELLIGENCE

The field of AI (Artificial Intelligence) has been described as the "fourth industrial revolution," as it stands to radically redefine how we work and live our lives on a global scale.[1] Because this field is so vast and rapidly expanding, for the sake of our concerns here, we will limit the discussion to AI in the healthcare context, where it is already growing in numerous ways[2] and is beginning to have a major impact on every aspect of healthcare. For example, AI-augmented healthcare has the potential to help physicians improve their performance and thus save and enhance patients' lives[3] with extremely accurate and perceptive

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1 Kathleen Murphy et al., "Artificial Intelligence for Good Health: A Scoping Review of the Ethics Literature," *BMC Medical Ethics* 22, no. 1 (February 2021): 14. https://doi.org/10.1186/s12910-021-00577-8.

2 AI in medicine can be categorized into two subtypes: virtual (i.e., neural network-based guidance in treatment decisions) and physical (i.e., robots assisting in performing surgeries or intelligent prostheses). See Pavel Hamet and Johanne Tremblay, "Artificial Intelligence in Medicine," *Metabolism* 69 (April 2017): 36–40, https://doi.org/10.1016/j.metabol.2017.01.011; Amisha, Paras Malik, Monika Pathania, and Vyas Kumar Rathaur, "Overview of Artificial Intelligence in Medicine," *Journal of Family Medicine and Primary Care* 8, no. 7 (July 2019): 2328–331. https://doi.org/10.4103/jfmpc.jfmpc_440_19.

3 Ibid.

diagnostics,[4] predictive tools, decision support, reduced accidental deaths and injuries, and increased productivity. AI can work faster and more efficiently than humans and recognizes issues that a human would be unable to perceive.[5] With the ability even to innovate and generate new scientific knowledge and discoveries,[6] AI's promise seems boundless.

And yet, such use of AI has also been met with resistance from healthcare professionals[7] due to concerns related to such issues as privacy, confidentiality, patient autonomy, informed consent, liability, false information, and bias.[8] In addition, many in the healthcare industry are concerned that although AI may reduce healthcare costs, it will also reduce the number of jobs, setting off a different kind of economic effect that may carry negative implications.[9] There are two issues, however, that are of unique concern for religious and cultural minorities and where observant Jews can focus attention in order to ensure that these new technologies are developed appropriately: impersonalization and values in decision-making.

Impersonalization

As mentioned, one of the central promises of AI is its ability to analyze health data more efficiently, thereby leading (the argument goes) to greater quality of care via improved diagnostics and determination of treatment options. Quality patient care, however, is more than efficiency. It also entails the enactment of certain human traits such as critical thinking, interpersonal and communication skills, emotional intelligence, compassion, and creativity—all elements that cannot be properly replaced by machine learning.[10] The use of AI also raises issues of social isolation, such as reduced human contact between patients and healthcare providers.[11] This is

4 For example, the ability to diagnose skin cancer more accurately than a dermatologist; see Andre Esteva et al., "Dermatologist-Level Classification of Skin Cancer with Deep Neural Networks," *Nature* 542, no. 7639 (February 2017): 115–18. https://doi.org/10.1038/nature21056. Radiologists may view hundreds of thousands of scans throughout their careers, while a deep-learning algorithm could incorporate data from millions of scans instantaneously to recognize abnormalities; see Ahmed Hosny et al., "Artificial Intelligence in Radiology," *Nature Reviews Cancer* 18, no. 8 (August 2018): 500–10. https://doi.org/10.1038/s41568-018-0016-5. Similarly, a randomized clinical trial found that AI proved more successful in assessing and diagnosing cardiac function than echocardiogram assessments made by sonographers and that cardiologists were unable to distinguish between assessments made by the AI and sonographers; see "Late-breaking Heart Research: AI More Accurate Than Technicians," Cedars-Sinai, August 28, 2022, https://www.cedars-sinai.org/newsroom/late-breaking-heart-research-ai-more-accurate-than-technicians/.

5 Daniel Castro and Joshua New, "The Promise of Artificial Intelligence," Center for Data Innovation, October 2016, http://www2.datainnovation.org/2016-promise-of-ai.pdf; see Amisha et al.

6 Oscar Álvarez-Machancoses and Juan Luis Fernández-Martínez, "Using Artificial Intelligence Methods to Speed Up Drug Discovery," *Expert Opinion on Drug Discovery* 24, no. 8 (August 2019): 769–77. https://doi.org/10.1080/17460441.2019.1621284.; Nic Fleming, "How Artificial Intelligence Is Changing Drug Discovery," *Nature* 557, no. 7707 (May 2018): S55–S57. https://doi.org/10.1038/d41586-018-05267-x.

7 Avi Goldfarb and Florenta Teidodoridis, *Why Is AI Adoption in Health Care Lagging*? (Brookings Institute, 2022), https://www.brookings.edu/research/why-is-ai-adoption-in-health-care; Giovanni Briganti and Oliver Le Moine, "Artificial Intelligence in Medicine: Today and Tomorrow," *Frontiers in Medicine* 7, no. 27 (February 2020), https://doi.org/10.3389/fmed.2020.00027.

8 Michael J. Rigby, "Ethical Dimensions of Using Artificial Intelligence in Health Care," *AMA Journal of Ethics* 21, no. 2 (February 2019): 122. Amisha et al.

9 See discussion in Briganti, de Moine.

10 Concerns over eliminating jobs often arise when new technologies boost productivity and increase customer satisfaction, but they frequently end up benefiting society, and thus, some suggest that the focus should be on helping workers transition to new types of jobs. See Daniel Castro and Michael McLaughlin (Information Technology and Innovation Foundation, 2019), https://itif.org/publications/2019/02/04/ten-ways-precautionary-principle-undermines-progress-artificial-intelligence/. Amisha et al., 2328–331.

11 See detailed discussions in Arto Laitinen, Marketta Niemelä, and Jari Pirhonen, "Social Robotics, Elderly Care, and Human

an ethical concern because healthcare relationships are based primarily on trust and empathy. Although AI solutions can take over tasks that are more routine and standardized, they cannot reproduce the emotional capabilities of humans.[12] Consequently, an overreliance on the data that fuel clinical algorithms could devalue other forms of diagnosis and treatment.[13] This eventuality could lead to the dehumanization or *im*personalization of patient care,[14] from an intervention based on *listening* and *theory* to one based purely on *categorization* (which also adds to bias and discrimination concerns).[15] AI, in other words, is unlikely to effectively replace a physician's knowledge and understanding of a particular patient as a whole person with a complex life story, and it almost certainly cannot fully replace effective and supportive communication from a caring individual.

From a Jewish perspective, this is especially concerning since Judaism emphasizes the importance of holistic care. In the traditional Jewish prayer for healing, the *mi she'beirach*, we pray for both "a healing of the soul and a healing of the body." Indeed, classic rabbinic sources extol the importance of talking to patients, giving them the opportunity to express themselves, and ensuring that they do not feel lonely or isolated.[16] In fact, studies have shown that social isolation and loneliness contribute to risks of poorer health and premature death[17] and that a strong supportive relationship between a patient and physician can improve both the healthcare experience and clinical outcomes.[18]

All that said, AI need not undermine this value and in fact can even promote it. If trained carefully,[19] physicians can collaborate effectively with AI, reducing the time needed for diagnosis and determining

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Dignity: A Recognition-Theoretical Approach," in *What Social Robots Can and Should Do* (Amsterdam: IOS Press, 2016), https://doi.org/10.3233/978-1-61499-708-5-155; Nuffield Council on Bioethics, *Artificial Intelligence (AI) in Healthcare and Research* (Bioethics Briefing Note, 2018) https://www.nuffieldbioethics.org/publications/ai-in-healthcare-and-research; Tijs Vandemeulebroucke, Bernadette Dierckx de Casterlé, and Chris Gastmans, "The Use of Care Robots in Aged Care: A Systematic Review of Argument-Based Ethics Literature," *Archives of Gerontology Geriatrics* 74 (January 2018): 15–25. https://doi.org/10.1016/j.archger.2017.08.014. On healthcare robots replacing humans, see Murphy et al.

12 Kee Yuan Ngiam and Ing Wei Khor, "Big Data and Machine Learning Algorithms for Health-Care Delivery," The *Lancet Oncology* 20, no. 5 (May 2019): e262–e73. https://doi.org/10.1016/S1470-2045(19)30149-4.

13 Ferico Cabitza, Raffaele Rasoini, and Gian Franco Gensini, "Unintended Consequences of Machine Learning in Medicine," *JAMA* 318, no. 6 (August 2017): 517–18. https://doi.org/10.1001/jama.2017.7797; Michael J. Rosenfeld, Reuben J. Thomas, and Sonia Hausen, "Disintermediating Your Friends: How Online Dating in the United States Displaces Other Ways of Meeting," *Proceedings of the National Academy of Sciences of the United States of America* 116, no. 36 (September 2019): 17753–58. https://doi.org/10.1073/pnas.1908630116.

14 Eric Juengst et al., "From 'Personalized' to 'Precision' Medicine: The Ethical and Social Implications of Rhetorical Reform in Genomic Medicine," *The Hastings Center Report* 46, no. 5 (September 2016): 21–33. https://doi.org/10.1002/hast.614.

15 Jessica Morley et al., "The Ethics of AI in Health Care: A Mapping Review," *Social Science and Medicine* 260 (September 2020): 113172. https://doi.org/10.1016/j.socscimed.2020.113172.

16 *Yoma* 75a, based on *Mishlei* 12; *Sefer Chareidim*, quoted in *Tzitz Eliezer* 5: *Ramas Rachel* 3. Some explain that the Talmudic statement "The best of the doctors are destined for hell" is about doctors who focus only on physical maladies but don't care for the heart and soul of the patient. See Harry Friedenwald, *The Jews and Medicine: Essays* (Baltimore: Johns Hopkins Press, 1944), 1:11–13; Y.A. Shapiro, *Halachah Urefuah* (Chicago: Regensberg Institute, 1981), 2:335–339.

17 Julianne Holt-Lunstad and Carl Perissinotto, "Social Isolation and Loneliness as Medical Issues," *The New England Journal of Medicine* 388, no. 3 (January 2023): 193–95. https://doi.org/10.1056/NEJMp2208029.

18 John M. Kelley et al., "The Influence of the Patient-Clinician Relationship on Healthcare Outcomes: A Systematic Review and Meta-Analysis of Randomized Controlled Trials," *PLoS One* 9, no. 4 (April 2014): e94207. https://doi.org/10.1371/journal.pone.0094207.

19 Steven A. Wartman and C. Donald Combs, "Reimagining Medical Education in the Age of AI," *AMA Journal of Ethics* 21, no. 2 (February 2019): 146–52. https://doi.org/10.1001/amajethics.2019.146. They point out that with the rise of AI, medical education should shift from a focus on knowledge recall to training students to interact with and manage AI effectively,

treatment options, decreasing some of the routine responsibilities of medical practice, and allowing clinicians more time to get to know each patient and what makes them unique. The speed of AI can thus enable healthcare providers to recenter their focus on human needs, spending quality time with their patients on meaningful matters, and providing the human touch and empathy necessary for truly patient-centered care.[20] If physicians are trained accordingly, and this opportunity is properly harnessed, AI could actually facilitate a return to Dr. William Osler's ideal that "a good physician treats the disease, but the great physician treats the patient."[21]

To ensure that caring for the whole patient—not just their illness—is promoted, the Jewish community should advocate for medical schools to train their students to interact with and manage AI systems effectively, understand the ethical complexities, and, especially, focus on improving communication and empathy skills. We should also encourage hospitals to help their providers spend more time supporting their patients. Recognizing what we can accomplish in this area may be limited, I further suggest that we train and encourage our community volunteers, *bikkur cholim* groups, chaplains, and rabbis to redouble efforts to provide supplemental holistic, supportive, whole-person care for those who are hospitalized.

Values in Decision Making

AI in healthcare presents an additional ethical concern. AI algorithms are not always intelligible or clearly shared. Such a system is often referred to as a "black box," when patients and even healthcare providers have little access to how decisions are made,[22] hindering the ability of laypeople to scrutinize the output of such systems.[23] AI could thus undermine patients' ability to receive treatment in accordance with their own values and preferences[24] and be meaningfully involved in shared decision-making.[25] This might also undermine an individual's

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to identify ethical complexities that may arise, and to improve communication and empathy skills. There may be a need for patient education as well, as some patients may simply focus on the increased diagnostic and treatment accuracy of AI and the ease of conversing with machines and devalue the importance of human interaction and relationships. See Jorg Goldhahn, Vanessa Rampton, and Giatgen A. Spinas, "Could Artificial Intelligence Make Doctors Obsolete?" *BMJ* 363 (November 2018): k4563. https://doi.org/10.1136/bmj.k4563.

20 Bree Holtz, Victoria Nelson, and Ronald K. Poropatich, "Artificial Intelligence in Health: Enhancing a Return to Patient-Centered Communication," *Telemedicine Journal and E-Health* 29, no. 6 (November 2022): 795–97. https://doi.org/10.1089/tmj.2022.0413. On the other hand, clinicians' extra time might be used up explaining the many advantages of AI and the increase in information that it shares, and some health systems might respond to the added efficiency by increasing the volume of patients a clinician is expected to see. See Matthew Nagy and Bryan Sisk, "How Will Artificial Intelligence Affect Patient-Clinician Relationships?" *AMA Journal of Ethics* 22, no. 5 (May 2020): 397–400.

21 Roy Porter, *Blood & Guts: A Short History of Medicine* (New York: W. W. Norton, 2004, reprint), p. 43.

22 Hunna J. Watson et al., "Genome-Wide Association Study Identifies Eight Risk Loci and Implicates Metabo-Psychiatric Origins for Anorexia Nervosa," *Nature Genetics* 51, no. 8 (August 2019): 1207–14. https://doi.org/10.1038/s41588-019-0439-2.

23 Murphy et al. This also brings up privacy concerns; see Kadircarn H. Keskinbora, "Medical Ethics Considerations on Artificial Intelligence," *Journal of Clinical Neuroscience* 64 (June 2019): 277–82. https://doi.org/10.1016/j.jocn.2019.03.001.

24 Beth L. DuFault and John W. Schouten, "Self-Quantification and the Datapreneurial Consumer Identity," *Consumption Markets and Culture* 23, no. 3 (2020): 290–316. https://doi.org/10.1080/10253866.2018.1519489; Rosalind J. McDougall, "Computer Knows Best? The Need for Value-Flexibility in Medical AI," *Journal of Medical Ethics* 45, no. 3 (March 2019): 156–60. https://doi.org/10.1136/medethics-2018-105118. See also Murphy et al.; Cristina Trocin et al., "Responsible AI for Digital Health: A Synthesis and a Research Agenda," *Information Systems Frontiers* (June 2021): https://doi.org/10.1007/s10796-021-10146-4**;** Alvin Rajkomar et al., "Scalable and Accurate Deep Learning with Electronic Health Records," *NPJ Digital Medicine* 1, no. 18 (May 2018): https://doi.org/10.1038/s41746-018-0029.

25 Effy Vayena et al., "Digital Health: Meeting the Ethical and Policy Challenges," *Swiss Medical Weekly* 148, no. 34 (January 2018): w14571. https://doi.org/10.4414/smw.2018.14571; Effy Vayena, Allesandro Blasimme, and I. Glenn Cohen, "Machine Learning in Medicine: Addressing Ethical Challenges," *PLoS Medicine* 15, no. 11 (2018): e1002689. https://doi.org/10.1371/journal.pmed.1002689.

confidence in their ability to refuse treatment when necessary.[26]

The need for explanation in the medical context stems from the fact that people tend to over-trust and over-rely on computer systems and AI decision-support systems ("automation bias").[27] However, even when making the simplest medical decisions, a multiplicity of values comes into play, reflecting social norms, professional commitments, institutional and economic considerations, and our own personal beliefs and perspectives.[28] More significantly, the values programmed into AI algorithms may reflect those of some groups, but not necessarily of the individual patient. This situation can be very concerning for observant Jews or others who have specific views on matters such as the value and sanctity of life. AI-produced results can often be heavily value-laden, based on definitions of "healthy," societal "importance," or assumptions about quality of life,[29] which are not consonant with the patient's own values,[30] thus imposing values on patients who may not subscribe to them.[31] This could also undermine compliance with AI decision-making and erode public trust in the entire healthcare system.

Such issues have actually arisen before in rabbinic literature, such as in the context of brain death. Although many assume that it is the physician's role to define what it means to be deceased, Jewish law recognizes that death is more than simply a medical or scientific issue. Death is a process, and the point at which a human being no longer retains the status of a living entity is the subject of complex religious, philosophical, and moral discussions. Modern medicine has articulated its own definitions of death, and a barrage of medical tests have been designed to help determine when the patient's state matches the defined status. However, this definition itself simply represents a choice of a particular point in the dying process that the medical tests can isolate and test for. There is no purely "scientific" reason to choose that point in the process. Even the medical establishment must rely on meta-scientific considerations, whether ethical, social, philosophical, or some combination thereof, to justify its position. So too, many patients expect their own cultural or religious values and preferences to be respected in the healthcare setting (and all aspects of their lives), and reliance on AI in medical decision-making can undermine that goal.

This issue could be addressed by requiring transparency and striving to make such a system as explainable as possible to those who utilize it,[32] especially why it comes to the conclusions that it does and what values are involved in those decisions. Although some forms of complex AI are very difficult to explain, we can either advocate for the use of simpler AI models when necessary (especially when we know that they can match our values), or that the more complex models be modified to be more intelligible, so that they can be understood, if not by anyone who would be utilizing them, then at least by some experts.[33] Ethical considerations are sometimes ignored when they conflict with profit or speed of development. However, just as a good clinician is expected to be able to explain why they

26 Thomas Ploug and Soren Holm, "The Biobank Consent Debate: Why 'Meta-Consent' Is Still the Solution!" *Journal of Medical Ethics* 45, no. 5 (May 2019): 295–97. https://doi.org/10.1136/medethics-2018-105258.

27 Marzyeh Ghassemi, Luke Oakden-Rayner, and Andrew L. Beam, "The False Hope of Current Approaches to Explainable Artificial Intelligence in Health Care," *Lancet Digit Health* 3, no. 11 (November 2021): e745–e50, notes 37–38. https://doi.org/10.1016/S2589-7500(21)00208-9.

28 Richard M. Zaner, *Ethics and the Clinical Encounter* (Hoboken, NJ: Prentice Hall, 1988), ch. 2.

29 WHO Guidance, *Ethics and Governance of Artificial Intelligence for Health* (World Health Organization, 2021), p. 29, https://www.who.int/publications/i/item/9789240029200.

30 Ibid.

31 Morley et al.

32 WHO, 27.

33 Brian Christian, *The Alignment Problem: Machine Learning and Human Values* (New York: W. W. Norton, 2020), ch. 3.

arrived at a particular recommendation, AI should be able to do so as well. The ability to explain keeps AI accountable and is essential for an observant Jew to use it or benefit from it.[34]

It may require some technical expertise to be able to understand and interpret a given AI decision-making process and the role of a particular set of values. There is thus a need to train religious experts whose job it is to ensure that patients' values are being respected.[35] Indeed, in the Orthodox community, detailed documentation of the identity of a gestational carrier in cases of surrogacy is required—in order to prevent the child from ever marrying another child of either the egg donor, the sperm donor, or the surrogate[36]—and specially trained (female) religious supervisors (*mashgichot*) are required during the egg retrievals and laboratory procedures of the IVF process.[37] Rabbinic authorities did not allow artificial reproductive technologies in their communities until these safeguards were in place. Here too, there may be a need for transparency and specially trained individuals to ensure that AI is fair and inclusive of a given patient's own value system.

Our community can train people who understand the technology and are also able to explain to *rabbanim* which factors and values go into AI's decisions, in order to effectively advocate for appropriate safeguards and educate our community, so that together we ensure that halachah is followed properly. Such individuals may be able to help provide alternate approaches for patients in the following ways: using alternate AI programs; helping rabbis and patients understand the embedded values of particular programs; and explaining the calculations that go into the recommendations that AI makes so that we can better understand why it recommends a certain surgery, treatment, or triage decision (such as in the ER or ICU), etc. We can thus determine if we agree with a particular recommendation or not based on the many applicable halachic principles relevant to these decisions. Such individuals may become especially crucial as "chat bots" learn to program better than humans, and fewer and fewer people have a proper grasp of what AI is doing and why. Although nobody may be able to fully understand all that goes into the decisions that AI produces, the role of these individuals would be to provide oversight, checking the work of the AI and validating that we can agree with its value-based recommendations, instead of blindly trusting the computer systems.

Jewish values demand that we stay in the forefront of ensuring "responsible Artificial Intelligence," by attempting to highlight our moral responsibilities related to this rapidly developing technology, ensuring that the design and implementation of these applications are ethically, socially, and legally responsible.[38]

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34 Castro, McLaughlin. Much AI software used in healthcare comes from commercial entities that want to protect their intellectual property, and others argue that requiring AI to be explainable will make it less accurate and slow down innovation. However, explainability is important in keeping AI safe and enhancing public trust. Furthermore, some argue that if an algorithm is so complex that the developers themselves can't understand how it works, it is likely not a good candidate for healthcare; see Jason H. Moore, "The Question Medical AI Can't Answer," *Scientific American*, July 29, 2021, https://www.scientificamerican.com/article/the-question-medical-ai-can't-answer/. See critique of explainable AI in M. Ghassemi et al., cited above.

35 Indeed, WHO, pp. 25, 140–44, recommends developing a system for independent oversight to ensure equitable use of AI technology.

36 R. Moshe Feinstein (*Igros Moshe*, *Even Ha'ezer* 1:7); R. Zalman Nechemiah Goldberg (*Techumin* 19, 273–81); *B'mareh Habazak* 9:42, n. 17. See also *Ratz Katzvi*, *Even Ha'ezer* 2:29–30.

37 R. Auerbach (*Nishmas Avraham*, *Even Ha'ezer* 1:6 (2) [13 in 3rd ed.]); *Encyclopedia Refuit Hilchatit* [Hebrew] 2:559, n. 4; *Yabia Omer* 2, *Even Ha'ezer* 1 (13); R. Elyashiv, quoted in *Nishmas Avraham*, *Even Ha'ezer* 1:6 (29 in 3rd ed.); *Assia* 61–62 (5758); *Ratz Katzvi*, *Even Ha'ezer* 418–19.

38 Trocin et al.; Stuart McLennan et al., "An Embedded Ethics Approach for AI Development," *Nature Machine Intelligence* 2 (September 2020): 488–90. https://doi.org/10.1038/s42256-020-0214-1. Some form of enforcement measures may prove necessary, perhaps through regulation, certification, or voluntary measures; comment by Elettra Bietti, in *Proceedings*

It will thus be crucial to ensure safeguards and a strong legal and regulatory framework to protect the public and maintain patient privacy and trust.[39] We don't yet have sufficient professional history and norms or the legal and professional accountability mechanisms for AI that exist for other areas of medicine.[40] This lack is particularly concerning in a healthcare context, where there are significant cultural and religious sensitivities and where lives are at stake.

There are also some broader issues that AI gives rise to, which overlap with some of those in gene editing technology, to which we now turn our attention.

II. ETHICAL ISSUES IN CRISPR

CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) gene editing is a technology that can change an organism's DNA by either adding, removing, or altering genetic material at particular locations in the genome. This technology was adapted by scientists based on a genome editing process that happens naturally in some bacteria as an immune defense by capturing small pieces of a virus's DNA and inserting them into their own DNA. In that process, the bacteria learn how to recognize the virus and then cut it apart to disable it if it attacks again.[41] CRISPR is a rapidly developing field that has been described as possessing "unprecedented potential to revolutionize" healthcare because of its ability to cure disease,[42] and has thus been called "the biggest biotech discovery of the century."[43] A Nobel prize in chemistry was awarded to the founders of CRISPR gene editing in 2020. The ability to edit our own genetic makeup is certainly one of the most profound issues that humanity has ever faced.[44]

It is important to distinguish between two general categories of CRISPR: "somatic" and "germline." Somatic-cell editing is a much less controversial technique[45] used to edit just some, but not all, aspects of a person who has already been born. These changes will not be inherited by future generations.[46] The other form, germline gene editing, is when edits are made in reproductive cells (human eggs or sperm) or an early-stage embryo, thus making inheritable changes that will be passed along to all of the cells of all future generations of that individual. This process can thus completely alter humankind and is

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of the 2020 Conference on Fairness, Accountability, and Transparency (ACM, 2020), eds. Mirelle Hildebrandt, and Carlos Castillo (New York: Association for Computing Machinery, 2020), pp. 210–19.

39 Charalampia Xaroula Kerasidou, et al., "Before and beyond Trust: Reliance in Medical AI," *Journal of Medical Ethics* 48, no. 11 (November 2022): 852–56. https://doi.org/10.1136/medethics-2020-107095.

40 McLennan et al.

41 NIH National Library of Medicine, "What are genome editing and CRISPR-Cas9?" *Medline Plus*, March 22, 2022, https://medlineplus.gov/genetics/understanding/genomicresearch/genomeediting. For an overview of technology, advances, and ethical issues in CRISPR, see Fani Memi, Aglaia Ntokou, and Irinna Papangeli, "CRISPR/CAS9 Gene-Editing: Research Technologies, Clinical Applications, and Ethical Considerations," *Seminars in Perinatology* 42, no. 2 (December 2018): 487–500. https://doi.org/10.1053/j.semperi.2018.09.003.

42 Larry G. Locke, "The Promise of CRISPR for Human Germline Editing and the Perils of 'Playing God,'" *The CRISPR Journal* 3, no. 1 (February 2020): 27–31. https://doi.org/10.1089/crispr.2019.0033; Michael D. Sullivan, *The Ethics of CRISPR: What We Can Do vs. What We Should Do*, (Paper, Washington and Lee University, 2018), p. 3. https://dspace.wlu.edu/handle/11021/33966.

43 Carl Zimmer, "Breakthrough DNA Editor Born of Bacteria," *Quanta Magazine*, February 6, 2015, https://quantamagazine.org/20150206-crispr-dna-editor-bacteria/.

44 Walter Isaacson, *The Code Breaker: Jennifer Doudna, Gene Editing, and the Future of the Human Race* (New York: Simon & Schuster, 2021), p. 335.

45 Ted Peters, "Should Crispr Scientists Play God?" *Religions* 8, no. 4 (April 2017): 61. https://doi.org/10.3390/rel8040061 7; Martina Baumann, "CRISPR/Cas9 Genome Editing—New and Old Ethical Issues Arising from a Revolutionary Technology," *Nanoethics* 10, no. 2 (April 2016): 139–59. https://doi.org/10.1007/s11569-016-0259-0.

46 Memi et al., 494; Isaacson, pp. 246, 288.

therefore much more controversial.[47] While germline manipulation via CRISPR raises many concerns, there are three that warrant particular attention: therapy versus enhancement, safety concerns, and fairness concerns.

Therapy vs. Enhancement and Playing God

There is significant discussion in this field on distinguishing between *medical therapy/treatments* that are focused on fixing dangerous genetic abnormalities versus *enhancements* that are intended to improve human capacities or traits. Most ethicists argue that health treatments are more justifiable than enhancements,[48] but they also recognize that it can become very difficult to distinguish between the two.[49] Eliminating serious genetic illnesses may be an obvious medical treatment, but what about avoiding below-average height or IQ, or above-average weight? What about hair or eye color in a place where there is a social preference for one over the other?[50] The distinction can get very blurry, the slippery slope moves quickly, and the exact point at which we have gone too far is difficult to know. Furthermore, not everything fits neatly into these categories.

Some genetic editing is more of a "prevention,"[51] and some involves not just enhancements, but "super-enhancements," such as developing new capabilities that humans have never possessed before, like the ability to see infrared light, hear super-high frequencies, or prevent aging, and other superhuman capabilities.[52] Accordingly, the categories are helpful but insufficient, and other distinctions may be necessary as well.[53]

Precedent for addressing this issue by leading rabbinic thinkers of previous generations can be found in the case of Pre-Implantation Genetic Diagnosis (PGD) and cloning. Rabbinic scholars permitted PGD for the sake of medical therapy but not enhancement, which was seen as too close to "playing God" (*kavshei d'Rachmana*),[54] as will be discussed below. However, there are cases in which otherwise prohibited actions have been permitted for the sake of quality of life, such as removing corneas from a corpse in order to transplant them into a living person, even though it is not lifesaving per se.[55] Therefore, it is possible rabbinic authorities may similarly permit not only medical therapies, but also some forms of enhancement, if these are deemed essential for basic quality of life. Amongst rabbinic authorities, the red line seems to lie with creating new capabilities that have never before existed naturally in human beings ("super-enhancements").[56] Such changes are seen as going too far in "playing God."

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47 Ibid., pp. 245, 276, 336; Memi et al., 496.

48 There is also much stronger public support for medical therapy than there is for enhancements; see Jung Lee, "The Crispr Revolution in Genome Engineering: Perspectives from Religious Ethics," *Journal of Religious Ethics* 50, no. 3 (November 2022): 333–60. https://doi.org/10.1111/jore.12402.

49 Isaacson, p. 338.

50 Ibid., p. 361.

51 Some have argued that the easiest germline editing to justify may be in the case of autosomal recessive diseases where both parents are homozygous, or autosomal dominant diseases where at least one parent is homozygous. In such cases, PGD is not an option, and editing would be the only way to have a healthy child who is genetically one's own; see Baumann, p. 145.

52 Isaacson, p. 338.

53 For example, some distinguish between absolute improvements (beneficial to all of society, like resistance to a virus) and positional improvements (only benefits me if nobody else gets it, such as extra height) and argue that society should only favor enhancements that would benefit all of society over those that only give the recipient a positional advantage; see Isaacson, pp. 350–51, n. 10.

54 This is based on the Talmudic principle (*Berachos* 10a) of not interfering in the ways of Heaven (*ba'hadei kavshei d'Rachmana lamah lach*). See *Nishmas Avraham*, *Even Ha'ezer* 1. Secular ethicists also use PGD as a paradigm for approaching CRISPR; see Sullivan. On PGD analogy, see Isaacson, pp. 274, 337.

55 *Nishmas Avraham*, *Yoreh Deah* 349.

56 R. Avraham Steinberg, *Harefuah K'Halachah*, 1:221, in the name of R. Elyashiv regarding cloning. This is likely based on *Ramban* to *Vayikra* 19:19.

The issue of "playing God"—the concern that it is wrong for humans to attempt to have the power to completely control the world—has been an objection to these innovations in some bioethics articles opposing germline editing.[57] Although many in the scientific community do not identify with theological concerns, scientists cannot afford to ignore these issues. Since science relies on government funding, and this technology has the power to affect all of society, it requires widely held and well-informed public approval to legitimize it.[58] Furthermore, not only religious people express this kind of concern;[59] it is often articulated in secular terms[60] as a risky deviation from the natural reproductive process by taking control of the human species in ways that could impact future generations without fully understanding what those ramifications will be.[61] Abusing our power in this way is seen as irresponsible, since the evolutionary process is beyond human capacity to fully understand, making it likely that interference with our genes will result in negative outcomes.[62] Some also worry that manipulating the mysterious and delicately interwoven forces of nature could impact society by undermining crucial traits of empathy, humility,[63] striving for excellence,[64] and appreciation for diversity.[65]

There are religious thinkers who see "playing God" as categorically or intrinsically wrong regardless of any consequences,[66] but most recognize that engaging in technology and innovation can also be seen as

57 In a study of 160 articles opposing germline gene editing, 13 of them identified playing God as a primary concern; see Locke, p. 28. See Isaacson, citations on p. 269, n. 5.

58 Locke, p. 28.

59 Isaacson, p. 363.

60 Michael J. Sandel, *The Case Against Perfection: Ethics in the Age of Genetic Engineering* (Cambridge: Harvard University Press, 2004). This concern is articulated in many classical Jewish sources as the importance of "*derech ha'tevah*." See, for example, the *Sefer Hachinuch* on the prohibitions of interbreeding animals (Mitzvah 244) and plants (Mitzvah 245) and of mixing linen and wool garments (Mitzvah 551; he also makes this point in Mitzvah 62). See also *Ramban* (*Vayikra* 19:19); R. Kook, *Otzros Hare'iyah* 2:901. However, these concerns would not explicitly forbid gene editing, since a desire not to change nature is not the complete reason for them. For example, the prohibition of crossbreeding plants (other than trees) only applies in Israel and to foods fit for human consumption. It is referred to as a "*chok*," meaning a law with no clear reason (*Vayikra* 19:19), and the *Rambam* provides a totally different rationale for the prohibitions against mixing different species—to separate us from idolatry (*Moreh Nevuchim* 3:37).

61 Locke, 28–29.

62 Ibid., 29.

63 Sandel; Sandel's argument is that it is important to appreciate the world and that our powers are not of our own making, and thus, we should have an attitude of modesty, solidarity, restraint, and humility. He argues that excessive manipulation of our genome could undermine those values and the sense of appreciating life as a gift, since it fuels an excessive drive for mastery of nature and deprives parents of the humility and sympathies that openness to a less orchestrated life allows. His concern is therefore about the risks to those performing genetic manipulation even more than to those whose genes are being manipulated. Others have critiqued this approach by arguing that nature also includes horrible illnesses, and we don't simply accept that, but rather strive to make improvements; see Leon Kass, "Ageless Bodies, Happy Souls: Biotechnology and the Pursuit of Perfection" *New Atlantis* 1 (Spring 2003): 9–28.

64 The Jewish tradition recognizes the value in striving and hard work, not just the end results. See, for example, *Rashi* (*Vayikra* 26:3) that one should work hard at the study of Torah (though we do utilize many aids in acquiring knowledge, such as search engines or the printing press, which many consider to be good things).

65 Isaacson, pp. 281, 287, 364–365; Locke, p. 28. Sandel sees this as a form of "hyperagency" or overextending our role and failing to see the gifted character of human powers and achievements, which is thus not intrinsically bad, but something that could lead to negative outcomes with the human tendency to overreach with hubris that often knows no limits. See Cynthia S.W. Crysdale, "Playing God? Moral Agency in an Emergent World," *Journal of the Society of Christian Ethics* 23, no. 2 (Fall-Winter 2003): 243–59. Others fear that the technology itself will lead to increased hubris; see Sandel.

66 Locke, p. 29; see also Isaacson, p. 273 (see citations). For example, some argue that genetic manipulation itself violates the Divine image in the human species; see Peters.

a form of partnering with God in creation.[67] In Jewish thought, "playing God" can be a good thing[68] as long as the action itself isn't prohibited and doesn't lead to a prohibited act, and the benefits outweigh the risks.[69] We don't just accept imperfection in the world, but are required to intervene with nature in order to treat illness and make the world a better place.[70] Indeed, the Gemara states that after the first Shabbos, God granted Adam "creative knowledge similar to Divine knowledge," which he used to create the first fire and then to mate a female horse and a male donkey to create a mule.[71] These actions reflect the notion that God granted humanity creative capabilities within nature and the knowledge to be able to harness those powers for the good.[72] As long as we don't take it too far (such as "super-enhancements"), using our creative capabilities can be a blessing.

It thus is not "playing God" that is objectionable, but rather the "playing around" with these God-like powers that is problematic. Talk of God in relation to these incredible scientific advancements should evoke reflections on wisdom, love, and altruism.[73] When using the phrase "playing God" regarding these incredible powers, the emphasis should be put on the word *playing*. Being God-like, within reason and in a responsible manner, is good. "Playing" is not.

Safety Concerns

As with any new technology, such as those detailed above regarding AI, and certainly with one as powerful and influential as germline gene editing, there are significant risks of very profound unintended "off-target" consequences and side effects, some of which may not be perceived for decades.[74] When

67 See Locke, p. 30. However, *Shach* (*Yoreh Deah* 179:18), cautions that tampering with creation should only be done when it is to sanctify the name of God or perform a great mitzvah, but he worries that there are no longer people today who are pure enough to engage in such matters properly. See also n. 90 below.

68 The Midrash relates that R. Akiva defended the Jewish mandate to heal the sick by comparing it to interfering with God's vineyard, explaining that "just as the tree, if not weeded, fertilized, and plowed, will not grow and bring forth its fruits…so it is with the human body. The fertilizer is the medicine and the healing the means, and the tiller of the earth is the physician," (*Otzar Midrashim* 2:580). R. Akiva also defended the Jewish mandate to support the poor, despite the claim that this contravenes the Divine decree that the pauper be poor, by stating that we are all God's children about whom God cares (*Bava Basra* 10a). See also *Tanchuma* (*Tazria* 5), where R. Akiva defends the practice of circumcision against a Roman general's challenges by arguing that God put humans in the world to complete Creation; just as God created wheat, our job is to make it into bread. Similarly, R. Immanuel Jakobovits states, "In the Jewish tradition, ['playing God'] is expressly sanctioned in the Biblical words 'And he [an attacker] shall surely cause him [his victim] to be healed.' The Talmud states: 'From here we see that the physician is given permission to heal'"; see Daniel Baltimore, "Will Cloning Beget Disaster?" *The Wall Street Journal*, May 2, 1997, https://www.wsj.com/articles/SB862525241176637000. See also R. Judah Loew (*Maharal*) of Prague, *Be'er Hagolah*, pp. 38–39, and R. Eliyahu Dessler, *Michtav MeEliyahu*, 1:270–71, who emphasize that when developing technology, it is our responsibility not only to innovate, but also to make sure that there are safeguards against the technology being used improperly and that advances will be implemented productively. Similarly, the Midrash relates that Adam was told not only to master but also to protect the world (*Midrash Koheles* 7:28). See also R. J. David Bleich, "Cloning: Homologous Reproduction and Jewish Law," in R. J.D avid Bleich (ed.), *Bioethical Dilemmas II* (New York: Targum Press, 2006), pp. 7–15; R. Michael Broyde, "Pre-implantation Genetic Diagnosis, Stem Cells, and Jewish Law," *Tradition* 38, no. 1 (Spring 2004): 54–75.

69 Steinberg, 1:223–24.

70 The Rabbis state that the Torah's commandment to engage in healing (*Shemos* 21) is meant to imply that we should not rely on God to heal (*Toras Ha'adam*, *Inyan Hasakanah*), and we may attempt to heal even those illnesses that seem to come from Heaven (*Tosafos*, *Bava Kama* 85a).

71 *Pesachim* 54a.

72 Steinberg, 1:223.

73 Locke, p. 30.

74 Indeed, a study of 160 articles identified 79 reasons against germline gene editing, and most of them were safety issues related to off-target effects; see Locke, p. 27; Isaacson, p. 271. Even genes that have negative ramifications have a purpose, and we do not always know what they are or what the ramifications of removing them will be. For example, the gene mutation that causes sickle cell anemia also confers immunity for malaria; see Isaacson, p. 343.

it comes to gene editing, we are faced with the fact that despite the incredible advances that have been made in understanding the human genome, we still have a very limited understanding of the many and precise roles of each of our genes, both individually and in combination with other genes and other parts of the entire genome, and hence what may happen when an individual gene is edited out or changed.[75] Moreover, malicious individuals or states could take advantage of this technology, perverting it to intentionally harm others.[76] Rogue doctors or biohackers could use it in irresponsible ways that could cause permanent damage on a very large scale.[77] However, these concerns are not intrinsic to CRISPR, and could theoretically be addressed with very careful experimentation, ethical research, and very strict guidelines and oversight (in much the same way as has been done with other scientific advances).

Fairness Concerns

In addition to safety concerns, there is also a social justice argument that gene editing will increase inequality since these procedures may be so expensive that only the very wealthy will have the opportunity to benefit from them. This could exacerbate existing inequalities and permanently genetically encode them into humanity,[78] creating a subclass of enhanced elites and completely undermining contemporary values of equal opportunity for all people.[79] This technology could also lead to social pressure to edit one's children simply because many others are doing so,[80] raising fears of creating "designer babies," "dehumanizing our species,"[81] and a slippery slope leading to eugenics (the selected breeding of the human race, which has included racial hygienics).[82]

On the other hand, new technologies tend to start out expensive and difficult to obtain but gradually become much more accessible to all.[83] Furthermore, in our consumer-driven society, if this technology is overly restricted, scientists will simply move elsewhere, such that only the very wealthy and connected will be able to take advantage of it, exacerbating inequalities even more.[84] Indeed, many feel that it

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75 Classical Jewish sources have also expressed recognition of multiple interconnected aspects of our identities. For example, the *Chovos Halevavos* (*Shaar Habechinah* 5:27) points out that although we may think it would be ideal to have a perfect memory, there are benefits of forgetfulness at certain times. For example, unending sorrow would result from constantly remembering everything we have experienced. Similarly, the Gra on *Seder Olam* points out that when the Rabbis excised the desire to worship idols from the soul, this also had the side effect of removing the ability to prophesy. See also *Yoma* 69b. Similarly, emotions are not simply "positive" or "negative," and humans are very neurologically complex: selective serotonin reuptake inhibitors are used to treat depression, but they can also cause aggression. Anger is also a target for bioenhancement, but anger can sometimes be appropriate and a key to resisting injustice. Drugs such as oxytocin may enhance bonding between couples but can also reinforce and entrench unjust or abusive situations; see Sara Goering, "Resisting Transhumanist Fantasies," *The Hastings Center Report* 51, no. 1 (January-February 2022): 61–63. https://doi.org/10.1002/hast.1341.

76 Inmar Persson and Julian Savulescu, *Unfit for the Future: The Need for Moral Enhancement* (Oxford: Oxford University Press, 2012). See also Isaacson, pp. 260, 283.

77 Ibid., p. 288.

78 Isaacson, p. 274.

79 Ibid., pp. 360, 362–63.

80 Ibid., p. 331.

81 Ibid., pp. 276, 280.

82 Memi et al., p. 496. Some claim that the problematic form of eugenics is when the burden falls disproportionately on the weak and the poor, but if the benefits and burdens of genetic improvement are fairly distributed, it is not inherently objectionable and may even be morally required; see Sandel.

83 Isaacson, p. 288. However, this might not be true in the case of gene editing. Since there are no generic drugs in this sector, and since not everyone will have knowledge of gene editing possibilities if it does not achieve broader public acceptance, prices will not necessarily decrease; see Baumann, p. 146.

84 Isaacson, p. 363.

is an ethical and irresponsible "sexual roulette" to not improve our children's health and well-being by preventing their suffering and editing their genes when we have the ability to do so."[85]

Furthermore, the argument goes, society allows investing in other sorts of advantages for our children—such as private tutors or coaches—because we have a moral responsibility to look after future generations, so why is it problematic to give them beneficial genes others have inherited naturally?[86] There have been some public policy suggestions to attempt to combat the inequality concerns,[87] and more protections to mitigate this risk are likely needed.

III. THE PRECAUTIONARY PRINCIPLE

How might rabbinic authorities respond to these developing concerns? Although CRISPR and AI are extraordinary advancements, many forms of risky and controversial cutting-edge research have taken place for many years, such as dangerous experiments to develop a smallpox vaccine using the cowpox virus or studies of pathogens that can kill or sicken masses of people, and we have learned that such research can result in enormous benefits for humanity. We have similarly learned that such endeavors can also have terrible consequences.[88] Pharmaceutical companies constantly debate with patient advocates and regulatory agencies over the "right to try" by accelerating approvals of new drugs in the hope of helping individuals suffering from imminently life-threatening conditions (even when there is very low likelihood of success), versus the cautious goals of first ensuring robust data collection, safety, and efficacy in order to help the most people possible over the long term.[89]

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85 Joseph Fletcher, *The Ethics of Genetic Control: Ending Reproductive Roulette* (New York: Doubleday, 1974), p. 158; Isaacson, pp. 268, 278, 367–368. This is especially true when undertaken for a disease where there is no other hope of a cure; Inigo de Miguel Beriain, "Should Human Germline Editing Be Allowed? Some Questions on the Basis of the Existing Regulatory Framework," *Bioethics* 33, no. 1 (January 2019): 105–111. https://doi.org/10.1111/bioe.12492.

86 Steve Connor, "Nobel Scientists Happy to 'Play God' with DNA," *The Independent*, May 17, 2000, https://www.independent.co.uk/news/science/nobel-scientist-happy-to-play-god-with-dna-277364.html; Julian Savulescu, "Procreative Beneficence: Why We Should Select the Best Children," *Bioethics* 15, no. 5–6 (October 2001): 413–26. https://doi.org/10.1111/1467-8519.00251; Isaacson, pp. 277, 360.

87 Ibid., p. 392. For example, if patents for genetic engineering techniques were forbidden, there would still be plenty of funding to cure diseases but less payoff for racing to be the first to devise methods for enhancements. Those that are invented might be cheaper and more widely available, since anyone could copy them, and this could act as a reasonable slowdown in the science in return for making it more equitable.

88 Amy Gutmann, *New Directions: The Ethics of Synthetic Biology and Emerging Technologies*, (Presidential Commission for the Study of Bioethical Issues, 2011), p. 125, https://bioethicsarchive.georgetown.edu/pcsbi/synthetic-biology-report.html.

89 Franklin G. Miller and Steven Joffe, "Balancing Access and Evaluation in the Approval of New Cancer Drugs," *JAMA* 305, no. 22 (June 2011): 2345–46. https://doi.org/10.1001/jama.2011.784. Taking time to carefully approve drugs can help more people in the long run, because accelerated approval may expose patients for long periods of time to drugs that may not be safe and effective, risking disease progression and additional harm, wasting time and money, distracting from trials of products that may be better, and diverting from the pursuit of alternatives; see Holly Fernandez Lynch and Alison Bateman-House, "Facilitating Both Evidence and Access: Improving FDA's Accelerated Approval and Expanded Access Pathways," *The Journal of Law, Medicine, and Ethics* 48, no. 2 (June 2020): 365–81, https://doi.org/10.1177/1073110520935352. Furthermore, there is concern that accelerating approval could delay the generation of data needed to make evidence-based decisions about approval and use of new drugs, and this diversion of resources toward expanded access could have serious implications for the much larger number of patients who would benefit from slower approval of drugs. It may also prevent innovation that might produce effective treatment, since other researchers might not invest resources in treatments once another drug has already been approved; see Steven Joffe and Holly Fernandez Lynch, "Federal Right-to-Try Legislation—Threatening the FDA's Public Health Mission," *The New England Journal Medicine* 378, no. 8 (February 2018): 695–97. https://doi.org/10.1056/NEJMp1714054; Sarah S.P. DiMagno, Aaron Glickman, and Ezekiel J. Emanuel, "Accelerated Approval of Cancer Drugs—Righting the Ship of the US Food and Drug Administration," *JAMA Internal Medicine* 179, no. 7 (July 2019): 922–23. https://doi.org/10.1001/jamainternmed.2019.0584.

As science increasingly gains the ability to change the world and our genome, the stakes intensify. There is often a culture within the world of science that focuses on provocative research, national scientific competitiveness, achieving celebrity, and being first to discover something.[90] However, the risks become very difficult to calculate, and knowing how far to go with newfound capabilities and how to best serve the good of humanity become challenging and polarizing questions. "Bioliberals" approach technological advancement enthusiastically,[91] with the belief that we must have the freedom to encourage and speed up the process as rapidly as possible to aid innovation, develop the economy, and improve health and well-being.[92] "Bioconservatives"[93] worry about the potential negative consequences and risks of new developments and sometimes find new activities to be morally or "intrinsically" objectionable.[94]

Somewhere between these extremes is an approach favored by most bioethicists, known as "the precautionary principle."[95] Initially articulated at a 1992 United Nations Conference on Environment and Development regarding genetically modified agriculture and food, this is the view that when new therapies and technologies can cause unknown harm to the world or potentially negative consequences for generations to come, the burden of proof regarding their safety must be thoroughly demonstrated by those advocating for the new therapy or policy *before* moving forward with it.[96]

This is especially so in the case of CRISPR, since science has demonstrated that the human genome is more complex than previously thought, and our capabilities may thus proceed faster than our knowledge about the precise outcomes of applying this new technology.[97] Similarly, many worry that if not advanced wisely, AI can become more intelligent and skilled than humans. Therefore, if not aligned with human goals and values, it could

90 Isaacson, p. 306. Interestingly, the *Ben Ish Chai* argues that the ability to make permanent changes in the world is a Divine trait, which must be exercised with much caution and wisdom, because when humans create things just to show off their power, they will ultimately fail (*Ben Yehoyadah*, *Sanhedrin* 65b). See also n. 67 above.

91 This approach is sometimes referred to as the "proactionary principle"; see Max More, "The Proactionary Principle: Optimizing Technological Outcomes," in Max More and Natasha Vita-More (eds.), *The Transhumanist Reader: Classical and Contemporary Essays on the Science, Technology, and Philosophy of the Human Future* (New York: Wiley & Sons, 2013), pp. 258–67; Erik Parens, Josephine Johnston, and Jacob Moses, *Ethical Issues in Synthetic Biology: An Overview of the Debates* (Washington, DC: Woodrow Wilson International Center for Scholars, 2009); this approach is also sometimes referred to as the "innovation principle"; see Adam Thierer, *Permissionless Innovation: The Continuing Case for Comprehensive Technological Freedom* (Arlington: Mercatus Center at George Mason University, 2014). The innovation principle holds that because most technological innovations benefit society and pose modest and not irreversible risks, a government's role should be to pave the way for widespread innovation while building guardrails and penalties for bad actors where necessary; see Castro, McLaughlin.

92 Some argue that excess caution about potential risks, such as bans on importing or cultivating genetically modified organisms (GMOs) despite their safety, can reduce benefits and create new problems, such as higher food prices, increased greenhouse gas emissions, and potential loss of thousands of lives due to malnourishment; see Castro, McLaughlin.

93 Isaacson, pp. 268, 280, 287. "Bioliberalism" is sometimes called "biotech utopianism," and "bioconservatism" is sometimes called "technoskepticism."

94 Gutmann, p. 135; Gregory E. Kaebnick, "Should Moral Objections to Synthetic Biology Affect Public Policy?" *Nature Biotechnology* 27, no. 12 (December 2009): 1106–08. https://doi.org/10.1038/nbt1209-1106.

95 Marko Ahteensuu and Per Sandin, "The Precautionary Principle," in Sabine Roeser, Rafaela Hillerbrand, Per Sandin, Martin Peterson (eds.), *Handbook of Risk Theory: Epistemology, Decision Theory, Ethics, and Social Implications of Risk* (Dordrecht: Springer, 2012), pp. 961–78; Steve Clarke, "Future Technologies, Dystopic Futures, and the Precautionary Principle," *Ethics and Information Technology* 7, no. 3 (September 2005): 121–26. https://doi.org/10.1007/s10676-006-0007-1; Peters, p. 2.

96 Gutmann, p. 123.

97 Baumann, p. 154.

become motivated to do negative things, such as taking control of the future from humanity for its own interests, resulting in an existential threat to humanity.[98]

Some have articulated the precautionary principle as, "Rather than march forward and risk falling off a cliff, the burden of proof requires that we locate all the cliffs before marching."[99] This approach, based on the value of "non-maleficence," seeks to limit harm while at the same time recognizing that research should move forward—but only when we are ready and can proceed with caution. The precautionary principle is thus temporary, with the goal of eventually creating permanent benefit ("beneficence") for humanity.[100] This perspective seeks a "prudent path forward"[101] that does not require us to say "no" to all new innovations, even as it does not always encourage saying "yes" right away either. It is trying to find the proper balance between the two, a yellow light[102] that can say, "Yes, but not yet."[103]

This seems to be the approach to medical innovation that many rabbinic thinkers take as well.[104] For example, the first generation of rabbinic leaders to address the issue of living organ donation did not give it enthusiastic support, but expressed much caution for many years, gradually becoming more supportive as the procedure became safer and more beneficial, eventually praising and even encouraging it.[105] A similar evolution occurred regarding rabbinic

98 Toby Ord, *The Precipice: Existential Risk and the Future of Humanity* (London: Hachette Books, 2020), pp. 29, 143–48. Ord thus suggests that of all the existential threats to humanity, unaligned Artificial Intelligence is the greatest risk to humanity's potential in the next hundred years (ibid., p. 168). WHO, p. 25, thus recommends that humans must remain in full control of AI systems. This fear is especially acute in the military context, where robot soldiers could make war much more common and deadly.

99 Ted Peters, "CRISPR, the Precautionary Principle, and Bioethics," *Theology and Science* 13, no. 3 (July 2015): 267–70. https://doi.org/10.1080/14746700.2015.1056583. There are many forms of this principle, such as "negative" and "positive," as well as different theories about how strong a burden of proof of safety is required. See in-depth philosophical analysis of this principle in Julian J. Koplin, Christopher Gyngell, and Julian Savulescu, "Germline Gene Editing and the Precautionary Principle," *Bioethics* 34, no. 1 (January 2020): 49–59. https://doi.org/10.1111/bioe.12609.

100 Ibid.

101 Isaacson, pp. 287, 289, based on David Baltimore et al., "A Prudent Path Forward for Genomic Engineering and Germline Gene Modification," *Science* 348, no. 6230 (April 2015): 36–38. https://doi.org/10.1126/science.aab1028.

102 Francoise Baylis, *Altered Inheritance: CRISPR and the Ethics of Human Genome Editing* (Cambridge, Mass.: Harvard University Press, 2019); Jocelyn Kaiser, "U.S. Panel Gives Yellow Light to Human Embryo Editing," *Science*, Feb. 14, 2017, https://www.science.org/content/article/us-panel-gives-yellow-light-human-embryo-editing; Kelsey Montgomery, "3Q: Behind the Scenes of the National Academy of Sciences' Report on Human Genome Editing," Massachusetts Institute of Technology, Feb. 27, 2017, https://news.mit.edu/2017/3-questions-richard-hynes-nas-human-genome-editing-report-0224; Peters, p. 2. Regarding exactly how far and fast to go, the "yellow light" metaphor has been interpreted very differently by various parties; see Isaacson, p. 303, plus notes, pp. 293, 342, 370.

103 Peters, "CRISPR"; Peters, "Should CRISPR Scientists Play God?" p. 6.

104 Steinberg, 1:215–16.

105 In the 1960s, rabbinic authorities noted the dangers of kidney donation and thus only cautiously allowed it and in fact discouraged it (*Minchas Yitzchak* 6:103; *Igros Moshe*, *Yoreh Deah* 2:174[4]; *Tzitz Eliezer* 9:45), whereas by 1981, it was referred to as a mitzvah (*Yechaveh Daas* 3:84) and in more recent years has been strongly praised and encouraged by many leading rabbinic authorities (*Teshuvos Minchas Asher* 3:123[2017]; *Shiurei Torah L'Rofim* 6:416, p. 387 [2020]). In a similar example concerning dead donors, when heart transplants first became possible R. Moshe Feinstein ruled that it would be forbidden for both the donor and the recipient, as it constitutes murder (*Igros Moshe*, *Yoreh Deah* 2:74[1]). However, by the end of his life, some claimed R. Feinstein permitted such transplants given the advances in their safety (*Igros Moshe*, *Yoreh Deah* 4:54). However, he may still have maintained that heart transplantation entails murdering the donor; see *Nishmas Avraham*, *Yoreh Deah* 339 (2) (551 in 3rd ed.). Furthermore, the validity of this responsum has been hotly contested. See David Shabtai, *Defining the Moment: Understanding Brain Death in Halakhah* (Tel Aviv: Shoresh Press, 2012), pp. 249–56. So too, when artificial hearts were new and experimental, rabbinic authorities forbade receiving them but noted that if they became safer and more routine, they would become permissible (*Nishmas Avraham*, *Yoreh Deah* p. 86, with agreement of R S.Z. Auerbach).

attitudes toward IVF. When it was new, many rabbinic authorities forbade it, whereas today, most permit and even encourage it.[106] Some rabbinic thinkers explain that their rulings changed in these areas *specifically because* it is important for authorities in Jewish law to start by cautiously monitoring how new technology works and what it leads to, making sure that it is proven to be safe and beneficial before permitting and adopting it.[107] As our technical capabilities rapidly increase, it may be crucial to slow down progress in order to give us time and space for our wisdom to catch up.

In a conversation on this topic with R. Asher Weiss, he argued that many of these rabbinic authorities displayed excessive caution. He suggested that when the goal is saving life, we should seek to encourage new technologies to progress as quickly as possible, but nevertheless with many of the precautions mentioned above. He compared this to driving an ambulance to save a life. The ambulance should be driven as speedily as possible to reach the patient in need. However, it would be irresponsible to drive recklessly, since that would in fact jeopardize the ambulance's likelihood of saving the life.[108]

CONCLUSION

To ensure that we take a prudent path forward, it is important that appropriate clinical evaluation is undertaken—especially by establishing guidelines for safety and efficacy. Ethical issues need to be resolved as effectively as possible, and a social consensus must be formed regarding whether this is an acceptable way for medical technologies to evolve.[109] These consequential issues must be settled by society as a whole, not by individuals or the scientific community alone.[110] Public debate and scrutiny is essential, as it can help educate broader society and improve public confidence.[111] It is thus especially crucial to include religious communities in the conversation, because they can help develop broader buy-in and facilitate reflections related to meaning, values, and diverse perspectives.[112]

From a Jewish perspective, many of these innovations can be embraced for reasons detailed above. But maintaining humility and recognition of our limitations becomes increasing crucial as our capabilities increase. Traditional Jewish sources thus caution us to take the risks very seriously by recognizing that even if we are allowed to "play God," we should not "play" with God-like powers.

Oxford philosopher and ethicist Toby Ord makes a very profound and startling point about the place society now finds itself in his book, *The Precipice*.[113] He suggests that considering human civilization is only about 5,000 years old—but has the potential

106 A very stark example can be detected within the writings of one prominent rabbinic authority, R. Moshe Shternbuch. In 1991, he wrote that IVF was totally prohibited because of wasting seed and the breakdown of the holiness and purity of lineage (*Teshuvos V'hanhagos* 2:689, 3:406–07). In 1997, he slightly reduced his opposition but still avoided permitting it (3:406–07); in 2002, he softened his prohibition further (4:285), and then more so in 2009 (5:317). By 2014, he wrote that he had changed his mind, and IVF is not only not forbidden, but *obligatory*, since it had proven to be very safe and effective in helping people have children, and he thus ruled that it fulfilled the commandment to procreate (6:241). A similar evolution occurred regarding IVF in general society as well, in which it was initially denied state funding until privately funded medical successes led to rapid acceptance by regulatory bodies, clinicians, and patients; see Martin Johnson et al., "Why Medical Research Council Refused Robert Edwards and Patrick Steptoe Support for Research on Human Conception in 1971," *Human Reproduction* 25, no. 9 (September 2010): 2157–74. https://doi.org/10.1093/humrep/deq155.

107 R. Zvi Ryzman points out this gradual change in R. Shternbuch's view and then received this explanation from R. Mendel Shafran, (*Ratz Katzvi*, *Even Ha'ezer* 17–22).

108 Personal conversation, Jerusalem, March 2023.

109 Isaacson, p. 322.

110 Ibid., pp. 331, 357–58.

111 Locke, p. 30.

112 Lee, 3–5.

113 Ord, pp. 206–07.

to continue for millennia longer—in the life cycle of humanity, we may now just barely be in what is comparable to an adolescent phase. This is the age at which a child begins to rapidly develop physical abilities and appetite for risk but does not yet have adequate self-control, wisdom, or insight about their long-term future. When it comes to our own children, we can design socially recognized limitations on what children can and cannot access to protect them from their own still-undeveloped capacities of discernment.

Perhaps, Ord argues, humanity should also have such safeguards. The problem is that unlike with children, there are no wise adults to decide these rules for us. Instead, God has empowered us to use the Torah to figure out how to govern and control ourselves without yet possessing the wisdom to adequately do so. Put slightly differently, our unprecedented power requires us to take unprecedented responsibility. Part of the expectation of the Jewish People to be "a light unto the nations" includes sharing Jewish wisdom on consequential matters with all of humanity.[114]

Even if gene editing techniques can eventually enhance our human *intelligence*, or AI gives humanity easy access to much more data, these alone do not lead to *wisdom*, which requires much deeper understanding of consequences and intricacies of the human condition. Wisdom is often found in the ability to recognize that just because we can do something does not mean that we should. Precedent can be found for this attitude in the actions of King Chizkiyahu, who was praised by Chazal for hiding the Book of Remedies (*Sefer Refuos*), even though it could be used to cure people, since it was leading to a lack of humility and reliance on God.[115]

The challenges may prove to be much more complex than we could ever imagine. For instance, concerns related to "off-target" impacts of manipulating our genome were addressed above, but there are also potential *moral* off-target effects that some thinkers warn us about. If the human body is "perfected" to the point at which it does not age and slow down, what incentives would there be for the old to make way for the young? If the young are not given a chance to lead, might this lead to a prolongation in the young of functional immaturity? Enhancing the vitality of the old may thus slow or prevent the maturation of the young. If the young have no incentive to lead, and the old have no desire to pass the baton to a new generation, what will happen to human progress and social advancement? If people knew they could live very long lifespans, might there be less motivation to accomplish and innovate in the first place?[116] In this way, concerns about the speedy advance of

114 R. Aryeh Kaplan writes that "being chosen is more of a responsibility than a privilege. Israel has the incessant mission of proclaiming God's teaching to the world. It is thus written, 'I, God, have called you in righteousness…and have set you up as a covenant of the people, for a light to the nations' (*Isaiah* 42:6). This does not mean that Torah should be taught to gentiles, but that they should be informed of the universal commandments," see R. Aryeh Kaplan, *Handbook of Jewish Thought*, vol. 1 (Brooklyn: Moznaim, 1990), p. 55. Similarly, R. Jonathan Sacks writes that Judaism "contains a message for all humanity, and much in the 21st century will depend on whether this message or a different one prevails. Judaism belongs to the human conversation, and we must take the trouble to share our ideas with others," see R. Jonathan Sacks, *Future Tense: A Vision for Jews and Judaism in the Global Culture* (London: Hodder & Stoughton, 2009), pp. 7, 129–30; see also R. Jonathan Sacks, *To Heal a Fractured World: The Ethics of Responsibility* (New York: Schocken, 2007), ch. 9. Yakov Nagen, "Sharing Torah with the World: The Jewish Responsibility to Non-Jews," *Tradition* 54, no. 3 (Summer 2022): 29–50, demonstrates that Judaism requires Jews to share Jewish wisdom with the world and argues that the Talmudic prohibition against teaching Torah to non-Jews was only intended for certain contexts that mostly do not apply today.

115 *Pesachim* 56a; *Rashi*, *Pesachim* 56a and *Berachos* 10b.

116 Kass. This concept may find Jewish precedent in a fascinating interpretation of the verse, "One generation goes and another comes; the earth remains forever," (*Koheles* 1:4). The *Michlol Yofi* commentary, cited in *Otzar Hamidrashim* (*Koheles*), suggests that this verse means righteous people recognize that righteous people will be needed after they leave the world as well. For the earth to "remain forever," the next generation of righteous people must be developed before the previous one leaves this world. See also R. Jonathan Sacks, *Judaism's Life-Changing Ideas* (Jerusalem: Maggid Books, 2020), p. 307; Lee, p. 20: it is our imperfections and impermanence that make us human.

CRISPR may be seen not only as a bioconservative perspective, but may also be ultimately understood as concern about encouraging human fulfillment, flourishing, and progress.

As AI is increasingly utilized in medical decision-making, it may eventually recommend CRISPR in various scenarios. However, since Jewish law may accept utilizing gene editing technologies for some medical therapies but not for enhancements (as discussed above), deep learning models may not be able to discern the moral difference between gene editing for health optimization and gene editing for human enhancement more generally, thus further blurring ethical lines.[117] Similarly, questions such as what it means to be human[118] create a central role for religious, philosophical, and ethical thinkers. AI tools and genetic enhancements may prove helpful if harnessed properly, a task that will take much wisdom, and no doubt some Divine blessing, to accomplish.

SUMMARY OF CONCERNS AND JEWISH APPROACHES

Concern 1

Overreliance on AI could diminish the role of interpersonal and communication skills, emotional intelligence, compassion, trust, and empathy. This leads to concerns related to social isolation and the dehumanization or *im*personalization of care, contrary to what is known to be essential for well-being and against the Jewish value of care for the whole person.

Solutions

- Advocate for hospitals to help their providers spend more supportive, quality time with their patients so that physicians are freed from some routine responsibilities of medical practice, in order to get to know their patients better and provide appropriate recommendations for each unique situation.
- Encourage medical schools to train their students to interact with and manage AI systems effectively, understand the ethical complexities, and, especially, focus on improved communication and empathy skills.
- Train and encourage our community volunteers, *bikkur cholim* groups, chaplains, and rabbis to redouble efforts to provide supplemental holistic, supportive, whole-person care for those who are hospitalized.

Concern 2

Although there is a tendency to trust computerized decision-support systems, AI algorithms and reasoning are not always intelligible or clearly shared ("black box") or are too complex for most individuals to understand and explain. However, not all medical decisions are based purely on scientific criteria, but often involve values that may be subject to religious values. This is especially concerning for anyone whose medical decision-making is based on their own value system, since the values programmed into AI algorithms may not reflect their own.

Solutions

- Advocate for transparency and "explainability," meaning the ability to understand how a system is working and why it comes to its conclusions. Although some forms of complex AI are very difficult to explain, we should either advocate for the use of simpler models when necessary (especially when we believe that an AI-generated recommendation can match our values) or that the more complex models be designed to be more intelligible so they can be understood, at least by some experts.
- Train individuals who thoroughly understand both the AI technology and Jewish law who can explain to *rabbanim* which factors and values went into an AI-generated decision

117 Murphy et al.; see also Walter Johnson and Eleonore Pauwels, *How to Optimize Human Biology: Where Genome Editing and Artificial Intelligence Collide* (Brief, Wilson Center, 2017), p. 27.

118 John D. Loike and Avram Steinberg, "Human Cloning and Halakhic Perspectives," *Tradition* 32, no. 3 (Spring 1998): 40; Bleich, p. 1; Azriel Rosenfeld, "Religion and the Robot," *Tradition* 8, no. 3 (Fall 1966): 17–26; Lee, p. 18.

or provide alternate approaches for patients by using AI that is programmed differently. These individuals can help rabbis and patients understand when programs are based on values and what those values are, and help determine if we agree with a particular recommendation or not, or help to advocate for appropriate safeguards, checking the work of the AI and validating that we can agree with its value-based recommendations, instead of blindly trusting the computer systems. They can also help to educate our community to ensure that halachah is followed properly.

Concern 3

Manipulating our genes is taking control of the human species in ways that could impact future generations without fully understanding what those ramifications might be, and is a problematic form of "playing God."

Solutions

- Precedent for addressing this issue by leading rabbinic thinkers of previous generations can be found in the case of PGD, in which they distinguished between *medical therapy/treatments* that are focused on fixing dangerous genetic abnormalities (which they permitted) and *enhancements* that are intended to improve human capacities or traits (which they forbade because of "playing God"—*ba'hadei kavshei d'Rachmana*).
- Some forms of enhancement that are essential for basic quality of life may be justifiable.
- The red line amongst rabbinic authorities is creating new capabilities that have never existed naturally in human beings ("super-enhancements").
- "Playing God" is thus good when it involves responsibly and carefully partnering with God to promote health and wellness, as long as the action itself is not prohibited and doesn't lead to a prohibited act, and the benefits outweigh the risks.

Concern 4

There are significant risks of very profound unintended "off-target" consequences and side effects, some of which may not be perceived for decades.

Solutions

- Careful experimentation, ethical research, and very strict guidelines and oversight.
- Precedent from the rabbinic response to organ donation and IVF demonstrates that a Jewish approach to innovation supports the "precautionary principle," in which new technologies or innovations are cautiously monitored to carefully determine their safety and efficacy before permitting and adopting them. This approach advocates for slowing down progress to give us time and space for our wisdom to catch up.