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Can DNA Be Speech?

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Abstract

DNA is generally regarded as the basic building block of life itself. In the most fundamental sense, DNA is nothing more than a chemical compound, albeit a very complex and peculiar one. DNA is an information-carrying molecule. The specific sequence of base pairs contained in a DNA molecule carries with it genetic information and encodes for the creation of particular proteins. When taken as a whole, the DNA contained in a single human cell is a complete blueprint and instruction manual for the creation of that human being.

This Article discusses a myriad of current and developing ways in which people are utilizing DNA to store or convey information of all kinds. For example, researchers have encoded the contents of a whole

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book in DNA, demonstrating the potential of DNA as a way of storing and transmitting information. In a different vein, some artists have begun to create living organisms with altered DNA as works of art. Hence, DNA is a medium for the communication of ideas. Because of the ability of DNA to store and convey information, its regulation must necessarily raise concerns associated with the First Amendment's prohibition against the abridgment of freedom of speech.

New and developing technologies, and the contemporary and future social practices they will engender, necessitate the renewal of an approach towards First Amendment coverage that takes into account the purposes and values incarnated in the Free Speech Clause of the Constitution. This Article proposes and applies a framework for analysis in the context of contemporary social practices that involve the manipulation of DNA as a case study from which we can hope to gain valuable insights regarding First Amendment doctrine in general.

INTRODUCTION

DNA: "Deoxyribonucleic acid, a self-replicating material which is present in nearly all living organisms as the main constituent of chromosomes. It is the carrier of genetic information."[1] DNA is generally regarded as the basic building block of life itself. In the most fundamental sense, DNA is nothing more than a chemical compound, albeit a very complex one. DNA is a molecule consisting of two strands of bonded atoms coiled around each other to form a double helix that resembles a spiral ladder.[2] "Each rung of the ladder consists of a pair of chemical groups called bases (of which there are four types), which combine in specific pairs so that the sequence on one strand of the double helix is complementary to that on the other . . . ."[3]

DNA is a very peculiar type of molecule: it is an information-carrying molecule. The specific sequence of base pairs contained in a DNA molecule carries with it genetic information and encodes for the creation of particular proteins.[4] When taken as a whole, the DNA contained in a single human cell is a complete blueprint and instruction manual for the creation of that human being.[5] This Article discusses a myriad of current and developing ways in which people are utilizing DNA to store or convey information. For example, researchers have encoded the contents of an entire book into DNA, demonstrating the potential of DNA as a way of storing and transmitting information.[6] In a different vein, some artists have begun to create living organisms with altered DNA as works of art.[7] Hence, DNA is a medium for the communication of ideas. Because of the ability of DNA to store and convey information, its regulation must necessarily raise concerns associated with the First Amendment's prohibition against the abridgment of freedom of speech.

The DNA and speech issues discussed in this Article raise a host of questions regarding the repercussions to intellectual property and privacy law regimes if DNA is determined to be an expression, with regulation triggering First Amendment scrutiny. Can DNA be deemed a thing or device upon which a work of authorship may be fixed? Can

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[1] *DNA*, OXFORD DICTIONARIES, http://oxforddictionaries.com/definition/english/DNA (last visited May 5, 2014).
[2] *Id.*
[3] *Id.*
[4] U.S. DEP'T OF HEALTH & HUMAN SERVS., THE NEW GENETICS 4–5 (2010).
[5] *Id.*
[6] *See* Francie Diep, *This Book Has a Twist: It's Been Converted into DNA*, NBC NEWS (Aug. 16, 2012, 2:21 PM), http://www.nbcnews.com/id/48692531/ns/technology_and_science-innovation/t/book-has-twist-its-been-converted-dna/.
[7] *See, e.g.*, BIO ART, http://www.ekac.org/transgenicindex.html (last visited Feb. 15, 2015).

individuals deprive society of the benefit of the free flow of ideas that publication of the information contained in DNA would entail? Does the Free Speech Clause require the application of some form of a fair use doctrine in the context of patented DNA sequences? Questions such as these lead to the collision and intermingling of privacy, patent, and copyright law with freedom of expression. Given our contemporary sensibilities regarding the centrality of our genetic material in matters of self-definition, an analysis of the interaction between intellectual property, privacy, and speech is necessary in this context.

All of these questions serve as further support for the thesis that new and developing technologies—and the contemporary and future social practices they will engender—necessitate a renewed approach towards First Amendment coverage, privacy, and intellectual property law that takes into account the purposes and values incarnated in both the Free Speech and the Patent and Copyright Clauses of the Constitution. Resorting to technicalities regarding original intent, historical tradition, and formalist textualism is grossly insufficient, misleading, and downright disingenuous. Courts must engage in an intellectually honest analysis of the constitutional values furthered—or threatened—by particular social practices. We must strive to define the proper place and objective of the First Amendment guarantee of freedom of expression while tackling the age-old balance that the Constitution establishes between incentivizing the progress of the arts and sciences through limited private monopolies over intellectual property and the need to share information freely in our society. This Article attempts to do just that in the context of contemporary social practices that involve the manipulation of DNA as a case study from which we can hope to gain valuable insights regarding First Amendment, privacy, and intellectual property doctrine in general.

I. FIRST AMENDMENT PRINCIPLES AND THE PROBLEM OF DNA

New technologies and scientific discoveries can create ripples in our social institutions. These ripples affect the way we govern ourselves and redefine and reshape our understanding of basic concepts that are central to the protection of our civil liberties. What does it mean to "speak" under the First Amendment in this new technological age? In this context, both courts and scholars have assessed, for example, how the use of computer code to communicate is an exercise of our right to free speech and how the regulation of code can affect our communications.[8] A basic understanding of the structure and function of

[8] For a detailed account of the jurisprudence and literature on this subject, see Jorge R. Roig, *Decoding First Amendment Coverage of Computer Source Code in the Age of YouTube, Facebook, and the Arab Spring*, 68 N.Y.U. ANN. SURV. AM. L. 319 (2012) [hereinafter Roig, *Decoding*].

DNA can inform analogies with computer code and other expressive media and provide insight into how genetic code might interact with the First Amendment.

A. *DNA as Information; Information as Speech*

DNA is a lot like computer code. In fact, it is a lot like our regular language. This becomes clear if we take a closer look at a DNA molecule. A DNA strand contains four types of smaller molecules that geneticists refer to in shorthand as A, T, C, and G.[9] These molecules alternate along the strand, like the rungs on a ladder, to form an almost infinite number of possible combinations.[10] These molecules then take the place in DNA of the ones and zeroes in computer code.[11] They play the same role that the letters of our alphabet play in the English language. And their combinations form the equivalent of words in the messages that DNA conveys. Meaning is etched into every single cell in our bodies. DNA is language.

DNA, then, is a very peculiar molecule. It has the ability to carry information.[12] Furthermore, human beings are able to read out the coded stories that lie within the DNA double helix.[13] The information-carrying capabilities of DNA raise questions about whether the Free Speech Clause of the First Amendment might be implicated when DNA is regulated. Hence, an analysis of the potential First Amendment coverage of DNA should start by looking at the extent to which information itself is considered "speech" for First Amendment purposes.

Our analysis of information as speech begins with a look at two recent Supreme Court opinions that have broached the subject. First, in *Association for Molecular Pathology v. Myriad Genetics, Inc.*,[14] the Supreme Court held that isolated DNA (in this case the BRCA1 and BRCA2 genes, which correlate with a woman's risk of developing breast cancer) cannot be patented because it is naturally occurring within the body. The Court also held, however, that synthetic DNA can be patented because it omits non-coding information and thus does not occur in nature.[15]

In *Myriad*, the Supreme Court acknowledged the information-

[9] Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 133 S. Ct. 2107, 2111 (2013).
[10] *Id.*
[11] *See* Diep, *supra* note 6. In order to encode the contents of a book into DNA, biologists first converted an HTML draft of the book into binary, then assigned a value of 0 to blocks A and C and a value of 1 to corresponding blocks T and G. *Id.*
[12] *Myriad*, 133 S. Ct. at 2118.
[13] *Id.*
[14] *Id.* at 2111.
[15] *Id.*

carrying capacity of DNA.[16] Hence, the Court held that the patent claims involved in the case "understandably focus on the genetic information encoded in the BRCA1 and BRCA2 genes."[17] Nevertheless, the Court's attention to this characteristic of DNA only centered on the statutory patent law issues before it. The Court did not analyze any First Amendment issues.

The parties and amici curiae, however, did raise the First Amendment in some of their briefs. For example, Petitioners argued that Myriad's claims to BRCA1 and BRCA2 inhibit research and patients' abilities to secure affordable and effective screening.[18] "Patents on isolated DNA, whether small segments or whole genes, also violate the First Amendment because they block scientific inquiry into the patented DNA."[19] Further, Petitioners claimed that patents on BRCA1 and BRCA2 violate the First Amendment because they effectively lock up the body of knowledge surrounding those genes: "These patents prevent access to each person's individual genetic information and deprive others from examining the BRCA1 and BRCA2 genes and engaging in fundamental scientific work. It is not possible to 'invent around' human genes, as it is with a true invention, like a carburetor."[20] "Because the patents grant control over a body of knowledge and over pure information, they violate the First Amendment."[21]

For their part, some amici also argued that Myriad's patents in human genes and related methods are invalid under the First Amendment because they violate the ability of doctors, patients, and researchers to give and receive information.[22] These same amici further explained later on in the context of the same litigation that,

> Although the issuance of a copyright or patent will, necessarily, impact speech rights in some capacity, the issuance of a patent over genetic material itself is a substantial and impermissible intrusion into the speech rights of numerous potential third party plaintiffs, including researchers, patients, physicians and research groups. . . . In particular, human gene patents create "monopolies of expression" that prevent searching inquiry in the context of the scientist's laboratory and sharing information fully in the context of the physician's office. . . . First Amendment values instruct that a vibrant marketplace of ideas requires open access to the storehouse of

[16] *Id.* at 2118.
[17] *Id.*
[18] Petition for Writ of Certiorari at 30, *Myriad*, 133 S. Ct. 2107 (No. 11-725), 2011 WL 6257250.
[19] *Id.*
[20] *Id.*
[21] *Id.* (citing Ashcroft v. Free Speech Coal., 535 U.S. 234, 253 (2002)).
[22] Brief of Kali N. Murray and Erika R. George as Amici Curiae Supporting Petitioners at 3, 12, *Myriad*, 133 S. Ct. 2107 (No. 11-725), 2012 WL 5388794.

> knowledge. . . . The right to receive information is an inherent corollary of the right of free speech explicitly guaranteed by the Constitution.[23]

The parties' arguments in *Myriad* were chronicled in the academic literature: "[c]ritics of DNA patenting, including the ACLU and the plaintiffs in *Myriad*, have attempted to mount a First Amendment challenge to DNA patenting by asserting that DNA, as the biological blueprint for protein production, is not merely a chemical compound but, more importantly, also a carrier of information."[24] Vincent Y. Ling particularly points out the connection made by the plaintiffs in *Myriad* between the First Amendment argument and other doctrines in intellectual property law:

> The plaintiffs in *Myriad* supported their First Amendment argument by analogizing to copyright law. The fair use doctrine in copyright law upholds First Amendment values in certain scenarios where they conflict with copyright law. In addition, copyright law draws a clear dichotomy between ideas and expression—while expression is copyrightable, mere ideas are not. The First Amendment, the plaintiffs argued, applies similarly to preclude ideas from being patentable.[25]

All in all, however, Ling characterizes the First Amendment arguments raised in *Myriad* as radical and having a low probability of success, particularly in the Federal Circuit Court of Appeals.[26]

Arguments similar to those made in *Myriad* were also raised, albeit in a more limited way, in a student comment published before the Supreme Court opinion was issued.[27] While Kauble "recognizes that there are some First Amendment arguments that the ACLU can make in opposition to gene patents, [she] suggests that the ACLU goes too far in claiming that all gene patents should be banned. . . . [and] fails to address just how far this First Amendment protection should span."[28] Instead, she proposes that "[u]sing the First Amendment as a lens is one way to determine whether an object identified in a patent application

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[23] Brief of Kali N. Murray and Erika R. George as Amici Curiae Supporting Petitioners at 14–18, *Myriad*, 133 S. Ct. 2107 (2013) (No. 12-398), 2013 WL 432954.

[24] Vincent Y. Ling, *Patently Ours? Constitutional Challenges to DNA Patents*, 14 U. PA. J. CONST. L. 813, 834 (2012) (footnote omitted).

[25] *Id.* at 835 (citing, among others, Campbell v. Acuff-Rose Music, 510 U.S. 569, 579 (1994) and Baker v. Selden, 101 U.S. 99, 104 (1879)) (footnotes omitted).

[26] *Id.* at 836 (noting that the Federal Circuit has been reluctant to recognize DNA as primarily a carrier of information).

[27] Krysta Kauble, Comment, *Patenting Everything Under the Sun: Invoking the First Amendment to Limit the Use of Gene Patents*, 58 UCLA L. REV. 1123 (2011).

[28] *Id.* at 1126.

should be classified as a natural phenomenon."[29] Specifically, she argues that applying a First Amendment "narrowly tailored" test when evaluating the validity of proposed gene patents can help distinguish unpatentable natural phenomena from patentable objects.[30] According to Kauble, "[e]xamining the rationale for prohibiting patenting natural phenomena—that patents should not remove anything from the public domain—demonstrates that there is an underlying First Amendment protection against patenting natural phenomena."[31] Her argument, she states, "is buttressed by evidence that overbroad gene patenting is already inhibiting potentially life-saving research by making it practically impossible for multiple researchers to pursue tests and remedies based on promising genes."[32]

As mentioned above, in spite of all the arguments made by the parties, amici, and commentators, the Supreme Court in *Myriad* did not address any of these First Amendment concerns. The Court did, however, squarely address the issue of how the First Amendment responds to the regulation of information in *Sorrell v. IMS Health Inc.*[33] In *Sorrell*, Vermont's Prescription Confidentiality Law violated the First Amendment because it imposed speaker- and content-based restrictions on use of prescriber data that could not be justified under a heightened scrutiny standard by the State's asserted interests in physician confidentiality, protecting doctors from harassing sales behavior, lowering the cost of medical services, and promoting public health.[34] The Court stated that an individual's right to speak is implicated when information he or she possesses is subjected to restraints on the way in which the information might be used or disseminated.[35] The Court noted "that the creation and dissemination of information are speech within the meaning of the First Amendment."[36] The Court further explained that "Vermont's statute could be compared with a law prohibiting trade magazines from purchasing or using ink."[37] "Facts, after all, are the beginning point for much of the speech that is most essential to advance human knowledge and to conduct human affairs."[38] Consequently, "[a]n individual's right to speak is implicated when information he or she possesses is subjected to 'restraints on the

[29] *Id.* at 1173.
[30] *Id.* at 1164–70.
[31] *Id.* at 1173.
[32] *Id.*
[33] Sorrell v. IMS Health Inc., 131 S. Ct. 2653 (2011).
[34] *Id.*
[35] *Id.*
[36] *Id.* at 2667. *See also* Bartnicki v. Vopper, 532 U.S. 514 (2001); Rubin v. Coors Brewing Co., 514 U.S. 476 (1995); Dun & Bradstreet, Inc. v. Greenmoss Builders, Inc., 472 U.S. 749 (1985) (plurality opinion).
[37] *Sorrell*, 131 S. Ct. at 2667.
[38] *Id.*

way in which the information might be used' or disseminated."[39]

The Court's holding in *Sorrell*—that information and facts are speech—has not gone unnoticed. Ashutosh Bhagwat, for example, has opined that this has troubling implications for personal privacy and could be significant to the analysis of a number of existing and potential regulations designed to protect personal privacy.[40] He instead advocates recognizing the distinction between facts of public significance and purely private facts.[41] However, he recognizes that the Court's pronouncements in *Sorrell* point to a broad First Amendment coverage of information: "These passages . . . evince some quite clear views on the subject of the proper treatment of information: Information and facts are speech (indeed, that is the 'rule')."[42] "The Court ultimately rejected the First Amendment defense, but it began its analysis by acknowledging that facts and other scientific expression, including computer code, constitute speech."[43] "Under current law, the sale of specific information, including prescriber-identifying information, constitutes speech fully protected by the First Amendment."[44]

A similar recognition of the potential reach of *Sorrell* can be found in Boumil et al.'s work: "[t]he PI data at issue represented speech, since the First Amendment protects 'even dry information, devoid of advocacy, political relevance, or artistic expression.'"[45] They also point out that the Court did not construe the statute at issue "as a regulation of conduct, reasoning that the creation and distribution of information constituted protected expression within the meaning of the First Amendment."[46] "The *Sorrell* Court determined that 'the creation and dissemination of information are speech within the meaning of the First Amendment.' Yet the information at issue neither came from the public domain nor re-enters the public domain after it is used."[47]

Fred H. Cate and Robert Litan also point out that the First Amendment curtails the power of the government to limit distribution of information.[48] At the same time, however, they highlight the fact that there is also some basis for a First Amendment constitutional right to

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[39] *Id.* at 2665.
[40] Ashutosh Bhagwat, *Sorrell v. IMS Health: Details, Detailing, and the Death of Privacy*, 36 VT. L. REV. 855 (2012).
[41] *Id.*
[42] *Id.* at 860.
[43] *Id.* at 862–63.
[44] *Id.* at 867.
[45] Marcia M. Boumil et al., *Prescription Data Mining, Medical Privacy and the First Amendment: The U.S. Supreme Court in* Sorrell v. IMS Health Inc., 21 ANNALS HEALTH L. 447, 467 (2012).
[46] *Id.* at 479.
[47] *Id.* at 488.
[48] Fred H. Cate & Robert Litan, *Constitutional Issues in Information Privacy*, 9 MICH. TELECOMM. & TECH. L. REV. 35, 49–58 (2002).

privacy.[49] "There is necessarily, and within suitably defined areas, a concomitant freedom not to speak publicly, one which serves the same ultimate end as freedom of speech in its affirmative aspect."[50] It is unclear how this conflict between a First Amendment right to freedom of information and privacy laws will be resolved.[51] This inevitably raises important questions, such as: 1) under what standard should privacy laws be reviewed, strict or intermediate scrutiny?; and 2) how, if at all, does the First Amendment apply to privacy laws that limit the ability to collect and privately use personal information?[52]

Other commentators have challenged the First Amendment critique of data privacy regulation.[53] Neil M. Richards, for example, argues that not all information flow regulations require First Amendment scrutiny.[54] Information regulation can be constitutionally upheld.[55] He argues that regulation of use of information does not regulate speech, but rather conduct.[56] He points to the fact that American law includes legal obligations not to disclose information about another that do not attract First Amendment scrutiny, such as contract law, tort law, property law, fiduciary and confidentiality duties, and trade secret law.[57] He attempts to distinguish data mining and the use of personal information for marketing purposes as an economic right, instead of a political right.[58] Richards argues that "the Supreme Court has stated on several occasions that individuals have a constitutional right to prevent the government from making public at least certain kinds of information about themselves."[59]

Most recently, Jane Bambauer has published an interesting article in which she asks: "Is Data Speech?"[60] She argues that, although not all data is speech, regulation of some types of data should be subject to First Amendment Scrutiny.[61] "Data is not automatically speech in every context; . . . data can be generated without any expectation to be

[49] *Id.* at 40–42.
[50] *Id.* at 41 (quoting Harper & Row Publishers, Inc. v. Nation Enterprises, 471 U.S. 539, 559 (1985)).
[51] *Id.* at 57–63.
[52] *Id.* at 57–58.
[53] *See* Neil M. Richards, *Reconciling Data Privacy and the First Amendment*, 52 UCLA L. REV. 1149 (2005).
[54] *Id.* at 1168–82.
[55] *Id.*
[56] *Id.* at 1192–93.
[57] *Id.* at 1195–97.
[58] *Id.* at 1217–21 (discussing the "bifurcated system of judicial review" that gives deference to legislative actions that regulate economic rights but imposes a much higher level of scrutiny on those that limit political rights).
[59] *Id.* at 1157. *See also* Anna M. Taruschio, *The First Amendment, the Right Not to Speak and the Problem of Government Access Statutes*, 27 FORDHAM URB. L.J. 1001 (2000) (considering the conflict between positive and negative free speech rights created by "access legislation").
[60] Jane Bambauer, *Is Data Speech?*, 66 STAN L. REV. 57 (2014).
[61] *Id.* at 60.

reviewed and interpreted."[62] But, Bambauer claims, "asking whether all data should be treated as speech misses the point: any time the state regulates information precisely because it informs people, the regulation rouses the First Amendment."[63] She explains that personal data is at once a compilation of facts (or potential "speech") and a valuable commodity:

> Data communicates. It tells a narrative just as effectively as prose, imagery, and music to those with the training to interpret it. Its style is dry, but this does not interfere with its ability to light up the mind. A database can be interpreted directly by a person with the help of a codebook, and it can also be translated into other more familiar forms of expression like maps, charts, graphs, and descriptive sentences.[64]

It is important to note that Bambauer's article uses the term "information" to refer to "any objective representation of something that has occurred"—it does not need to be man-made.[65] On the other hand, "data" refers to information that has been deliberately "captured and recorded into a fixed, man-made format."[66] In this respect, she points out that "man-made data has more similarities to traditional speaker-listener arrangements than other types of information . . . so it might have a more promising claim to the First Amendment's protections."[67] She explains that "[s]ome scholars, myself included, have homed in on the distinction between functional data and other types of records as a useful boundary for law."[68]

On the other hand, Bambauer claims that the distinction between "information" and "information-gathering", which has been used to determine what is and is not protected, is untenable because it arbitrarily gives preference to older information-gathering methods while disfavoring new technologies.[69] After evaluating existing case law, she concludes that it strongly suggests the conclusion that the First Amendment protects raw facts.[70] She deems other cases that come to the

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[62] *Id.*
[63] *Id.* at 60–61.
[64] *Id.* at 70.
[65] *Id.* at 65.
[66] Jane Bambauer, *Is Data Speech?*, 66 STAN L. REV. 65 (2014).
[67] *Id.* at 66.
[68] *Id.*
[69] *Id.* at 61 ("The cases treat a journalist who observes an event differently depending on whether she records the incident by taking meticulous notes using pad and paper (protected) or by using the video function on her iPhone (unprotected).").
[70] *Id.* at 71–77 (considering cases addressing First Amendment challenges to privacy regulations, limitations on commercial speech, copyright law, and identifying a pattern "illustrating that the right to speech requires, and assumes, a right to learn new things").

conclusion that data creation is conduct, and not speech (because it is insufficiently expressive), as outdated.[71] Bambauer argues, instead, that data should receive First Amendment speech protection any time the motive behind personal information regulation (privacy legislation) is limiting the spread of information.[72]

The logic of Bambauer's argument is at least partly grounded on a "right to receive" or right to listen.[73] Because the article goes on to propose a First Amendment rule centered around an individual right to record available information and learn from it, or a right to "create knowledge," the lack of a traditional speaker turns out not to be determinative.[74]

Julie E. Cohen has also addressed the conflict between free speech and privacy interests in her comprehensive assessment of theories of data privacy.[75] She explains that one of these theories is based on the idea that data privacy protection would interfere with data collectors' speech rights and prevent them from participating in the "marketplace of ideas."[76] Cohen claims that this theory is flawed because substantial government interests in data privacy have been overlooked, individual autonomy has been undervalued, and market-institutional considerations of information exchanged as property (securities, patent, copyright, etc.) have been overvalued.[77] "In the sense that counts for First Amendment purposes, personally-identified data is not collected, used or sold for its expressive content at all; it is a tool for processing people, not a vehicle for injecting communication into the 'marketplace of ideas.'"[78] She considers that "the data itself is distinct from the speech that proposes and defines the transaction. . . . The data is itself the subject matter of the transaction—the 'goods' exchanged. . . . It isn't purchased to be 'read.'"[79] "The accumulation, use, and market exchange of personally-identified data . . . aren't really 'speech' at all."[80]

Cohen further argues that the First Amendment right to publish personally identified facts is not absolute, and should be limited on the basis of "newsworthiness."[81] Ultimately, she rejects all of the traditional theories of data privacy and proposes a new "personal autonomy"

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[71] Jane Bambauer, *Is Data Speech?*, 66 STAN L. REV. 77–86 (2014).
[72] *Id.* at 87.
[73] *Id.* at 74–75.
[74] *Id.* at 84–105.
[75] Julie E. Cohen, *Examined Lives: Informational Privacy and the Subject as Object*, 52 STAN. L. REV. 1373 (2000).
[76] *Id.* at 1409, 1411.
[77] *Id.* at 1408–23.
[78] *Id.* at 1414.
[79] *Id.* at 1417–18 (footnote omitted).
[80] Julie E. Cohen, *Examined Lives: Informational Privacy and the Subject as Object*, 52 STAN. L. REV. 1418 (2000).
[81] *Id.* at 1429.

framework that permits data privacy measures within the parameters of the Constitution.[82] "The point is that these are difficult questions that can't be answered by rote incantation of the proposition that information exchange is speech. It just isn't that simple."[83] She posits that "personally-identified data [should be] the property or quasi-property of the individual to whom it refers."[84] In such a world, "data processors' asserted speech rights cannot be absolute, and may not prevail at all."[85] More importantly, she states, "the First Amendment protects the right to publish information lawfully obtained through one's own efforts."[86]

Shubha Ghosh, on the other hand, argues that regulation of information (as described in *Sorrell*) is not inconsistent with First Amendment values and can in fact encourage the marketplace of ideas.[87] Some regulation encourages the underlying values of "liberty, autonomy, and fairness."[88] However, his article mostly emphasizes the commercial speech that results after the data in question is accessed, and does not especially touch on whether the data itself is speech for the purposes of the First Amendment.[89] It instead explores ownership of data under copyright, patent, trade secret, and misappropriation theories.[90]

Finally, Eugene Volokh avers that, although contract-based privacy limitations are constitutionally sound, broader information privacy legislation may not be.[91] He worries that creating a new First Amendment exception for personally identifiable data (or broadening an existing exception) could be directly applicable to other methods of speech controls, thereby creating a problematic precedent.[92] If broadened, existing constitutional speech restrictions based on intellectual property,[93] restraints on commercial speech,[94] restraints on

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[82] *Id.* at 1377.
[83] *Id.* at 1419.
[84] *Id.* at 1420.
[85] *Id.*
[86] *Id.* at 1429.
[87] Shubha Ghosh, *Informing and Reforming the Marketplace of Ideas: The Public-Private Model for Data Production and the First Amendment*, 2012 UTAH L. REV. 653 (2012).
[88] *Id.* at 658.
[89] *Id.* Ghosh notes that Justice Kennedy's majority opinion in *Sorrell* recognized raw information as "speech" rather than a "mere commodity" to be traded or regulated without regard for First Amendment protection. *Id.* at 661–62 (citing Sorrell v. IMS Health Inc., 131 S. Ct. 2653, 2666–67 (2011)). However, Ghosh focuses primarily on the significance of the data as "valuable components of inputs to decision-making and the crystallization of knowledge and opinions." *Id.* at 662.
[90] *Id.* at 669–83.
[91] Eugene Volokh, *Freedom of Speech and Information Privacy: The Troubling Implications of a Right to Stop People from Speaking About You*, 52 STAN. L. REV. 1049 (2000).
[92] *Id.* at 1051.
[93] *Id.* at 1063–80. Some privacy advocates have argued that individuals may have a property interest in personal information about themselves. *See, e.g.*, Cohen, *supra* note 75, at 1420

speech not of public concern,[95] or restraints narrowly tailored to a compelling government interest,[96] could be applied as precedent to allow other types of restrictions.[97] He warns that, once people grow to accept, and even like, government restrictions on supposedly "unfair" communication of true facts, it may be easier to justify further restrictions promoting the government's idea of "fairness."[98]

All in all, there is great disagreement about the level of First Amendment protection that different types of information or data should receive. Myriad approaches have been suggested, with no clear consensus being reached. In fact, even the implications of the Supreme Court's own holding in *Sorrell* are the subject of substantial dispute. Hence, it is unlikely that our analysis of the expressive aspects of DNA will easily be settled solely on the basis of theories regarding the First Amendment coverage of information or data.

(arguing that personal information is the "quasi-property of the individual to whom it refers"); Lawrence Lessig, *The Architecture of Privacy*, 1 VAND. J. ENT. & TECH. L. 56, 63 (1999) (suggesting that in light of increasingly permanent, precise, and efficiently searchable records of information and behavior, the law could protect privacy through property law by "g[iving] individuals the rights to control their data"); Richard S. Murphy, *Property Rights in Personal Information: An Economic Defense of Privacy*, 84 GEO. L.J. 2381 (1996) (discussing the economic benefits to both the dissemination of personal information and protection of privacy, and considering property rights in information disclosed with consent, either express or implied, and information disclosed involuntarily). Professor Volokh argues that restrictions on distribution of information based in property rights are nevertheless restrictions on speech, and concludes that existing intellectual property law does not cover personal information and cannot be expanded to do so without creating a potential for privatization of pure facts. Volokh, *supra* note 91, at 1063–80.

[94] Volokh, *supra* note 91, at 1080–87. Professor Volokh identifies "commercial speech" as that which "proposes a commercial transaction," rather than speech sold as an article of commerce or speech pertaining solely to economic interests. *Id.* at 1080–81. Therefore, existing commercial speech doctrine would not encompass communications of consumer data from one business to another (even though the speakers may not be individuals and the content of the message is fact rather than ideas). *Id.* at 1082–84. Broadening the definition of "commercial speech" to include such communications, argues Volokh, will pose a risk to other speech touching on economic matters. *Id.* at 1084–87.

[95] *Id.* at 1088–1106. Volokh argues that restrictions on private information grounded in a distinction between matters of public and private concern are untenable in theory and unsupported by precedent. *Id.* at 1088–98. Adoption of this theory, he warns, gives courts the slippery task of determining what information is and is not of "legitimate public interest" and provides a platform to not only expand existing restrictions on speech (those on sexually-themed speech, for example), but also to create new ones. *Id.* at 1098–1106.

[96] *Id.* at 1106–22. Some scholars suggest that even if private data is protected speech under the meaning of the First Amendment, it may nevertheless be regulated where there is a countervailing compelling government interest in doing so. *Id.* Professor Volokh identifies several proposed compelling interests—preservation of dignity, preventing emotional distress, recognition of "privacy" as a "civil right," ensuring that Internet use remains attractive to privacy-conscious consumers, and obstructing discrimination or fraud—and concludes that the First Amendment does not permit content-based restrictions on speech merely because it is offensive or distasteful, might conceivably inhibit economic growth, or has the potential to facilitate misconduct. *Id.* at 1110–22.

[97] *Id.* at 1122–24.

[98] *Id.* at 1115–16.

B. *Who Can Speak?*

Our discussion of DNA as "speech" also necessarily raises questions regarding the role of a speaker. If DNA can indeed be recognized as speech under some circumstances, whose speech is it? Does our First Amendment jurisprudence require a speaker before free speech coverage can be triggered? New technologies like genetic testing and modification reshape our understanding of what "speech" is for the purposes of First Amendment analysis, and raise questions about the significance and role of the "speaker" in that analysis. Some scholars propose a methodology that disregards this question almost completely.[99] However, some courts and other commentators have highlighted the need for a human speaker to trigger First Amendment coverage.

The first such case is that of Blackie the Talking Cat. In *Miles v. City Council of Augusta*, the Eleventh Circuit Court of Appeals found that there could be no violation of Blackie the Talking Cat's purported First Amendment rights because the Bill of Rights only protects persons, not talking cats. [100] The court expounded, only partly tongue-in-cheek,

> This Court will not hear a claim that Blackie's right to free speech has been infringed. First, although Blackie arguably possesses a very unusual ability, he cannot be considered a "person" and is therefore not protected by the Bill of Rights. Second, even if Blackie had such a right, we see no need for appellants to assert his right *jus tertii*. Blackie can clearly speak for himself.[101]

The Free Speech Clause, then, could not just be invoked by anything, but only by a "person," under the Constitution. However, the question remains as to whether the issue in *Miles* was limited to one of standing; the court did not expand upon the underlying substantive issue of whether the cat's utterances could be considered "speech."[102]

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[99] *See* Bambauer, *supra* note 60. In her assessment of whether data can be speech under the meaning of the First Amendment, Professor Bambauer rejects the theory that the distinction should be based on whether the information at issue was compiled by a human "speaker" or collected mechanically. *Id.* at 59–60. Instead, she suggests, First Amendment scrutiny is triggered not based on the existence of an identifiable "speaker" or an intended "listener," but whether the government is "regulat[ing] information . . . because it informs people." *Id.* at 61.

[100] Miles v. City County of Augusta, 710 F.2d 1542 (11th Cir. 1983).

[101] *Id.* at 1544 n.5.

[102] Blackie's alleged First Amendment rights were in fact ancillary to the case; the plaintiffs objected to a provision of an Augusta ordinance requiring purchase of a $50 business license to engage in trades or occupations not otherwise mentioned, on the grounds that it was vague and overbroad facially and as applied to their practice of collecting "donations" from visitors seeking to hear Blackie. *Id.* at 1543–44. The district court disposed of plaintiffs' argument that the licensing requirement infringed their First Amendment rights by concluding that the ordinance was a permissible revenue-generating occupation tax, not a restriction against solicitation or

Tim Wu has taken a tack akin to the one that finished Blackie the Talking Cat's constitutional ambitions.[103] With regards to Blackie the Talking Cat, Wu has this to say,

> It should be clear that a computer and Blackie are similar. Neither is human, and both have been trained to express themselves in a way that is informative or entertaining to humans. As such, Blackie the Talking Cat is indicative of one way that courts treat nonhumans who generate what resembles human speech: not very seriously. . . . The presumption in Blackie—that the identity of the speaker matters for the First Amendment—is also reflected by courts' treatment of children and young adults. Judicial decisions in the last four decades suggest that young people have First Amendment rights, but fewer than those of adults.[104]

Wu has addressed the interesting question of potential "speech" generated by computer processes and algorithms.[105] He explains that as computers are relied on to do more and more tasks, they "reason through automated algorithms" and output, send, and receive information in communications called "algorithmic outputs."[106] Some commentators consider this output First Amendment speech when it is communicative in nature.[107] However, Wu argues that this analysis fails because it yields absurd results.[108] Instead, he claims, courts should treat communications differently when they are "closely tied to some functional task."[109] According to Wu, coverage may be limited in a way that allows the state to "regulate the functional aspects of the communication process, while protecting its expressive aspects."[110]

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speech. Miles v. City Council of Augusta, 551 F. Supp. 349, 351–52 (S.D. Ga. 1982). The Eleventh Circuit affirmed on the grounds that Blackie's "speaking engagements" were plainly a business "entirely intended for pecuniary enrichment" and within the legitimate scope of the city's occupation tax ordinance, rather than hinging its decision on whether Blackie's vocalizations were First Amendment speech. *Miles*, 710 F.2d at 1544.

[103] Tim Wu, *Machine Speech*, 161 U. PA. L. REV. 1495 (2013) [hereinafter Wu, *Machine Speech*].

[104] *Id.* at 1501.

[105] *Id.* at 1496.

[106] *Id.*

[107] *Id.* at 1497. *See, e.g.*, Stuart Minor Benjamin, *Algorithms and Speech*, 161 U. PA. L. REV. 1445, 1482–83 (2013) (proposing that First Amendment coverage could be extended to communications by algorithms, provided they have been sent and received with a "substantive message"); Eugene Volokh & Donald M. Falk, *Google: First Amendment Protection for Search Engine Search Results*, 8. J.L. ECON. & POL'Y 883, 892 (2012) (asserting that Internet search results generated automatically by algorithms are First Amendment speech, in part because the output is "expressive" rather than purely mechanical).

[108] Wu, *Machine Speech*, *supra* note 103, at 1527–29. A car alarm, points out Wu, is expressive of the mechanism's "opinion" that the car is being stolen, but cannot reasonably be considered speech. *Id.* at 1527.

[109] *Id.* at 1496.

[110] *Id.* at 1497.

First, "courts tend to withhold protection from carrier/conduits . . . [which] handle, transform or process information" but do not necessarily regulate or even know the content of the communication, and ultimately have a primarily functional relationship with that content, such as a Federal Express.[111] Second, courts do not usually protect functional tools, such as contracts or navigational charts.[112] According to Wu, these two tendencies create a functionality doctrine that provides a framework for analyzing algorithmic outputs.[113]

As a result, Wu draws a tentative line between protected "speech products" and unprotected "communication tools."[114] Following this logic, coverage of blogging software, GPS navigation, etc. must be examined more closely to balance the interests of public communication and private commercial interests.[115]

Wu then identifies four lines demarcating coverage under the First Amendment: personhood,[116] speech,[117] motive,[118] and abridgement.[119] In light of these considerations, Wu argues, "[f]unctionality will usually be the line that divides speech and communications."[120] Under this standard, Google search results do not merit First Amendment protection because the output is an elaborate, functional index rather

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111 *Id.*

112 *Id.*

113 *Id.*

114 *Id.* at 1498.

115 *Id.* On the one hand, free speech values are advanced when modern-day speakers' interactions with advancing technology fall within the ambit of First Amendment coverage. On the other, overbroad First Amendment coverage threatens to constitutionalize private commerce and software development and raises concerns regarding attribution of speech to multiple institutional "speakers." *See id.* at 1498, 1504–06.

116 *Id.* at 1500–06. Wu evaluates case law surrounding different types of "speakers" and concludes that the identity of the speaker is pertinent as to whether and to what extent the First Amendment covers and protects expression. *Id.* at 1500–03. Wu concludes that machines and programs that produce algorithmic outputs are, like Blackie the cat, unlikely to qualify as cognizable "speakers" for the purpose of evaluating free speech rights. *Id.* at 1503. Instead, any resulting "speech product" is more plausibly attributable to the program's designer, while individual users of "communication tools" like Twitter are the speakers of the content they generate. *Id.* at 1504–06.

117 *Id.* at 1506–14. Wu concludes that the distinction between protected speech and unprotected communications is derived from the Supreme Court's gradual development of categorical exclusions (those categories of communication that the Supreme Court does not recognize as speech, such as obscenity) and inclusions (communications that are always subject to First Amendment scrutiny, such as protests). *Id.* at 1508–12. Under this framework, Wu notes that the Supreme Court has already begun to develop categorical inclusions for certain types of computer programs and predicts that courts will continue to develop these categorical rules in establishing whether a machine's communications are speech. *Id.*

118 *Id.* at 1514–16 (noting that First Amendment scrutiny can be triggered wherever the government's motive for imposing the restriction is censorship of the communication's content). *See also* Bambauer, *supra* note 60.

119 *Id.* at 1516–17 ("An extraordinarily opaque dimension of the First Amendment's domain is provided by the requirement that the law in question must actually burden speech.").

120 *Id.* at 1517.

than an expression of Google's (or Google programmers') choices.[121] Accordingly, Wu concludes, electronic concierges should be analyzed in much the same way, such that the more a programmer's own biases or opinions are projected, the more likely there will be First Amendment coverage.[122]

It should be noted that the "functionality" paradigm that Wu endorses has been criticized by other commentators and rejected by some courts for a variety of reasons.[123]

Moreover, the argument that only human speech should be entitled to First Amendment coverage finds little support in *Search King, Inc. v. Google Technology, Inc.*[124] In *Search King*, the District Court found Google immune from tort liability for decreasing the PageRank of the plaintiff's website because the rankings, despite being advertised as honest and objective, are opinions protected by the First Amendment.[125] The Court reasoned that Google's algorithms that determine the rankings are ultimately subjective representations of its programmers' decisions regarding which factors should be weighed and how heavily.[126]

More importantly, the Supreme Court has made some recent (and some not so recent) statements regarding the free speech rights of corporations that weigh against limiting First Amendment coverage simply because of the lack of a human speaker. For example, when a corporation is "speaking," the Court emphasized the nature of the expression rather than the identity of the speaker.[127] Similarly, almost forty years ago, in *First National Bank of Boston v. Bellotti*, the Court explained that "[t]he inherent worth of the speech in terms of its capacity for informing the public does not depend upon the identity of

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121 *Id.* at 1528–29. *See also* Tim Wu, Opinion, *Free Speech for Computers?*, N.Y. TIMES (June 19, 2012), http://www.nytimes.com/2012/06/20/opinion/free-speech-for-computers.html ("[A]s a general rule, nonhuman or automated choices should not be granted the full protection of the First Amendment, and often should not be considered 'speech' at all".).

122 Wu, *Machine Speech*, *supra* note 103, at 1531–33. "The rule of thumb is this: the more the concierge merely tells the user about himself, the more like a tool and less like protected speech the program is." *Id.* at 1533.

123 *See* Junger v. Daley, 209 F.3d 481, 484 (6th Cir. 2000) ("The fact that a medium of expression has a functional capacity should not preclude its constitutional protection. Rather, the appropriate consideration of the medium's functional capacity is in the analysis of permitted government regulation."); Robert Post, *Encryption Source Code and the First Amendment*, 15 BERKELEY TECH. L.J. 713, 714 (2000) [hereinafter Post, *Encryption*] (noting that while movie projectors are unambiguously functional devices, they are clearly within the reach of the First Amendment); Jorge R. Roig, *Emerging Technologies and Dwindling Speech*, 16 U. PA. J. CONST. L. 1235, 1259 (2014).

124 Search King, Inc. v. Google Technology, Inc., No. CIV-02-1457-M, 2003 WL 21464568 (W.D. Okla. May 27, 2003).

125 *Id.* at *3.

126 *Id.* at *4.

127 *See* First Nat'l Bank of Boston v. Bellotti, 435 U.S. 765 (1978); *see also* Wu, *Machine Speech*, *supra* note 103, at 1502.

its source, whether corporation, association, union, or individual."[128] This holding was recently reaffirmed in *Citizens United v. Federal Election Commission*.[129] In *Citizens United*, the Court stated that "[t]he Court has recognized that First Amendment protection extends to corporations."[130]

Regarding the Supreme Court's treatment of corporate speech, Wu explains,

> Courts treat corporations far more generously than either young adults or animals. Since First National Bank of Boston v. Belotti in 1978, the Supreme Court has taken the position that when a corporation is speaking, courts should ignore the identity of the speaker and focus on the nature of the expression. . . . The main difference the courts draw between animals, minors, and corporations centers on the quality of the speech in question, and in particular the sense that the expression reflects intelligent choices.[131]

In this instance as well, there does not seem to be an easy path to follow in determining whether DNA should be covered under the First Amendment on the basis of the identity of the speaker, or lack thereof. Hence, we must dig deeper into the particular nature of DNA and, more importantly, the specific social practices and usages that human beings are engaging in that exploit DNA's communicative potential.

II. CAN DNA BE SPEECH?

While the First Amendment expressly protects freedom of "speech,"[132] it is clear that its coverage extends far beyond the spoken word.[133] Whether DNA molecules themselves, the information they contain, or their intentional manipulation might merit First Amendment coverage depends on whether they fall under the Supreme Court's expansive definition of speech.

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[128] *Bellotti*, 435 U.S. at 777. Justice Powell, writing for the majority, emphasizes the dual role of the First Amendment in protecting not only the individual speaker's right to self-expression but a general right of the public "to discussion, debate, and dissemination of . . . ideas." *Id.* at 783. In concluding that the plaintiff's identity is irrelevant to resolution of the free speech claims, the *Bellotti* court seems to suggest that First Amendment protection extends to information disseminated by any speaker, even Blackie the Cat.

[129] Citizens United v. Fed. Election Comm'n, 558 U.S. 310 (2010).

[130] *Id.* at 342.

[131] Wu, *Machine Speech*, *supra* note 103, at 1502–03.

[132] U.S. CONST. amend. I.

[133] *See* Charles W. Rhodes, *The First Amendment Structure for Speakers and Speech*, 44 SETON HALL L. REV. 395, 429–39 (2014) (discussing the extension of First Amendment coverage to various non-linguistic forms of communication).

A. *A Framework for Analysis*

This Article considers the question of First Amendment coverage using a two-part inquiry: 1) is the particular activity communicative enough to be considered speech for First Amendment purposes or, if the activity at issue is not communicative in and of itself, is it central to the development of a medium for the expression of ideas?; and 2) if the activity passes either of these criteria, does it advance First Amendment values so as to merit coverage as "speech?"[134] In short, only activities that are either inherently communicative or necessary as a medium to facilitate expression *and also* advance First Amendment values are considered speech for the purposes of coverage and analysis.[135]

1. Step One: Is the Activity Sufficiently Related to Expression?

First, we need to consider whether the activity under consideration is sufficiently related to expression to merit First Amendment coverage.[136] There are two ways in which this can happen.[137] First, the activity may be communicative, as established by the Supreme Court.[138] Second, even if not communicative in and of itself, the activity may be so central to the development of a medium for the communication of ideas that its regulation might raise First Amendment concerns.[139]

a. Is the Activity Itself Communicative Enough?

The Supreme Court has defined speech for First Amendment purposes in a series of cases addressing both expressly communicative conduct (such as the oral or written word) and "symbolic speech" or "expressive conduct."[140] Whether relating to "pure speech" or symbols or activities that convey ideas, the Court considers the parameters of First Amendment coverage based on the communicative nature of the asserted "speech."[141]

The Court has consistently held that the written or spoken word constitutes pure speech, "entitled to comprehensive protection under the First Amendment."[142] Pure language is generally recognized as inherently communicative, such that "a court need only assess the expressiveness of conduct in the absence of the 'spoken or written word.'"[143] With notable exceptions,[144] the oral or written word is

134 *See* Roig, *Decoding*, *supra* note 8, at 325–26.
135 *Id.* at 326.
136 *Id.* at 326–27.
137 *Id.* at 327.
138 *Id.*
139 *Id.*
140 Spence v. Washington, 418 U.S. 405 (1974).
141 *Id.*
142 Tinker v. Des Moines Indep. Cmty. Sch. Dist., 393 U.S. 503, 506 (1969).
143 Bernstein v. U.S. Dep't of State, 922 F. Supp. 1426, 1434 (N.D. Cal. 1996).

usually considered speech per se, automatically within the spectrum of First Amendment coverage.[145]

Where an activity lacks the inherently communicative nature of the written or spoken word, but is nevertheless expressive, the Court has developed and modified a series of tests to determine whether the activity at issue constitutes speech under the meaning of the First Amendment. In *Spence v. Washington*,[146] the Court used a two-prong test to conclude that the display of an upside-down United States flag affixed with a large peace symbol was protected expression.[147] Under this test, the activity or symbol a) must have "an intent to convey a particularized message"[148] and b) must contain a "likelihood . . . that the message [will] be understood."[149] About twenty years later, the Court modified the test to eliminate the requirement of a particularized message.[150] According to the Court, limiting constitutional protections to expressions of "a narrow, succinctly articulable message . . . would never reach the unquestionably shielded painting of Jackson Pollock, music of Arnold Schoënberg, or Jabberwocky verse of Lewis Carroll."[151] This test has since been applied to extend First Amendment coverage to other activities that, considered in context, have the potential to communicate and express ideas.[152]

While the Court and most commentators have traditionally recognized a doctrinal distinction between "pure speech" and "expressive conduct,"[153] closer consideration reveals that both forms of expression are subject to the same analysis.[154] Ultimately, whether a given activity is considered speech or not turns on whether, under the circumstances and within a given social context, a symbol, gesture, action, or representation has the potential to communicate a message.[155] In the case of "pure speech," the Court has made a per se determination that written and spoken languages are so broadly culturally recognized as communicative tools that their expressive nature is presumed to fall

144 See discussion *infra* Section II.A.2 regarding traditionally disfavored categories of speech.
145 *See, e.g.*, *Tinker*, 393 U.S. at 505–06; Cox v. Louisiana, 379 U.S. 536, 555 (1965) (suggesting that communications made by pure speech are afforded special freedoms under the First and Fourteenth Amendments).
146 418 U.S. 405 (1974).
147 *Id.* at 416.
148 *Id.* at 410–11.
149 *Id.* at 411.
150 Hurley v. Irish-American Gay, Lesbian & Bisexual Grp. of Bos., 515 U.S. 557, 569 (1995).
151 *Id.*
152 *See, e.g.*, Virginia v. Black, 538 U.S. 343, 354–57 (2003) (recognizing the expressive nature and various messages potentially communicated by burning a cross); Texas v. Johnson, 491 U.S. 397 (1989) (extending First Amendment protection to flag burning as part of a political demonstration).
153 Roig, *Decoding*, *supra* note 8, at 334–37.
154 *Id.*
155 *Id.* at 333–34.

within the umbrella of the First Amendment.[156] Other forms of expressive conduct must be examined more closely to determine whether, in a given social and cultural context, the activity has the potential to express an idea to others.[157] Regardless of whether the expression takes the form of spoken language or a symbolic gesture, the inquiry remains the same: does the activity have the potential to communicate an idea, even if the idea is not readily discernible or even if communication is not specifically intended?[158]

b. Is the Activity Central to the Development of a Medium for the Communication of Ideas?

Even when an activity itself is not communicative enough to be considered speech, it may still merit First Amendment coverage if it is central to the development of communicative media.[159] Newspapers,[160] motion pictures,[161] and the Internet[162] have been recognized as media for the communication of ideas subject to First Amendment protection. Accordingly, regulation of non-speech conduct that ultimately restricts the development of these media is also subject to First Amendment scrutiny. For example, "[i]f the state were to prohibit the use of projectors without a license, First Amendment coverage would undoubtedly be triggered."[163] Similarly, courts have held that regulations on the placement of newspaper racks[164] and restrictions on computer software code[165] must be considered under the First Amendment. Even when an activity lacks independent communicative value under the first prong of the test, it may still be deemed essential to the development of communicative media under the second prong.

2. Step 2: Does the Activity Promote First Amendment Values?

The inquiry does not end after an activity has been identified as either communicative or crucial to communicative media. Even where an activity has been identified as either communicative or crucial to communicative media, the inquiry does not end there. Even "pure speech," which is undoubtedly communicative, is not necessarily

156 *Id.* at 330–32.
157 *Id.* at 337 ("The Court has simply given us a test—the Spence-Hurley test—for deciding when a particular activity is communicative enough to be considered speech for purposes of First Amendment coverage: when, in a particular social context, sufficient conventions exist such that the communication of ideas between people is possible . . . .") (emphasis omitted).
158 *Id.*
159 Post, *Encryption*, *supra* note 123, at 717.
160 City of Lakewood v. Plain Dealer Publ'g Co., 486 U.S. 750 (1988).
161 Joseph Burstyn, Inc. v. Wilson, 343 U.S. 495, 501 (1952).
162 Reno v. ACLU, 521 U.S. 844, 870 (1997).
163 Post, *Encryption*, *supra* note 123, at 717.
164 *City of Lakewood*, 486 U.S. at 750.
165 Universal City Studios, Inc. v. Corley, 273 F.3d 429 (2d Cir. 2001).

subject to First Amendment coverage: fighting words,[166] for example, or certain defamatory false statements of fact[167] are clearly expressive, yet their "prevention and punishment [has] never been thought to raise any Constitutional problem."[168] This apparent inconsistency reflects the Court's determination that certain types of speech are "no essential part of any exposition of ideas"[169] and "utterly without redeeming social importance."[170] Communicative value alone, then, does not explain the Court's "speech" jurisprudence. Even overtly expressive conduct may not fall within the scope of the First Amendment if it does not advance any of the social values underlying the Free Speech Clause. This Article identifies four such values: 1) truth; 2) democracy; 3) autonomy; and 4) community.[171]

a. Truth

The significance of the First Amendment has frequently been described in terms of competition between opposing beliefs, often articulated as the "marketplace of ideas."[172] In this fictional marketplace, various ideas may "compete" freely and without government interference,[173] allowing the best ideas to eventually gain public acceptance by "entrusting the people to judge what is true and what is false."[174] The Supreme Court has used this analytical framework to deny First Amendment coverage to otherwise expressive activity, holding that the "risk that the Government may effectively drive certain ideas or viewpoints from the marketplace" is "inconsequential" in the case of obscene or defamatory speech "because the social interest in order and morality outweighs the negligible contributions of those categories of speech to the marketplace of ideas."[175] Thus, even some utterances of the oral or written word may fall outside of the scope of the First Amendment if they do not promote the truth-finding function or contribute to the marketplace of ideas.

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166 *See, e.g.*, R.A.V. v. City of St. Paul, Minn., 505 U.S. 377 (1992); Chaplinsky v. New Hampshire, 315 U.S. 568 (1942); Purtell v. Mason, 527 F.3d 615 (7th Cir. 2008).
167 Gertz v. Robert Welch, Inc., 418 U.S. 323, 340 (1974).
168 *Chaplinsky*, 315 U.S. at 571–72.
169 *Id.* at 572.
170 Roth v. United States, 354 U.S. 476, 484 (1957).
171 *See* Roig, *Decoding*, *supra* note 8, at 347–58. *See also* Robert Post, *Participatory Democracy and Free Speech*, 97 VA. L. REV. 477, 478 (2011) [hereinafter Post, *Participatory Democracy*]; *but see* Lee Tien, *Publishing Software as a Speech Act*, 15 BERKELEY TECH. L.J. 629, 636–37 (2000) (arguing that coverage is a reflection of "whether someone is speaking" rather than a "grand theoretical framework of First Amendment values").
172 Abrams v. United States, 250 U.S. 616, 624 (1919) (Holmes, J., dissenting). *See also* United States v. Alvarez, 132 S. Ct. 2537, 2545 (2012); Davenport v. Wash. Educ. Ass'n, 551 U.S. 177, 188–89 (2007); McIntyre v. Ohio Elections Comm'n, 514 U.S. 334, 341–42 (1995).
173 N.Y. State Bd. of Elections v. López Torres, 552 U.S. 196, 208 (2008).
174 Citizens United v. Fed. Election Comm'n, 558 U.S. 310, 355 (2010).
175 *Davenport*, 551 U.S. at 188.

Critics argue that the "marketplace" model fails because it rests on the erroneous assumption that the availability of more information will ultimately result in good ideas and accurate facts driving out bad ideas and falsehoods.[176] Others suggest that today's marketplace is distorted and dominated by corporate speakers and the elite, particularly in the wake of the Supreme Court's decision in *Citizens United v. Federal Election Commission*.[177] Still, others argue that "truth" is not an objective value.[178] Despite these and other critiques, however, the search for truth continues to serve as an underlying principle that informs First Amendment jurisprudence. But while the "marketplace of ideas" is a prevalent and instructive doctrine, the search for truth cannot be the only value underlying freedom of speech.[179]

b. Democracy

Other commentators analyze the First Amendment in terms of its relationship to preserving a healthy democracy.[180] This contribution can be assessed under three models of self-governance: the participatory model, the Meiklejohnian model, and the adversarial model.[181]

The participatory model emphasizes the role of open public

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[176] *See, e.g.*, Derek E. Bambauer, *Shopping Badly: Cognitive Biases, Communications, and the Fallacy of the Marketplace of Ideas*, 77 U. COLO. L. REV. 649, 673–703 (2006) (explaining how biases in acquiring, processing, and using information undermine the assumption that over time, people will distinguish truth from falsehood); Lyrissa Barnett Lidsky, *Nobody's Fools: The Rational Audience as First Amendment Ideal*, 2010 U. ILL. L. REV. 799 (2010) (arguing that the marketplace theory's core presumption that audiences are generally rational and can distinguish the truth, quality, and credibility of speech has been called into question by empirical evidence).

[177] As Justice Stevens expressed in his dissent:

> [T]here are substantial reasons why a legislature might conclude that unregulated general treasury expenditures will give corporations "unfai[r] influence" in the electoral process, and distort public debate in ways that undermine rather than advance the interests of listeners. The legal structure of corporations allows them to amass and deploy financial resources on a scale few natural persons can match.

Citizens United, 558 U.S. at 469 (Stevens, J., dissenting) (citation omitted). *See also* Saby Ghoshray, *Examining* Citizens United*'s Expansive Reach: Looking Through the Lens of the Marketplace of Ideas and Corporate Personhood*, 57 WAYNE L. REV. 373, 411–14 (2011) ("[W]hat is the legitimate chance that a non-corporate individual's political speech will be able to rise through the domineering conglomeration of corporate speech from the media, Internet, and associated technological paraphernalia, in order to retain its visibility?").

[178] *See* Pierre J. Schlag, *An Attack on Categorical Approaches to Freedom of Speech*, 30 UCLA L. REV. 671, 727 (1983) ("Some have argued that truth is not objective, but rather subjective, that is, dependent upon the personality, values, and past history of a particular individual.").

[179] *See* Post, *Participatory Democracy*, *supra* note 171, at 479 (emphasizing that truth cannot be the only value favored by the First Amendment, as "[t]he First Amendment recognizes no such thing as a 'false' idea." (quoting Hustler Magazine, Inc. v. Falwell, 485 U.S. 46, 51 (1988))).

[180] *See* Burt Neuborne, *Toward a Democracy-Centered Reading of the First Amendment*, 93 NW. U. L. REV. 1055 (1999).

[181] Martin H. Redish & Abby Marie Mollen, *Understanding Post's and Meiklejohn's Mistakes: The Central Role of Adversary Democracy in the Theory of Free Expression*, 103 NW. U. L. REV. 1303 (2009).

discourse and political participation in legitimizing democratic government.[182] A "sense of inclusion"[183] in the democratic process is essential to preserving underlying core values of self-governance and self-determination.[184] Under this approach, the First Amendment should preserve this individual sense of authorship and participation by "safeguarding . . . public discourse from regulations that are inconsistent with democratic legitimacy."[185] Thus, First Amendment protection should extend to "those speech acts and media of communication that are socially regarded as necessary and proper means of participating in the formation of public opinion."[186]

By contrast, the Meiklejohnian model deemphasizes the importance of individual, personal feelings of involvement in governance in favor of ultimately attaining "the voting of wise decisions."[187] Under this model, democracy is advanced not by enabling everyone to participate, but by ensuring the circulation of as much information as possible and enabling voters to "make the best-informed, most intelligent, democratic decisions."[188] Therefore, the First Amendment should primarily preserve the right to access and use information necessary to cast an informed vote.[189]

The adversarial model recognizes the competing ideologies, values, and interests in American life and sees the democratic process as the framework in which advocates of contrary positions continuously battle for political victories.[190] These conflicts are resolved by democratic equality: the power to determine the outcome is distributed equally through the vote, and individuals and groups can seek to influence that outcome by persuading others to vote according to their own preferences.[191] "The relationship is adversarial . . . because it acknowledges that collective decisionmaking will inevitably produce winners and losers."[192] The First Amendment serves this model by enabling individuals to identify and promote where their own interests lie among these competing values, make democratic decisions to

[182] Robert Post, *The Constitutional Status of Commercial Speech*, 48 UCLA L. REV. 1, 7 (2000) ("[D]emocratic legitimacy depends upon citizens having the warranted belief that their government is responsive to their wishes.").
[183] Redish & Mollen, *supra* note 181, at 1323.
[184] *See* Robert Post, *Reconciling Theory and Doctrine in First Amendment Jurisprudence*, 88 CAL. L. REV. 2353, 2367 (2000).
[185] *Id.* at 2368.
[186] Post, *Participatory Democracy*, *supra* note 171, at 483.
[187] Redish & Mollen, *supra* note 181, at 1312.
[188] Roig, *Decoding*, *supra* note 8, at 353.
[189] *See* Citizens United v. Fed. Election Comm'n, 558 U.S. 310, 339 (2010) ("The right of citizens to inquire, to hear, to speak, and to use information to reach consensus is a precondition to enlightened self-government and a necessary means to protect it.").
[190] Redish & Mollen, *supra* note181, at 1351–52.
[191] *Id.* at 1353–54.
[192] *Id.* at 1354.

advance those interests, and advocate for others to do the same.[193]

All three models recognize a symbiotic relationship between freedom of speech and a healthy and vibrant democracy. However, democratic values alone cannot account for the breadth of First Amendment "speech" recognized by the Supreme Court, either.[194]

c. Autonomy

While advancing truth and democracy are undoubtedly core values in First Amendment jurisprudence, these values cannot be the only goals of protected speech. For example, the Court has expressly ousted obscene material lacking any "serious literary, artistic, political, or scientific value"[195] from a place in the truth-oriented marketplace of ideas.[196] Furthermore, by definition, expression that a court has found to have no political value under the *Miller* test for obscenity cannot be adjudged to contribute to democratic values. Nevertheless, the Court does extend First Amendment protection to private possession of obscene materials.[197] This apparent irregularity illustrates another important value underpinning the First Amendment: autonomy.

"If the First Amendment means anything, it means that a State has no business telling a man, sitting alone in his own house, what books he may read or what films he may watch."[198] Even where expressive activities cannot be said to advance any grander truth-finding or democratic purpose, the individual's interest in self-expression, creativity, freedom of thought, and self-realization warrants the full protection of the First Amendment.[199] "Our whole constitutional heritage rebels at the thought of giving government the power to control men's minds,"[200] and preserving this autonomy and freedom of thought is contingent on guarding free expression from State intervention.[201]

While recognizing the underlying value of autonomy explains the Court's extension of First Amendment coverage to certain expressive activity (especially private expression), it does little to pinpoint the proper approach in situations where the individual speaker's autonomy and right to expression conflict with the autonomy of an unwilling audience. This conflict implicates the final underlying value of community.

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193 *Id.* at 1367.
194 *See* Post, *Participatory Democracy*, *supra* note 171, at 488 ("I do not contend that the value of democratic self-governance can explain all First Amendment decisions.").
195 Miller v. California, 413 U.S. 15, 24 (1973).
196 Davenport v. Wash. Educ. Ass'n, 551 U.S. 177, 188 (2007).
197 Stanley v. Georgia, 394 U.S. 557, 559 (holding that criminal prosecution for private possession of obscene materials is prohibited by the Constitution).
198 *Id.* at 565.
199 *See* Roig, *Decoding*, *supra* note 8, at 354–55.
200 *Stanley*, 394 U.S. at 565.
201 *See* Roig, *Decoding*, *supra* note 8, at 354–55.

d. Community

While preservation of individual autonomy would seem to mandate full First Amendment coverage for personally expressive speech like fighting words or defamation, such utterances in fact receive only limited protection, if any.[202] Advancement of the above First Amendment values might seem to command unlimited expression and exchange of ideas. However, some of these ideas may be extremely unpopular, offensive, or even abusive, according to prevailing community standards. To preserve channels of communication and limit the potentially destructive effects of this inevitable conflict, the values of truth, democracy, and autonomy must be tempered by a countervailing interest in preserving the community and promoting reason, respect, civility, fairness, and tolerance, in some extreme, self-destructive cases.[203]

e. Prioritizing Values

At this point, we must ask ourselves, is one First Amendment value more important than the others? Many different answers have been proposed in this regard.[204] "In the end, nonetheless, it is important to heed the Supreme Court's warning in *Stevens* that defining whole categories of speech out of First Amendment coverage must not be done 'on the basis of a simple cost-benefit analysis.'"[205]

These First Amendment values are inherently interrelated. Consequently, weighing and prioritizing such values in each case should be the subject of an open and unconstrained debate. "The Constitution serves a multiplicity of masters: order, equality, autonomy, justice, and democracy, amongst others. There is no reason why the freedom of speech guaranteed by the First Amendment—a central tenet of our system—should be bound by rigid hierarchies as to the values it serves."[206] In this context, "we must be especially aware of the fact that the Court has recently been reluctant to create new categories of disfavored speech."[207] For this reason, as we apply this analytical framework, "we must err on the side of caution, fully conscious of the Court's interpretation of the First Amendment as favoring more, rather

[202] *See generally* Gertz v. Robert Welch, Inc., 418 U.S. 323, 340 (1974) (extending limited protection for false defamatory statements); Chaplinsky v. New Hampshire, 315 U.S. 568 (1942) (denying First Amendment protection under the "fighting words" doctrine).
[203] *See* Roig, *Decoding*, *supra* note 8, at 355–56.
[204] For a discussion of those alternative proposed answers, see *id.* at 356–57.
[205] *Id.* at 358 (quoting United States v. Stevens, 559 U.S. 460, 471 (2010)).
[206] *Id.*
[207] *Id.* (citing Brown v. Entm't Merchs. Ass'n, 131 S. Ct. 2729 (2011) (refusing to create a category of disfavored speech for violent video games)); *Stevens*, 559 U.S. at 471 (refusing to create a category of disfavored speech for depictions of animals being intentionally tortured and killed).

than less, coverage of general classes of speech."[208]

B. *Applying the Framework to DNA*

As previously established, existing approaches in the doctrine and literature regarding First Amendment coverage of analogous situations are insufficient to definitively answer whether DNA can be speech under the First Amendment. Therefore, the application of the more general analytical framework proposed above to the specific case of DNA is necessary.

1. DNA Can Be Closely Related to Expression

Certainly, the sequence of nucleotides on a strand of DNA conveys coded information. As previously explained, naturally occurring DNA contains information about itself and the living being from whence it comes. Furthermore, the information-carrying properties of DNA can be used to encode all kinds of other information. In this sense, DNA is communicative itself and can be used to develop a medium for the communication of ideas.

The Supreme Court's own recent description in *Association for Molecular Pathology v. Myriad Genetics, Inc.* of some of the intricacies and characteristics of DNA is a good place to start when analyzing the close relationship between DNA and the expression of ideas.

> [G]enes form the basis for hereditary traits in living organisms. The human genome consists of approximately 22,000 genes packed into 23 pairs of chromosomes. Each gene is encoded as DNA, which takes the shape of the familiar "double helix" that Doctors James Watson and Francis Crick first described in 1953. Each "cross-bar" in the DNA helix consists of two chemically joined nucleotides. The possible nucleotides are adenine (A), thymine (T), cytosine (C), and guanine (G), each of which binds naturally with another nucleotide: A pairs with T; C pairs with G. The nucleotide cross-bars are chemically connected to a sugar-phosphate backbone that forms the outside framework of the DNA helix. Sequences of DNA nucleotides contain the information necessary to create strings of amino acids, which in turn are used in the body to build proteins. . . .
>
> Creation of proteins from DNA involves two principal steps, known as transcription and translation. In transcription, the bonds between DNA nucleotides separate, and the DNA helix unwinds into two single strands. A single strand is used as a template to create a complementary ribonucleic acid (RNA) strand. The nucleotides on the DNA strand pair naturally with their counterparts, with the exception that RNA uses the nucleotide base uracil (U) instead of

[208] *Id.*

> thymine (T). Transcription results in a single strand RNA molecule, known as pre-RNA, whose nucleotides form an inverse image of the DNA strand from which it was created. . . . The resulting product . . . is known as messenger RNA (mRNA), which creates amino acids through translation. In translation, cellular structures known as ribosomes read each set of three nucleotides, known as codons, in the mRNA. Each codon either tells the ribosomes which of the 20 possible amino acids to synthesize or provides a stop signal that ends amino acid production.
>
> DNA's informational sequences and the processes that create mRNA, amino acids, and proteins occur naturally within cells. Scientists can, however, extract DNA from cells using well known laboratory methods. These methods allow scientists to isolate specific segments of DNA—for instance, a particular gene or part of a gene—which can then be further studied, manipulated, or used. It is also possible to create DNA synthetically through processes similarly well known in the field of genetics. . . .
>
> Changes in the genetic sequence are called mutations. Mutations can be as small as the alteration of a single nucleotide—a change affecting only one letter in the genetic code. Such small-scale changes can produce an entirely different amino acid or can end protein production altogether. Large changes, involving the deletion, rearrangement, or duplication of hundreds or even millions of nucleotides, can result in the elimination, misplacement, or duplication of entire genes. Some mutations are harmless, but others can cause disease or increase the risk of disease. As a result, the study of genetics can lead to valuable medical breakthroughs.[209]

Hence, DNA is not only a molecule that encodes information in its chemical structure, but also one that is hardwired to replicate itself naturally and efficiently.

> Significantly, because the copies reproduced are identical to the original, and therefore can function as another template for further copying, software and DNA are both susceptible to viral replication. . . . [A] DNA sequence serves as the template for production of an exact copy, and each copy likewise can serve as a template for subsequent copies. Indeed, the terms "viral replication" and "computer virus," widely used in connection with digital files and computer software, arise out of the remarkable propensity of viral DNA to self replicate.[210]

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[209] Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 133 S. Ct. 2107, 2111–12 (2013) (footnote omitted).

[210] Christopher M. Holman, *Copyright for Engineered DNA: an Idea Whose Time Has Come?*, 113 W. VA. L. REV. 699, 715 (2011).

Furthermore, the encoded messages contained in DNA can be easily altered, and even brand new messages can be created. These codes, in turn, can be translated into chains of amino acids and complex proteins. All of these features can be done in the microscopic world of the cell. DNA is a peculiar molecule, indeed.

As we will further explore below, many individuals throughout the world have recently been exploiting the communicative capabilities of DNA to convey messages of all kinds in multiple different ways. The specifics of these developing social practices will be discussed in more detail below, but it is enough to point out at this stage that such uses of DNA establish its close relationship to the expression of ideas. DNA can be both communicative itself and crucial to the development of media for the communication of ideas. Consequently, DNA passes the first step in our analytical framework for determining whether a particular activity can be considered "speech" under the First Amendment.

2. DNA Is More Than Information: First Amendment Values in DNA

That DNA molecules carry and transmit information does not, on its own, provide a definitive answer as to whether the data it contains might be considered "speech" for the purposes of the First Amendment. The question of First Amendment coverage of DNA requires taking into account several other factors. DNA, however, is much more than just information. The developing social practices that utilize DNA's communicative capabilities indeed further First Amendment values.

As we shall see below, the natural behavior of DNA is only the beginning. Currently, individuals are manipulating DNA in a myriad of ways that exploit its ability to code for information and to subsequently store, replicate, process, and manipulate that information. Specifically, this Article identifies three main categories of human activities that could potentially implicate First Amendment values. In each of these three categories, individuals are expressing meaning in different ways through the use of DNA.

a. DNA as Message

The first category of activities is the simplest one. In this category, DNA is the message itself. There are several ways in which the messages encoded in the DNA chain of base pairs can convey important messages about themselves.

First, geneticists can communicate with one another regarding their work by being able to share the DNA strands on which they are working. A specific example of how scientists are currently using DNA to establish standards and communicate scientific facts and ideas to

each other is DNA barcoding.[211] Through this process, DNA sequences are "read" by scientists to determine the taxonomy of an unidentified species.[212] In this way, a reliable bank of information concerning all identified species can be centralized and understood by all scientists around the world, who can then use the information gathered and stored in that bank to aid in their own research. Hence, using DNA as the language for this databank of genetic barcodes furthers the First Amendment value of truth.

Furthermore, in considering whether this type of DNA-based communication might merit First Amendment coverage, analogies to similarly coded communications, such as computer code, music, and mathematical or chemical formulae are instructive. In *Universal City Studios, Inc. v. Corley*, the Second Circuit Court of Appeals determined that computer code is recognizable as speech under the meaning of the First Amendment and drew comparisons to other encoded communications, such as music and mathematical equations.[213] "Communication does not lose constitutional protection as 'speech' simply because it is expressed in the language of computer code. Mathematical formulae and musical scores are written in 'code,' *i.e.*, symbolic notations not comprehensible to the uninitiated, and yet both are covered by the First Amendment."[214] "Even dry information, devoid of advocacy, political relevance, or artistic expression, has been accorded First Amendment protection."[215]

> [P]rogrammers communicating ideas to one another almost inevitably communicate in code, much as musicians use notes. Limiting First Amendment protection of programmers to descriptions of computer code (but not the code itself) would impede discourse among computer scholars, just as limiting protection for musicians to descriptions of musical scores (but not sequences of notes) would impede their exchange of ideas and expression.[216]

The Sixth Circuit Court of Appeals similarly recognized the importance of guaranteeing the ability of both scientists and artists to communicate their ideas to each other in another case dealing with computer source code.[217] "The Supreme Court has explained that 'all ideas having even the slightest redeeming social importance,' including

[211] BARCODE OF LIFE: IDENTIFYING SPECIES WITH DNA BARCODING, www.barcodeoflife.org (last visited Sept. 2, 2015).
[212] *Id.*
[213] Universal City Studios, Inc. v. Corley, 273 F.3d 429, 447–48 (2d Cir. 2001).
[214] *Id.* at 445.
[215] *Id.* at 446.
[216] *Id.* at 448.
[217] Junger v. Daley, 209 F.3d 481 (6th Cir. 2000).

those concerning 'the advancement of truth, science, morality, and arts' have the full protection of the First Amendment."[218]

Nevertheless, some commentators have argued against extending the full coverage of the First Amendment in the scientific context. Barry P. McDonald claims that the Constitution does not guarantee freedom of scientific inquiry in the same way it guarantees political or religious freedom.[219] He argues that scientists cannot claim the protection except under "speech" or "press."[220] Regulations that burden performance of experiments or research may implicate the First Amendment only to the extent that they burden the type of expression or expressive conduct encompassed by First Amendment claims more generally.[221] Precedent supports the idea that regulations of scientific expression itself are subject to standard First Amendment scrutiny, but regulation of non-expressive conduct, such as empirical research or experimentation, may be subject to little or no constitutional analysis.[222] In short, McDonald concludes that restrictions on scientific activities that are not otherwise expressive do not implicate the First Amendment merely because they are scientific.[223] Instead, scientists, like other plaintiffs challenging regulation of conduct on First Amendment grounds, must show that the restriction has substantially burdened protected expression.[224] He

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[218] *Id.* at 484 (citing Roth v. United States, 354 U.S. 476, 484 (1957)).

[219] Barry P. McDonald, *Government Regulation or Other "Abridgments" of Scientific Research: the Proper Scope of Judicial Review Under the First Amendment*, 54 EMORY L.J. 979 (2005).

[220] *Id.* at 980. McDonald notes the lack of any specific textual source for a constitutionally guaranteed freedom of scientific inquiry, with the absence of evidence suggesting the existence of such a right at the time the Constitution was framed and ratified and the failure of the Constitution's structure to support the theory that such a right is implied. *Id.* at 998–1008.

[221] *Id.* at 1020–21. The oft-cited justification for a broad constitutional right to scientific expression—that the right to engage in experimentation and research is protected as an "essential precondition" to speech about scientific information—is unworkable, says McDonald, because it would effectively preclude the government from placing restrictions on any conduct that speakers might wish to discuss: "On this argument, any conduct that is arguably necessary to engage in particular types of expression—such as riding a bicycle in order to write about that experience—would be protected by the First Amendment." *Id.* at 1000.

[222] *Id.* at 1008–09, 1016–20. "Whether a geneticist is conducting an experiment by altering the DNA of a microorganism in a lab or an astrophysicist is measuring the radioactive emissions emanating from a distant galaxy, these scientists are mainly engaged in nonexpressive conduct." *Id.* at 993-94.

[223] McDonald argues:

> Accordingly, for a scientist to challenge a restriction on her research under standard First Amendment doctrine, it seems clear that she would need to demonstrate (1) that the pertinent law explicitly restricted communicative activities associated with that research, (2) that the government was using regulations of more general conduct to effectively restrict scientific expression, or (3) that if the pertinent restriction was being used to regulate noncommunicative conduct, the restriction incidentally burdened any associated scientific expression in a constitutionally significant manner.

Id. at 1020–21.

[224] *See generally* Turner Broad. Sys., Inc. v. FCC, 512 U.S. 622 (1994) (noting that state action that targets speech or is based on its content or message is subject to rigorous scrutiny, while content-neutral speech restrictions need only pass an intermediate level of scrutiny); United States v. O'Brien, 391 U.S. 367 (1968) (explaining that generally applicable restrictions on conduct do

suggests that this conclusion might encourage more scientists to publish their opinions, so that restrictions on their research methods or subjects will more directly burden speech and invite First Amendment protection.[225]

However, there is plenty of Supreme Court precedent extending robust First Amendment protection to academic discourse. "Our Nation is deeply committed to safeguarding academic freedom, which is of transcendent value to all of us and not merely to the teachers concerned. That freedom is therefore a special concern of the First Amendment, which does not tolerate laws that cast a pall of orthodoxy over the classroom."[226] "[T]he First Amendment protects scientific expression and debate just as it protects political and artistic expression."[227] This is why "scientific seminars, discussions, and publications are covered by the First Amendment."[228] "Authors routinely write books and articles in which they communicate procedures to each other. . . . [S]uch writings are unambiguously covered by the First Amendment."[229]

The law, then, suggests that the protection of geneticists' ability to communicate with each other regarding their scientific ideas in the most efficient and effective way possible furthers the value of truth previously discussed. "Teachers and students must always remain free to inquire, to study and to evaluate, to gain new maturity and understanding; otherwise our civilization will stagnate and die."[230]

But truth is not the only value furthered by free scientific discourse. Nearly twenty-five years ago, Ferguson posited that "scientific advances contribute to the nation's capacity for self-government by enhancing the electorate's 'knowledge, intelligence and sensitivity to human values.'"[231] Ferguson also pointed out that "scientific information has a direct and vital bearing on a wide range of public policy issues,"[232] including "the proposed regulation of

not implicate the First Amendment; where such restrictions have an incidental effect on expression, the resulting burden cannot be greater than necessary to further an important government interest).

[225] McDonald, *supra* note 219, at 1057–60.

[226] Keyishian v. Bd. of Regents, 385 U.S. 589, 603 (1967).

[227] Bd. of Trustees of Leland Stanford Junior Univ. v. Sullivan, 773 F. Supp. 472, 474 (D.D.C. 1991) (citing Miller v. California, 413 U.S. 15, 34 (1973); Roth v. United States, 354 U.S. 476, 484 (1957); United States v. U.S. Dist. Court for Cent. Dist. of Cal., 858 F.2d 534, 542 (9th Cir. 1988)).

[228] Roy G. Spece, Jr. & Jennifer Weinzierl, *First Amendment Protection of Experimentation: A Critical Review and Tentative Synthesis/Reconstruction of the Literature*, 8 S. CAL. INTERDISC. L.J. 185, 187 n.4 (1998).

[229] Post, *Encryption*, *supra* note 123, at 718.

[230] Sweezy v. New Hampshire, 354 U.S. 234, 250 (1957).

[231] James R. Ferguson, *Scientific and Technological Expression: A Problem in First Amendment Theory*, 16 HARV. C.R.-C.L. L. REV. 519, 542 (1981) (quoting Alexander Meiklejohn, *The First Amendment Is an Absolute*, 1961 SUP. CT. REV. 245, 256 (1961)).

[232] *Id.* at 542–43.

recombinant DNA research."[233] Even back in 1981, Ferguson noted that "with the mounting evidence of biological influences on human social behavior, some observers have called for a biologically informed perspective on public policy, a perspective that draws on biological ideas in much the same way that current perspectives draw on economic theory."[234] "In these ways and many others, then, the free flow of scientific information and ideas is essential to the decisionmaking process in a democratic state."[235]

More recently, others have also called attention to the important relationship between genetic research and democracy. Niclas Hagen et al., for example, argue that "decisions on the application of technologies related to existential questions such as the ontological status of embryos or the risk of stigmatisation of individuals with hereditary disorders must be carried out in ways allowing for transparency and citizen control."[236] Their point of view is not unique, and has been bolstered by others: "Science and Technology Studies literature on this theme energetically promotes direct citizen participation to democratise technically complex and expert-permeated fields."[237]

As illustrated by Ferguson's early recognition, and others' more recent elaboration, of the important role scientific research can play in shaping public policy, and vice versa, free scientific discourse also furthers the value of democratic self-governance. "To summarise, the main reason to juxtapose genetics and democracy is that applications of genetic knowledge bring to the fore problems that are urgent to pay attention to from a democratic perspective."[238] Ferguson concludes as follows: "It is thus clear that a system of free scientific expression promotes each of the three major interests that the Court has identified as first amendment concerns. On this basis, it seems clear that the first amendment value of scientific speech is at least equal to that of any other category of expression."[239]

Nevertheless, Ferguson goes on to weigh against this the potential

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[233] *Id.* at 543.
[234] *Id.*
[235] *Id.*
[236] Niclas Hagen et al., *Genetics and Democracy—What Is the Issue?*, 4 J. COMMUNITY GENET. 181, 183 (2013).
[237] *Id.* (citing Brian Wynne, *Public Engagement as a Means of Restoring Public Trust in Science—Hitting the Notes, but Missing the Music*? 9 COMMUNITY GENET. 211 (2006); Brian Wynne, *May the Sheep Safely Graze? A Reflexive View of the Expert–Lay Knowledge Divide in* RISK, ENVIRONMENT AND MODERNITY: TOWARDS A NEW ECOLOGY 44–83 (Scott M. Lash, Bronislaw Szerszynski & B. Wynne, eds. 1996); Sheila Jasanoff, *Civilization and Madness: The Great BSE Scare of 1996*, 6 PUBLIC UNDERST. SCI. 221–32 (1997); SHEILA JASANOFF, THE FIFTH BRANCH: SCIENCE ADVISERS AS POLICYMAKERS (1990)).
[238] *Id.* at 184.
[239] Ferguson, *supra* note 231, at 543. Ferguson identifies the three underlying First Amendment interests as: "the individual interest in self-expression, the social interest in the free flow of information and ideas, and the political interest in informed self-government." *Id.* at 533.

for harmful use of scientific information, and in particular "technological speech."[240] Specifically, Ferguson cautions with regards to the potential pernicious use of "the recently acquired recombinant DNA technology. By enabling scientists to piece together genetic material in novel combinations, this technology poses potential hazards of considerable magnitude."[241] He states that there are "some critics [who] have argued that recombinant techniques could provide a terrorist group with the means of cheaply creating an effective weaponry in the form of new epidemic pathogens."[242] He also mentions that "[o]thers have suggested that the recombination of genetic material from different species in self-replicating organisms could lead to a biological crisis by breaching the evolutionary barrier against the interbreeding of species."[243]

It should be noted that Ferguson's worries have not been forgotten. There are many who currently warn against the potential dangers of, for example, making changes to the human germ line.[244] Nevertheless, it has been almost twenty-five years since Ferguson's predictions, and his worst fears have not come to pass. Instead, a more accurate prediction of the development of DNA technology was the following, presented by Ferguson in 1981:

> At the same time, however, research with recombinant DNA promises to yield an astonishing array of social benefits. It is now clear, for instance, that the new technology will soon be used to produce a wide range of vital substances including "improved vaccines, scarce hormones, specially designed drugs, enzymes and perhaps even food." Indeed, scientists have already achieved some notable triumphs in the use of recombinant techniques to create bacteria that synthesize human hormones such as insulin and somatotropin. Beyond these immediate benefits, recombinant technology may also herald an era of "true gene therapy," for, according to many scientists, it will eventually enable physicians to correct genetic mutations that are responsible for a broad range of human diseases. Finally—and perhaps most importantly—recombinant DNA provides the scientific community with an invaluable research tool that will contribute greatly to a deeper

[240] *Id*. at 543–45.
[241] *Id*. at 546.
[242] *Id*. (citing Clifford Grobstein, *The Recombinant-DNA Debate*, 237 SCIENTIFIC AM. 22, 31 (1977)).
[243] *Id*. (citing Robert L. Sinsheimer, *Recombinant DNA—On Our Own*, 26 BIOSCIENCE 599, 599 (1976); Robert L. Sinsheimer, *Troubled Dawn for Genetic Engineering*, 68 NEW SCIENTIST 148 *passim* (1975); CLIFFORD GROBSTEIN, A DOUBLE IMAGE OF THE DOUBLE HELIX: THE RECOMBINANT-DNA DEBATE 48–50 (1979)).
[244] *See, e.g.*, Edward Lanphier et al., *Don't Edit the Human Germ Line*, 519 NATURE 410 (2015).

> understanding of genetic processes, and thus facilitate yet additional advances in medicine, chemistry, and agriculture.[245]

As such, Ferguson's final embrace of "technological speech" as fully covered under the First Amendment seems most appropriate, particularly in the case of DNA:

> It seems clear, then, that the social value of technological expression is so substantial that this category of speech cannot be viewed as warranting less protection than other forms of expression. If this is granted, it follows that restraints on scientific and technological expression should generally be viewed from a standard first amendment perspective. In particular, the constitutional inquiry should rely on settled principles of first amendment law to determine if the state's interest in regulating the information at issue is sufficient to justify a restraint on fully protected speech. Such an approach would not ignore the unique dangers occasionally posed by scientific and technological information; rather, it would address them on a case-by-case basis in weighing the particular state interest in regulation.[246]

We fully concur with his analysis almost twenty-five years later. Any such concerns regarding harmful use should be dealt with in the protection stage of First Amendment analysis, applying the appropriate level of heightened scrutiny. However, such analysis ought to be performed with due consideration of First Amendment principles.

The nascent field of genopolitics is another extremely interesting, if controversial, area of study on how the messages contained in our DNA might compromise important First Amendment values. Genopolitics explores the relationship between DNA and political ideologies and engagement.[247] Various studies suggest that certain genes can be correlated with ideological tendencies or engagement levels.[248] On the other hand, several commentators have criticized the methodology and results of those studies.[249] Hence, a verdict on genopolitics is far from reached. The following provides a closer look at this debate.

First, John R. Alford et al. argue that existing studies on the relationship between genes and certain behaviors or personality traits

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[245] Ferguson, *supra* note 231, at 546 (citations omitted).
[246] *Id.* at 546–47 (citations omitted).
[247] Thomas B. Edsall, Opinion, *Are Our Political Beliefs Encoded In Our DNA?*, N.Y. TIMES (Oct. 1, 2013, 11:22 PM), http://opinionator.blogs.nytimes.com/2013/10/01/are-our-political-beliefs-encoded-in-our-dna/.
[248] *See infra* notes 250–266 and accompanying text.
[249] *See infra* notes 272–299 and accompanying text.

tend to suggest that other social behaviors, such as political beliefs or engagement, may also have a heritable component.[250] Similarly, Christopher Dawes et al. present evidence suggesting that cognitive ability, personal control, and extraversion are traits with a hereditary component that contribute to the variation in political participation, such as voting frequency.[251]

Peter K. Hatemi and Rose McDermott, upon reviewing the developing field of the interaction between genes and politics with a specific focus on individual studies, have described how the study of political behaviors is broadening. The study of such behaviors now includes genetic, biological, social, and environmental factors.[252] "Today, some 40 years after Eaves, Eysenck, and Martin established that differences in attitudes are genetically influenced, an unprecedented amount of literature exploring genetic, neurological, physiological, and hormonal influences on political attitudes, ideologies, vote choice, political participation, political trust, sophistication, party identification, out-groups, and political violence has emerged."[253]

More specifically, Hatemi et al. aver that there is a relationship between an underlying disposition for fear, which has a hereditary component, and policy preferences related to out-groups, such as immigration and foreign affairs.[254] Douglas R. Oxley et al. found that individuals with measurably lower physical sensitivities to loud noises and startling images are also more inclined to support foreign aid, liberal immigration policies, gun control, and other policies generally associated with American liberalism.[255]

Hatemi et al. have expanded on the aforementioned research, and explain that, while there is no "politics gene," relationships between thousands of genetic variations may combine to interact with environment and neurobiology to inform political ideologies and behaviors.[256] "Genetic influences on political ideology are not boundless and social influences are far from irrelevant to the transmission of ideology. Political ideologies are complex, interactive,

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[250] John R. Alford et al., *Are Political Orientations Genetically Transmitted?*, 99 AM. POL. SCI. REV. 153, 153 (2005).

[251] Christopher Dawes et al., *The Relationship Between Genes, Psychological Traits, and Political Participation*, 58 AM. J. POL. SCI. 888 (2014).

[252] Peter K. Hatemi & Rose McDermott, *The Genetics of Politics: Discovery, Challenges, and Progress*, 28 TRENDS IN GENETICS 525, 525 (2012).

[253] *Id.* (citations omitted).

[254] Peter K. Hatemi et al., *Fear as a Disposition and an Emotional State: A Genetic and Environmental Approach to Out-Group Political Preferences*, 57 AM. J. POL. SCI. 279 (2013).

[255] Douglas R. Oxley et al., *Political Attitudes Vary with Physiological Traits*, 321 SCI. 1667, 1668 (2008).

[256] Peter K. Hatemi et al., *Genetic Influences on Political Ideologies: Twin Analyses of 19 Measures of Political Ideologies from Five Democracies and Genome-Wide Findings from Three Populations*, 44 BEHAV. GENETICS 282, 292 (2014).

and environmentally contingent and phenotypic heterogeneity is undoubtedly present."[257] However, the authors argue that an integrated theory of social values and behavior will include hereditary, genetic influences as well as those derived from the environment, social groups, education, and other mechanisms.[258] They further state that, despite mounting evidence of the relationship between genes and political behaviors and ideologies, the role of genetic influences has not been integrated into the general discourse.[259] In a 2014 article, they describe two new empirical studies performed to address criticisms related to population and measures limitations and the relative absence of genome-wide results in previous studies.[260] Essentially, the studies show that, while there is no single "politics gene," thousands of minor genetic variations may combine to ultimately interact with neurobiological pathways and the environment to affect political ideologies and behaviors.[261] "[I]t appears once ideological orientations become instantiated by some function of genetic disposition, environmental stimulus or epigenetic process, the psychological mechanisms that guide behavior in predictable ways appear somewhat stable and this stability appears to be related to genetic disposition."[262] The authors hope to integrate these different disciplines to learn more about behavior and the genetic influence on political ideology.[263]

James H. Fowler and Darren Schreiber, for their part, understand that cross-disciplinary collaboration between biologists and social scientists could help further understanding of human behavior.[264] Biologists are learning that genes play an important role in political behavior, and developments in neuroscience indicate that the human brain may be particularly adapted to solve uniquely political social problems.[265] They point out that studies (and twin studies in particular) have indicated that there may be a relationship between genes and certain social behaviors, such as altruism, bargaining, and attitude towards risk.[266] Variations in these behaviors contribute to differences in political behavior.[267] Some studies suggest a correlation between

[257] *Id.* at 291.
[258] *Id.*
[259] *Id.* at 291–92.
[260] *Id.* at 285–90.
[261] *Id.* at 292.
[262] Peter K. Hatemi et al., *Genetic Influences on Political Ideologies: Twin Analyses of 19 Measures of Political Ideologies from Five Democracies and Genome-Wide Findings from Three Populations*, 44 BEHAV. GENETICS 282, 292 (2014).
[263] *Id.*
[264] James H. Fowler & Darren Schreiber, *Biology, Politics, and the Emerging Science of Human Nature*, 322 SCI. 912 (2008).
[265] *Id.*
[266] *Id.* at 912–13.
[267] *Id.* at 913.

voter turnout and genes that regulate dopamine and serotonin.[268] Neurologists are identifying areas of the brain associated with social cognition, distinct from technical cognitive tasks, that are also related to political thinking.[269] For example, Fowler and Schreiber cite a study that "examined the heritability of voter participation by matching publicly available voter registration records to a twin registry in Los Angeles, analyzing self-reported turnout in the National Longitudinal Study of Adolescent Health . . . and analyzing other forms of political participation."[270] "In all three cases, both genes and environment contributed significantly to variation in political participation."[271]

On the other hand, Evan Charney and William English claim that studies identifying a genetic component to political behaviors are oversimplified and that their methodology does not adequately represent the effect of environmental and other non-hereditary influences.[272] They mount a serious critique of the methodologies and assumptions used by genopolitics researchers who claim to have identified a relationship between certain gene variants and political behavior.[273] Charney and English argue, for example, that Alford, Funk, and Hibbing's study finding that genetic factors are more significant than environmental ones in determining whether a person is a liberal or conservative was based on a classical twin study but that, due to scientific advances, many of the assumptions underlying twin studies must now be reevaluated.[274] They also aver that correlation between genes and voting behavior is inherently imprecise due to qualitative variations in what "voting" means.[275] The data sets used, for example, only evaluate whether a person voted in the last presidential election, not "voting behavior."[276] Some studies also do not account for population stratification or variable frequency of certain alleles between different populations.[277] They point out that, if you separate the results from these studies into individual ethnic groups, the correlation between the genetic marker and behavior varies significantly.[278] Additionally, when heterozygous females are excluded from the study, the association

[268] *Id.*
[269] James H. Fowler & Darren Schreiber, *Biology, Politics, and the Emerging Science of Human Nature*, 322 SCI. 913 (2008).
[270] *Id.* at 912.
[271] *Id.*
[272] Evan Charney & William English, *Candidate Genes and Political Behavior*, 106 AM. POL. SCI. REV. 1 (Feb. 2012).
[273] *Id.*
[274] *Id.* at 1.
[275] *Id.* at 5.
[276] *Id.*
[277] *Id.* at 5–6.
[278] Evan Charney & William English, *Candidate Genes and Political Behavior*, 106 AM. POL. SCI. REV. 6 (Feb. 2012).

between genes and behavior becomes even weaker.[279] Charney and English also claim there are errors in the way the study analyzed addresses and accounted for families.[280] If you restrict the study to unrelated individuals, they argue, there is not a significant correlation between the specified genes and behavior.[281]

Additionally, they note that the entire idea of correlation between genes and behavior is being revisited.[282] The relationship between genes and behavior is extremely complex, and a single phenotype, such as height variation, is controlled by many genes, each of which has only a fraction of a percent of influence on the variation.[283] "We cannot equate a particular allele straightforwardly with the production of a particular form of a protein and from that with the production of a particular physiological effect and corresponding phenotype."[284] Even single-gene mutations can have a huge variance in phenotype.[285] "Genes do not regulate the extent to which they are capable of being transcribed in any obvious, unidirectional manner."[286] A single gene can be associated with a number of different behaviors.[287] "Once considered the paragon of stability, DNA is subject to all manner of transformation."[288]

Furthermore, environmental variance can also have a tremendous effect on behavior.[289] "Voting in a country where voting in national political elections is *mandatory* . . . is in important ways a different behavior than voluntary voting in the United States, as is voting in a country where one risks one's life by showing up at the voting booth or voting for the wrong candidate, or where the results of the election are predetermined."[290] "Clearly, there are good reasons to believe that voting is a behavior influenced by family environment. Moreover, both the shared environment and genetic profiles of 'siblings' vary systematically depending on whether they are identical twins, fraternal twins, siblings of different ages, cousins, or unrelated persons living in the same house."[291]

To further complicate matters, recent studies are gathering increasing evidence that individual human beings have multiple

[279] *Id.* at 6–8.
[280] *Id.* at 8–10.
[281] *Id.*
[282] *Id.* at 10–11.
[283] *Id.* at 11–30.
[284] Evan Charney & William English, *Candidate Genes and Political Behavior*, 106 AM. POL. SCI. REV. 10 (Feb. 2012).
[285] *Id.* at 11–12.
[286] *Id.* at 10.
[287] *Id.*
[288] *Id.*
[289] *Id.* at 4.
[290] Evan Charney & William English, *Candidate Genes and Political Behavior*, 106 AM. POL. SCI. REV. 5 (Feb. 2012).
[291] *Id.* at 9 (citation omitted).

genomes.[292] This raises concerns for forensic scientists, genetic counselors, and others who use human DNA in their work or research.[293] "Some people, for example, have groups of cells with mutations that are not found in the rest of the body. Some have genomes that came from other people."[294] "Science's changing view is also raising questions about how forensic scientists should use DNA evidence to identify people."[295] "It's also posing challenges for genetic counselors, who can't assume that the genetic information from one cell can tell them about the DNA throughout a person's body."[296]

In any case, the prospect of the government having access to and utilizing information in its citizens' DNA to predict or assess their political ideologies is extremely troubling.[297] In fact, whether the science behind such predictions or assessments is solid or not becomes irrelevant if the government believes that it might be, and acts accordingly. The creative mind might imagine a government campaign of gene therapy to increase its citizenry's participation rate in elections or political activities. Such a policy would be tantamount to mind control, a possibility abhorrent to the First Amendment values of democratic self-governance and autonomy. Similarly destructive to all four values discussed above would be the use of such information by government to discriminate against potential political adversaries. The recent history of voter identification laws and the less recent history of racially biased poll taxes and literacy requirements for voting, among others, are scary precedents that could be repeated through the use of genetic testing. Hence, any regulation of DNA along these lines should be subject to the most exacting First Amendment scrutiny.

b. DNA as Code

Another way in which humans are using DNA's informational capabilities is by using its coding language and system to store all kinds of information that has nothing to do with genetics or biology at all. The ability to do so has a lot to do with the striking similarities between DNA code and computer code.

In the context of proposing that copyright protection be extended to engineered DNA sequences, Holman provides a detailed explanation of how genetic code and computer code are similar, and how they can

[292] Carl Zimmer, *DNA Double Take*, N.Y. TIMES (Sept. 16, 2013), http://www.nytimes.com/2013/09/17/science/dna-double-take.html.
[293] *Id.*
[294] *Id.*
[295] *Id.*
[296] *Id.*
[297] For a brief discussion of how private parties might also use the information in our DNA to manipulate our choices, *see* Jorge R. Roig, *Your DNA Speaks – Do You Have a Choice?*, TEDX (May 16, 2014), http://tedxtalks.ted.com/video/Your-DNA-Speaks-Do-You-Have-a-Ch.

easily be translated one to the other:

> Returning to DNA, the analogy between software code and genetic code is striking. A genetic sequence provides a series of instructions directing a living cell to perform functions dictated by the instructions. Genetic engineering permits a human to dictate these instructions. Like a computer program, a genetic sequence can be expressed in a format directly interpretable by a human, albeit instead of a series of zeros and ones, it is a sequence of A, T, C and G's, representing the four primary nucleotides that make up DNA.
>
> Genetic sequences can also be represented at various levels of abstraction. A three nucleotide codon representing an amino acid can be symbolized by a single letter representing that amino acid. A string of codons representing a protein domain can be expressed as a single symbol representing the domain, and a combination of domains can be expressed as a single protein. A string of nucleotides constituting a regulatory element, such as a promoter or enhancer, can be represented by a single symbol. For a good example of an engineered genetic sequence represented at a very high level of abstraction, see the figure used by Venter and colleagues to represent the full-length sequence of the synthetic bacterial genome they created. By means of abstraction, they are able to represent a genetic sequence comprising 582,970 nucleotides essentially as a notated circle. A recent article describes the importance of being able to represent genetic sequences at a high level of abstraction in order to facilitate the design of complex synthetic DNA molecules.
>
> Like software, in order to be useful, engineered genetic sequences must be transcribed into a format that can be interpreted by the primary intended audience, the difference being the audience in this case is a cell rather than a computer. In either case, this involves physically transcribing instructions into the appropriate medium of communication at a "nano" level. In the case of a CD-ROM, the reflective properties of a thin layer of aluminum are altered by making microscopic indentations, while in DNA the ordering of molecular subunits (individual nucleotides) conveys the message to the appropriate audience.[298]

One of the first examples of how DNA can be used as code to store and communicate information is the work of Dr. George Church who, with the help of his colleague, Sriram Kosuri, both from Harvard University, translated his most recent book on genomic engineering,[299]

[298] Holman, *supra* note 210 at 713 (citing J. Craig Venter et al., *Creation of a Bacterial Cell Controlled by a Chemically Synthesized Genome*, SCI., July 2010, at 52; Jonathan A. Goler et al., *Genetic Design: Rising Above the Sequence*, 26 TRENDS IN BIOTECH. NO. 10 538 (2008)).

[299] GEORGE CHURCH AND ED REGIS, REGENESIS: HOW SYNTHETIC BIOLOGY WILL REINVENT NATURE AND OURSELVES IN DNA (2012). *See also* George M. Church et al., *Next-Generation*

in its entirety, into DNA code, printed it out on an actual strand of DNA, and then read it back from the DNA strand.[300] By converting text to digital form, and then substituting the resulting ones and zeroes with DNA base pairs, any book or document can be stored in DNA.[301] In fact, any file that is converted to digital format can be stored in the same way. Dr. Church explains that the resulting DNA strand can be a viscous liquid or a solid salt.[302] The encoded DNA is extremely resilient, easy to store, and can last for extremely long periods of time.[303] Such storage is also cheap, and growing ever cheaper. "Already, the production costs . . . have dropped from $10,000 per million base pairs of DNA in 2001 to about 10 cents per million base pairs in 2012, according to the National Human Genome Institute."[304] Furthermore, huge amounts of information can be stored in DNA. It is estimated that "[a] mere milligram of the molecule could encode the complete text of every book in the Library of Congress and have plenty of room to spare."[305]

A second team of scientists, this time in the United Kingdom, has made a translation into DNA of Shakespeare's sonnets, Dr. Martin Luther King, Jr.'s "I Have a Dream" speech, a photograph of their laboratory, sound files, and an early article by Dr. James Watson and Dr. Francis Crick about DNA.[306] Nick Goldman and Ewan Birney of the European Bioinformatics Institute at the European Molecular Biology Laboratory were able to encode all of these text, sound, and image files and to successfully retrieve them with 100% accuracy.[307] As described above, they first translated the information into binary form and then coded into DNA.[308] Thereby, they facilitated the error-free recovery of information.[309] They note that one of the important advantages to storing information this way is the remarkable ability of DNA to curl itself up using a natural method of compression that makes it extremely

Digital Information Storage in DNA, 337 SCI. 1628 (2012).

[300] Robert Lee Hotz, *Future of Data: Encoded in DNA*, WALL ST. J. (Aug. 16, 2012, 8:33 PM), http://online.wsj.com/article/SB10000872396390444233104577593291643488120.html. *See also* Francie Diep, *Book Converted to DNA Then 'Read' to Show Off Bio-Digital Storage*, NBC NEWS, https://web.archive.org/web/20140112005256/http://www.nbcnews.com/technology/book-converted-dna-then-read-show-bio-digital-storage-947354 (Aug. 16, 2012, 3:11 PM).

[301] *See* Hotz, *supra* note 300.

[302] *Id.*

[303] *Id.*

[304] *Id.*

[305] John Bohannon, *DNA: The Ultimate Hard Drive*, SCI. (Aug. 16, 2012 2:10 PM), http://news.sciencemag.org/math/2012/08/dna-ultimate-hard-drive.

[306] Jesse Emspak, *DNA Stores MLK's Speech, Shakespeare's Sonnets*, DISCOVERY NEWS (Jan. 23, 2013, 1:08 PM), http://news.discovery.com/tech/biotechnology/dna-stores-mlk-speech-shakespeare-130123.htm.

[307] *Id.*

[308] *Id.*

[309] *Id.*

small and effective at storing huge amounts of information in very little space.[310]

> Storing digital data by conventional methods doesn't exactly take up a lot of space these days. One can get a pocket-sized hard drive that stores a terabyte of information, equal to hold about 2,000 hours of music. But storing information on DNA means cramming 2,000 times as much data onto a sugar cube-sized device.[311]

Additionally, as mentioned before, this form of data storage is remarkably resilient and can last for tens of thousands of years.[312]

Susan Alexjandre, on the other hand, has been using the same process in reverse: instead of translating and storing her music in DNA, she translates the DNA itself into music.[313] She uses spectrograph frequencies of DNA, converts those wavelengths into hertz, and then brings the resulting frequency down to a level where human ears can hear it.[314] The result is the "sound" of DNA.[315] "Most of the molecular data comes from spectrographs that I collect in science libraries," she says.[316] "Spectrographs list frequencies from almost anything on the atomic level such as DNA, water, hydrogen and oxygen, etc."[317] This type of artistic expression furthers both the values of truth and autonomy in ways that could hardly be said to compromise the integrity of our community. Hence, it serves to further support the case for First Amendment coverage of DNA.

Willem "Pim" Stemmer, the scientist who invented "DNA shuffling,"[318] made another interesting proposal along these lines in 2002.[319] "To circumvent what he perceived to be a prohibition against direct copyright protection for engineered DNA, he outlined a proposal whereby a DNA sequence is converted into music, and then copyrighted as a musical work."[320] His mental exercise was meant to illustrate the similarities between traditional art forms, such as music, and DNA sequences created by human beings. The logic of his point, made for the

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310 *Id.*
311 *Id.*
312 *Id.*
313 Susan Alexjander & David W. Deamer, *The Infrared Frequencies of DNA Bases as Science and Art*, 18 IEEE ENGINEERING IN MEDICINE AND BIOLOGY 74 (1999).
314 *Id.*
315 *Id.*
316 Susan Alexjander, *Frequently Asked Questions*, OUR SOUND UNIVERSE, http://www.oursounduniverse.com/?page_id=388 (last visited Sept. 3, 2015).
317 *Id.*
318 DNA shuffling is a process used to engineer synthetic genes and proteins. *See* Jon Cohen, *How DNA Shuffling Works*, 293 SCI. 237 (2001).
319 Holman, *supra* note 210, at 704.
320 *Id.* (citing Willem P.C. Stemmer, *How to Publish DNA Sequences with Copyright Protection*, 20 NATURE BIOTECH. 217 (2002)).

purposes of copyright law, is equally valid in terms of applying the Free Speech Clause. If a musical score and an original DNA sequence are so similar in nature that the messages contained in one can be expressed alternatively in the other, why should the law treat them any differently? If a piece of music is "speech" for First Amendment purposes, so should an original strand of DNA.

In *Universal City Studios, Inc. v. Corley*, the Second Circuit Court of Appeals determined that computer code is recognizable as speech under the meaning of the First Amendment and drew comparisons to other encoded communications, such as music or mathematical equations.[321] "Communication does not lose constitutional protection as 'speech' simply because it is expressed in the language of computer code. Mathematical formulae and musical scores are written in 'code,' *i.e.*, symbolic notations not comprehensible to the uninitiated, and yet both are covered by the First Amendment."[322] The same should be true for DNA when it is used as code.

The use of DNA as code literally creates a new medium for the storage, replication, distribution, and communication of ideas. This new medium is resilient, compact, efficient, and accurate. Through its use, all of the values incarnated in the First Amendment protection of free speech, truth, democracy, autonomy, and community, can be furthered, much in the same way that they are furthered by inventions such as the printing press or the Internet. DNA is the brick and mortar of the Great Library of Alexandria of the future: a Great Library that could last much longer, be much smaller, and could even have redundant backups all across the world (and even beyond). As such, the regulation of this new medium of communication must trigger First Amendment scrutiny.

c. Phenotype as Message

The final category of uses of DNA for communicative purposes involves the capacity of DNA to instruct a biological system to produce amino acids and proteins. The result of such production, and its outward macroscopic appearance and effects, are referred to by geneticists as the phenotype.[323] The corresponding sequence of DNA that codes for a particular phenotype is called the genotype.[324] To put it simply, a sequence of DNA in a person's cell may carry the instructions to produce black pigmentation in that person's hair. Said DNA sequence is the genotype for dark black hair. The dark black hair itself that is then

[321] Universal City Studios, Inc. v. Corley, 273 F.3d 429, 445–46 (2d Cir. 2001). *See also* Junger v. Daley, 209 F.3d 481, 484 (6th Cir. 2000).
[322] *Corley*, 273 F.3d at 445.
[323] *What is Genotype? What is Phenotype?*, PERS. GENETICS EDUC. PROJECT, http://www.pged.org/personal-genetics-101/what-is-genotype-what-is-phenotype/ (last visited Feb. 26, 2015).
[324] *Id.*

produced by the person's body and that grows out of her scalp is the phenotype.

Changes in DNA, then, can produce different phenotypes. And the creation of different phenotypes can serve to express artistic, political, or other types of messages. The techniques to do just that have been progressing recently at an amazing pace:

> Today, the ascent of synthetic biology is transforming genetic engineering in fundamental ways, enabling an entirely new level of control and precision. Synthetic biologists are increasingly able to design and synthesize genetic sequences that deviate substantially from anything occurring naturally and capable of performing novel and often highly useful functions. Techniques that rely upon naturally occurring DNA sequences as starting material, such as DNA shuffling and other modes of directed molecular evolution, have been successfully deployed to create synthetic gene sequences deviating substantially from anything found in nature. Work is progressing on methods for de novo genetic design, which results in genetic sequences bearing even less resemblance to any natural counterpart.[325]

This increase in the use of the expressive capacity of DNA through synthetic biology has led some commentators to argue that we are due to reconsider the applicability of copyright law to DNA, a question that was addressed in the 1980s but has since been mostly forgotten.[326]

An illuminating example of just such an expressive use of DNA is the artistic work of Eduardo Kac.[327] Kac creates what he calls "Transgenic Bio Art."[328] One of his most celebrated creations is Alba, the GFP Bunny, who glows bright green under certain lights.[329] Kac produced Alba's glow effect by introducing a synthetic version of fluorescent genes from jellyfish into her genome.[330] Kac has also made

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[325] Holman, *supra* note 210, at 717 (citing Alok Jha, *From the Cells Up*, GUARDIAN (Mar. 9, 2005, 8:02 PM), http://www.theguardian.com/science/2005/mar/10/science.research/print; Arti Rai & James Boyle, *Synthetic Biology: Caught Between Property Rights, the Public Domain, and the Commons*, 5 PLOS BIOLOGY 0389, 0389 (2007); SHELDON J. PARK & JENNIFER R. COCHRAN, PROTEIN ENGINEERING AND DESIGN (1st ed. 2009)).

[326] *See* Holman, *supra* note 210, at 717; Andrew W. Torrance, *DNA Copyright*, 46 VAL. U. L. REV. 1 (2011) (citing Irving Kayton, *Copyright in Living Genetically Engineered Works*, 50 GEO. WASH. L. REV. 6 191, 191–92 (1982)); Dan L. Burk, *Copyrightability of Recombinant DNA Sequences*, 29 JURIMETRICS J. 469, 531–32 (1988–89); Jorge A. Goldstein, *Copyrightability of Genetic Works*, 2 BIO/TECH. 138 (1984); Donna Smith, Comment, *Copyright Protection for the Intellectual Property Rights to Recombinant Deoxyribonucleic Acid: A Proposal*, 19 ST. MARY'S L.J. 1083, 1096–1108 (1988).

[327] BIO ART, http://www.ekac.org/transgenicindex.html (last visited Aug. 1, 2014).

[328] *Id.*

[329] Eduardo Kac, *GFP Bunny*, BIO ART, http://www.ekac.org/gfpbunny.html#gfpbunnyanchor (last visited Aug. 1, 2014).

[330] *Id.*

works consisting of such interesting flights of fancy as the Edunia, "[t]he central work in the 'Natural History of the Enigma' series."[331] The Edunia "is a plantimal, a new life form [Kac] created . . . a genetically engineered flower that is a hybrid of [him]self and Petunia."[332] Along with Kac's detailed explanations regarding the meaning and intent behind his works, these artistic creations are powerful statements regarding the nature of life itself and our place in the universe. These expressions further all of the First Amendment values previously discussed, particularly the values of truth and autonomy. Consequently, their regulation should trigger First Amendment scrutiny.

Another example of the alteration of genetic material to create animals with expressive phenotypes is the manufacture and sale of glow-in-the-dark fish.[333] At almost any local pet store nowadays one can find for sale, colorfully advertised to attract children, fish that have been genetically altered to glow in different neon colors when placed near a black light.[334] This purely commercial use of DNA does not seem to greatly further any of the First Amendment values discussed, but it does not appear to be particularly harmful to any of them either.

On the other hand, one could easily imagine the scales on a fish, the feathers on a bird, or the fur on a mammal being altered to have color patterns that would actually display written messages. Such technology could be used to make powerful artistic or even political statements. For example, at the time of writing of this Article, there is an ongoing active armed conflict between Israel and the territories inhabited by Palestinians. It would be an interesting exercise of political speech to alter the DNA of a flock of doves (the dove being an internationally and culturally recognized symbol for peace) so that their plumage spelled the word "peace" in different languages, program the birds to be attracted to, say, gunpowder, and release them in the Gaza Strip. Ethical concerns about the fate of the doves aside, it would surely make a striking statement worthy of First Amendment coverage.[335]

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[331] Eduardo Kac, *Natural History of the Enigma*, BIO ART, http://www.ekac.org/nat.hist.enig.html (last visited Aug. 1, 2014).

[332] *Id.*

[333] Lauren Johnston, *Looking for a New Pet? GloFish*, CBS NEWS (Dec. 3, 2003, 6:20 PM), http://www.cbsnews.com/news/looking-for-a-new-pet-glofish/.

[334] *Id.*

[335] Whether a First Amendment defense to, for example, an indictment for animal cruelty would survive the applicable scrutiny is of course another question altogether. But that is a question of First Amendment protection, not coverage. *See* Roig, *Decoding*, *supra* note 8, at 328–31 (discussing the important distinction between questions of coverage and questions of protection). One could imagine that a general animal cruelty prohibition would be deemed content-neutral and subjected to an intermediate, time, place, and manner scrutiny under *Clark v. Cmty. for Creative Non-Violence*, 468 U.S. 288, 293 (1984) or *United States v. O'Brien*, 391 U.S. 367, 376 (1968). Protecting the lives of innocent doves could be found to be an important state interest, and a statute that prohibits causing their death by putting them, quite literally, in the crossfire, may be

How about art imitating life? That is one of the themes behind the art of Heather Dewey-Hagborg.[336] This plastic artist collects items that people casually leave behind, like cigarette butts, and harvests from them traces of DNA.[337] She processes the DNA and extrapolates from it computer models of what the people that left the items behind might look like.[338] Finally, she creates sculptures, photographs, and other pictorial, graphic, or sculptural representations of the individuals' approximate likenesses.[339] Again, this serves as an example of an artist making works that certainly further the values of truth and autonomy under the First Amendment.

Scientists have created a program that transfers organic chemical structures with solar storage potential into lines of computer code.[340] The program then allows the user to remove parts of the code and splice it with other solar-capable molecules in order to create an "organic battery."[341] "The Curio Molecular Designer will allow you to help us design new materials. By following simple chemical rules and using our predictive model, you can help us develop new candidates for solar cell materials."[342]

But this particular experiment is not the only one of its kind. According to Holman:

found to be narrowly tailored to achieve that important interest while also leaving alternative channels of communication open (you could have programmed them to just fly over the Gaza Strip during a ceasefire, for example, instead of driving them straight to the barrels of the guns). Of course, a conviction for animal cruelty in the middle of a war in which dozens of children are being killed in their homes, schools, and United Nations shelters may very well be a powerful political statement in itself.

336 Heather Dewey-Hagborg, STRANGER VISIONS, http://deweyhagborg.com/strangervisions/ (last visited Aug. 1, 2014). *See also* Lucas S. Osborn, *Of PhDs, Pirates, and the Public: Three-Dimensional Printing Technology and the Arts*, 1 TEX. A&M L. REV. 811, 815–16 (2014) (referencing and briefly describing Heather Dewey-Hagborg's work); Jorge R. Roig, *Your DNA Speaks – Do You Have a Choice?*, TEDX (May 16, 2014), http://tedxtalks.ted.com/video/Your-DNA-Speaks-Do-You-Have-a-Ch (same).

337 Heather Dewey-Hagborg, STRANGER VISIONS, http://deweyhagborg.com/strangervisions/ (last visited Aug. 1, 2014).

338 *Id.* Police investigators are using similar technology to create predictive "mug shots" of suspects using DNA found at crime scenes. Andrew Pollack, *Building a Face, and a Case, on DNA*, N.Y. TIMES (Feb. 23, 2015), http://www.nytimes.com/2015/02/24/science/building-face-and-a-case-on-dna.html. While the images produced by DNA phenotyping are certainly not a completely accurate depiction of the suspect's features, investigators say it can predict some features, such as eye, hair, or skin color, fairly accurately. *Id.* Critics of the practice say that complex facial features cannot accurately be produced using DNA, worry that it might promote racial profiling, and raise concerns about how the widespread use of the practice might raise concerns about privacy and civil liberties. *Id.*

339 *Id.* The accuracy, or lack thereof, of these approximate likenesses is, of course, beside the point, to some extent, although it may very well be relevant in any potential legal dispute between the artist and her "subjects."

340 MOLECULAR SPACE, http://www.molecularspace.org (last visited Feb. 26, 2015).

341 *Id.*

342 *Id.*

> For example, undergraduates and even high school students are now able to design genetic constructs by rearranging DNA modules in creative and often ingenious ways. The BioBricks Foundation is assembling a set of DNA modules, which it refers to as "standard biological parts," for use in this sort of higher level genetic engineering.[343]

These examples show the immense potential for scientific cooperation and even crowdsourcing created by our ability to manipulate DNA sequences by interchangeably translating information from DNA to computer code and back. The First Amendment covered marketplace of ideas would surely benefit from such open interaction.

Finally, let us indulge our futuristic tendencies and go on a short flight of fancy. It is not hard to imagine that very soon scientists will be able, and perhaps willing, to offer parents-to-be the option of manipulating their future children's genetic material to produce preferred physical traits. For one thing, doctors could very well advocate the use of gene therapy on developing embryos, or even on the parents' reproductive cells, to rid their children of genetic diseases. In fact, this has already been done, to a limited extent, for the past decade.[344] But it does not take an exceptional imagination to think that parents might want to engage in more cosmetic genetic engineering of their children. This possibility would surely raise all sorts of ethical and legal dilemmas, from questions about personhood and property to issues of privacy and copyright. In that sense, Merry Jean Chan has proposed an intellectual property model she calls the "authorial parent paradigm."[345] Chan explains,

> Anchoring parental rights in the First Amendment provides a coherent and current descriptive alternative account of the Court's parental rights jurisprudence while also avoiding some of the problems attending substantive due process. . . . Parenting—both procreation and childrearing—can be thought of as creative expression, akin to authorship. Procreation, the prerequisite for childrearing, mingles two sets of DNA into one new, unique blueprint for a person. Childrearing is a process by which adults imbue their children with values, knowledge, skills, traits, etc., that shape the kind of adults that children grow up to be. These works of authorship in parenting give rise to parental rights.

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[343] Holman, *supra* note 210, at 718 (citing iGEM 2009, http://2009.igem.org/Main_Page (last visited Sept. 3, 2015); BIOBRICKS FOUND., http://bbf.openwetware.org/ (last visited Mar. 8, 2011)).

[344] *See* Charles Coutelle et al., *The Challenge of Fetal Gene Therapy*, 1 NATURE MED. 864 (1995) (describing early attempts at fetal gene therapy).

[345] Merry Jean Chan, *The Authorial Parent: An Intellectual Property Model of Parental Rights*, 78 N.Y.U. L. REV. 1186, 1187 (2003).

> Under a First Amendment approach to parental rights, those aspects of parenting that most clearly implicate expressive values are at the core of what the Constitution protects in parental rights. However, the First Amendment does not by itself provide the extent to which parental rights may be regulated. . . .
>
> The extent of [a parent's] control over her work is dictated by societal recognition of her copyright. . . .
>
> The project of this Note is not to make an exact analogy between parental rights and copyright; the two are dissimilar in many ways. However, a structural comparison is useful.[346]

If we consider the expressive potential of DNA, then the act of parenting itself, particularly when technologically assisted, may very well be fraught with First Amendment, as well as intellectual property, implications.[347]

This topic, of course, opens the door to a myriad of potential discussions of great interest that, unfortunately, are well beyond the scope of this Article. At this point, though, it is worth highlighting how many of the questions raised are not merely sterile issues of property or contract law, but rather deeply personal matters that must be considered in the context of the Bill of Rights and, specifically for purposes of this Article, the First Amendment. In this sense, Holman expounds, "The resistance against property rights in DNA is visceral, due in large part, I believe, to the deeply personal, some would say spiritual, link between DNA and the essence of what it means to be human, and between an individual and his or her own unique DNA."[348] His instinct seems right on point.

In the end, our newfound ability to directly manipulate DNA sequences, and thereby alter the corresponding phenotypes that express themselves in living organisms, allows for expressive uses of DNA heretofore not thought. Many of these uses would further or compromise First Amendment values of the highest order. Hence, our regulation of such uses must be subject to the rigors of our First Amendment doctrine.

CONCLUSION

This Article has attempted to highlight some of the most interesting and well-known contemporary social practices that make use of DNA's information-carrying capacity. This social, human context evinces the need to see DNA as more than just a molecule. DNA can be,

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346 *Id.* at 1187–89.

347 *See also* Holman, *supra* note 210 (proposing that the creation of original DNA sequences be subject to copyright law).

348 *Id.* at 705.

and frequently is, speech. It carries important messages about itself. But it also can serve as a powerful mechanism for storing, replicating, distributing, and even processing all kinds of other information. Furthermore, because DNA is the underlying mechanism through which living things are defined and engineered, it can also serve as the blueprint for new biological creations that may amount to individual expression themselves.

In this context, originalism and formalism are inadequate, ineffective, and inefficient means of applying the Constitution to emerging legal conundrums. While this may seem obvious to the fervent non-originalist, the example of DNA can serve as a convincing argument to those youthful (not just chronologically) and open legal minds that might be on the fence, or even initially situated on the originalist side of the fence.

The omnipresence of DNA, its importance in our society and in our definition of ourselves, and the total failure of formalist and originalist approaches to untangle the constitutional riddles that it raises, serve as a particularly striking endorsement of a more flexible, honest, and open analysis of such issues as the definition of "speech" for purposes of First Amendment coverage. Hopefully, this Article speaks with at least a fraction of the eloquence with which all the scientists, artists, engineers, and thinkers mentioned here are wielding the tremendous expressive capacity of that most fascinating labyrinth that we share with every living thing: DNA.