# Ethics of Emerging Technologies in the Life Sciences: Bibliography, Emerging Biotechnologies


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**Year**

2017


**Description**


A bibliography that includes books, journal articles and web sites looking at the ethics of emerging biotechnologies, and including sections on synthetic biology, CRISPR-Cas9 and other genomic editing technologies, and genetic screening and genetic modification in embryos.


**Body**

## General

## Books

**Sandler, Ronald L., ed. 2014. *Ethics and Emerging Technologies*. New York: Palgrave Macmillan.**

*A collection of articles on the ethical dimensions of emerging technologies covering several topics and themes, including: general reflections on ethics and technology, reproductive technologies, biomedical and therapeutic technologies, human enhancement technologies, information technologies, robotics and artificial intelligence, environment and technology, agricultural technologies, and synthetic genomes and artificial life. The editor of the collection, Sandler, also provides an in-depth introduction on the ethics of emerging technologies, and presents a framework for the ethical analysis of emerging technologies. His framework includes an analysis of the potential benefits of the new technology, along with an analysis of extrinsic and intrinsic concerns that the technology may raise. Next, it includes a "power analysis" meant to identify those who benefit most from the emerging technology and those who may be left worst off, and a "form of life analysis" designed to consider how emerging technology might restructure the current social, ecological, economic, and political conditions. Lastly, his framework includes a consideration of alternative approaches to attaining certain ends, without the emerging technology.*

# Journal Articles

**Brey, Philip A. E. 2012. "Anticipatory Ethics for Emerging Technologies." *NanoEthics* 6 (1): 1-13.**

*The author presents a new approach to study the ethics of emerging technologies, called "anticipatory technology ethics," or ATE. The author argues for an ethical analysis of emerging technologies that emphasizes the research and development stage of new technologies; more specifically, an analysis of possible future technological devices, their applications, and their social consequences. The major challenge for this analysis is the problem of uncertainty. The author then compares his new approach to other approaches to ethical analyses of emerging technologies, including ethical technology assessment, the techno-ethical scenarios approach, and the ETICA approach.*

# Synthetic Biology

# Websites

**Presidential Commission for the Study of Bioethical Issues. 2010. "New Directions: The Ethics of Synthetic Biology and Emerging Technologies."**
*The Presidential Commission for the Study of Bioethical Issues released a report in 2010 that provides a wide-ranging review of the emerging field of synthetic biology that issues 18 recommendations including a call for coordinated federal oversight of scientists working in both large institutions and smaller settings.*

**The Hastings Center. 2009. "Ethical Issue in Synthetic Biology."**
*Describes a project that looks at the rapid advancement in the area of synthetic biology and discusses the ethical questions raised. The site includes a number of presentations given by members of the project, as well as links to publications from this project.*

***Science. 2011. "Synthetic Biology: Special Issue." doi:* 10.1126/science.333.6047.1235**
*This special issue looks at how the field of synthetic biology is contributing to our understanding of biology and how we can harness this understanding to benefit humanity, from improving biofuels to treating diseases.*

# Books

**Bedau, Mark A. and Emily C., eds. 2009. *The Ethics of Protocells: Moral and Social Implications of Creating Life in the Laboratory*. Cambridge: MIT Press.**
*This book is a collection of articles that examine the moral and social implications of creating proto-cells, self-assembling and self-replicating chemical systems, or artifacts that can perform a limited set of functions. The articles' topics range from assessing and managing risk in the face of uncertainty, new considerations of the precautionary principle, and lessons from recent historical cases of emerging technologies and knowledge-sharing arrangements to considerations of future benefits of artificial cells.*

**Carlson, Robert H. 2010. *Biology is Technology: The Promise, Peril, and New Business of Engineering Life*. Cambridge: Harvard University Press.**
*Carlson provides a detailed overview of the latest emerging biotechnologies in the field of synthetic biology. He also provides examples of social, legal, economic, and*

*ethical issues about these emerging technologies. He further proposes that how we interpret the meaning of these new technologies, and how we establish their use, will affect the development of future innovations in the field.*

# Journal Articles

**Anderson, James, Natalja Strelkowa, Guy-Bart Stan, Thomas Douglas, Julian Savulescu, Mauricio Barahona, and Antonis Papachristodoulou. 2012. "Engineering and Ethical Perspectives in Synthetic Biology." *EMBO reports* 13 (7): 584-590.**
*The authors provide an overview of the engineering and ethical challenges of synthetic biology. The authors mention several ethical concerns about synthetic biology, such as the idea of humans creating life and "playing God," the limitations of reductionist approaches that might blur the line between life and machine, and the moral status of synthetic organisms. However, the authors argue that the most pressing ethical issue about these emerging technologies should be the risks of releasing synthetic organisms into the environment. Because predictability and control of these systems is never completely guaranteed, the most pressing problem is to determine what level of uncertainty and what kinds of risks are acceptable. The authors then discuss the merits and potential shortcomings of applying the precautionary principle to making policy decisions regarding synthetic biology research and application. Lastly, the authors consider who should be involved in the deliberations about appropriate regulation of synthetic biology.*

**Bedau, Mark A., Emily C. Parke, Uwe Tangen, and Brigitte Hantsche-Tangen. 2009. "Social and Ethical Checkpoints for Bottom-Up Synthetic Biology, or Protocells." *Systems and Synthetic Biology* 3 (1-4): 65-75.**
*The authors discuss the ethical, social, and regulatory issues specific to research and development of protocells. They first address the difference between "top-down" synthetic biology and "bottom-up" synthetic biology, with a focus on the construction of protocells. They describe six checkpoints in this process: (1) systematic and advancing research in protocells synthesis, (2) the technical feasibility of protocells, (3) creating the first fully autonomous protocells in the laboratory, (4) protocells that could survive outside the laboratory, (5) actually releasing protocells outside the laboratory, and (6) protocells that are toxic or infectious. Finally, the authors provide ten recommendations for ethically*

*responsible scientific research on protocells that relate to the six checkpoints.*

**Carlson, Rob. 2011. "Staying Sober about Science." *Hastings Center Report* 41 (4): 22-25.**
*Carlson addresses the problem of communicating the risk-benefit ethical analyses of emerging technologies to a broader public, especially in light of the sensational media coverage about synthetic biology and genetic engineering. The author also makes a case for the kind of prudent vigilance espoused in the Presidential Commission for the Study of Bioethical Issues.*

**Cho, Mildred K., and David A. Relman. 2010. "Synthetic ‘‘Life,’’ Ethics, National Security, and Public Discourse." *Science* 329 (5987): 38-39.**
*The authors argue that the most pressing challenge concerning the ethical issues in synthetic biology is to develop effective oversight mechanisms. The authors call for an expanded notion of risk that goes beyond the notion of biosafety and biosecurity, and includes a consideration of social, economic, and environmental risks and benefits. These ethical concerns will require the participation of experts in fields other than genomics, genetics, and molecular biology. They also claim that oversight mechanisms should ensure that the benefits of these emerging technologies are not oversold and that experts take the time to communicate their work to non-experts and to the general public.*

**Dabrock, Peter. 2009. "Playing God? Synthetic Biology as a Theological and Ethical Challenge." *Systems and Synthetic Biology* 3 (1-4): 47-54.**
*The author addresses the common reproach against synthetic biology, i.e. that it amounts to “playing God,” within a framework of theological ethics. He explains that, on the one hand, the phrase is invoked to express concern that some technological progress exceeds the abilities and the accompanying responsibilities of humankind. On the other hand, many thinkers, such as Ronald Dworkin, reject the use of the expression in ethical debates. The author argues that while the advances in synthetic biology are not completely ethically unproblematic, they are not inherently “sinful” or a threat to the “divine domain.” The author concludes that theological ethics can contribute to discussions in applied ethics and policy-making about synthetic biology by laying out some of the normative preconditions for these discussions, including our understanding of human identity and the pursuit of the “good” life.*

**Dana, Genya V., Todd Kuiken, David Rejeski, and Allison A. Snow. 2012. "Synthetic Biology: Four Steps to Avoid a Synthetic-Biology Disaster." *Nature* 483 (7387): 29-29.**

*The authors address the risk of introducing novel, synthetic microorganisms into the environment and how to assess that risk and other associated ecological impacts. The authors propose four areas of research into the risks associated with synthetic microorganisms. The first proposal is to study the differences between the metabolic functions of natural and synthetic organisms. The second proposal is to study how synthetic organisms might affect natural habitats, food webs, and biodiversity. The third proposal is to research the rate at which these organisms might evolve. And, the fourth proposal is to study gene transfer capabilities in synthetic microorganisms. The authors conclude by claiming that public agencies should fund environmental risk research alongside basic research in synthetic biology.*

**Douglas, Thomas, and Julian Savulescu. 2010. "Synthetic Biology and the Ethics of Knowledge." *Journal of Medical Ethics* 36 (11): 687-693.**

*The authors address what they believe to be one of the most pressing ethical challenges posed by advances in synthetic biology – i.e. the risk that knowledge from synthetic biology will be misused for biological terrorism or warfare. Thus, part of the ethical discussions will have to concern the extent to which knowledge creation and dissemination should be regulated. Given this "new" problem, the authors argue that bioethicists should develop an "ethics of knowledge."*

**Erickson, Brent, Rina Singh, and Paul Winters. 2011. "Synthetic Biology: Regulating Industry Uses of New Biotechnologies." *Science* 333 (6047): 1254-1256.**

*The authors argue that policies and regulations of emerging biotechnologies in synthetic biology should ensure the continuation of commercial innovation and development while protecting the public from potential harm. The authors think that the same kind of self-regulation that was applied to genetic engineering technologies, such as recombinant DNA, in the 1970s, should be applied to research and development in synthetic biology. The authors discuss some recent biotechnological innovations and warn about the use and limitations of metaphors in synthetic biology, such as modularity, genetic program, and reprogramming the genetic code. The authors end by arguing for self-governance in the scientific community. They cite the guidelines from the President's Bioethics Commission review of synthetic biology, such as the guiding principles of prudent vigilance and*

*regulatory parsimony, to support their position.*

**Gutmann, Amy. 2011. "The Ethics of Synthetic Biology: Guiding Principles for Emerging Technologies." *Hastings Center Report* 41 (4): 17-22.**
*The author, chair of the Presidential Commission for the Study of Bioethical Issues, summarizes the guiding principles and the policy recommendations found in the Commission's first published report. The guiding ethical principles are: public beneficence, responsible stewardship, intellectual freedom and responsibility, democratic deliberation, and justice and fairness. The main recommendations are summed up by "prudent vigilance" and "regulatory parsimony," indicating the Commission's decision not to call for a moratorium on research and development of emerging technologies in synthetic biology.*

**Kaebnick, Gregory E. 2011. "Of Microbes and Men." *Hastings Center Report* 41 (4): 25-28.**
*The author addresses ethical concerns about synthetic biology centered on the notion of the relationship between humans and nature. One idea of this relationship is characterized by a discourse of "altering nature to meet human demands." The other is characterized by a discourse of "altering human demands to accommodate nature." The author sides with the latter, but claims that it's not necessarily inconsistent with the technological advances in synthetic biology.*

**Kaebnick, Gregory E. 2009. "Should Moral Objections to Synthetic Biology Affect Public Policy?" *Nature Biotechnology* 27 (12): 1106-1108.**
*The author argues that moral concerns originating from different views about the relationship between nature and emerging technologies in the field of synthetic biology do not provide a basis for imposing regulatory constraints on research and development in synthetic biology. The author addresses three types of claims about the relationship between humans and nature: (1) metaphysical claims about nature and its moral significance, (2) claims about intrinsic moral values in nature, and (3) claims about possible consequences, such as environmental harms. He concludes that only the third provides a plausible basis on which to form public policy, and that present public policy reflects that approach.*

**Kaebnick, Gregory E. 2010. "Synthetic Biology, Analytic Ethics." *Hastings Center Report* 40 (4): c3-c3.**
*The author claims that a general moratorium on research in synthetic biology is not needed, in light of the announcement that researchers at the JCVI had created a*

*synthetic life form. The author also states that the most significant moral problems that have to do with synthetic biology are about assessing and evaluating potential outcomes, especially because many of the associated risks are low probability, but high impact. For that reason, ongoing moral deliberations and discussions are necessary.*

**Kwok, Roberta. 2010. "Five Hard Truths for Synthetic Biology." *Nature* 463 (7279): 288-290.**

*The author lays out five challenges to engineering approaches to studying and manipulating complex living systems and suggests some ways to address these challenges. The five challenges are: (1) many parts are undefined, (2) the circuitry is unpredictable, (3) the complexity is unwieldy, (4) many parts are incompatible, and (5) variability crashes the system.*

**McKenna, Phil. 2009. "Rise of the Garage Genome Hackers: A Do-It-Yourself Movement Hopes to Open Up Synthetic Biology to Anyone with a Passion for Tweaking DNA." *New Scientist*: 20-21.**

*In this short news article, the author presents the possible benefits and possible risks of amateur biology, given that it involves the synthesis and manipulation of genes and microorganisms outside of the regulatory oversight of academic and research institutions. On the one hand, there is concern that an amateur biologist or engineer may produce and release harmful biological materials, such as newly created pathogens, into society. On the other hand, there is hope that the movement of DIY biologists can spur creativity and innovation to help solve real-world problems.*

**Miller, Seumas, and Michael J. Selgelid. 2007. "Ethical and Philosophical Consideration of the Dual-Use Dilemma in the Biological Sciences." *Science and Engineering Ethics* 13 (4): 523-580.**

*The authors address the “dual-use” dilemma arising in the context of advances in biology and bioengineering. The “dual-use” dilemma is characterized by research and development that might produce results and technologies that are used for beneficial purposes, but might also be used for causing harm (e.g. bioterrorism). The authors claim that this dilemma is present at several levels: It presents a challenge for the individual researcher because she needs to be wary of her work being stolen or misused. It also presents a dilemma for institutions and governments because they need to ensure bio-security, while also ensuring the conditions for scientific development and innovation. The authors provide taxonomy of different types of*

*“experiments of concern” in the life sciences, a concept originating from the US National Research Council’s 2004 report, Biotechnology Research in the Age of Terrorism. They then provide examples of research that ought to be restricted, and examples of research dissemination that ought to be restricted. The authors conclude by proposing two institutional models that can deal with these challenges in an ethically justifiable manner. The first model, “Institutional and Governmental Control,” mandates “personnel security, licensing of dual-use technologies [and] ...education and training,” and applies to both “public and private sector research centres” (566). The second model, “An Independent Authority,” calls for an authority that would be independent of both public and private research institutions, and government bodies, and would be comprised of scientists, ethicists, and national security experts (567).*

**Murray, Thomas H. 2011. "Interests, Identities, and Synthetic Biology." *Hastings Center Report* 41 (4): 31-36.**

*The author addresses a particular “intrinsic” concern about synthetic biology, which he describes as disputes over identities and compares them to disputes over interests. The author defines the former as “arguments over core beliefs about one’s place in the world and the possibilities of flourishing.” With respect to synthetic biology, the author suggests that the concern about humankind’s relationship with nature represents a dispute over identities.*

**Newson, Ainsley J. 2011. "Current Ethical Issues in Synthetic Biology: Where Should We Go From Here?" *Accountability in Research* 18 (3): 181-193.**

*The author provides a general overview of scientific research in the field of synthetic biology, and outlines three ethical claims about synthetic biology. (1) Bioethicists should not create a new, specialized subfield in bioethics to address the ethical issues in synthetic biology. (2) Bioethicists should focus on new concepts and issues emerging from the field of synthetic biology. (3) Ethical discussion about synthetic biology should be cooperative and inter-disciplinary.*

**Parens, Erik, Josephine Johnston, and Jacob Moses. 2008. "Do We Need ‘Synthetic Bioethics’?" *Science* 321 (5895): 1449.**

*The authors address whether bioethicists should create a subfield called “synthetic bioethics” to address the social, legal, and ethical issues arising from synthetic biology. They argue against what they call “the further balkanization” of bioethics. Instead, the authors suggest that applying familiar ethical frameworks to new*

*scientific developments might be more fruitful in providing practical solutions.*

**Schmidt, Markus, Agomoni Ganguli-Mitra, Helge Torgersen, Alexander Kelle, Anna Deplazes, and Nikola Biller-Andorno. 2009. "A Priority Paper for the Societal and Ethical Aspects of Synthetic Biology." *Systems and Synthetic Biology* 3 (1-4): 3-7.**
*The authors present the information they gathered on priority issues concerning the safety, security, and ethical issues emerging from synthetic biology. Their information was gathered from a literature review, interviews with scientists, social scientists, and other stakeholders. The issues they emphasize are categorized under four headings. First, the safety issues address the unintentional exposure or accidental release of harmful biological material, and include the topics of (1) new methods of risk assessment, (2) synthetic safety systems (bio-safety engineering), and (3) diffusions of synthetic biology to amateur biologists. Second, the security issues address the potential misuse of emerging technologies in synthetic biology, and include the topics of (1) awareness, (2) education, (3) governance and oversight, and (4) technical solutions. Third, the ethical issues address the normative aspects of the procedures and applications of synthetic biology, and include the topics of (1) designing and creating life, (2) assessing risks and benefits, and (3) benefits, access and justice. And, fourth, the issue of "science-public interface" includes (1) education, (2) public engagement, and (3) and stakeholder involvement.*

**Tucker, Jonathan B., and Raymond A. Zilinskas. 2006. "The Promise and Perils of Synthetic Biology." *New Atlantis* 12 (1): 25-45.**
*The authors first provide a brief survey of engineering strategies within the field of synthetic biology, including genome design and construction, applied protein design, natural product synthesis, and the construction of functional gene circuits in cells and micro-organisms. They then present research obstacles and potential risks in synthetic biology. They emphasized that because engineered microorganisms are capable of self-replication and evolution, there is a high degree of unpredictability within this particular field of bioengineering. This situation gives rise to three types of risk: the risk of accidental release, the risk of testing in an open environment (in the context of applications in agriculture and bioremediation), and the risk of deliberate misuse. The authors then present ways to mitigate these risks.*

**Wolinetz, Carrie D. 2012. "Implementing the New US Dual-Use Policy." *Science* 336 (6088): 1525-1527.**

*The author addresses challenges with identifying, assessing, and regulating dual-use research (DURC) in the life sciences. DURC is defined as "research that is intended for legitimate, beneficial purposes but also carries a risk of being used for malicious purposes." The principle challenge is how to mitigate the associated risks without stifling scientific research in the life sciences. The author uses the recent reviews of the H5N1 avian influenza publications to illustrate the challenges with risk research, and with distinguishing between acceptable from non-acceptable risks.*

**Zenonos, Georgios, and Jeong Eun Kim. 2010. "Life, and... Neurosurgery After the First "Synthetic Cell"." *Neurosurgery* 67 (2): N14-N15.**
*The authors address the announcement of the creation of the first "synthetic" cell by researchers at the JCVI, and outline some of the possible applications that may come out of this new scientific field.*

# CRISPR-Cas9 & Other Genome Editing Technologies

## Journal Articles

**Baltimore, B. D., Paul Berg, Michael Botchan, Dana Carroll, R. Alta Charo, George Church, Jacob E. Corn, et al. 2015. "A Prudent Path Forward for Genomic Engineering and Germline Gene Modification." *Science* 348 (6230): 36-38.**
*The authors discuss the science and ethics of new genome editing technologies, with a focus on the use of CRISPR-Cas9, and offer a set of recommendations to ensure the ethical use of this technology. The authors argue that germline gene modification is controversial because it invokes the fear of a slippery slope from medical interventions designed to eradicate diseases to other non-medical uses. They also stress that the long-term consequences of these interventions remain unknown. The authors recommend an open dialogue about the benefits and the risks of this new technology to ensure the public's trust in science.*

**Doudna, Jennifer A., and Emmanuelle Charpentier. 2014. "The New Frontier of Genome Engineering with CRISPR-Cas9." *Science* 346 (6213): 1258096.**

*A review article about CRISPR-Cas9 technology and its potential applications. The authors explain the difference between other genome editing technologies that make use of engineered nucleases with site-specific recognition capacities, such as zinc-finger nucleases (ZFNs) and TAL effector nucleases (TALENs). The enzyme complex can be used for DNA deletion, insertion, replacement, modification, and labeling, as well as transcription regulation. The authors also list possible applications of this biotechnology in biomedicine and agriculture.*

**Jasanoff, Sheila, J. Benjamin Hurlbut, and Krishanu Saha. 2015. "Human Genetic Engineering Demands More Than a Moratorium." *The Guardian*, April 7.**

*The authors claim that the suggested moratorium on emerging genome editing technologies, such as CRISPR-Cas9, is a relic from the 1975 Asilomar conference; a meeting which addressed public concerns about the safety of recombinant DNA technology. They argue that there are limitations to the Asilomar approach to discussing social and ethical issues arising from emerging biotechnologies, and that perhaps the Asilomar conference is not the best model by which scientists can engage the broader public about emerging biotechnologies. Instead, the authors suggest that more efforts are needed by leaders and scientists to engage citizens within a deliberative democracy, such as building a more complex architecture that enables public participation, as well as investing in education in science, technology, and society studies, in addition to STEM education.*

**Vogel, Gretchen. 2015. "Embryo Engineering Alarm." *Science* 347 (6228): 1301-1301.**

*The author draws parallels between the technological advancements that warranted the Asilomar meeting about recombinant DNA in 1975 and current genome editing technologies, such as CRISPR-Cas9, zinc-fingers, and TALENs. She reports on the views of scientists that have published initial recommendations on these technologies in Science and Nature. There seems to be consensus that a complete moratorium isn't needed, but researchers should not use these technologies to genetically modify human beings. They believe that scientists ought not to use these technologies for therapeutic purposes until more is known about how gene editing affects the entire genome and how it affects normal development.*

# Genetic Screening & Genetic Modification in Embryos

# Journal Articles

**Botkin, Jeffrey R., Ellen Wright Clayton, Norman C. Fost, Wylie Burke, Thomas H. Murray, Mary Ann Baily, Benjamin Wilfond, Alfred Berg, and Lainie Friedman Ross. 2006. "Newborn Screening Technology: Proceed with Caution." *Pediatrics* 117 (5): 1793-1799.**

*The authors address the recent report by the American College of Medical Genetics (ACMG), which recommended a significant expansion in the number of conditions targeted by newborn screening (NBS) programs. They advocate for a more cautious approach based on two general concerns. First, the authors express concern about the limitations of the ACMG process. Second, they express concern about how quickly programs are expanding without the necessary infrastructure in place to ensure that the technology improves the lives of newborns.*

**Emerson, Claudia, Stephanie James, Katherine Littler and Fillippo Randazo. 2017. "Principles for Gene Drive Research." *Science* 358 (6367): 1135-1136. doi: 10.1126/science.aap9026.**

*The recent outbreak of Zika virus in the Americas renewed attention on the importance of vector-control strategies to fight the many vector-borne diseases that continue to inflict suffering around the world. In 2015, there were ~212 million infections and a death every minute from malaria alone. Gene drive technology is being explored as a potentially durable and cost-effective strategy for controlling transmission of deadly and debilitating vector-borne diseases. Additionally, its suitability is being evaluated for various potential applications in conservation biology, including a highly specific and humane method for eliminating invasive species from sensitive ecosystems.*

**Green, Nancy S., Siobhan M. Dolan, and Thomas H. Murray. 2006. "Newborn Screening: Complexities in Universal Genetic Testing." *American Journal of Public Health* 96 (11): 1955-1959.**

*The authors evaluate the costs, benefits, and risks associated with emerging newborn screening technologies, and present three cases of genetic disorders to*

*illustrate the complexities associated with this technology, focusing on phenylketonuria (PKU), medium chain acyl-CoA dehydrogenase deficiency (MCAD), and cystic fibrosis (CF). The authors point out that making inferences and drawing conclusions about the results of genetic screens is difficult because they can reveal genes with incomplete penetrance, genes that reveal only a disposition to a certain disease or condition, and genes associated with disorders that cannot be currently treated. Moreover, many diseases and conditions are affected by multiple genes, and gene-environment interactions. All of these factors pose social and ethical challenges for preparing public health systems to incorporate the newborn screening technology.*

**Kaebnick, Gregory E. 2009. "Designing Baby Neatherthals: Reconstructed DNA Gestating in a Chimp Womb Would Raise Serious Bioethical Questions." *Science Progress*, March 10.**

*The author addresses the ethics of the possibility of designing baby Neanderthals by gestating reconstructed DNA in a chimp womb. Some have argued that bringing back extinct species is justifiable merely if it fulfills our intellectual curiosity, while others claim it could be justifiable for reasons of ecological restoration. The author argues that it's better not to do it, at least at this point in time, because there are still too many unanswered ethical questions about intervening in nature to create sentient beings.*

**Murray, Thomas H. 2014. "Stirring the Simmering "Designer Baby" Pot." *Science* 343 (6176): 1208-1210.**

*Murray addresses the question of how much discretion parents should be granted given some of the emerging reproductive technologies. The author discusses several technologies, including mitochondrial transplantation technologies, 23andMe's Family Traits Inheritance Calculator, genetic testing for sex selection, and analysis of fetal cell free DNA (cfDNA) in pregnant women with whole genome and whole exome sequencing technologies. The author also mentions four ethical considerations with which scholars have tried to frame the public discourse over the extent of parental discretion in the use of reproductive technologies. These include: 1) "whether parental discretion should hold near-absolute sway," 2) "whether a child should have the prospect of 'a decent chance of a happy life,'" 3) "whether the welfare of the child-to-be should come first," and 4) whether models emphasizing the deep interrelationship of parent and child should be considered." Murray calls for more public discourse in the US about these emerging technologies.*

**Parens, Erik. 2014. "The Thorny Ethics of Prenatal Genetic Testing." *Time,* February 4.**

*In this opinion pieces, the author considers whether prospective parents should be allowed to access all the genetic information they want about their fetus. The author argues that, ideally, the answer is yes, but on the condition that parents truly understand the information presented to them. Two technological advances in prenatal screening present challenges: whole genome sequencing and the ability to retrieve samples of the fetus's genome earlier during pregnancy.*

## Contributor(s)

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Bibliography

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Ethics of Emerging Technologies in the Life Sciences

## Topics

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## Discipline(s)

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