GENES, MEMES, LANGUAGE, AND NANOMACHINES: A NANOSCALE APPROACH TO REFUGEE AND IMMIGRATION LAW

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[W]et nanotechnology is incredibly powerful . . . think of how beautiful your daughter is.
~ Dr. Richard Smalley, 1996 Nobel Prize Laureate in Nanotechnology[1]

We have been living in the Age of Nanotechnology for hundreds of years . . . what has distinguished past efforts from current achievements is understanding and control.
~ Dr. Douglas Natelson, Professor, Rice University, 2015[2]

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[1] Richard E. Smalley, Nobel Prize Laureate, Nanotechnology and the Next 50 Years, University of Kansas City School of Education (Mar. 20, 1997). *But see, e.g.*, R.E. Smalley, Nanotechnology and the Next 50 Years, University of Dallas Board of Councilors (Dec. 7, 1995) (transcript available at http://www.oocities.org/area51/shadowlands/6583/project075.html) [hereinafter Smalley, University of Dallas].

[2] DOUGLAS NATELSON, NANOSTRUCTURES AND NANOTECHNOLOGY 4 (2015).

There is no document of civilization which is not at the same time a document of barbarism.
~ Walter Benjamin, 1940[3]

I. INTRODUCTION

This article centers on "nanotechnology." However, at the outset, it important to put aside its technical definition and not to think about what it means. It is a new revolutionary technology in some important respects, but it must be thought about in a new way.

The term relates to that which is universally familiar to all. One sees it every morning when they look in the mirror to wash their face or brush their hair.[4] They see it when they look at the color of someone's eyes or skin, the green of a tree and its structure contrasted with other trees and foliage in a forest. Ones tastes it eating food. They experience it when their relative is being treated for cancer[5] or see a nuclear bomb test on television. They note it growing up acquiring their own ethnicity or observing someone else's different ethnicity. It is the basis of human language. It can spread when humming a tune.[6] One even experiences it when they think a thought.

What is new about this term is only increased understanding and ability.[7] Once this is understood, new analysis follows about the law and its ability to regulate some newer aspects of this old technology. This article explores these issues in depth. They are among the most important issues today and few are less critical nor as fast evolving.

The first step in this process will be to look into the mirror of the past. It is a story about a man named Walter Benjamin. It is about his ethnicity, language, and his infamous observation about civilization,[8] or better, human nature.[9] All of which, are regulated by law.

A. THE EXAMPLE OF WALTER BENJAMIN

Walter Bendix Schoenflies Benjamin[10] was a German ethnic Jew born in 1892 to a wealthy Berlin family.[11] Benjamin became a very influential

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[3] A.J. Goldman, *Hannah Arendt and Walter Benjamin Don't Talk. They Sing,* N.Y. TIMES, June 24, 2018, at C5.

[4] *See* Smalley, University of Dallas, *supra* note 1.

[5] *See, e.g.*, Fangfang Cao et al., *Ultrasmall Nanozymes Isolated Within Porous Carbonaceous Frameworks for Synergistic Cancer Therapy: Enhanced Oxidative Damage and Reduced Energy Supply*, 30 CHEMISTRY MATERIALS 7831, 7831 (2018).

[6] *See* RICHARD DAWKINS, THE SELFISH GENE 245–60 (1976) (discussing memes as new replicators in Chapter 11).

[7] *See* NATELSON, *supra* note 2, at 4.

[8] *See* Goldman, *supra* note 3, at C5.

[9] Human nature may reveal violent tendencies. STEPHEN PINKER, THE BLANK SLATE: THE MODERN DENIAL OF HUMAN NATURE 6 (Penguin Books 2002).

[10] "The German Jewish critic and philosopher Walter Benjamin (1892–1940) is now widely considered to be one of the most important witnesses to European modernity." HOWARD EILAND & MICHAEL W. JENNINGS, WALTER BENJAMIN A CRITICAL LIFE 1 (2014).

[11] Peter Osborne & Matthew Charles, *Walter Benjamin*, STAN. ENCYCLOPEDIA OF PHIL. (July 22, 2015), https://plato.stanford.edu/archives/fall2015/entries/benjamin/. At the height of Benjamin's career

critical theorist and philosopher and remains one today.[12] In 1933, Benjamin left Germany for the last time with other Jewish contemporaries.[13] He continued his work abroad living in Denmark and France.[14]

Benjamin was initially placed into a concentration camp for German citizens in France.[15] After the German invasion, he lived in fear in Vichy, France. He attempted to flee to Spain with friends[16] because he lacked the necessary exit visa.[17] During this time—a period known as the "reign of terror"—he told a friend that people "were being dragged out of their beds in the middle of the night, tortured and then murdered."[18] Benjamin then hiked through the Pyrenees mountains, attempting to enter Spain as an illegal refugee,[19] but was turned away at a small border town for not having the necessary exit visa.[20] That evening on September 27, 1940, Benjamin took his own life[21] in Portbou because "soon after his arrival in Spain he was betrayed by the hotel owner."[22] He feared "the Spanish would turn him over to the French border police, who would hand him to the Nazis . . . ."[23] At the

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in the 1920s and 1930s, his "politically oriented, materialist aesthetic theory proved an important stimulus for both the Frankfurt School of Critical Theory and the Marxist poet and dramatist Bertolt Brecht." *Id*. His work continues to spur literature productivity to this day in large volume. *Id*. His colleagues today claim that he significantly contributed to the "revival of Early German Romanticism." *Id*. Benjamin graduated *summa cum laude* from the University of Bern in Switzerland in 1919 and his doctoral dissertation, The Concept of Art Criticism in German Romanticism, helped spur his novella on Goethe that put into play his described art criticism. *Id*. Benjamin moved from writing for "*Der Anfang* ('The Beginning'), a journal dedicated to Wyneken's principles on the spiritual purity of youth" to turning to the left and visiting Moscow. *Id*. *See* WALTER BENJAMIN, MOSCOW DIARY (Gary Smith, ed. & Richard Sieburth, trans., 1986). He "was closely involved in the plans for a left-wing periodical to be entitled "Crisis and Critique," in collaboration with Ernst Bloch; Sigfried Kracauer; and, among others, the Marxist poet, playwright, and theatre director Bertolt Brecht." Osborne & Charles, *supra* note 11. "Bertolt Brecht was one of the most influential playwrights of the 20th century." *Bertolt Brecht*, POETRY FOUNDATION, https://www.poetryfoundation.org/poets/bertolt-brecht. (last visited Aug. 26, 2019).

[12] *See generally* Osborne & Charles, *supra* note 11.

[13] "And then in 1933, the year in which the Nazis came to power and Benjamin fled Germany for the last time . . . ." Stuart Jeffries, *The Storm Blowing from Paradise: Walter Benjamin and Klee's Angelus Novus*, VERSO BOOKS (Aug. 2, 2016), https://www.versobooks.com/blogs/2791-the-storm-blowing-from-paradise-walter-benjamin-and-klee-s-angelus-novus.

[14] *See, e.g.*, JAY PARINI, BENJAMIN'S CROSSING: A NOVEL (1996) (a fictionalized autobiography of Benjamin's flight abroad in France and Spain).

[15] "With the outbreak of war in 1939, Benjamin was temporarily interned in the French "concentration camps" established for German citizens." Osborne & Charles, *supra* note 11.

[16] *See, e.g.*, Douglas Martin, *Lisa Fittko, Who Helped Rescue Many Who Fled the Nazis, Dies at 95*, N.Y. TIMES, Mar. 21, 2005, at B7.

> [Lisa] Fittko emerged from a leftist, artistic family to become active in the resistance to Hitler in the early months of his rule, then fled to continue the fight in other European countries for seven years. For seven tense months in 1940 and 1941, she escorted refugees on a tortuous path over the Pyrenees mountains so they could go on to Spanish and Portuguese ports to seek passage to safe havens. Many of the people she helped were intellectuals, artists, and anti-Nazi organizers. The first refugee she helped was Walter Benjamin, a Marxist literary critic and philosopher, whose work has drawn new interest in recent years because of his provocative insights on subjects from consumerism to surrealism. *Id*.

[17] *See* Osborne & Charles, *supra* note 11.

[18] EILAND & JENNINGS, *supra* note 10, at 391–92.

[19] *Id*.

[20] "But that initial mission was thwarted when the Spanish authorities ordered the group to return to France because they lacked proper exit visas, a requirement that had not been enforced in the past and was ignored in the future." Martin, *supra* note 16, at B7.

[21] "Mr. Benjamin died at the age of forty-eight in Room No. 4 on the second floor of the Hotel de Francia, a cheap pension in Port-Bou, Spain, on September 27, 1940, having apparently committed suicide." *Id*.

[22] Stuart Jeffries, *World News: Did Stalin's Killers Liquidate Walter Benjamin?*, THE GUARDIAN (Jul. 8, 2001), https://www.theguardian.com/world/2001/jul/08/humanities.internationaleducationnews [hereinafter Jeffries, *World News*].

[23] *Id*.

time, he was already carrying an approved visa to enter the United States.[24] This story is also only one of many stories of personal torment for refugees.[25]

B. IMMIGRATION AND REFUGEE LAW AS DOCUMENTS OF BARBARISM

Accounts similar to Benjamin's occurred in some of the most advanced civilized countries. A leader in film,[26] science,[27] and music, Germany was the center of human civilization[28] in Europe[29]—also considered a pinnacle of civilization.[30] Today, the United States is also a center of civilization[31] considering its role in film, music, literature, and science.[32] Is it the case that the law of one of the world's most civilized nations killed Benjamin? Was German immigration law the cause? Or, did French or Spanish immigration law and policy cause or justify his death? Benjamin was a wonderous intellectual and remains a cherished product of civilization to this day. Yet did the law kill him? And if so, why? This final question relates to Benjamin's observation on civilization and barbarism[33] and whether it was

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[24] EILAND & JENNINGS, *supra* note 10, at 675.

[25] There has been recently speculation that Benjamin may have been killed by Stalinists, and that he and others leftist intellectuals were becoming disillusioned by the Soviet Union, including with the Hitler-Stalin Pact. *See* Jeffries, *World News*, *supra* note 22 ("The renowned German writer and critic may not have died at his own hands . . . .").

Benjamin had, perhaps unwittingly, associated with Comintern agents . . . [and he] was part of a subculture honeycombed with dangerous people - it was known not to be safe. In the late Thirties . . . Stalinist agents in Spain were assigned to track down German-speaking anti-Stalinists and torture them into false confessions of betraying the Republic. *Id*.

This is not an established credible theory, the general consensus is that he took his own life; however, in regard to this paper's thesis, it is not relevant if the Russians were after him for being anti-Stalin or the Nazis for being Jewish, leftist or anti-Nazi, because the goals and targeting are both similar.

[26] *See, e.g*., KLAUS KREIMEIER, THE UFA STORY: A HISTORY OF GERMANY'S GREATEST FILM COMPANY, 1918-1945 (Weimar and Now: German Cultural Criticism, Robert Kimber & Rita Kimber, trans., 1999) (discussing that Germany "challenged Hollywood for cultural dominance and market share in Jazz Age Europe").

[27] *See id*. *See generally* Michael Greshko, *Who Are the Nobel Prize Winners? We've Crunched the Numbers,* NAT'L GEOGRAPHIC (Oct. 3, 2018), https://news.nationalgeographic.com/2017/10/nobel-prize-winners-laureates-charts-graphics-science/.

[28] *See, e.g*., David Niose, *Noam Chomsky: On Humanism, the Vulnerability of Secular Nationalism, and the Mother of All Book Plugs*, THE HUMANIST (Jan. 1, 2007), https://www.thefreelibrary.com/Noam+Chomsky%3a+on+humanism%2c+the+vulnerability+of+secular+nationalism%2c...-a0159178785 (discussing book review of NOAM CHOMSKY, HEGEMONY OR SURVIVAL (Henry Holt & Co., N.Y. 2004)). "Germany, remember, was the most civilized part of the world. It was the peak of Western civilization, the center of the arts, the sciences, and literature. If you wanted to study physics, you went to Germany." *Id*.

[29] *See, e.g*., PETER WATSON, THE GERMAN GENIUS: EUROPE'S THIRD RENAISSANCE, THE SECOND SCIENTIFIC REVOLUTION, AND THE TWENTIETH CENTURY (Taschenbuch, English ed. 2011).

[30] *But see* ROBERT FISK, THE GREAT WAR FOR CIVILISATION (2005) (discussing analogies to Europe and World Wars to Middle East with European involvement and theme of "civilization" juxtaposed to European claim of being civilized), Rick Noack, *Long-Forgotten Einstein Letter That Predicted Threat of Anti-Semitism Reemerges with Ominous Message,* WASH. POST (Nov. 14, 2018) (discussing study by Kantor Center for the Study of Contemporary European Jewry at Tel Aviv University and that "[s]ince the report's release in April, anti-Semitic incidents have further increased across Europe, with a 69 percent jump in France so far this year. The spike in attacks against minorities is not limited to Jews, as Muslims have also become more frequent targets.").

[31] Despite its present position of cultural and economic dominance, the U.S. also has had its own issues with anti-Semitism. *See, e.g*., JOSEPH W. BENDERSKY, THE JEWISH THREAT: ANTI-SEMITIC POLITICS OF THE U.S. ARMY (2000).

[32] *Cf*., Greshko, *supra* note 27.

[33] Goldman, *supra* note 3 ("'There is no document of civilization which is not at the same time a document of barbarism,' Benjamin wrote in 1940 . . . .").

premonition of his own fate—were documents of civilization also documents of barbarism?

C. WALTER BENJAMIN ON THE NANOSCALE

Benjamin's thoughts or memes were a potential threat[34] as well as his Jewish genes.[35] He had high intellectual development; his knowledge, memories, and brain development, could be measured precisely[36] to the nanometer. Language faculties in the brain could also be precisely measured to the nanometer.[37]

Other Jews from Europe, such as Albert Einstein, were able to flee to the U.S. as refugees.[38] Some came to the U.S. on work visas because they had required skills.[39] Those physical skills, their memories, and their brains could be measured down to the nanometer. Society knows the skills Einstein had and continues to study and measure his brain in terms of structure, microscale, and even nanoscale.[40] Intelligence has now been linked to

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[34] *See generally* DAGMAR BARNOUW, WEIMAR INTELLECTUALS AND THE THREAT OF MODERNITY (1988) (discussing figures of the Weimar republic: Walter Rahtenau, Robert Musil, Thomas Mann, Walter Benjamin, Ernst Jünger, Hermann Broch, and Alfred Döblin).

[35] "In their public statements, the Nazis repeatedly asserted that the connection between World war II and the Jews was cause and necessary. . . . [Hitler] and his propagandists insisted that the 'extermination' of the Jews as a justified response to a war launched against Germany by 'international Jewry." JEFFREY HERF, NAZI PROPAGANDA DURING WORLD WAR II AND THE HOLOCAUST 2 (2006). *See, e.g.*, JOSEPH W. BENDERSKY, A CONCISE HISTORY OF NAZI GERMANY 61 (2007).

Changing American Sensibilities after World War II and the Holocaust also altered attitudes and their expression. The vehement anti-racial anti-Semitism flaunted so arrogantly by many officers in the 1920s would be later expressed only privately or in more subtle forms after Nazism made such views disreputable within an increasingly progressive American society. *Id*.

See also BENDERSKY, *supra* note 31, at xvii.

[36] *Cf*. Winfried Denk, Kevin L. Briggman & Moritz Helmstaedter, *Structural Neurobiology: Missing Link to a Mechanistic Understanding of Neural Computation*, 13 NATURE 351 (2012).

Several technical developments over the past decade, such as serial block-face electron microscopy and trans-synaptic viral tracing, have made the structural biology of neural circuits conceivable: we may be able to obtain the structural information needed to reconstruct the network of cellular connections for large parts of, or even an entire, mouse brain within a decade or so. Given that the brain's algorithms are ultimately encoded by this network, knowing where all of these connections are should, at the very least, provide the data needed to distinguish between models of neural computation. *Id*. at 351.

[37] *See generally* NOAM CHOMSKY, ASPECTS OF THE THEORY OF SYNTAX (2014) (cornerstone book on generative grammar and language connection to brain biological structure), NOAM CHOMSKY, ON LANGUAGE (1998), NOAM CHOMSKY, THE SCIENCE OF LANGUAGE (2012), and NOAM CHOMSKY, TOPICS IN THE THEORY OF GENERATIVE GRAMMAR 1978).

[38] Clifton B. Parker, *Jewish Émigrés Who Fled Nazi Germany Revolutionized U.S. Science and Technology*, *Stanford Economist Says*, STAN. REPORT (Aug. 11, 2014), https://news.stanford.edu/news/2014/august/german-jewish-inventors-081114.html. "U.S. patents increased by 31 percent in fields common among Jewish scientists who fled Nazi Germany for America . . . . Their innovative influence rippled outward for generations, as the émigrés attracted new researchers who then trained other up-and-comers." *Id*. "[T]he arrival of German Jewish émigrés to America who were fleeing the Nazi regime in the 1930s revolutionized U.S. science and innovation." *Id*.

[39] *See* Benjamin Bederson, Am. Physical Soc'y, Fritz Reiche and German Refugee Scientists, Philadelphia, P.A. (Apr. 5–8, 2003) (describing process, obtaining grants and visas for helping many physicists leave Germany and occupied countries to the U.S.).

[40] *See* Dr. Sandra F Witelson, Debra L Kigar, & Thomas Harvey, *The Exceptional Brain of Albert Einstein,* 353 LANCET 2149, 2149 (1999) ("Albert Einstein is one of the intellectual giants of recorded history, and the preservation of his brain provides the possibility of an important case study. Since Einstein's death, there has been no report of the gross anatomy of his brain. Here we present the first such study.").

Einstein's brain weight was not different from that of controls, clearly indicating that a large (heavy) brain is not a necessary condition for exceptional intellect. Microscopic differences may underlie gross anatomical differences. The limited data on Einstein's brain do not point to a difference in the number of neurons throughout the depth of the cortex in the frontal or temporal lobes . . . but possibly a difference

genetic selection, cultural proclivity, and susceptibly to genetic-based disease at the nanoscale level for European or Ashkenazi Jews.[41] Nanoscale ethnic and religious targeting ended and was deemed evil, but it remains a strong presence and is currently resurging.

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Nobel Prize Laureate Richard Smalley, who won the Nobel Prize in chemistry in 1996 for his graphene buckeye tubes, said humans are wet nanotechnology.[42] In other words, humans are nanomachines.[43] Twenty-one years ago, just after he won his Nobel Prize, Professor Smalley gave a lecture about the critical importance of nanotechnology in the next fifty years.[44] Although legal scholarship fails to fully grasp this concept, nanotechnology research and regulating government agencies do not.

D. NANOTECHNOLOGY

Nanotechnology will be revolutionary,[45] it will be akin to the industrial revolution,[46] and it will transform society.[47] Humans already use it for their tissues, organs, blood cells, brains, behavior, physical performance, and DNA. Some scholars believe nanotechnology will transform society so dramatically that if the law cannot change in advance it must, at least, be prepared to act. The power behind nanotechnology is the human ability to build things—not simply organic substances in their natural state but also in other forms, e.g. carbon in the form of diamonds—from the bottom up,

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in the ratio of the number of glial cells relative to neurons in the left parietal cortex . . . . However, the findings do suggest that variation in specific cognitive functions may be associated with the structure of the brain regions mediating those functions. *Id*. at 2152.

[41] *See* Gregory Cochran, Jason Hardy & Henry Harpending, *Natural History of Ashkenazi Intelligence,* 38 J. BIO. SCI. 659, 659 (2006).

This paper elaborates the hypothesis that the unique demography and sociology of Ashkenazim in medieval Europe selected for intelligence. Ashkenazi literacy, economic specialization, and closure to inward gene flow led to a social environment in which there was high fitness payoff to intelligence, specifically verbal and mathematical intelligence but not spatial ability . . . . [W]e propose that the well-known clusters of Ashkenazi genetic diseases, the sphingolipid cluster and the DNA repair cluster in particular, increase intelligence in heterozygotes. Other Ashkenazi disorders are known to increase intelligence . . . . Gene frequencies at a large number of autosomal loci show that if there was a bottleneck then subsequent gene flow from Europeans must have been very large . . . [and] these are signatures of strong and recent natural selection. *Id*.

[42] *See* Smalley, University of Dallas, *supra* note 1.

[43] *Id*.

[44] *Id*.

[45] Gregory Mandel, *Nanotechnology Governance,* 59 ALA. L. REV. 1323, 1324 (2008) ("Experts expect nanotechnology to transform society, revolutionizing fields as diverse as health care, energy, and the environment. . . . For the first time in history, there is the opportunity for a governance system to develop simultaneously with an emerging technology.").

[46] Colin Milburn, *Nanotechnology in the Age of Posthuman Engineering: Science Fiction as Science,* 10 CONFIGURATIONS 261, 261 (2002).

[N]anotechnology foresees a technocultural revolution that will, in a very short time, profoundly alter human life as we know it. The ability to perform molecular surgery on our bodies and our environment will have irrevocable social, economic, and epistemological effects; our relation to the world will change so utterly that even what it means to be human will be seriously challenged. *Id*.

See Christine Peterson, *Molecular Nanotechnology: The Next Industrial Revolution*, FORESIGHT INST., https://foresight.org/nano/IEEEComputer.html (last visited Aug. 26, 2019) (specifically referring to molecular nanotechnology).

[47] FRITZ ALLHOFF ET AL., NANOETHICS: THE ETHICAL AND SOCIAL IMPLICATIONS OF NANOTECHNOLOGY 40–54 (2007) (an exploration of the sociological and ethical implications of nanotechnology, which impact will impact human life, environment and even personal relationships on a scale unlike other technologies).

molecule by molecule, atom by atom.[48] "Technological convergence has consequences not only for human rights and the way they can be exercised, but also for the fundamental concept of what characterizes a human being."[49]

E. THESIS

I have studied nanotechnology for almost twenty years and believed fifteen years ago[50] that existing law, such as genetic engineering laws, could be applied to nanotechnology.[51] However, large advances in nanotechnology could require legal change.[52] Today, the Law directly referencing "nanotechnology" has grown but remains relatively minimal. Legal scholarship for the past twenty years has continued to postulate and not notice the elephant in the room—itself. Legally, the focus should be not only on future law but also the past and present.

Past and present focus reveals that the law already works at the nanoscale, especially Refugee Law. The Law has done this for thousands of years, before anyone understood the nanoscale and long before gene-edited babies were born.[53] The change is in humans' understanding of and ability to change things on the nanoscale. Consequently, humans' understanding of how the Law works must also change.

In addition, immigration and refugee laws govern matters on "barbarism," or the underside of civilization. It is a powerful force of political consolidation, including human evolution. Ironically, although refugee laws originated to protect individuals from barbarism, they can be an avenue for implementing the very biases they seek to protect.

The mechanism that harmed Benjamin happens in every country to this day and is governed by law. Benjamin's story illustrates the current need to understand the Law in this new way. Benjamin's life and his observation of civilization and barbarism have taken years to research and analyze; yet many refugees like him are fleeing more frequently than ever, requiring a prompt response. The legal outlook in this article will both improve present law and policy and prepare society for the future.

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[48] *See generally* K. ERIC DREXLER, ENGINES OF CREATION: THE COMING ERA OF NANOTECHNOLOGY (1987), K. ERIC DREXLER, GAYLE PERGAMIT & CHRIS PETERSON, UNBOUNDING THE FUTURE: THE NANOTECHNOLOGY REVOLUTION (1991).

[49] Giorgia Guerra, *An Interdisciplinary Approach for Comparative Lawyers: Insights from the Fast-Moving Field of Law and Technology*, 19 GERMAN L.J. 579, 579 (2018).

[50] *See* Doug Tsuruoka, *Nanotech Boom Expected To Force Legal Scrambling; Could New Laws Be Needed?; Nanotechnology Backers are Moving Ahead Quickly, but Headaches May Follow*, INV. BUS. DAILY, Sept. 30, 2003, at A05 ("T.S. Twibell, an associate attorney with the Kansas City, Mo., law firm Kurlbaum Stoll Seaman Mustoe & McCrummen, writes about nanotech legal issues.").

[51] *Id*. ("He says existing federal and local laws are adequate to cover nanotech without serious revision."). Laws already on the books relating to genetic engineering, for instance, could be used to cover nanotech. *Id*.

[52] *Id*. ("'But such laws may fall short if there are big advances in nanotech,' Twibell says. 'That's the time when we may need ethical or other laws to address the peculiarities of nanotechnology,' Twibell said.").

[53] Alice Klein & Michael Le Page, *World's First Gene-Edited Babies Announced by a Scientist in China*, NEW SCIENTIST (Nov. 26, 2018), https://www.newscientist.com/article/2186504-worlds-first-gene-edited-babies-announced-by-a-scientist-in-china/ (discussing technical details of how Chinese scientist utilized twenty-two embryos from seven pairs of women and men, some of whom were HIV-positive, to edit out a gene to create immunity to HIV and how, if true, it raises a number of ethical issues by including humans in these types of experiments).

This article will first describe nanotechnology in more detail. It will then provide an overview of legal thought in this arena. Next, it will focus on components that are not typically thought of as being on the nanoscale, such as memories, personalities, ethnicity, language, and skills. It will then describe how the nanotechnology field is growing in this direction. It will demonstrate how refugee and immigration law has long focused on the nanoscale and by doing so, immigration law effectively engineers societal genetic, physical, and psychological traits while consolidating power.[54] Finally, the article will discuss how teaching and making new law and policy can better consider issues by focusing on the nanoscale. This new way of framing immigration and refugee law will enable the law to be better understood, taught, and implemented. In the process, it will lay out a new perspective to not only balance ethical and social concerns but also better address today's security and economic concerns—a priority in emerging nanotechnology.

F. WHY IS IMMIGRATION AND REFUGEE LAW RELEVANT TO NANOTECHNOLOGY?

Nanotechnology can apply to many human areas, such as nanomedicine in its preventive, curative, and performance enhancing capacities. Current legal discussion does not focus on humans but rather primarily on their environs or interactants. Refugee and immigration law epitomize human regulation because it uniquely focuses on nanoscale qualities to a degree unlike any other law. For example, it can focus on one's political thoughts, political proclivities, ethnicity, language, skills and abilities, familial/genetic relations, whether one has a disease, and whether one is a criminal or terrorist threat. Moreover, current nanotechnology research and application, regardless of the existence of a firm definition of "nanotechnology," is already being applied to humans. Humans crossing borders who are impacted by nanotechnology will challenge U.S. law on ethical and other novel issues, more so than on other legal areas. Initially, it will tend to go unnoticed. However, an intimate focus on these issues will teach valuable lessons as humans embark on an unparalleled, revolutionary trek to understanding and controlling themselves and their environment on the nanoscale.

II. NANOTECHNOLOGY AND LEGAL IMPACT

A. AN OVERVIEW OF NANOTECHNOLOGY–A TECHNOLOGY HUNDREDS OF YEARS OLD

After attempting to put aside the technical definition, the question can now be asked and answered: What exactly is "nanoscale" or "nanotechnology"? Nanotechnology has been around for hundreds of

[54] This is a process-oriented proposition, not results-oriented. Although there is science behind the fact that culture can change evolution and it is reasonable to follow that law affects evolution, a scientific inquiry would need to be made to support a proposition that law causes or engineers revolutionary change.

years;[55] it is just that there has been enormous advance in its understanding and control.[56] At legal symposiums, scholars note that "nanotechnology or nanoparticles more accurately have been around for a long time" and have "actually been here for about 10,000,000,000 years."[57] They ask: "Is this technology even new from our world? Can we regulate this using our existing systems?"[58]

Nanotechnology also has been heralded simply as the technology of the small.[59] It is "tiny technology" that some say was first coined at Tokyo University in 1974 by Norio Taniguchi.[60] A nanometer is one billionth of a meter.[61] "A single human hair is about 100,000 nanometers across."[62] Things on the nanoscale refer to the nanoscale of measurement, and some regard nanotechnology as dealing with sizes from one to one hundred nanometers.[63] Gold atoms are one nanometer in size and human DNA is about 2.5 nanometers across.[64] Human neurons vary in size, proximity to each other, and components, but neurons can range from six to eighty nanometers.[65] Additionally, their cellular function with other elements, including nanoparticles,[66] and the microscopic study of brain tissue relate to the nanoscale.[67]

Humans have long made historical achievements in nanotechnology. In the fourth century A.D., the Lycurgus cup was an artifact made of dichroic glass that contained seventy nm particles of gold and silver which appeared green; but when light passed through it, they appeared red.[68] The optical effect of red was caused by gold particles and the green was caused by silver

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[55] NATELSON, *supra* note 5, at 4.

[56] *See id*.

[57] Symposium: Interdisciplinary Approaches to Medical Nanotechnology: Defining the Issues, *Transcript of the Lives Symposium Interdisciplinary Approaches to Medical Nanotechnology: Defining the Issues,* 6 IND. HEALTH L. REV. 385, 405 (2009), https://journals.iupui.edu/index.php/ihlr/article/download/16554/16700/.

[58] *Id*.

[59] Gary E. Marchant, *Small is Beautiful: What Can Nanotechnology Do for Personalized Medicine?*, 7 CURRENT PHARMACOGENOMICS & PERS. MED. 231, 231 (2009) ("Nanotechnology, the 'science of the small', is revolutionizing diverse areas of research, product development and manufacturing, and commerce.").

[60] Anastasia D. Carter, *Comment: Overly Broad Patents on Nanostructures: How Patent Policy Obstructs the Development of Cancer Diagnostics and Treatments on a Macro,* 46 TEX. TECH L. REV. 562, 562 (2014) ("Nanotechnology is, quite simply, 'tiny technology.' The term 'nanotechnology,' coined by Norio Taniguchi of Tokyo University in 1974, represents the endeavors involved in researching, producing, and applying materials and devices measuring between one and one hundred nanometers.").

[61] Nano.gov, *Size of the Nanoscale*, NATIONAL NANOTECHNOLOGY INITIATIVE, https://www.nano.gov/nanotech-101/what/nano-size (last visited Aug. 26, 2019).

Just how small is "nano?" In the International System of Units, the prefix "nano" means one-billionth . . . . [H]ere are some examples: A sheet of paper is about 100,000 nanometers thick, A strand of human DNA is 2.5 nanometers in diameter, There are 25,400,000 nanometers in one inch, . . . A single gold atom is about a third of a nanometer in diameter [and] One nanometer is about as long as your fingernail grows in one second. *Id*.

[62] WESLEY C. SANDERS, BASIC PRINCIPLES OF NANOTECHNOLOGY xii (2019).

[63] *See id*.

[64] *See generally* Nano.gov, *supra* note 61.

[65] Cedric S. Raine, *Characteristics of the Neuron, in* BASIC NEUROCHEMISTRY: MOLECULAR, CELLULAR AND MEDICAL ASPECTS (G.J. Siegel et al. eds., 1999).

[66] V. Brunetti et al., *Neurons Sense Nanoscale Roughness with Nanometer Sensitivity*, PNAS (Feb. 23, 2010), https://www.pnas.org/content/pnas/early/2010/03/15/0914456107.full.pdf.

[67] *Cf.* Marco Cantoni, Christel Genoud, Cécile Hébert & Graham Knott, *Large Volume, Isotropic, 3D Imaging of Cell Structure on the Nanometer Scale*, MICROSCOPY & ANALYSIS 13 (May 2010), https://microscopy-analysis.com/sites/default/files/magazine_pdfs/mag%202010_May_Cantoni.pdf.

[68] SANDERS, *supra* note 62, at 2.

particles.[69] The Damascus swords were other artifacts with nanoscale achievements.[70] The Damascus swords were famous for being able to cut silk as it fell to the ground, as they were unusually strong, sharp, and flexible.[71] Their production included use of organic materials, heating, and forging.[72]

Microscopic analysis of the Damascus swords revealed the formation of carbon nanotubes,[73] which in principle are similar to the higher-developed precursor of nanotubes,[74] or *Bucky Balls*,[75] that earned Richard Smalley and two others the Nobel Prize in 1996.[76] Carbon nanotubes are largely credited to Japanese scientist Sumio Iijima[77] of NEC Corporation[78] in 1991[79] and scientists L. V. Radushkevich and V. M. Lukyanovich, who first published writing on fifty nm nanotubes in the Soviet *Journal of Physical Chemistry* in 1952.[80] However, the Cold War and Russia may have obscured Radushkevich and Lukyanovich's work from the West.[81] Before this, the first scientific discussion of such nanotubes was in 1889.[82] Thus, carbon nanotubes have long been part of human nanotechnology.[83]

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[69] *Id*.

[70] *Id*. at 3.

[71] *Id*.

[72] *Id*.

[73] Barnaby J. Feder, *Richard E. Smalley, 62, Dies; Chemistry Nobel Winner,* N.Y. TIMES, Oct. 25, 2005, at C16.

New forms of the element carbon – called fullerenes – in which the atoms are arranged in closed shells was discovered in 1985 by Robert F. Curl, Harold W. Kroto and Richard E. Smalley. . . . In time, the nanotubes, which were discovered by researchers at NEC in Japan in 1991, emerged as the more promising form of fullerene for most commercial applications. But many researchers date the dawn of modern nanotechnology to the excitement ignited by the buckyballs, for which Drs. Kroto, Curl and Smalley shared the 1996 Nobel Prize in Chemistry. *Id*.

[74] *Id*.

[75] *Richard E. Smalley, Robert F. Curl, and Harold W. Kroto*, SCI. HISTORY INST., https://www.sciencehistory.org/historical-profile/richard-smalley-robert-curl-harold-kroto (last updated Dec. 4, 2017) ("Nobel laureates Smalley, Curl, and Kroto discovered buckminsterfullerene, also known as the buckyball").

[76] Press Release, The Royal Swedish Academy of the Sciences, The Nobel Prize in Chemistry 1996 (Oct. 9, 1996), https://www.nobelprize.org/prizes/chemistry/1996/press-release/.

[77] *See Directory Page*, *Iijima Sumio Japanese Scientist,* ENCYCLOPEDIA BRITANNICA, https://www.britannica.com/biography/Iijima-Sumio, (last visited Aug. 28, 2019)*; Directory Page*, *Nanotechnology* ENCYCLOPEDIA BRITANNICA, https://www.britannica.com/technology/nanotechnology#ref836973 (last visited Aug. 28, 2019).

[78] NEC is a a Japanese Corporation. *See generally* NEC, https://www.nec.com/ (last visited Aug. 28, 2019).

[79] *Carbon Nanotube*, NEC, https://www.nec.com/en/global/rd/technologies/cnt/index.html (last visited Aug. 28, 2019)

("'Carbon nanotube' was discovered in 1991 by Sumio Iijima, a senior research fellow at NEC (then Chief Researcher at NEC's Fundamental Research Laboratories). NEC is conducting research and development targeting next-generation transistors using carbon nanotubes.").

[80] Л. В. Радушкевич, *О Структуре Углерода, Образующегося При Термическом Разложении Окиси Углерода НаЖелезном Контакте* [*The Structure of Carbon Produced by Thermal Composition of Carbon Monoxide on Contact with Iron*], 26 ЖУРНАЛ ФИЗИЧЕСКОЙ ХИМИИ 88, 88–95 (1952), *available at* http://nanotube.msu.edu/HSS/2006/4/2006-4.pdf (Russ.). *See generally* Mich. St. U., *The Nanotube Site*, http://nanotube.msu.edu/ (last visited Sept. 1, 2019), *Carbon Nanotube*, SCI. DAILY, https://www.sciencedaily.com/terms/carbon_nanotube.htm (last visited Sept. 1, 2019).

[81] Marc Monthioux & Vladimir L. Kuznetsov, *Who Should be Given the Credit for the Discovery of Carbon Nanotubes?*, 44 CARBON 1621 (2006).

[82] *Id*. at 2.

[83] Another example is stained glass windows in the Middle Ages, utilizing nanotechnology with glass metal. SANDERS, *supra* note 62, at 3.

Achievement in nanotechnology brought light to itself through Nobel Prizes and through people like Erik Drexler,[84] a graduate of the Massachusetts Institute of Technology ("MIT"), who focused his PhD dissertation on molecular nanotechnology. In two cornerstone books in the late-1980s and early-1990s,[85] Drexler described and envisioned nanotechnology in a way that helped garner his title as one of the "fathers" of nanotechnology. His work broadened nanotechnology's influence in popular culture, even inspiring Michael Crichton's 2006 novel *Prey* and worrying Prince Charles with darker conceptions of nanotechnology, as noted in the British *Guardian* newspaper. When the *Guardian* reviewed Drexler's books, it also encapsulated the popular impact of his work:

> In his book, Engines of Creation, K Eric Drexler reminded readers that every manmade and natural object around us is an arrangement of (mostly very common) atoms and molecules. The ability to arrange those molecules more regularly will allow us to build materials many times stronger and lighter than those used in engineering today. This could bring a space elevator within reach, allowing us to explore the solar system and exploit the resources of the planets and asteroids cheaply. In the body, nanomachines could fight disease, or even aging, one atom at a time, restoring them to the configurations characteristic of healthy tissue.
>
> An advanced nanotechnology would be capable of repairing the damage we have done to our environment, capturing carbon out of the air and salting it away under the earth, or using it to build the light, strong, diamond-like materials the nanotech-enabled human-scale technology will depend on. Ultimately, the most basic and useful elements we will need (carbon, oxygen, hydrogen, nitrogen, etc.) can be harvested out of the air and dirt and assembled into useful configurations with barely an hour of work. Nanotechnology has the potential to build a post-scarcity material economy . . . .
>
> Drexler didn't shy away from confronting the negative possibilities of uncontrolled nanotech development in his book . . . . There are many terrifying possibilities for nanotechnology; military nanomachines could infiltrate human bodies and systematically tear them apart using the same principles medical nanomachines will use to repair them. An uncontrolled nanomachine designed to replicate itself could lead to the "grey goo" scenario that once panicked Prince Charles.[86]

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[84] Ed Regis, *The Incredible Shrinking Man,* WIRED (Oct. 1, 2004), https://www.wired.com/2004/10/drexler/ (discussing Drexler's initial vision and competing versions including with Smalley of describing the future of nanotechnology, possibilities and its molding by government funding).

[85] *See* DREXLER, *supra* note 48, and DREXLER ET AL., *supra* note 48.

[86] Thomas Barfield, *Get Ready for a World of Nanotechnology*, THE GUARDIAN (Sept. 2, 2010), https://www.theguardian.com/commentisfree/2010/sep/02/nanotechnology-world-technological-leap.

This type of description, and a multitude of others in his books, did much to inspire and catch the imagination of many, and, in many ways, drive forward excitement towards this apparently "new" field. "Space elevators," taught in classrooms and referenced on programs like Nova on PBS, have now become a reality because of better controlled nanotubes developed from Smalley's original *Bucky Balls*.[87]

Some scientists, including Smalley, however, questioned parts of the scientific basis such as the chemistry of nanomachines operating in "wet" environments.[88] Smalley and others were also concerned that some unrealistic, scary scenarios could unduly alarm the public and stifle technological development.[89] Legal thought must be aware of this duality because as many writers work to capture attention and imagination, they will cite Drexler's work; or, conversely, they may attempt to relegate it. Current nanotechnology, however, exclusively uses a wide array of molecular nanotechnology. Nanotechnology has been significantly affected by attempts by para-science to polarize Drexler and Smalley's views, as scientific development can also be a very political process[90] One can see this reflected in current legal scholarship on nanotechnology and contrast to current scientific developments in nanotechnology.

Nanotechnology can also refer to biotechnology or "wet" nanotechnology, which relates to organic materials (such as carbon or water) and more traditional, "dry" materials[91] (such as diamondoid substance, silicon, or constructs of nanorobots), as well as precision tool instruments[92] used to move atoms or artificial red blood cells.[93] This dry nanotechnology is most often referred to as "nanotechnology," and this particular type of nanotechnology may be labeled "molecular" nanotechnology.[94]

However, nanotechnology is undefined under the law[95] and there is no established consensus on its precise meaning—for good reason. To fully understand the legal ramifications of nanotechnology, one must understand its multitude of classes, including humans, life, and products not typically associated with it. Yet current research hints that it may be archaic to make

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[87] WGBH Educational Foundation, *A Nanotube Space Elevator*, PBS: NOVA SCIENCENOW (Aug. 26, 2008), https://www.pbs.org/wgbh/nova/education/tech/nanotube-space-elevator.html (includes discussion of nanotubes and *Bucky Balls* which can be used for Space Elevators from science fiction, for sixth- to twelfth-grade audience).

[88] *See, e.g.*, Rudy Baum, *Nanotechnology: Drexler and Smalley Make the Case For and Against 'Molecular Assemblers'*, 81 CHEMICAL & ENGINEERING NEWS 37, 37–42 (2003), *available at* http://pubs.acs.org/cen/coverstory/8148/8148counterpoint.html.

[89] *See id.* ("Smalley's objections to molecular assemblers go beyond the scientific. He believes that speculation about the potential dangers of nanotechnology threatens public support for it. Notions about the darker side of nanotechnology have rapidly entered the public consciousness.").

[90] *See generally* Sarah Kaplan & Joanna Radin, *Bounding an Emerging Technology: Para-scientific Media and the Drexler-Smalley Debate About Nanotechnology*, 41 SOC. STUD. SCI. 457 (2011) (asserting that what nanotechnology means, who gets to speak for it, and what research counts as nanotechnology is a very political process).

[91] *See* Smalley, University of Dallas, *supra* note 1.

[92] *C.f.* ROBERT A. FREITAS & RALPH C. MERKLE, KINEMATIC SELF-REPLICATING MACHINES (Landes Bioscience 2004), http://www.MolecularAssembler.com/KSRM.htm.

[93] *See, e.g.* ROB BURGESS, UNDERSTANDING NANOMEDICINE: AN INTRODUCTORY TEXTBOOK 281–322, 389–442 (Jenny Stanford Pub., 1st ed., 2012).

[94] *See generally* Peterson, *supra* note 46.

[95] *See infra* note 104 and accompanying text (discussing that the lack of a definition of nanotechnology is an issue).

any distinction; in fact, legal discourse tends to focus only on novel, dry, and future molecular nanotechnology. Today's nanotechnological developments, particularly in nanomedicine, make the connection between nanotechnology and humans apparent. The techniques employed in nanotechnology research often draw no linguistic boundaries. Regardless of how one defines nanotechnology, the latest nanomedicine and nanotechnology developments demonstrate that nanotechnology includes full integration of a wide variety of disciplines throughout its development and application. While this includes humans, all life forms, and limitless inanimate substrates, methods continue to move towards "molecular" nanotechnology.[96]

B. REVIEW OF LEGAL SCHOLARSHIP ON NANOTECHNOLOGY

1. Law's Inadequate Preparation for Nanotechnology

Scholars regularly point out the importance of law keeping pace with technology. Some scholars believe that the legal profession should make sure it follows science and respect its professional commitment to scientific quality.[97] Barriers between law and science should be removed while working towards unification,[98] especially when addressing social concerns with technology.[99]

One of the first scholarly attempts at addressing nanotechnology was made by Frederick Fiedler and Glenn Reynolds in 1994.[100] Fiedler and Reynolds pointed out that although "space travel, artificial intelligence, and genetic engineering" will have large impacts, they will be "little more than a blip on the horizon" as compared to nanotechnology.[101] They vibrantly state that "[f]ull-fledged nanotechnology promises nothing less than complete control over the physical structure of matter . . . . The implications of such capabilities are significant: to dramatize only slightly, they are comparable to producing a 747 or an ocean liner from the mechanical equivalent of a single fertilized egg."[102] With such capability, they warn:

> [I]f experience is any guide, the problems will probably appear before the solutions. That means that the period in which nanotechnology first begins to mature will be a particularly dangerous and delicate time. If nanotechnology appears in a world that is politically stable and economically fair, in which human rights and the rule of law are respected, the consequences are likely to be much more benign than if

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[96] MICHAEL KÖHLER & WOLFGANG FRITZSCHE, NANOTECHNOLOGY: AN INTRODUCTION TO NANOSTRUCTURING TECHNIQUES 4–8 (2008).

[97] Deborah M. Hussey Freeland, *Law & Science: Toward a Unified Field,* 47 CONN. L. REV. 529, 570–71 (2014).

[98] *Id*. at 571.

[99] *Id*.

[100] *See generally* Frederick A. Fiedler & Glenn H. Reynolds, *Legal Problems of Nanotechnology: An Overview,* 3 S. CAL. INTERDISC. L.J. 593 (1994).

[101] *Id*. at 594–95.

[102] *Id*. at 599.

> it appears in a world in which nations are at one another's throats and human decency is an endangered species.[103]

Some scholars consider the biggest issues to be the inability to define nanotechnology[104] and the application of old laws to new technologies.[105] Localities such as Berkeley, California that are intellectual centers of nanotechnology have entered the fray and have begun regulating nanotechnology research.[106]

Journal articles in the past decade essentially describe nanotechnology without a framework.[107] Law school scholarship promoted the use of soft law[108] modeled on non-binding international environmental instruments[109] and frameworks implemented by institutions such as the World Bank, the World Health Organization, or the United Nations Environmental Program.[110] The environmental impact of nanotechnology and the duty to cooperate would assist the nanotechnological model.[111] Scholars warn, however, that the current environmental regulatory authority is inadequate to regulate nanotechnology.[112]

Professor Reynolds, one of the most prolific writers on technology and space, wrote that regulation will continue to evolve and that safety concerns

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[103] *Id*. at 627.

[104] Symposium, *supra* note 57, at 406, 409.

> [W]e have to be able to define it, and right now, we don't have a consensus on what nanotechnology, or nanoparticle, or Nanomedicine, or any of those terms really mean, and that lack of definition is a major problem, because we can't regulate it until I get to define it, and by the way, you don't want me defining it by myself. . . . Our lack of a legal definition, this one bothers me a great deal as you must be able to tell. Because if I can't define it, I can't regulate it. I can't make you do anything. *Id*.

[105] *Id*. at 410 ("We continue to use old systems for these new technologies".).

[106] *Id*. at 408.

> The other question here which remains, is that we have to decide where these decisions are going to be made, either it is going to be at the global level, at national level, state, local? . . . Berkeley, California has passed regulations on nanotechnology research. So you see an example of local activity. *Id*.

[107] *See* James R. Brindella, *Environmental and Land Use Law: Nanotechnology and the Dilemmas Facing Government and Business*, 83 FLA. BUS. J. 73 (2009) (discussing the history of nanotechnology, the difficulties of regulating new nanotechnology, a detailed history of nanotechnology, the entire host of products involved in nanotechnology and that "[u]ntil a legal framework evolves, individual businesses developing, importing, using, or selling nanomaterials will have to chart their own courses with respect to potential liability for nuisance, negligence, strict liability, and environmental damage.").

[108] *See* Vincent R. Johnson, *Nanotechnology, Environmental Risks, and Regulatory Options,* 121 PENN ST. L. REV. 471, 502–03 (2016) (arguing for a soft law approach which refers to "non-binding international agreements or norms").

> The basic role of soft law is to create expectations which, once widely subscribed to, can be translated into binding legal obligations, i.e., hard law. Ideally, soft lawmaking is a fluid process because binding obligations and enforcement mechanisms are not in issue. This fluidity may enable international parties to reach a consensus more quickly, and thereby respond more promptly to scientific and technological changes. *Id*. at 502.

[109] *See id*. ("That framework treaty might be patterned on the Vienna Convention for the Protection of the Ozone Layer, a treaty which imposed no binding substantive obligations, but set the stage for adopting ozone reduction mandates under the Montreal Protocol on Substances that Deplete the Ozone Layer.") (citations omitted).

[110] *See id*.

[111] *See id*. at 503 ("There is a well-established principle of international environmental law, 'affirmed in virtually all international environmental agreements of bilateral and regional application,' as well as in global instruments, that there is a duty to cooperate in matters concerning the protection of the environment.") (citations omitted).

[112] *See id*. ("General regulatory regimes, such as those dealing with chemical and toxic substances in the European Union and the United States, may prove to be inadequate to deal with the scientifically complex challenges of nanotechnology.").

will follow models such as biotechnology.[113] He believes self-regulation consequently is important or that "conscientious commentators' concerns can be met through a regulatory approach that will not stifle the development of nanotechnology."[114] He worries that such concerns could cause nanotechnology to be banned, and that limiting nanotechnology to military applications could cause issues.[115] In addition, he believes it is better if it is devoted to life-saving technology, making it more beneficial.[116] This type of nanotechnology must not be stifled by regulation.[117]

Legal scholars have continued to note that nanotechnology will transform society, especially in energy, healthcare, and the environment.[118] They believe that a new type of governmental system will emerge with nanotechnology.[119] Legal preparation can begin with data gathering and reporting by the industry.[120] There should be flexibility by the government to regulate, while protecting a company's ability to experiment, and add health and environmental protection.[121] Companies must have incentives to govern in a socially responsive manner.[122] Stakeholders should participate in legal development,[123] and international frameworks must develop as nanoparticles and products begin crossing international borders.[124]

2. Nanotechnology and Environmental Law

Scholars have also begun focusing on the environmental context of nanotechnology, and found that in 2006 there were "over 200 products already in the marketplace today that use nanomaterials, including paints,

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[113] Glenn Harlan Reynolds, *Nanotechnology and Regulatory Policy: Three Futures,* 17 HARV. J.L. & TECH. 179, 209 (2003) ("As nanotechnology continues to develop, it is likely that the debate over regulation will also evolve. Experience with biotechnology indicates that early concerns about safety are likely to be overblown.").

[114] *Id*. ("[A]n effective regulatory regime can be based on consensus and self-regulation.").

[115] "Though there are likely to be some calls for a complete ban on nanotechnology, such a strategy will not succeed. Its unworkability means that such calls will probably come from antitechnology groups who command little political support." *Id*.

[116] *See id*.

[117] "Similarly, efforts to limit nanotechnology to military applications alone are likely to face serious social, technical and political hurdles, as knowledge diffuses and as the public seeks access to potentially life-saving technologies." *Id*.

[118] Mandel, supra note 45, at 1324.

[119] *Id*.

[120] *Id*. at 1375 ("All agencies should evaluate additional incentives they can provide to industry to promote data gathering and reporting.").

[121] *See id*. at 1378.

Governmental agencies should work with firms to permit flexibility in how regulatory requirements are achieved to the extent practicable while still protecting human health and the environment. Flexibility will allow industry to experiment with economic or technical feasibility and various control approaches, while still ensuring adequate protection. Such experimentation also may help develop additional information on nanotechnology risk and the relative advantages of various governance approaches. *Id*.

[122] *Id*. at 1376 ("Many of the nanotechnology governance goals identified above can be advanced by developing incentives for nanotechnology industry to act in a socially responsible manner. These incentives can include economic, public relations, social values, and legal mechanisms.").

[123] *Id*. at 1379 ("Broad stakeholder outreach and dialogue will bring credibility, new ideas, current information, continual feedback, and public trust to the nanotechnology governance system. . . . Public trust in nanotechnology and nanotechnology governance is critical to the success of the industry.").

[124] *Id*. at 1381.

[N]anotechnology clearly implicates unique international challenges. Nanotechnology products are already involved in global commerce, and nanoparticles will create cross-boundary human health and environmental concerns. As the United States' system for governing nanotechnology develops, it is necessary that a parallel effort take place to integrate the national system within what should be a developing international structure. *Id*.

glare-reducing coating for eyeglasses and autos, sunscreens, sporting goods, cosmetics, stain-resistant clothing, and organic light emitting diodes used in laptop computers, cell phones, and digital cameras."[125] Additionally, "[a] recent survey found that there are already 1645 nanotech companies—about one half of which are small businesses—operating in the United States, but that number will likely increase substantially."[126]

"From an environmental perspective, nanomaterials offer both opportunities and challenges."[127] Benefits could include "remediation, monitoring, and green production[,]"[128] "iron nanoparticles . . . used to clean up soil by neutralizing contaminants such as polychlorinated biphenyls, DDT, and dioxin[,]" and "the manner in which they could fundamentally change the way goods are manufactured." This includes the elimination of waste in production,[129] demonstrating a need for effective governance addressing high-priority legal and policy questions.[130]

In 2016, some analysts projected that the nanotechnology market was $39.2 billion and that it would be $90.5 billion by 2021.[131] In 2008, it was estimated that three to four new nanotechnology products were entering the market every week, [132] and "[b]y some estimates, revenue from the sale of nanotechnology-enabled products made in the United States has grown more than six-fold from 2009 through 2016."[133]

There have been legal challenges to nanomaterial registration; these include the Environmental Protection Agency ("EPA") registering nanomaterials for use as antibiotics, courts allowing registration challenges against the EPA, and further administrative inquiries.[134] There has been discussion[135] surrounding the EPA establishing new rules regarding carbon nanotubes and "concerns for 'pulmonary toxicity, fibrosis, carcinogenicity,

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[125] Linda K. Breggin & Leslie Carothers, *Governing Uncertainty: The Nanotechnology Environmental, Health and Safety Challenge,* 31 COLUM. J. ENV'T. L. 285, 288 (2006).

[126] *Id*.

[127] *Id*. at 290.

[128] *Id*.

[129] *Id*.

[130] *Id*. at 329.

[131] *See* ANDREW MCWILLIAM, THE MATURING NANOTECHNOLOGY MARKET: PRODUCTS AND APPLICATIONS 15-20 (BCC Research, 2016) (projecting that the global nanotechnology market should reach $90.5 billion by 2021 from $39.2 billion in 2016).

[132] *New Nanotech Products Hitting the Market at the Rate of 3–4 Per Week,* PHYS.ORG (Apr. 24, 2008), https://phys.org/news/2008-04-nanotech-products-week.html.

[133] *Frequently Asked Questions*, NANO.GOV: NATIONAL TECHNOLOGY INITIATIVE, https://www.nano.gov/nanotech-101/nanotechnology-facts (last visited Sept. 1, 2019).

[N]anotechnology is becoming ubiquitous in our daily lives and has found its way into many commercial products, for example, strong, lightweight materials for better fuel economy; targeted drug delivery for safer and more effective cancer treatments; clean, accessible drinking water around the world; superfast computers with vast amounts of storage; self-cleaning surfaces; wearable health monitors; more efficient solar panels; safer food through packaging and monitoring; regrowth of skin, bone, and nerve cells for better medical outcomes; smart windows that lighten or darken to conserve energy; and nanotechnology-enabled concrete that dries more quickly and has sensors to detect stress or corrosion at the nanoscale in roads, bridges, and buildings. *Id*.

[134] *See* Peter Hsiao & Andrew Stanleya, *Nanotechnology and the Environment: Big Things in Small Packages,* 30 PRAC. REAL EST. L. 21, 21 (2014) (discussing Natural Resources Defense Council v. EPA, 735 F.3d 873 (9th Cir. 2013) which involved "a detailed opinion reviewing the technical merits of the petition, the court vacated EPA's registration decision and remanded the matter for further administrative proceedings. For now, the decision prevents nanosilver from being used as an anti-bacterial agent in textiles.").

[135] Matthew Kaplan & Jennifer Woloschyn, *Graphene: Regulatory Considerations for the "Wonder Material,"* 11 NANOTECHNOLOGY L. & BUS. 225, 228 (2014).

mutagenicity, and immunotoxicity' as well as potential harm from water releases . . . ."[136] Additionally, personal protective equipment is required and the production process must prevent water release.[137] Commentators observe that the EPA will similarly regulate other nanomaterials under the Toxic Substances Control Act ("TSCA") if there are health or environmental risks.[138] In fact, "studies are surfacing that suggest that graphene may interfere with normal cell function and may negatively impact the environment," suggesting that the EPA will regulate graphene and other materials similarly.[139] Other commentators believe the EPA has taken too aggressive of an approach towards nanosilver, and provide recommendations to maneuver around EPA regulations.[140]

Other research warns of regulatory inadequacies of nanotechnology and that applying laws like the TSCA, Clean Air Act ("CAA"), Clean Water Act ("CWA"), and Occupational Safety and Health Act ("OSHA") to nanotechnology—in conjunction with insufficient oversight by the EPA—is dangerous because the laws do not specifically address nanotechnology.[141] They recommend bonding requirements for nanotechnology as an interim measure because of potential health and environmental effects.[142]

3. Nanotechnology and Healthcare Law

Scholars also focused on healthcare, noting that it will revolutionize the field and that the U.S. and European Union are preemptively, cautiously examining nanotechnology.[143] They often discuss the lack of sufficient regulation and have proposals for addressing these gaps. Some believe that current regulation suffices in regards to medical devices.[144] These scholars believe that there should be a wait-and-see approach in order to better understand the science, and determine what direction the technology will take.[145] In 2010 many scholars believed nanotechnology was only in the research and development phase.[146] Only then, they said, can the development be seen sufficiently to implement legal change.[147] Ethical tasks

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[136] *Id*. at 227.
[137] *Id*. at 228.
[138] *Id*.
[139] *Id*.
[140] David L. Wallace & Justin A. Schenck, *EPA Targets Nanotechnology: Hi-Ho, Nanosilver, Away?*, 11 NANOTECHNOLOGY L. & BUS. 207, 207, 213–216 (2014) (discussing historical nanosilver regulation).
[141] *See generally* Albert C. Lina, *Size Matters: Regulating Nanotechnology*, 31 HARV. ENV'T. L. REV. 349 (2007).
[142] *Id*. at 406–07.
[143] *Id*. at 425 ("Nanotechnology and nanomedicine have the potential to revolutionize the medical field in many beneficial ways. . . . Current regulatory structures for medical devices and technology may initially be an appropriate platform from which to govern nanomedicine. The technology, however, may quickly outgrow the effectiveness of these regulations.").
[144] *See id*.
[145] *Id*. ("The United States and the European Union should continue to employ the 'wait and see' approach to nanotechnology and nanomedicine regulation until more is learned from research and development.").
[146] *Id*. at 424.

Though nanotechnology and nanomedicine are still firmly situated in the research and development phase, the United States and the European Union have both decided to preemptively examine this emerging technology. Both countries are proceeding cautiously, however, with regard to regulation of this new technology. Through adoption of "wait and see" approaches, the nations will be better situated to meaningfully deal with and regulate the technology once the science is fully understood. *Id*.

[147] *Id*.

forces should be set up to monitor human enhancement[148] and other ethical issues akin to those raised by stem cell research.[149] Other scholars believe that nanotechnology should submit to a voluntary regulatory scheme to incentivize research into potential hazards, stimulate innovation, and improve public perceptions of nanotechnology.[150]

4. Nanotechnology and Workplace Protection

More recently, scholars have felt that most discussions of regulatory nanotechnology were still too focused on workplace exposure rather than environmental concerns.[151] They believe history shows that eventually regulation catches up with need and then becomes more detailed.[152] The unique aspects of nanotechnology will drive it toward self-regulation with flexible "soft law mechanisms" in which a good measure of professional judgment would be implemented.[153] Historically, governments are also slower to respond than businesses.[154] Little faith is held in establishing new hybrid structures, but there must be continued investigation.[155]

5. Patent and Copyright Law in Nanotechnology

Much of the legal discussion surrounding nanotechnology includes the development of patents and the rush to patent ideas at the onset of research, making the rush for patents in nanotechnology unlike any other field.[156] Nanotechnology is "almost the first new field in a century in which the basic ideas are being patented at the outset"[157] and the "U.S. Patent and Trademark Office has now created a new technology class designed to track nanotechnology products."[158] Patents need more protection because they are

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It will not be until these scientific advancements occur that the governments will be able to adequately see the limitations of the application of current regulatory structures already in place as they apply to nanotechnology and nanomedicine. Once these limitations are adequately realized, it will be possible for meaningful regulation to follow. The future of meaningful regulation will only stem from careful monitoring of the research and development of nanotechnology. *Id*.

[148] *Id*. ("U.S. and the EU should consider creating task forces to analyze and monitor the ethical considerations surrounding nanomedicine. As with stem cell research.").

[149] *Id*. at 425 ("Much like stem cell research, nanomedicine technology raises specific ethical considerations that must be explored and considered when contemplating the regulation of not only its research and development, but also its inevitable use in society.").

[150] Katie Millera, *Nanotechnology: How Voluntary Regulatory Programs can both Ease Public Apprehensions and Increase Innovation in the Midst of Uncertain Federal Regulations,* 8 IND. HEALTH L. REV. 435, 469 (2010–2011) ("A voluntary regulatory scheme for the nanotechnology industry is the best option among the many proposed but imperfect solutions to bring about immediate results. A voluntary scheme will incentivize research into the potential hazards of nanomaterials, increase public perception of the industry, and stimulate innovation.").

[151] Reut Snira, *Trends in Global Nanotechnology Regulation: The Public-Private Interplay,* 17 VAND. J. ENT. & TECH. L. 107, 167 (2014).

[152] *Id*.

[153] *Id*.

[154] *Id*. at 167–68.

[155] *Id*.

[156] Mark A. Lemley, *Patenting Nanotechnology,* 58 STAN. L. REV. 601, 601 (2005).

Universities and companies are rushing to the patent office in record numbers to patent nanotechnology inventions. This rush to the patent office is so significant that many law firms have established nanotechnology practice groups. . . . The emerging science of nanotechnology and other inventions make the role of patents more significant in this arena than elsewhere. *Id*.

[157] *Id*.

[158] *Id*.

overly broad, inhibiting nanotechnological development such as developing what is needed for cancer treatment.[159]

Many argue that nanotechnology is too important to not be afforded suitable patent protection.[160] There should not be too much protection from previous patents and new ones should not be over-restricted.[161] Other scholars agree in some respects, believing that overbroad patents limit innovation and that strong patent rights are necessary.[162]

Commentators discuss industry specific products such as batteries, lighting, display, and healthcare; although developments to date have been only incremental, "new manufacturing techniques like self-assembly promise to alter the nature of manufacturing all together."[163]

Commentators believe that intellectual property must be balanced with societal interests such as placing nanobioinformatics in the public domain so that nanoscale science can be properly monitored and planned.[164] It would enable the combination of "nanotechnology and biocomputing with clinical oncology for personalized detection, diagnosis and treatment of human cancer, and developing an 'intelligent' information system for data management, interpretation, and for translation of new results to clinical applications."[165]

Other recent scholarship notes that it is government involvement that has helped the nanotechnology industry and that it likely would not have flourished without strong government support in patent protection, funding research, building infrastructure to allow market entry, and providing financial security to mitigate the risk of uncertain nanotechnology markets.[166]

There have been attempts to register DNA sequencing but the Copyright Office has to date refused. Commentators believe there are solid doctrinal and legal grounds for the Office's refusal, but there also is worry that future technologies could challenge its decisions.[167]

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[159] Carter, *supra* note 60, at 562 (describing the current flows of the patent review process for nanotechnology and how it inhibits emerging and undeveloped nanotechnology and developments in cancer treatment).

[160] Christopher Anderson, *Small Can Be Inventive: The Patentability of Nanoscale Reproductions of Macroscale Machines,* 9 WM. & MARY BUS. L. REV. 285, 325 (2017) (stating *inter alia* that "[t]here is something inherently innovative and unique about development at this scale that is presumptively novel from macroscale prior").

[161] *Id*. at 326.

[162] Amit Makkera, *The Nanotechnology Patent Thicket and the Path to Commercialization,* 84 S. CAL. L. Rev. 1163, 1202 (2011) ("The characteristics of nanotechnology suggest that innovation will continue in the absence of strong patent rights. Historically, foundational patents of broad scope have been shown to stifle innovation.").

[163] Maseeh Mukhtar & Unni Pillai, *Nanomanufacturing: Application of Nanotechnology in Manufacturing Industries,* 12 NANOTECHNOLOGY L. & BUS. 5, 18 (2015).

[164] Maryam Ahmadi & Leila Ahmadi, *Intellectual Property Rights of Nanobioinformatics in Related International Conventions,* 12 NANOTECHNOLOGY L. & BUS. 92, 94 (2015).

[165] *Id*.

[166] *See* Lisa Larrimore Ouellette, *Nanotechnology and Innovation Policy,* 29 HARV. J.L. & TECH. 33, 34 (2015) ("Nanotechnology is thus a useful counterpoint both to the growing number of case studies on how innovation can flourish without intellectual property ("IP"), and to the myth of an independent private sector that produces breakthrough innovations without government intervention."). "Nanotechnology is one field that likely would not have evolved as rapidly without significant government involvement." *Id*. at 74.

[167] *See* Dan L. Burk, *DNA Copyright in the Administrative State,* 51 U.C. DAVIS L. REV. 1297, 1348–49 (2018).

6. Nanotechnology in Criminal and Military Law

Other scholars note that with nanotechnology's incredible potential for beneficial application will come new types of crimes, including forgery, murder, state crimes to robbery, and crimes involving artificial intelligence ("AI").[168] Research into military applications of nanotechnology is correspondingly developing.[169] Military applications of nanotechnology present new challenges including the ability to create weapons that result in fewer civilian casualties, yet that may depart from notions of what injuries inflicted or what type of suffering is humane.[170] Additionally, there are more detailed discussions of specific nanotechnology, such as nanolasers currently used with mice, and how they may be used in future human combat.[171]

Nanotechnology could change the ways in which wars are fought.[172] Some believe that existing regulation could cover or exclude nanotechnological weapons, but that there is a danger if there are classes of unregulated illegal weapons.[173] Currently, only the U.S. and Russia are engaged in this arena; but "nanotechnology is a transformative technology that is being acquired and developed at an alarming pace even in countries that have traditionally been considered technologically under-developed, such as India, Iran[,] and Thailand."[174]

7. International Nanotechnology Issues

a. The European Union and General International Trends

As military issues lead into the international context, much commentary is also focused on the international dimension of nano-regulation. In 2006, there was concern that

> no nano or nano-related regulations exist in the U.S. or the EU at this time, which require controls on process releases or production activities or prescribe specific workplace safety measures. To protect the public and the environment from the possible adverse effects of nanotechnology, completely new legislation and regulatory efforts will be necessary.[175]

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[168] Susan W. Brenner, *Nanocrime?*, U. ILL. J.L. TECH. & POL'Y 39, 57–100 (2011) (discussing new types of nano crimes such as forgery, murder, crimes against state, search, robbery and crimes associated with Artificial Intelligence).

[169] DANIEL RATNER & MARK RATNER, NANOTECHNOLOGY AND HOMELAND SECURITY: NEW WEAPONS FOR NEW WARS 1–5, 29–63, 39 (2004) (discussing new military applications of needs for issues such as air detection systems).

[169] Freeland, *supra* note 97, at 570–71.

[169] *Id*. (discussing nanotechnology and new threats for soldiers from bioweapons, social implications and needs for issues such as air detection systems).

[170] *See* Hitoshi Nasu, *Nanotechnology and the Future of the Law of Weaponry,* 91 INT'L L. STUD. 486, 502 (2015).

[171] *See* Kobi Leins, *Shining a Regulatory Spotlight on New Lasers: Regulation on the Use of Nanolaser Technologies in Armed Conflict,* 56 JURIMETRICS J. 261, 261, 262–65 (2016).

[172] *See* Nasu, *supra* note 170, at 514.

[173] *See id*. at 502, 514.

[174] *See id*. at 516.

[175] Louis Theodore & Leo Stander, Essay, *Regulatory Concerns and Health/Hazard Risks Associated with Nanotechnology,* 30 PACE ENV'T L. REV. 469, 472 (2013).

Engineers predicted that "[t]he concerns about nanotechnology will eventually lead to significant activities in the legal arena, as the health risks and hazard risks associated with nanotechnology are certain to generate legal conflicts in the future."[176] Engineers believed that the consequences of nanotechnology "will be determined by the extent to which the technical community manages this technology."[177] The European Union ("EU") has included nanotechnology regulation in its food sector.[178] Commentators believe that there must be an international commitment to nanotechnology regulation in the environmental context because of the potential negative impact of such technology, and that regulating it will be one of the most important future concerns.[179]

Other scholars see nanotechnology already fitting into existing regulatory frameworks,[180] such as "new chemicals" being identified.[181] Nevertheless, regulation is urgent because nanotechnological chemicals are novel and complex materials.[182] These scholars reviewed several countries, including Australia, the United Kingdom ("U.K."), the United States, and Japan, and found that all countries were inadequate in nanotechnology regulation, but that the U.K. was the most advanced.[183] They recommended that existing international bodies be developed to set these standards, as well as transnational non-governmental organizations ("NGO"s).[184]

b. Individual State Nanotechnology Activity

There is a lot of research internationally in nanotechnology, including Iran—which devotes financial support to scholarly publications on nanotechnology.[185] In Mexico, the emergence of nanotechnology and its regulation have been discussed, with Mexico modeling "the content of the U.S. guidelines for the regulation of nanotechnology and nanomaterials, which reflect an interest towards advancing a lighter or less restrictive regulation platform and a pro-trade stance."[186]

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[176] *Id*. at 485.

[177] *Id*. at 484

[178] Laura Salvi, *The EU's 'Soft Reaction' to Nanotechnology Regulation in the Food Sector*, 10 EUR. FOOD & FEED L. REV. 186, 193 (2015) (discussing when "[t]he debate on nanotechnology emerged within the European Union just over a decade ago when the EU Commission began to discuss the regulatory approach to adopt for the emerging phenomenon of nanotechnology" and "the EU regulatory framework on nanotechnologies offers a favoured perspective to observe the dynamic nature of the European regulatory systemand to analyze the ongoing process of legal innovation which deeply and specifically characterized the food law arena.").

[179] Dario Picecchia, *Tiny Things with a Huge Impact: The International Regulation of Nanomaterials*, 7 MICH. J. ENV'T. & ADMIN. L. 447, 478 (2018).

[180] Diana M. Bowman & Graeme A. Hodge, *A Small Matter of Regulation: An International Review of Nanotechnology Regulation*, 8 COLUM. SCI. & TECH. L. REV. 1, 63 (2007) ("[I]t is evident from this review that traditional nano-products are likely to fall within the pre-existing international regulatory frameworks" and "we observe that existing regulatory frameworks will form the immediate basis for regulating nanotechnologies").

[181] *Id*. at 62.

[182] *Id*.

[183] *Id*.

[184] *Id*. at 63.

[185] *See generally* Ali Ghanbaria, Mohammad Ebrahim Ardalani & Moslem Ghojavand, *Evaluated Investment in Iranian Nanotechnology Scholarly and Scientific Articles*, 8 NANOTECHNOLOGY L. & BUS. 296 (finding that paper quality was not correlated with financial support nor social or economic benefit achieved from government research investment).

[186] Guillermo Foladori & Edgar Záyago Lau, *The Regulation of Nanotechnologies in Mexico,* 11 NANOTECHNOLOGY L. & BUS. 164, 164 (2014).

In Germany, scholars discuss the need to converge disciplines from science and technology into law because of social perceptions and concerns, including "the fundamental concept of what characterizes a human being."[187] Further, "[s]ocial perceptions of risks and geopolitical contexts deeply affect the legal approach to uncertainty."[188]

Nanotechnology is in full swing in Russia as well.[189] Some analysts have estimated that Russia comprised "5% in all fullerene-related patent applications filed in European Patent Office by 2006."[190] However, "a systematic analysis of the Russian patent literature in the field has not yet been conducted"[191] and its patenting presents some long-standing institutional challenges.[192]

C. CURRENT NANOTECHNOLOGY LAW

1. Statutory Law and the National Nanotechnology Initiative

In 2017, the revised U.S. Code set forth the National Nanotechnology Program for the United States within Trade and Commerce,[193] implemented by the President through the National Nanotechnology Coordination Office.[194] This Office helps establish goals and measurements for federal nanotechnology research and development[195] to invest federal resources into nanotechnology,[196] and coordinates federal research.[197] Specifically, the program includes "developing a fundamental understanding of matter that enables control and manipulation at the nanoscale."[198] It helps: provide grants to investigators,[199] including interdisciplinary teams;[200] establishes research centers;[201] and, through merit-based[202] and competitive initiatives,[203]

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[187] Guerra, *supra* note 49, at 579 ("Converging technologies thus challenge us to develop a new, wider perspective on the concept of safety.").

[188] *Id*.

[189] Alexander I. Terekhov, *An Analysis of Russia's Patent Activity in the Carbon Nanostructures,* 12 NANOTECHNOLOGY L. & BUS. 68, 68 (2015) (discussing that "[c]arbon nanostructures are one of the main components of the Russian nanotechnology program. Using patent analysis, this article aims to: measure the level and dynamics of inventive activity of Russia in the field; . . . .").

[190] *Id*. at 69.

[191] *Id*.

[192] *See id* at 72.

Since adopting the Presidential initiative "Strategy of nanoindustry development" in 2007, the intensity of patent activity in Russia in the field of carbon nanostructures increased: in terms of the CAGR, from 15.5% in 2000–2007 to 18.2% in 2007–2013. Unfortunately, Russia has inherited from the USSR a weak tradition of patenting on an international scale. Table 1 counts the nanocarbonrelated patents that were granted (or filed for WIPO) during all period of time, based on the country of at least one inventor's address. According to this Table, Chinese inventors contributed to 9.69% of USPTO and 3.26% of WIPO patents for the carbon nanostructures, respectively, that puts them on top in BRIC. Russian inventors occupy second place in BRIC on their contribution to the WIPO patents (1.42%) and third place on their contribution to the USPTO patents (0.44%). But they made the biggest contribution to the fullerene- and nanodiamond-related patents of USPTO and WIPO as well as to the WIPO patents for OFNC. *Id*.

[193] 21st Century Nanotechnology Research and Development Act, 15 U.S.C. §§ 7501 et seq. (2017).

[194] *Id*.

[195] *Id*. at § 7501(a)(1).

[196] *Id*. at § 7501(a)(2).

[197] *Id*. at § 7501(a)(1).

[198] *Id*. at § 7501(b)(1).

[199] *Id*. at § 7501(b)(2).

[200] *Id*.

[201] *Id*. at § 7501(b)(4).

[202] *Id*.

[203] *Id*. at § 7501(b)(2).

it performs these functions with academic institutions, national laboratories, U.S. industry, and other partners.[204] In addition, it seeks to integrate microscale work,[205] utilize existing expertise in nanotechnology,[206] and encourage diversity—utilizing black colleges and minorities.[207]

Most importantly, this initiative focuses on legal and ethical concerns,[208] particularly with the "use of nanotechnology in enhancing human intelligence and in developing artificial intelligence which exceeds human capacity . . . ."[209] This must be considered and that "ethical, legal, environmental, and other appropriate societal concerns related to nanotechnology [must be] . . . "widely disseminated."[210] It also requires that "interdisciplinary nanotechnology research centers . . . include activities that address societal, ethical, and environmental concern."[211] Of course, it also addresses goal development and reporting mechanisms,[212] budget,[213] work with local governments, universities,[214] and small businesses,[215] and technology transfer[216] .

The program aims, in part, to establish the U.S. as a leader in nanotechnology.[217] It also seeks to promote U.S. industrial productivity and competitiveness through scientific and engineering research in nanotechnology.[218] The program must also result in benefits for society.[219]

2. Occupational Safety and Health

Aside from the National Nanotechnology Initiative and the scholarly discussion above, there is little law explicitly referencing nanotechnology. This hints that nanotechnology can be included with other issues. One of the primary authorities in current nanotechnology regulation is the OSHA. OSHA, within the U.S. Department of Labor ("DOL"), states in regard to nanotechnology: "A variety of companies are researching and developing nanotechnology. Although there are nanomaterials in a few products used in the construction industry, most of these activities fall under OSHA General Industry standards."[220] The DOL then references the generally applicable regulations.[221]

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[204] *Id*. at § 7501(b)(4)(B).
[205] *Id*. at § 7501(b)(4)(D).
[206] *Id*. at § 7501(b)(4)(C).
[207] *Id*. at § 7501(b)(4)(E).
[208] *Id*. at § 7501(b)(10).
[209] *Id*.
[210] *Id*. at § 7501(b)(10)(A).
[211] *Id*. at § 7501(b)(10)(B).
[212] *Id*. at § 7501(c)(1), 7501(c)(4)(A)–(D), 7501(d).
[213] *Id*. at § 7501(c)(5).
[214] *Id*. at § 7501(b)(6).
[215] *Id*. at § 7501(b)(7).
[216] *Id*.
[217] *Id*. at § 7501(b)(5).
[218] *Id*. at § 7501(b)(6).
[219] *Id*. at § 7501(c)(4)(D).
[220] *Nanotechnology*, U.S. DEP'T OF LABOR: OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION, https://www.osha.gov/dsg/nanotechnology/nanotech_standards.html (last visited Sept. 1, 2019).
[221] *See* 29 C.F.R. §§ 1904, 1910.132–1910.134, 1910.138, 1910.141, 1910.1200, 1910.1450, 1910.1027 (2013).

3. Environmental Protection

As legal scholarship points out, monitoring the environment and EPA oversight is an important area first addressing nanotechnology. The EPA is investigating and researching nanoscale materials[222] and simultaneously considers them to be "chemical substances" under the TSCA—with a new rule specifically referencing them. The new rule states that a chemical substance is nanoscale if it is "solid at 25 °C and standard atmospheric pressure, that is manufactured or processed in a form where any particles, including aggregates and agglomerates, are in the size range of 1–100 nm."[223] However, it does not apply to "chemical substance[s] that [are] manufactured or processed in a form where less than 1% of any particles, including aggregates, and agglomerates, measured by weight are in the size range of 1–100 nm."[224] The rule is careful to point out, nonetheless that the parameters are for the purpose of identifying chemical substances that are subject to the rule, and do not establish a definition of nanoscale material.[225]

It is not clear the degree to which the EPA is cognizant of animals, seeds, trees, and other environmental resources, which are also nanoscale and regulated in a manner that targets their nanoscale qualities, or how other types of nanotechnology outside its description can implicate its regulatory domain. This is likely to become a problematic issue in the attempt to define nanotechnology. The EPA has concluded that RNA, DNA, proteins, enzymes, viruses, substances that can dissolve in water to form ions, or other microorganisms' part of a film or surface[226] do not require reporting. Although they are part of current nanotechnology research, they are not considered nanoscale commodities by the EPA.[227]

4. Health and Disease Control

The American healthcare system, parts of which are overseen by the federal Department of Health and Human Services ("DHHS"), is another important area that has witnessed the reference and regulation of nanotechnology. Within DHHS is the Center for Disease Control ("CDC") that includes the National Cancer Institute ("NCI"); NCI now promotes and informs about nanotechnology's role in cancer treatment.[228] NCI states that "[n]anotechnology is a powerful tool for combating cancer and is being put to use in other applications that may reduce pollution, energy consumption, greenhouse gas emissions, and help prevent diseases," and that "NCI's

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[222] *Control of Nanoscale Materials under the Toxic Substances Control Act,* EPA: REVIEWING NEW CHEMICALS UNDER THE TOXIC SUBSTANCES CONTROL ACT (TSCA), https://www.epa.gov/reviewing-new-chemicals-under-toxic-substances-control-act-tsca/control-nanoscale-materials-under (last visited Sept. 1, 2019).

[223] 40 C.F.R. § 704.20 (2017).

[224] *Id*.

[225] *See id*.

[226] *Id*. at § 704.20(c).

[227] *See id*.

[228] *See Safety of Nanotechnology Cancer Treatment*, NATIONAL CANCER INSTITUTE: DIVISION OF TREATMENT AND DIAGNOSIS (Aug. 8, 2017), https://www.cancer.gov/sites/nano/cancer-nanotechnology/safety.

Alliance for Nanotechnology in Cancer is working to ensure that nanotechnologies for cancer applications are developed responsibly."[229]

NCI boldly states that "[t]here is nothing inherently dangerous about being nanosized. Our ability to manipulate objects at the nanoscale has developed relatively recently, but nanoparticles are as old as the earth."[230] It gives examples: "Many nanoparticles occur naturally (for example, in volcanic ash and sea spray) and as by-products of human activities since the Stone Age (nanoparticles are in smoke and soot from fire)" while emphasizing that "[t]here are so many ambient incidental nanoparticles, in fact, that one of the challenges of nanoparticle exposure studies is that background incidental nanoparticles are often at order-of-magnitude higher levels than the engineered particles being evaluated."[231] NCI also states that although there has been alarm from carbon nanotubes, "there is nothing uniquely toxic about nanoparticles as a class of materials."[232] NCI states that it makes use of its Nanotechnology Characterization Laboratory ("NCL") to research these issues and that "[i]n fact, most engineered nanoparticles are far less toxic than household cleaning products, insecticides used on family pets, and over-the-counter dandruff remedies."[233]

5. Food Safety

The Food and Drug Administration ("FDA"), another health regulator, has also begun highlighting nanotechnology and set up a task force.[234] The FDA has a strong opinion on the definition of nanotechnology: "[T]he Task Force does not recommend attempting to adopt formal, fixed definitions for such terms for regulatory purposes at this time. As [the] FDA learns more about the interaction of nanoscale materials with biological systems and generalizable concepts that can inform the agency's judgment, it may be productive to develop formal, fixed definitions, appropriately tailored to the regulation of nanoscale materials in FDA-regulated products."[235]

"[T]he Task Force believes that nanoscale materials will present regulatory challenges that are similar to those posed by other new technologies [the] FDA has dealt with in the past, such as biotechnology products, but also some potentially new challenges," [236] and regulation may be affected at some point. "In some cases, the presence of nanoscale materials may change the regulatory status/regulatory pathway of products.

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[229] *Id*.
[230] *Id*.
[231] *Id*.
[232] *Id*. The NCI states:

As with any new technology, the safety of nanotechnology is continuously being tested. The small size, high reactivity, and unique tensile and magnetic properties of nanomaterials—the same properties that drive interest in their biomedical and industrial applications—have raised concerns about implications for the environment, health, and safety (EHS). There has been some as yet unresolved debate recently about the potential toxicity of a specific type of nanomaterial—carbon nanotubes (CNTs)—which has been associated with tissue damage in animal studies. However, the majority of available data indicate that there is nothing uniquely toxic about nanoparticles as a class of materials. *Id*.

[233] *Id*.
[234] *See generally* NANOTECHNOLOGY: A REPORT OF THE U.S. FOOD AND DRUG ADMINISTRATION NANOTECHNOLOGY TASK FORCE (July 25, 2007), *available at* https://www.fda.gov/downloads/ScienceResearch/SpecialTopics/Nanotechnology/ucm110856.pdf.
[235] *Id*. at 6–7.
[236] *Id*. at 20.

The Task Force believes it is important that manufacturers and sponsors be aware of the issues raised by nanoscale materials and the possible change in the regulatory status/pathway when products contain nanoscale materials."[237] But first, more information must be obtained; commenters must illustrate specific cases and manufacturers must be made aware of any issues, reporting requirements, and difficulties in self-regulation.[238]

6. Space

Decades ago, the National Aeronautics and Space Administration ("NASA") began designing macroscale applications,[239] with far-reaching effects that can now be better implemented on a nanotechnological scale. This includes a 1982 study of a lunar self-replicating factory on the Moon.[240] The factory was expected to produce such a wide array of inexpensive products that it would awash society with a much higher standard of living and plentitude of products that would create deep social implications—even potential crises or social upheaval.[241] This project also demonstrated the power of building and operating systems utilizing self-replication, which nanotechnology will make a quicker and a more probable reality. NASA, as well as the Department of Defense, has always been on the forefront of pivotal scientific exploratory space engineering projects that, when successful, would transform society.[242] This hints at what is in store for nanotechnology. This includes Project Orion,[243] a classified project born in 1958[244] but rooted in the 1940s, which produced the first detailed report in 1955.[245] It explored and began testing the use of tactical nuclear bombs as space propulsion, and promised to launch space vehicles capable of launching payloads of "several thousands of tons" and able to "transport hundreds or thousands of people."[246] It would use conventional engineering and make humans a true "space faring society."[247]

Although space propulsion will not utilize small tactical nuclear bombs shooting out in quick succession as an ultrapowerful propellant any time soon, as in *Project Orion*, nanotechnology is nonetheless paving the way for advances in space propulsion on many fronts. In fact, in almost all aspects, nanotechnology will help lead humans become a space faring society. For example, in February 2018, *Nature* published a multi-faceted scientific article discussing how nanotechnology is applied to space propulsion in at

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[237] *Id*. at 32.

[238] *Id*.

[239] *See generally* JERRY GREY, LAWRENCE A. HAMDAN & AM. INST. AERONAUTICS & ASTRONAUTICS, SPACE MANUFACTURING 4: PROCEEDINGS OF THE FIFTH PRINCETON/AIAA CONFERENCE, MAY 18–21, 1981 (1981).

[240] *See, e.g*., ADVANCED AUTOMATION FOR SPACE MISSIONS (Nat'l Aeronautics & Space Admin. Sci. & Technical Info. Branch, Robert A. Freitas, Jr. & William P. Gilbreath, eds., 1982), *available at* http://www.islandone.org/MMSG/aasm/.

[241] *See id*. at § 5.5.1.

[242] *Cf*. GEORGE DYSON, PROJECT ORION: THE TRUE STORY OF THE ATOMIC SPACESHIP 4–9 (2002) (discussing *inter alia* NASA not taking on Project Orion until much later and the military being more initially involved).

[243] *See generally id*.

[244] *Id*. at 25.

[245] *Id*. at 23–24.

[246] *Id*. at 25.

[247] *Id*. at 87.

least ten components of an in-space propulsion engine, or adaptive thruster—including nanowires, self-healing structures, cathodes, magnetic systems, and acceleration channels.[248] This top science journal study states that "[m]ajor progress in robotics and microelectronics, as well as significant advances in nanoelectronics, make it possible to efficiently explore both near Earth and deep space with small spacecraft"; "[t]hese spacecraft and ultra-small satellites, sometimes referred to as Cubesats, are poised to permanently transform the global economy and mankind's approach to space exploration."[249]

Nanotechnology will revolutionize space exploration[250] and enable countries which currently cannot afford it to fully participate in it.[251] Development will also lead to leaps in other fields. NASA's Ames Research Laboratory, which in part focuses on nanotechnology, highlights other developments, including: electronic biochips and high strength composite materials; thermal protection; cooling systems, electronics, and sensors that utilize nanotubes; miniaturized electronics; sensors and information processing; high performance computers and high power optical systems for remote exploration; human implantable thermoelectric devices; carbon nanotubes that removal toxic gases from life support systems; micro-fabrication and micromachining processes; circuit chips; and radiation resistant devices.[252] Notable other areas include utilizing nanopores for gene sequencing, nanotubes for analyzing mission instruments and implantable astronaut health monitoring, and nanotechnological methods analyzing critical life science questions.[253] The other developmental opportunity areas are limitless, including optoelectronics and nanophotonics to develop more efficient lasers and "GEC cells" for analyzing plasma physics.[254]

Most important—particularly in regards to this article—is that the NASA Ames Lab is cross-disciplinary; its hybrid focus on nanotechnology

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[248] *See generally* I. Levchenko et al., *Recent Progress and Perspectives of Space Electric Propulsion Systems Based on Smart Nanomaterials*, 9 NATURE COMMS. 879 (2018).

[249] *Id*. at 879.

[250] *The Next Giant Leap*, NASA (Aug. 4, 2005), https://www.nasa.gov/vision/earth/technologies/27jul_nanotech.html ("If visionaries are right, nanotechnology could lead to robots you can hold on your fingertip, self-healing spacesuits, space elevators and other fantastic devices.").

[251] Stuart Clark, *Nanotechnology Can Launch a New Age of Space Exploration*, THE GUARDIAN (Apr. 17, 2012) https://www.theguardian.com/nanotechnology-world/nanotechnology-can-launch-a-new-age-of-space-exploration.

When nanotechnology is really developed, even countries that don't presently think about space will be able to afford space exploration. . . . Nanoengineering could produce surfaces that regulate spacecraft temperatures more efficiently than the materials used today. It could also generate more efficient solar cells, rendering large panels redundant. . . . *Id*.

The team discussed two ideas:

The first was a lightweight spacesuit that was more flexible than current garments. . . . The team's second idea was a "spider's web" of hairline tubes that could be deployed across large tracts of a planet's surface. Inside the tubes would be an army of nanosensors that could measure the surface temperature and composition. Each web would span a dozen kilometres and be capable of sensing a planetary environment in great detail. *Id*.

"Instead of general-purpose spacecraft, hundreds or even thousands of identical microchip-sized spacecraft could be deployed to perform highly specific tasks." *Id*.

[252] *Nanotechnology*, NASA: AMES RESEARCH CENTER, https://www.nasa.gov/centers/ames/research/technology-onepagers/nanotechnology-landing.html (last visited Sept. 1, 2019).

[253] *Id*.

[254] *Id*.

includes the Genome Research Facility, the Fundamental Space Biology Program, and the Center for Nanotechnology; it was "designed to support NASA research needs in genomics and nanotechnology and to advance research and development in bio-sensor technology through collaborative projects with academic and industrial partners . . . ."[255] Working with Baylor College of Medicine, Stanford, and Yale University, "projects include the Nanopore Project, which aims to exploit the unique properties of nanopores to identify single molecules of biological polymers, in particular those that contain life's genetic blueprint, the polynucleotide molecules of DNA and RNA."[256] Research developments would lead to improve aspects of the process that would sequence DNA "hundreds or even thousands of times faster than current methods," meaning "the nanopore device could replace existing DNA sequencing technology."[257]

In other areas "[s]cientists at the Center for Nanotechnology focus on state-of-the-art intersection of biology and materials science," termed "bio-nanotechnology."[258] It "applies the concepts and techniques of molecular biology to engineering objectives, such as the use of proteins as templates for the production of nano-scale electronic circuits . . . ."[259]A significant part of bio-nanotechnology is proteins, because they "are biomolecules that can naturally form highly-ordered structures and most importantly can be modified and manipulated by genetic engineering."[260]

What is most important about space and NASA's nanotechnology development—unlike the EPA or FDA—is not only the absence of law and regulatory discussion, but how it can be dramatically more impactive, from space exploration and making humans a true space faring society to its role in DNA sequencing, bio-nanotechnology research, and application.

7. Artificial Intelligence

If nanotechnology is not a game changer (and it would be almost impossible to argue otherwise), AI is the game changer, and they both can be combined.[261] Both nanotechnology and AI have been named as one of the twelve most fundamental risks to human society alongside nuclear war, global economic collapse, and major asteroid impact.[262] Nanotechnology will enable faster development and novel miniaturized application. Nanotechnology can first improve or make AI a true reality by allowing

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[255] *Nanotechnology at Ames*, NASA: AMES TECHNOLOGY CAPABILITIES & FACIILITIES, https://www.nasa.gov/centers/ames/research/technology-onepagers/ames_nanotech.html (last visited Sept. 1, 2019).

[256] *Id*.

[257] *Id*.

[258] *Id*.

[259] *Id*.

[260] *Id*.

[261] G. M. Sacha & P. Varona, *Artificial Intelligence in Nanotechnology,* 24 NANOTECHNOLOGY 452002, 452002 (2013) ("Convergence between artificial intelligence and nanotechnology can shape the path for many technological developments in the field of information sciences that will rely on new computer architectures and data representations, hybrid technologies that use biological entities and nanotechnological devices, bioengineering, neuroscience and a large variety of related disciplines.").

[262] Stuart Dredge, *Artificial Intelligence and Nanotechnology "Threaten Civilization"*, THE GUARDIAN (Feb. 18, 2015), https://www.theguardian.com/technology/2015/feb/18/artificial-intelligence-nanotechnology-risks-human-civilisation ("Technologies join nuclear war, ecological catastrophe, super-volcanoes and asteroid impacts in Global Challenges Foundation's risk report").

faster computation or information processing; it can do this a few ways. The first is to simply enable smaller computer processing chips. It has been reported that IBM has started manufacturing 5-nm computer chips and will introduce them to the market in 2020.[263] These can increase computer processing capacity over 10-nm chips by 40 percent.[264]

Another method is the use of light or quantum computer chips instead of electricity. Although they may take up to twenty-five years to emerge, they are well beyond the capabilities of today's computers.[265] Quantum teleportation would revolutionize communication and cryptology as well.[266] Nanotechnology also allows for another type of computer processing chip that uses physical signals instead of electrons working in three dimensions, which, at the physical scale, would allow computer processing storage to be billions of times more efficient[267] than today's silicon electric computer chips.[268] Artificial neurons are also being shown to compute faster than the human brain—"A computing system that mimics neural processing could make [AI] more efficient—and more human."[269]

D. ANALYSIS ON LEGAL THOUGHT AND NANOLAW

As most of the scholarship and commentary illustrate, nanotechnology is discussed largely in terms of advances in molecular nanotechnology through the use of new methods with new materials. The science behind the nanotechnology that is purposely being performed in labs or from patents has been a new milestone in human technology. Consequently, there is a tendency, including within legal scholarship, to see nanotechnology and its law as something new. In this context, there are legal strategies of looking to soft law, better regulation, self-regulation, better merging of the scientific and legal fields, promoting better patent development, focusing on health and environment, being cautious on military application, and preparing for new types of crime. These can all be valid strategies. Scholars argue that there must be a wait-and-see approach. Some argue that soft law should be

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[263] Aaron Tilley, *IBM Shows The World How To Build A Super Dense 5-Nanometer Chip,* FORBES (June 5, 2017), https://www.forbes.com/sites/aarontilley/2017/06/05/ibm-5nm-chips/#2a06af733c56 ("IBM said the 5nm chip achieves 40% performance boost, or 75% power efficiency with the same performance, over the current-generation 10nm chips coming out now.").

[264] *Id*.

[265] Sergio Boixo et al., *Characterizing Quantum Supremacy in Near-Term Devices*, 14 NATURE PHYSICS 595, 595 (2018) ("A critical question for the field of quantum computing in the near future is whether quantum devices without error correction can perform a well-defined computational task beyond the capabilities of state-of-the-art classical computers, achieving so-called quantum supremacy.").

[266] Matthew Luce, *China's Secure Communications Quantum Leap,* 10 JAMESTOWN FOUNDATION: CHINA BRIEF 12, 13 (2010) ("The Chinese experiment appears to shatter these records by claiming to be the first to use a high-powered blue laser to exchange quantum information over a free space channel, and to demonstrate the principle over a distance as great as 16 km.").

[267] *See, e.g*., Ralph C. Merkle, *It's a Small, Small, Small, Small World*, MIT TECH. REV. (Feb. 1, 1997), https://www.technologyreview.com/s/400021/its-a-small-small-small-small-world/.

With nanotechnology, we should be able to build mass storage devices that can store more than 100 billion billion bytes in a volume the size of a sugar cube, and massively parallel computers of the same size that can deliver a billion billion instructions per second-a billion times more than today's desktop computers. *Id*.

[268] Nanotubes have already been showed to outperform silicon. *See* G. J. Brady et al., *Quasi-Ballistic Carbon Nanotube Array Transistors with Current Density Exceeding Si and GaAs*, 2 SCI. ADVANCES e1601240, e1601240 (2016).

[269] Sara Reardon, *Artificial Neurons Compute Faster Than the Human Brain*, NATURE (Jan. 26, 2018), https://www.nature.com/articles/d41586-018-01290-0.

utilized because we first must understand the nanotechnology and what it will look like, before we can regulate it. Scholars and commentators also lament that there is not a sufficient or concise definition of nanotechnology. This is the elephant in the room that they do not see.

III. HUMANS AT THE NANOSCALE AND EMERGING HUMAN APPLIED NANOTECHNOLOGY

A. HUMANS AT THE NANOSCALE

1. Thinking of Humans and Life in a New Way

How can humans be nanotechnology? Humans are intelligent and they reproduce or self-replicate. They may even have souls, depending on one's philosophical or religious outlook. One can certainly say, with some support, that humans began differently from the nanotechnology that we see in the labs, read about in the science journals, see in documentaries, read in fiction books,[270] or even see in science fiction films.[271] Some horror movies even have nanorobots wreaking havoc on the human genetic code.[272] Most observations of humans in their present state of evolution are through science, the study of evolution, and the study of the human genome at the microscopic level. Although change can be presently seen, many of the larger evolutionary leaps are observed in geologic remnants and in the genome.

2. Humans Traits are Nanoscale

To assist with thinking of humans on the nanoscale, it helps to illustrate how they are already in the nanoscale. The nanoscale foci of the law involve not only directly genes, disease, and health status, but also cognitive experience, cognitive ability, physical ability or conditioning, and psychological predisposition. Science defines these constituents as nanoscale biological qualities. The idea that thinking or biological functioning relates to "energy," "psychic forces," or some unknown force outside of quantifiable biological units is a long defunct Aristotelian concept. Physical has come to mean anything and everything, which is a modern concept dating back to John Locke,[273] best epitomized by John Yolton's *Thinking Matter*.[274] Thoughts, experience, and memories are physical properties that can be measured. Human ideas and cultural traits can spread

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[270] *See* Baum, *supra* note 88, at 37–38 (discussing Michael Crichton's 2006 novel, *Prey*, and other fearful notions of nanotechnology). See *generally* MICHAEL CRICHTON, PREY (2006) (reaching number one on New York Times bestseller list, about nanoparticles programmed to destroy mankind escaping from a lab).

[271] *See, e.g.*, PROMETHEUS (Twentieth Century Fox 2012).

[272] *See* A.M. Lehr, *"Big Things Have Small Beginnings": Ridley Scott's Prometheus (2012) on Nanotechnology*, BIOCULTURE SEMINARS: GRADUATE SEMINARS AT VANDERBILT UNIVERSITY ON SCIENCE AND LITERATURE (Mar. 22, 2015), https://biocultures.wordpress.com/2015/03/22/big-things-have-small-beginnings-ridley-scotts-prometheus-2012-on-nanotechnology/ (discussing *inter alia* the quote "big things have small beginnings" and the drop of "black goo" on the Android David's fingertip). This "encapsulates the uneasy relationship between nanotechnologies and their associated corporate hyperobjects . . . ." *Id*.

[273] *See generally* JOHN LOCKE, OF THE CONDUCT OF THE UNDERSTANDING (Thoemmes Press 1993).

[274] *See generally* JOHN W. YOLTON, THINKING AND PERCEIVING (1962), JOHN W. YOLTON, THINKING MATTER: MATERIALISM IN EIGHTEENTH-CENTURY BRITAIN (1983).

and evolve like genes or viruses in the human population.[275] These concepts and terms are called "memes," referring to cultural transmission between humans akin to genetic transmission.[276]

Human language is also understood by top linguists to be directly tied to the physical brain or biological structure,[277] as well as skills—such as being a violin virtuoso—that tailor brain neurons mapped with MRI and other analysis. Additionally, the purpose of language is not primarily for communication, but rather for thinking.[278] Thinking and memory, or cognitive processing and memory storage, are now understood in terms of precise biological quantification and scale.

The nanoscale components of some of these human aspects have long been established to be genetic. This includes disease and race (though race has evolved to be generally considered a social construct) along with ethnicity and nationality. The phenotype, language, and behaviors associated are, however, nanoscale—genetic or not. All human traits are based on genes and environmental impact in ways that are not completely understood. Physical condition and skill, which includes mental skill and coordination, are growing more quantified and people have more recently become aware of their nanoscale characteristics. The physical measurement of memory, experience, brain or neurological conditioning, and psychological predisposition is sufficiently established to analyze regulatory aspects.

Memories in the human brain can be measured by neurons or quantified at the nanoscale. Memories are not random events but rather consist of "specific mechanisms [regulating] where information is stored within a neural circuit," as reported in the top science journals.[279] Memories in the human brain have been mapped to specific neurons,[280] specific neurotransmitters, and other factors in memory storage.[281] Research is even developing on specific memory erasures.[282] Memories specific to particular

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[275] *See* DAWKINS, *supra* note 6, at 245–60 (discussing memes as new replicators in Chapter 11).

[276] *See id*. at 245. This is a non-scientific but metaphorical explanation for illustration by a world-renowned evolutionary biologist.

[277] *See supra* note 37. *See also* ROBERT C. BERWICK & NOAM CHOMSKY, WHY ONLY US? 53–108 (2015) (discussing the evolutionary roots of language development in the human brain).

[278] *See* NOAM CHOMSKY, WHAT KIND OF CREATURES ARE WE? 15–16 (2018) (supporting the assertion that language is primarily for thought, and only incidental to communication).

[279] *See* Alcino J. Silva et al., *Molecular and Cellular Approaches to Memory Allocation in Neural Circuits*, 326 SCI. 391, 391 (2009).

[280] Methods have been established to map specific memory bearing neurons. *See* Xu Liu et al., *Optogenetic Stimulation of a Hippocampal Engram Activates Fear Memory Recall,* 484 NATURE 381, 381 (2012) (". . . our findings indicate that activating a sparse but specific ensemble of hippocampal neurons that contribute to a memory engram is sufficient for the recall of that memory. Moreover, our experimental approach offers a general method of mapping cellular populations bearing memory engrams.").

[281] Recent research also analyzes the interaction of neurons with neurotransmitters and pharmacology corresponding with emotional arousal. Ryan T. LaLumiere et al., *Emotional Modulation of Learning and Memory: Pharmacological Implications*, 69 PHARMACOLOGICAL REV. 236, 236 (2017).

The mechanisms underlying the emotional influences on memory involve the release of stress hormones and activation of the basolateral amygdala, which work together to modulate memory consolidation. Moreover, work suggests that this amygdala-based memory modulation occurs with numerous types of learning and involves interactions with many different brain regions to alter consolidation. Additionally, studies suggest that emotional arousal and amygdala activity in particular influence synaptic plasticity and associated proteins in downstream brain regions. *Id*.

[282] In fact, research has demonstrated that neurons can be targeted with successful memory erasure. *See* Jin-Hee Han et al., *Selective Erasure of a Fear Memory*, 323 SCI. 1492, 1492 (2009) (". . . [R]esults establish a causal link between a specific neuronal subpopulation and memory expression, thereby

fears, have also been mapped.[283] Neuron development has been measured even during the formation of a memory.[284] Researchers state: "Memory defines us as individuals; our personal preferences, skills, and wisdom are rooted in long-term memories. We draw on our memories to make sense of the present, and our memories help to direct our future behaviors."[285]

There is also a measure of specific skills, including those of musicians[286] and athletes, such as martial artists whose levels of aggressiveness can be correlated with types of brain development.[287] Specific brain development is being measured in the context of physical skill during the learning process to full development.[288] Scientific findings are detailed enough to detect whether brain neurological development is genetic or learned.[289]

Further, in addition to memories and skills, research shows that the essential elements of personality can also be mapped and measured,

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identifying critical neurons within the memory trace."), Sheena A. Josselyn, *Continuing the Search for the Engram: Examining the Mechanism of Fear Memories*, 35 J. PSYCHIATRY NEUROSCI. 221, 221 (2010) ("[R]esults show that particular neurons in the lateral amygdala, a brain region important for fear, are specifically involved in particular fear memories. . . . [W]e showed that selective ablation of the neurons overexpressing CREB in the lateral amygdala selectively erased the fear memory.").

[283] Leon G. Reijmers et al., *Localization of a Stable Neural Correlate of Associative Memory*, 317 SCI. 1230, 1230 (2007) ("The number of reactivated neurons correlated positively with the behavioral expression of the fear memory, indicating a stable neural correlate of associative memory."), Yu Zhou et al., *CREB Regulates Excitability and the Allocation of Memory to Subsets of Neurons in the Amygdala*, 12 NATURE NEUROSCI. 1438, 1438 (2009) ("Our findings demonstrate that CREB modulatesn the allocation of fear memory to specific cells in lateral amygdala . . . .").

[284] Jin-Hee Han et al., *Neuronal Competition and Selection During Memory Formation*, 316 SCI. 457, 457 (2007) (". . . [R]esults suggest a competitive model underlying memory formation, in which eligible neurons are selected to participate in a memory trace as a function of their relative CREB activity at the time of learning.") [hereinafter Han et al., *Neuronal Competition*].

[285] LaLumiere et al., *supra* note 281, at 237.

[286] *See* Cheryl D. Metcalf et al., *Complex Hand Dexterity: A Review of Biomechanical Methods for Measuring Musical Performance*, 5 FRONTIERS PSYCHOL. 1, 1 (2014). "Complex hand dexterity is fundamental to our interactions with the physical, social, and cultural environment. Dexterity can be an expression of creativity and precision in a range of activities, including musical performance. Little is understood about complex hand dexterity or how virtuoso expertise is acquired." *Id*. However, ". . . [r]ecent developments in methods of motion capture and analysis mean it is now possible to explore the intricate movements of the hand and fingers. These methods allow us insights into the neurophysiological mechanisms underpinning complex hand dexterity and motor learning." *Id*. The authors focus "specifically on biomechanical measurement and the associated technical challenges faced when measuring highly dexterous activities." *Id*.

[287] *See* S. Breitschuh et al., *Aggressiveness of Martial Artists Correlates with Reduced Temporal Pole Grey Matter Concentration*, 281 PSYCHIATRY RES.: NEUROIMAGING 24, 24 (2018) (". . . the increased GM [grey matter] concentration in aggressive controls might reflect a stronger cognitive top-down inhibition of their aggressiveness. Lower GM concentration in more aggressive martial artists may indicate a reduced need of inhibitory cognitive control because of their improved self-regulation skills.")

[288] Alan H. D. Watson, *What Can Studying Musicians Tell Us About Motor Control of the Hand?*, 208 J. ANATOMY 527, 530–32 (2006).

When a new set of movements is first being learned in humans, an area of the cortex that lies just anterior to the supplementary motor cortex (the presupplementary area) is briefly active. . . . [T]he supplementary motor cortex shows much less activity during this initial period, but once learning is complete it becomes active when the motor sequences are reenacted. The premotor cortex is also very active during the initial stages of learning. With further practice, the replaying of these sequences becomes fully automatic. . . . This posterior drift in cortical activation during learning will be encountered again when we discuss the contribution of the different motor areas of the brain in the context of musical experience. *Id*. (citations omitted).

[289] Assal Habibi et al., *Childhood Music Training Induces Change in Micro and Macroscopic Brain Structure: Results from a Longitudinal Study*, 28 CEREBRAL CORTEX 4336, 4336 (2018).

Several studies comparing adult musicians and nonmusicians have shown that music training is associated with structural brain differences. . . . We established at the onset that there were no pre-existing structural differences among the groups. . . . We conclude that music training induces macro and microstructural brain changes in school-age children, and that those changes are not attributable to pre-existing biological traits. *Id*.

including extraversion, neuroticism, agreeableness, and conscientiousness in the contexts of correlation to specific brain regions.[290] These findings have been duplicated in multiple studies.[291] The field of Personality Neuroscience has been developed to measure the brain in correlation with personality characteristics, albeit with some inevitable technical difficulty.[292] Correspondingly, conditions such as psychopathy, which correlate with a high number of violent crimes, have been measured in the brain.[293]

Language development has also been specifically measured in the brain. There has been significant consensus in linguistics, including with generative grammar, that human language capability is significantly inherited or genetic,[294] and language brain structures have been specifically measured in the brain and studied.[295] Brain measurement in relation to disease inheritance is more widely noted, but genetic inheritance of language and cognitive ability have also been measured.[296]

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[290] *See* Colin G. DeYoung et al., *Testing Predictions From Personality Neuroscience: Brain Structure and the Big Five*, 21 PSYCHOL. SCI. 820, 820 (2010) ("We used a new theory of the biological basis of the Big Five personality traits to generate hypotheses about the association of each trait with the volume of different brain regions.").

[291] *See* Dimitrios Kapogiannis et al., *The Five Factors of Personality and Regional Cortical Variability in the Baltimore Longitudinal Study of Aging*, 34 HUM. BRAIN MAPPING 2829, 2829 (2013) ("Our findings highlight personality-related variation that may be related to individual differences in brain structure that merit additional attention in neuroimaging research."), Roberta Riccelli et al., *Surface-Based Morphometry Reveals the Neuroanatomical Basis of the Five-Factor Model of Personality*, 12 SOC. COGNITIVE & AFFECTIVE NEUROSCI. 671, 671 (2017).

Neuroticism was associated with *thicker* cortex and *smaller* area and folding in prefrontal-temporal regions. Extraversion was linked to *thicker* pre-cuneus and *smaller* superior temporal cortex area. Openness was linked to *thinner* cortex and *greater* area and folding in prefrontal-parietal regions. Agreeableness was correlated to *thinner* prefrontal cortex and *smaller* fusiform gyrus area. Conscientiousness was associated with *thicker* cortex and *smaller* area and folding in prefrontal regions. *Id*.

[292] *See* Julien Dubois et al., *Resting-State Functional Brain Connectivity Best Predicts the Personality Dimension of Openness to Experience*, 1 PERSONALITY NEUROSCI. 1, 1 (2018). "Personality neuroscience aims to find associations between brain measures and personality traits." *Id*. Across all results, " . . . [o]penness to experience emerged as the only reliably predicted personality factor." *Id*. The authors "conclude with a discussion of the potential for predicting personality from neuroimaging data and make specific recommendations for the field." *Id*.

[293] *See, e.g.,* Nathaniel E. Anderson & Kent A. Kiehl, *The Psychopath Magnetized: Insights from Brain Imaging*, 16 TRENDS COGNITIVE SCI. 52, 52 (2012).

Psychopaths commit a disproportionate amount of violent crime, and this places a substantial economic and emotional burden on society. . . . [T]he neuroimaging literature is generally converging on a set of brain regions and circuits that are consistently implicated in the condition: the orbitofrontal cortex, amygdala, and the anterior and posterior cingulate and adjacent (para)limbic structures. *Id*.

[294] *Cf*. Ray Jackendoff, *Précis of Foundations of Language: Brain, Meaning, Grammar, Evolution*, 26 BEHAV. & BRAIN SCI. 651, 651 (2003).

Generative grammar was right to focus on the child's acquisition of language as its central problem, leading to the hypothesis of an innate Universal Grammar. However, generative grammar was mistaken in assuming that the syntactic component is the sole course of combinatoriality, and that everything else is "interpretive." The proper approach is a parallel architecture, in which phonology, syntax, and semantics are autonomous generative systems linked by interface components. *Id*.

[295] Angela D. Friederici, *The Brain Basis of Language Processing: From Structure to Function*, 91 PHYSIOLOGICAL REVS. 1357, 1357 (2011) ("These networks have been substantiated both by functional as well as by structural connectivity data. Electrophysiological measures indicate that within these networks syntactic processes of local structure building precede the assignment of grammatical and semantic relations in a sentence.").

[296] Paul M. Thompson et al., *Genetic Influences on Brain Structure*, 4 NATURE NEUROSCI. 1253, 1253 (2001).

We report on detailed three-dimensional maps revealing how brain structure is influenced by individual genetic differences. . . . These genetic brain maps reveal how genes determine individual differences, and may shed light on the heritability of cognitive and linguistic skills, as well as genetic liability for diseases that affect the human cortex. *Id*.

Dopamine plays a meaningful role in memory formation and cognitive functions including "belief formation" and false beliefs.[297] Genes may influence one's sensitivity to emotional stimuli.[298] Emotions such as happiness can be detected in the brain;[299] even positive emotions and sense of purpose have been found to have a biological or genetic correlation.[300] Not only are memories, emotions, and thoughts highly nanoscale but emotions themselves have significant roots in genes.[301]

B. CURRENT DEVELOPMENTS IN NANOTECHNOLOGY

As humans are nanoscale and are changed on the nanoscale in a variety of ways including by culture or law, new ways are being developed to assist, cure, or augment humans. Silver and gold nanoparticles, used in the Middle Ages in glass and cups, are now being used in new generations of antibiotics and biosensors.[302] New developments include: utilizing nanoparticles to transport drugs to infection sites;[303] a multitude of antibiotic treatments;[304] nano-enzymes for a "new generation" of antibiotics;[305] nano-enzymes for cancer treatment;[306] and protection of artificial implants and biomedical

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[297] *See generally* Disha Shah et al., *Resting-State Functional MRI and [18F]-FDG PET Demonstrate Differences in Neuronal Activity Between Commonly Used Mouse Strains*, 125 NEUROIMAGE 57 (2016).

[298] *See generally* Rebecca M. Todd et al., *Neurogenetic Variations in Norepinephrine Availability Enhance Perceptual Vividness,* 35 J. NEUROSCI. 6506, (2015).

[299] *See* Leonardo Machado & Amaury Cantilino, *A Systematic Review of the Neural Correlates of Positive Emotions*, 39 BRAZ. J. PSYCHIATRY 172, 172 (2016) (stating "we can conclude that positive emotions such as happiness activate specific brain regions . . .").

[300] *See generally* JOSEPH P. FORGAS & ROY F. BAUMEISTER, THE SOCIAL PSYCHOLOGY OF LIVING WELL (2018).

[301] *See* Laura Bevilacqua & David Goldman, *Genetics of Emotion*, 15 TRENDS COGNITIVE SCI . 401, 401 (2011).

Emotion is critical to most aspects of human behavior, and individual differences in systems recruited to process emotional stimuli, expressed as variation in emotionality, are characteristic of several neuropsychiatric disorders. . . . The effects of these genes can be validated by neuroimaging, neuroendocrine and other studies accessing intermediate phenotypes, deepening our understanding of mechanisms of emotion and variation in emotionality. *Id*.

[302] *See* Qing Li et al., *Silver Inlaid with Gold Nanoparticles: Enhanced Antibacterial Ability Coupled with the Ability to Visualize Antibacterial Efficacy,* 6 ACS SUSTAINABLE CHEMISTRY & ENGINEERING 9813, 9813 (2018).

Silver nanoparticles (Ag NPs) are widely used against bacteria, but further applications are restricted by their cytotoxicity. . . . An alloy nanostructure of gold nanoparticles (Au NPs) inlaid on Ag NPs was synthesized using egg white protein (denoted here as Au–Ag NPs), exhibiting an enhanced antibacterial effect and can visually indicate the antibacterial efficacy by fluorescence. . . . Efficient antibacterial activity coupled with the ability to visualize bacterial processes allow Au–Ag NPs to be a potential solution in medicine and biosensing. *Id*.

[303] *See, e.g*., Li-Sheng Wang et al., *Nanomaterials for the Treatment of Bacterial Biofilms*, 2 ACS INFECTIOUS DISEASES 3, 3 (2015) (discussing "the use of nanoparticle-based systems as active therapeutic agents and as vehicles to transport drugs to the site of infection. These applications require understanding of the surface interactions of nanoparticles with bacteria/biofilms . . .").

[304] *See, e.g*., Zhiwei Zhao et al., *Bacteria-Activated Theranostic Nanoprobes against Methicillin-Resistant Staphylococcus Aureus Infection*, 11 ACS NANO 4428, 4428 (2017) ("The strategy of bacteria-activated polyelectrolyte dissociation from nanoparticles proposed in this work could also be used as a general method for the design and fabrication of bacteria-responsive functional nanomaterials that offer possibilities to combat drug-resistant bacterial infections.").

[305] *See, e.g*., Zhaowei Chen et al., *Enzyme Mimicry for Combating Bacteria and Biofilms*, 51 ACCTS. CHEMICAL RES. 789, 789 (2018) (focusing "recent progress in the design and synthesis of artificial enzymes as a new generation of 'antibiotics' . . . ").

[306] *See, e.g*., Cao et al., *supra* note 5, at 7831 (". . . [O]ur study paves a new way for the development of high-performance MOFs-derived nanozymes particularly useful for the safe and efficient cancer therapy.").

devices.[307] There are nanotechnological strides in malaria treatment,[308] HIV therapy,[309] fighting pancreatic cancer,[310] fighting metastatic cancer,[311] fighting tumors,[312] neurological disorder treatment,[313] and DNA[314] construction for molecular circuitry for synthetic biology.[315] There have been many important advances in DNA nanotechnology[316] that could lead to nanorobotics, smart materials, DNA based computation, and material assembly.[317] The utilization of DNA in terms of building blocks and interactions assists with developing important nanotechnological tools.[318]

Some advancements have been in development for over twenty years, including artificial cells,[319] artificial red blood cells,[320] and artificial white

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[307] *See generally* Mohankandhasamy Ramasamy & Jintae Lee, *Recent Nanotechnology Approaches for Prevention and Treatment of Biofilm-Associated Infections on Medical Devices*, 2016 BIOMED. RES. INT'L. 1, (2016); Xianzhou Xie et al., *Tuning the Bandgap of Photo-Sensitive Polydopamine/Ag_3PO_4/Graphene Oxide Coating for Rapid, Noninvasive Disinfection of Implants*, 4 ACS CENT. SCI. 724, 724–38 (2018).

[308] Editorial, *Investing in the Future*, 9 NATURE 241, 241 (2014) ("Nanotechnology is an important tool in the fight against malaria.").

[309] *See* Upal Roy et al., *Characterization of Nanodiamond-based Anti-HIV Drug Delivery to the Brain*, 8 NATURE 1603, 1603 (2018).

[310] *See* Pavan P. Adiseshaiah et al., *Nanomedicine Strategies to Overcome the Pathophysiological Barriers of Pancreatic Cancer*, 13 NATURE 750, 750–65 (2016).

[311] Avi Schroeder et al., *Treating Metastatic Cancer with Nanotechnology*, 12 NATURE 39, 39 (2012) ("Nanoparticles have many potential benefits for diagnosing and treating metastatic cancer, including the ability to transport complex molecular cargoes to the major sites of metastasis, such as the lungs, liver and lymph nodes, as well as targeting to specific cell populations within these organs.").

[312] Jinjun Shi et al., *Cancer Nanomedicine: Progress, Challenges and Opportunities*, 17 NATURE 20, 20 (2017) (discussing "progress, challenges and opportunities in cancer nanomedicine and discusses novel engineering approaches that capitalize on our growing understanding of tumour biology and nano–bio interactions to develop more effective nanotherapeutics for cancer patients").

[313] Maya Srikanth & John A. Kessler, *Nanotechnology—Novel Therapeutics for CNS Disorders,* 8 NATURE 307, 307 (2012) (describing "recent advances in the development of nanotechnology for the treatment of neurological disorders—in particular, neurodegenerative disease and malignant brain tumours—and for the promotion of neuroregeneration").

[314] Andre V. Pinheiro et al., *Challenges and Opportunities for Structural DNA Nanotechnology*, 6 NATURE NANOTECH. 763, 763 (2011) ("DNA molecules have been used to build a variety of nanoscale structures and devices over the past 30 years, and potential applications have begun to emerge."). The authors "highlight the potential use of DNA nanostructures in molecular and cellular biophysics, as biomimetic systems, in energy transfer and photonics, and in diagnostics and therapeutics for human health." *Id*.

[315] Jiang Li et al., *Engineering Nucleic Acid Structures for Programmable Molecular Circuitry and Intracellular Biocomputation,* 9 NATURE CHEMISTRY 1056, 1056 (2017) (discussing "how to integrate the tools provided by DNA/RNA nanotechnology and related new technologies to construct nucleic acid nanostructure-based molecular circuitry for synthetic biology").

[316] Nadrian C. Seeman & Hanadi F. Sleiman, *DNA Nanotechnology,* 3 NATURE 17068, 17068 (2017) ("The field of DNA nanotechnology takes this molecule out of its biological context and uses its information to assemble structural motifs and then to connect them together. This field has had a remarkable impact on nanoscience and nanotechnology, and has been revolutionary in our ability to control molecular self-assembly.").

[317] Nadrian C. Seeman, *Structural DNA Nanotechnology: An Overview*, *in* 303 METHODS IN MOLECULAR BIOLOGY 143, 143 (S.J. Rosenthal & D.W. Wright eds., 2005) ("Structural DNA Nanotechnology uses unusual DNA motifs to build target shapes and arrangements. . . . DNA-based nanomechanical devices have been produced that are targeted ultimately to lead to nanorobotics.").

[318] Seeman, *supra* note 317, at 144 ("DNA-based nanomechanical devices can lead to a nanometer-scale robotics and to very smart materials, materials that respond to specific stimuli by particular spatial transitions. Structural DNA nanotechnology creates motifs that can be useful for DNA-based computation and for the algorithmic assembly of materials.").

[319] Thomas M. S. Chang, *Therapeutic Applications of Polymeric Artificial Cells*, 4 NATURE REVS. 221, 221 (2005) (describing "the historical development and principles behind polymeric artificial cells, the present state of the art in their therapeutic application, and the promises and challenges for the future").

[320] Robert A. Freitas Jr., *Exploratory Design in Medical Nanotechnology: A Mechanical Artificial Red Cell,* 26 ARTIFICIAL CELLS, BLOOD SUBSTITUTES, & BIOTECH. 411, 411 (1998).

blood cells,[321] which are types of nanorobots.[322] Types of artificial red blood cells are routinely used in Russia and South Africa.[323] Development goals include artificial organs,[324] tissues[325] including skin,[326] and other blood substitutes, such as platelets.[327]

Years ago, the top science journal, *Nature*, reported that scientists were already using tiny nanorobots to construct molecules in living animals.[328] Other work includes the development of neural sensors that work seamlessly into the brain, infusing millions for research.[329] Brain repair and improving

The artificial red blood cell or "respirocyte" proposed here is a bloodborne spherical 1-micron diamondoid 1000-atm pressure vessel with active pumping powered by endogenous serum glucose, able to deliver 236 times more oxygen to the tissues per unit volume than natural red cells and to manage carbonic acidity. An onboard nanocomputer and numerous chemical and pressure sensors enable complex device behaviors remotely reprogrammable by the physician via externally applied acoustic signals. *Id*.

[321] *See generally* Robert A. Freitas Jr., *Microbivores: Artificial Mechanical Phagocytes Using Digest and Discharge Protocol*, 14 J. EVOLUTION & TECH. 55 (2005).

[322] Apoorva Manjunath &Vijay Kishore, *The Promising Future in Medicine: Nanorobots,* 2 BIOMED. SCI. & ENGINEERING 42, 42 (2014) ("Nanorobotics is an emerging field of nanotechnology which deals with design and construction of devices at an atomic, molecular or cellular level. . . . The nanorobots such as respirocytes, microbivores and clottocytes are been designed to act as artificial substitutes of blood.").

[323] "The first experimental artificial red blood cells have all three major functions of red blood cells (rbc). However, the first practical one is a simple polyhemoglobin (PolyHb) that only has an oxygen-carrying function. This is now in routine clinical use in South Africa and Russia." Thomas M. S. Chang, *From Artificial Red Blood Cells, Oxygen Carriers, and Oxygen Therapeutics to Artificial Cells, Nanomedicine, and Beyond,* 40 ARTIFICIAL CELLS, BLOOD SUBSTITUTES & BIOTECH. 197, 197 (2012).

Research has now extended well beyond the original research on artificial rbc into many areas of artificial cells. . . . These are being used in nanotechnology, nanomedicine, regenerative medicine, enzyme/gene therapy, cell/ stem cell therapy, biotechnology, drug delivery, hemoperfusion, nanosensers, and even by some groups in agriculture, industry, aquatic culture, nanocomputers, and nanorobotics. *Id*.

[324] T. Yambe et al., *Nano Technology for the Development of Artificial Internal Organs*, *in* 25 IFMBE PROCEEDINGS: WORLD CONGRESS ON MEDICAL PHYSICS & BIOMEDICAL ENGINEERING 7–12 SEPTEMBER, 2009 MUNICH, GERMANY 536, 536–39 (Olaf Dössel & Wolfgang C. Schlegel eds., 2009).

[325] *See generally* BIOMATERIALS & NANOTECHNOLOGY FOR TISSUE ENGINEERING (Swaminathan Sethuraman, Uma Maheswari Krishnan & Anuradha Subramanian eds., 2016) (discussing nanotechnological approaches to regenerative tissue engineering, bioengineered skin and neural, bone, cartilage and ocular regeneration).

[326] Aezeden Mohamed & Malcolm (Mengqiu) Xing, *Nanomaterials and Nanotechnology for Skin Tissue Engineering*, 2 INT'L. J. BURNS & TRAUMA. 29, 29 (2012) ("Tissue engineering is an interdisciplinary area of nanomedicine in which biomaterial and medical science understands of pathological tissue and the principles used to achieve this understanding are applied to the improving or sustaining of tissue function through the development of biological substitutes.").

[327] *See* Robert A. Freitas Jr., *Clottocytes: Artificial Mechanical Platelets*, INSTITUTE FOR MOLECULAR MANUFACTURING, http://www.imm.org/?s=Clottocytes%3A+Artificial+Mechanical+Platelets (last visited Sept. 1, 2019).

[328] Yaniv Amir et al., *Universal Computing by DNA Origami Robots in a Living Animal*, 9 NATURE NANOTECH. 353, 353 (2014) (demonstrating that "DNA origami can be used to fabricate nanoscale robots that are capable of dynamically interacting with each other in a living animal"). The authors "successfully used the DNA origami robots in living cockroaches . . . to control a molecule that targets their cells." *Id*.

[329] Alan S. Brown, *Ever Smaller-Scale Tools Seek to Unravel that Complex Mystery in Our Heads*, AM. SOC'Y OF MECHANICAL ENGINEERS: NANOTECHOLOGY FOR THE BRAIN (Feb. 10, 2014), https://www.asme.org/wwwasmeorg/media/resourcefiles/engineeringtopics/bioengineering/0214mindreaders.pdf. "Flexible electronics make it possible to create neural sensors that bend with the curve of the brain. A flexible sensor (below right) monitors a cat's brain waves during an epileptic seizure." *Id*.

brain performance tools are in development,[330] such as cell surgery with nanoblades[331] and brain healing[332]—including after strokes.[333]

Over a decade ago, researchers developed methods to improve brain neuron performance with carbon nanotubes.[334] Nanotherapy for neuron regeneration[335] or shortening neurons[336] is reported about in top science journals. Even treatment of mental illness may be enhanced with "nanopsychiatry."[337] There is hope that nanorobots may help cure Alzheimer's disease.[338] Nanoparticles will hopefully improve or give humans infrared vision, as they have done with mice.[339]There is a plethora of scientific developments in nanotechnology and medicine and a

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[330] Ruxandra Vidu et al., *Nanostructures: A Platform for Brain Repair and Augmentation*, 8 FRONTIERS SYS. NEUROSCI. 1, 1 (2014) (". . . [N]anostructures at the interface between nanotechnology and neuroscience will play a pivotal role not only in addressing the multitude of brain disorders but also to repair or augment brain functions.").

[331] Ting-Hsiang Wu et al., *Mitochondrial Transfer by Photothermal Nanoblade Restores Metabolite Profile in Mammalian Cells*, 23 CELL METABOLISM 921, 921 (2016) (". . . [W]e report a new method for transferring isolated mitochondria into somatic mammalian cells using a photothermal nanoblade, which bypasses endocytosis and cell fusion.").

[332] Yeşim Aktaş et al., *Development and Brain Delivery of Chitosan–PEG Nanoparticles Functionalized with the Monoclonal Antibody OX26,* 16 BIOCONJUGATE CHEMISTRY 1503, 1503 (2005) ("These findings . . . indicate that this novel targeted nanoparticulate drug delivery system was able to translocate into the brain tissue after iv administration. Consequently, these novel nanoparticles are promising carriers for the transport of the anticaspase peptide Z-DEVD-FMK into the brain.").

[333] Kevin Bullis, *Rewriting Life, Brain-Healing Nanotechnology: A Ground-Breaking Treatment Could Restore Lost Abilities to Stroke Victims and Others,* MIT TECH. REV. (Mar. 14, 2006), https://www.technologyreview.com/s/405552/brain-healing-nanotechnology/.

Although victims of stroke and traumatic brain and spinal cord injuries sometimes recover through rehabilitation, they often have permanent disabilities, in part, because scar tissue and regulatory chemicals in the brain slow nerve growth, preventing nerve tissue from repairing itself. Now a treatment that has restored lost vision in lab animals appears to overcome these obstacles, allowing a mass of nerve cells to regrow after being cut. *Id*.

[334] Giada Cellot et al., *Nanotechnology: Carbon Nanotubes Might Improve Neuronal Performance by Favouring Electrical Shortcuts,* 4 NATURE NANOTECH. 126, 126 (2009).

Carbon nanotubes have been applied in several areas of nerve tissue engineering to probe and augment cell behaviour, to label and track subcellular components, and to study the growth and organization of neural networks. Recent reports show that nanotubes can sustain and promote neuronal electrical activity in networks of cultured cells, but the ways in which they affect cellular function are still poorly understood. Here, we show, using single-cell electrophysiology techniques, electron microscopy analysis and theoretical modelling, that nanotubes improve the responsiveness of neurons by forming tight contacts with the cell membranes that might favour electrical shortcuts between the proximal and distal compartments of the neuron. . . . These considerations offer a perspective that would allow us to predict or engineer interactions between neurons and carbon nanotubes. *Id*.

[335] *See* Timothy O. Austin et al., *Scientific Reports: Nanoparticle Delivery of Fidgetin siRNA as a Microtubule-based Therapy to Augment Nerve Regeneration*, 7 NATURE 9675, 9675 (2017) (discussing an improvement in an approach with nanoparticles that assists in nerve regeneration including nerve damage from spinal cord injuries).

[336] Gabriel A. Silva, *Nanotechnology: Shorting Neurons with Nanotubes*, 4 NATURE NANOTECH. 82, 82 (2009) ("New insights are emerging about the interactions between brain cells and carbon nanotubes, which could eventually lead to the development of nanoengineered neural devices.").

[337] *See* G. Fond, A. Macgregor & S. Miot, *Nanopsychiatry—The Potential Role of Nanotechnologies in the Future of Psychiatry: A Systematic Review*, 23 EUR. NEUROPSYCHOPHARMACOLOGY 1067, 1067–71 (2013) (discussing "areas where nanotechnology is applied and how they could be extended to care for psychiatric illnesses").

[338] ROBERT A. FREITAS JR., THE ALZHEIMER PROTOCOLS: A NANOROBOTIC CURE FOR ALZHEIMER'S DISEASE AND RELATED NEURODEGENERATIVE CONDITIONS 433 (Inst. for Molecular Manufacturing, 2016), *available at* http://www.imm.org/Reports/rep048.pdf.

[339] *See* Yuqian Ma et al., *Mammalian Near-Infrared Image Vision through Injectable and Self-Powered Retinal Nanoantennae*, 177 CELL 243, 243 (2019) ("This new method will provide unmatched opportunities for a wide variety of emerging bio-integrated nanodevice designs and applications.").

corresponding multitude of scientific journals devoted solely to nanotechnology.[340]

The academic and professional structure of teaching nanotechnology within engineering or the physical disciplines is a given, but it has grown to new dimensions in medicine and law. In 2007, Arizona State University law school offered the first regularly scheduled class in nanotechnology.[341] The first medical text on nanomedicine was published almost twenty years ago by one of the top biology text publishers.[342] The author, Robert Freitas, won the 2009 Feynman Prize in Nanotechnology for Theory.[343] In 2003, new texts on nanomedicine continued in "Biocompatibility"[344]; texts on "Systems and Operations"[345] and "Applications"[346] are expected.[347]

C. THINKING OF NANOTECHNOLOGY IN A NEW WAY

1. Struggle for definition and consensus within the scientific community

The word "nanotechnology" and its conception may obscure legal understanding. Since the definition of nanotechnology is broad enough to include humans, other life, and other processes, one can see how the law already regulates at the nanoscale.[348] Although one day nanotechnology may build a potato from water, air, and dirt,[349] today nanotechnology is implemented in plants by "augmenting them with nanomaterials that could enhance their energy production and give them completely new functions, such as monitoring environmental pollutants."[350] The law already regulates

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[340] *See, e.g.*, NANOMED.: NANOTECH., BIOLOGY & MED., https://www.journals.elsevier.com/nanomedicine-nanotechnology-biology-and-medicine (last visited Sept. 1, 2019) ("*Nanomedicine: NBM* is an international, peer-reviewed journal presenting novel, significant, and interdisciplinary theoretical and experimental results related to nanoscience and nanotechnology in the life sciences.").

[341] Gary E. Marchant et al., *Governing Emerging Technologies: The First 30 Years and the Next,* 56 JURIMETRICS J. 113, 113–14 (2015) (discussing *inter alia* "the nation's first regularly offered law school course on nanotechnology in 2007").

[342] *See generally* ROBERT A. FREITAS, JR., NANOMEDICINE, VOL. IIA: BIOCOMPATIBILITY *Preface & Acknowledgements (2003) ("[T]he safety, effectiveness, and utility of medical nanorobotic devices will critically depend upon their biocompatibility with human organs, tissues, cells, and biochemical systems. Classical biocompatibility … We also discuss the effects on the nanorobot of being placed inside the human body."), http://www.nanomedicine.com/NMIIA.htm.

[343] *See 2009 Foresight Institute Feynman Prize*, FORESIGHT INSTITUTE, https://foresight.org/about/2009Feynman.php#2009Winners (last visited Sept. 1, 2019) .

[344] *See generally* ROBERT A. FREITAS, JR., NANOMEDICINE, VOL. I: BASIC CAPABILITIES (1999).

[345] *See* David Grossman, *Chinese Government Officially Charges CRISPR Baby Scientist*, POPULAR MECHANICS (Jan. 22, 2019), https://www.popularmechanics.com/science/health/a25991256/chinese-government-officially-charges-crispr-baby-scientist/. *See generally* ROBERT A. FREITAS, JR., NANOMEDICINE, VOL. IIB: SYSTEMS AND OPERATIONS (forthcoming).

[346] *See* Grossman, *supra* note 345. *See generally* ROBERT A. FREITAS, JR., NANOMEDICINE VOL. III: APPLICATIONS (forthcoming).

[347] *See Active Research Interests*, ROBERT A. FREITAS, JR., https://www.rfreitas.com/ (last visited Sept. 1, 2019).

[348] Robert Freitas substantially contributed to this proposition in personal discussions since 1998 and first came up with the term "Replicator Law," which was also a title of this author's unpublished manuscript submitted as a comment to the University of Missouri-Kansas City Law Review. The manuscript proposes that when thinking about how to regulate nanotechnology, for guidance, one can look to other replicators to see how they are regulated.

[349] *See* Ralph Merkle, *Nanotechnology*, ZYVEX, https://www.zyvex.com/nano/ (last visited Sept. 1, 2019) ("If we rearrange the atoms in dirt, water and air we can make potatoes.").

[350] Juan Pablo Giraldo et al., *Plant Nanobionics Approach to Augment Photosynthesis and Biochemical Sensing*, 13 NATURE MATERIALS 400, 400 (2014).

agriculture commodities,[351] such as honey bees[352] and farm animals.[353] Additionally, for hundreds and thousands of years,[354] man has regulated[355] and altered agricultural commodities,[356] resulting in increased exploitation and technological advances simultaneously.[357]

Nanotechnology and how it is achieved are broad. As Professor Smalley stated, indirect chemistry can be nanotechnology.[358] Smalley won the Nobel Prize for building buckeye tubes—only five nanometers across—not by positioning the atoms one by one with an atomic sized tool but rather indirectly through chemistry.[359] Further, "[n]anotechnology and nanoscience have different meanings to different people."[360] Although some industries appear more inclined to be affected by nanotechnology, such as aerospace, health, energy, transportation, biotech, and communication, "all industrial centers depend on materials and devices made of atoms and molecules, by default they can all be improved by the application of nanomaterials and nanotechnology."[361] "Nanotechnology is, therefore, a horizontal and enabling technology that will impact ALL industries."[362] Additionally, nanotechnology is a converging discipline, converging previously independent disciplines, such as the integration of DNA into silicon, for example.[363]

The interface between plant organelles and non-biological nanostructures has the potential to impart organelles with new and enhanced functions. . . . [A] plant can be augmented to function as a photonic chemical sensor. Nanobionics engineering of plant function may contribute to the development of biomimetic materials for light-harvesting and biochemical detection with regenerative properties and enhanced efficiency. *Id*.

[351] *See generally* 7 U.S.C. chs. 1–115 (1936).

[352] 7 U.S.C. §§ 281 *et seq*.

[353] 7 U.S.C. §§ 391 *et seq*.

[354] *See generally* 7 U.S.C. §§ 391 *et seq*., SIMON LYSTER, INTERNATIONAL WILDLIFE LAW: AN ANALYSIS OF INTERNATIONAL TREATIES CONCERNED WITH THE CONSERVATION OF WILDLIFE (1985).

[355] Forestry conservation laws date as far back to 1900 B.C. in Babylon. LYSTER, *supra* note 354, at xxi. King Akhenaten of Egypt set aside nature reserves in 1370 B.C. Emperor Ashoka of India in the third century B.C. states:

Twenty-six years after my coronation, I declared that the following animals were not to be killed: parrots, mynas, the aruna, ruddy geese, wild geese, the nandimukha, cranes, bats, queen ants, terrapins, boneless fish, rhinoceroses . . . and all quadrupeds which are not useful or edible. . . . Forests must not be burned. *Id*.

For a thorough history of animal regulation in general and terms in animal regulation, see Steven M. Wise, *The Legal Thinghood of Nonhuman Animals*, 23 B.C. ENVTL. AFFS. L. REV. 471, 471–72 (1996), noting that animal regulation dates back to biblical times.

[356] *See, e.g*., ADRIAN SLATER, NIGEL W. SCOTT, & MARK R. FOWLER, PLANT BIOTECHNOLOGY: THE GENETIC MANIPULATION OF PLANT 105–31, 133–53, 156–82, 184–208. 316–40 (2nd ed. 2008) (discussing genetic manipulation of plants in terms of pest resistance, disease resistance, herbicide tolearance as well as societal resistance to genetific modified food), INST. MED. & NAT'L RES. COUNCIL, SAFETY OF GENETICALLY ENGINEERED FOODS: APPROACHES TO ASSESSING UNINTENDED HEALTH EFFECTS 23 (2004), *available at* https://www.ncbi.nlm.nih.gov/books/NBK215773/pdf/Bookshelf_NBK215773.pdf ("Modification to produce desired traits in plants, animals, and microbes used for food began about 10,000 years ago. These changes, along with natural evolutionary changes, have resulted in common food species that are now genetically different from their ancestors.")

[357] Advances in technology have led to increased animal exploitation. *See* F.V. GARCÍA AMADOR, THE EXPLOITATION AND CONSERVATION OF THE RESOURCES OF THE SEA i (1963).

[358] *See generally* Smalley, University of Dallas, *supra* note 1.

[359] *See generally id*.

[360] GABOR L. HORNYAK ET AL., INTRODUCTION TO NANOSCIENCE 10 (1st ed., CRC Press, 2008).

[361] *Id*. at 11.

[362] *Id*. at 12.

[363] *Id*.

Thus, nanotechnology may use the same methods as other fields. One can also see that the law regulating agriculture is not very different, and humans have been altering the DNA of agriculture[364] and agricultural commodities for thousands of years through a variety of indirect methods. Thus, the analogy to agriculture and animal law to human law—such as immigration law—becomes less radical. Humans have also long been regulated as animals and now are having new types of nanotechnology applied to their genetic and physical make-up. The change is only that they are growing more technologically sophisticated and increasing their scientific understanding of the nanoscale.

2. Artificial Self-Replication and Reproduction

Analogies between humans, life, reproduction, and replication, as compared to non-biological entities and processes, may seem far removed, but once explained in the context of present scientific technological breakthroughs, the analogies converge. The best epitome of this convergence and support for this conclusion is found in the book *Kinematic Self-Replicating Machines*.[365] This text by Robert Freitas and Ralph Merkle [366] surveys and analyzes innumerous kinematic self-replicating machines and simplifies understanding of the replicative mechanism to illustrate their conclusions.[367] The text is not only a preview of self-replicating machines, but can fall within the law regulating such machine replication. Freitas and Merkle deride the idea that artificial replicators cannot be made.[368]

IV. LAW AND CULTURE AT THE NANOSCALE

A. LAW AND CULTURE

Nanotechnology will bring dramatic change—but will it necessarily require a corresponding dramatic change in law? What if the law already regulates on the nanoscale? Generally, law can affect evolution, which occurs at the nanoscale. Culture has proven to be a stronger means of change

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[364] *See supra* note 356 and accompanying text.

[365] *See generally* FREITAS & MERKLE, *supra* note 92.

[366] Robert Freitas and Ralph Merkle, two of the world's best nanoscientists and researchers, published one of the most extensive surveys and analyses of self-replicating entities. *See id*. at Preface & Acknowledgements. The goal of the book is to help pave the way in understanding the analysis of self-replicators to nanotechnological or molecular scale self-replicating entities while principally surveying micro or macroscale replicators. *See generally id*. Generally, they discuss the concept of self-replicating machines. *See generally id*. It states at its outset that initially man did not create tools that appeared lifelike, but in the 1600s and 1700s began creating instruments that appeared at least to be enhancement of human organs and even robots. *Id*. at Chapter 1, *The Concept of Self-Replicating Machines*. They give the example of "Vaucanson's duck" which was "constructed and first exhibited in 1739 by Jacques de Vaucanson (1709–1782)" and "had over one thousand moving parts and was able to appear to eat, drink, defecate, quack, waddle, and flap its wings convincingly." *Id*. (citations omitted).

[367] Their discussion begins including classical machine replication theory such as Von Neuman's contributions. *See id*. at §§ 2.1, 2.1.2, 2.1.3, 2.2, 2.3.7, 3.3, 3.11, 3.19. Discussion is also included in Microscale and Molecular Kinematic Machine Replicators such as Self-Assembling Peptides, Porphyrins, Nucleotides and DNA. *See id*. at §§ 4.1.1, 4.2, 4.3, 4.5, 4.6–4.20, 5–6.

[368] Freitas and Merkle first suggest that many entities, such as computers, self-replicate, which is made possible by humans building them. *See id*. at §§ 2.2, 2.2.1. They discuss in detail how replication takes place and that a self-replicating entity need not be aware of itself to replicate and reproduce. *Id*. at Chapter 1, *The Concept of Self-Replicating Machines* They analogize DNA and human cellular structures as actually automatons which follow simple rules of construction to replicate. *See id*.

in human evolution than genes,[369] a concept supported by premier research in international journals such as *Nature*.[370] Research on evolution also shows that language can be a better indicator of genetic diversity than geography.[371] Legal scholars note that "[m]any of the important early anthropological insights about law built on a concept of culture as integrated, stable, consensual, bounded, and distinctive" and that "[c]ulture was defined as the common values, institutions, and regular social interactions shared by a group of people."[372] Additionally, scholars have pointed out that "[a]nthropological research from the 1920s to the 1950s demonstrated that law was a fundamental part of the normative system of any society and served to maintain its social order."[373] Most important, human migration and demography and linguistic variation have directly affected human evolution and genetic diversity.[374] Culture is also transmitted by learning through the brain, and cognitive science can be utilized for understanding.[375]

B. IMMIGRATION NANOLAW

Technically, refugee law is a large subset of immigration law. Broadly, the Immigration and Nationality Act ("INA") is the source of most U.S. immigration law.[376] The first part of the INA, Section 201, relates to general immigrant quotas,[377] setting caps on certain categories.[378] This includes

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[369] Adrian V. Bell et al., *Culture Rather Than Genes Provides Greater Scope for the Evolution of Large-Scale Human Prosociality*, 106 PNAS PROC. NAT'L ACAD. SCIS. 17671, 17673 (2009). *See* Nicole Creanza & Marcus W. Feldman, *Worldwide Genetic and Cultural Change in Human Evolution*, 41 CURRENT OPINION GENETICS & DEV. 85, 88 (2016) ("Researchers can better understand evolutionary patterns and human demographic history when both genes and culture are considered.").

[370] Kevin N. Laland et al., *How Culture Shaped the Human Genome: Bringing Genetics and the Human Sciences Together,* 11 NATURE REVS. GENETICS 137, 137–48 (2010). A multitude of researchers agree that human evolution has been shaped by gene–culture interactions. *Id*. For example, theoretical biologists use models to demonstrate that cultural processes can affect human evolution; anthropologists are investigating cultural practices that modify current selection, and geneticists are uncovering alleles subject to recent selection due to human activity. *Id*. Theoretical population genetics models are used to explore the ways genes and culture interact over time, including how and why culture may affect evolutionary rates. *Id*. Humans are the ultimate niche-constructing species. *Id*.

[371]" . . . [L]anguage seems to be a better predictor of genetic differences than geography, so genetic distance shows a stronger association with linguistic than geographic distance." Creanza & Feldman, *supra* note 369, at 88.

[372] Sally Engle Merry, *Law, Culture, and Cultural Appropriation*, 10 YALE J. L. & HUM. 575, 576 (1998).

[373] *Id*. *See* JOSEPH HENRICH, THE SECRET OF OUR SUCCESS: HOW CULTURE IS DRIVING HUMAN EVOLUTION, DOMESTICATING OUR SPECIES, AND MAKING US SMARTER 3–6 (2015) (discussing how culture affects human evolution), PETER J. RICHERSON & ROBERT BOYD, NOT BY GENES ALONE: HOW CULTURE TRANSFORMED HUMAN EVOLUTION 1–16 (2008).

[374] Nicole Creanza et al., *A Comparison of Worldwide Phonemic and Genetic Variation in Human Populations*, 112 PNAS PNAS PROC. NAT'L ACAD. SCIS. 1265, 1265 (2013) ("Linguistic data are often combined with genetic data to frame inferences about human population history."). The authors "analyze the largest available datasets of both phonemes and genotyped populations" and "test whether this demographic history has left similar signatures on phonemes—sound units that distinguish meaning between words in languages." *Id*.

[375] Oren Kolodny et al., *Integrative Studies of Cultural Evolution: Crossing Disciplinary Boundaries to Produce New Insights,* 373 PHIL. TRANSACTIONS ROYAL SOC'Y. B: BIOLOGICAL SCIS. 1, 4 (2018) ("Cultural evolution depends on the transmission of ideas, and to understand cultural transmission, we need to also understand the processes of learning that are centered in the brain.") " . . . [C]ultural evolution can benefit from inclusion of insights from cognitive science . . . ." *Id*.

[376] *See generally* Immigration and Nationality Act, 8 U.S.C. §§ 1101–1537 (1952). See 8 C.F.R. §§ 1.1–499.1 (2011) for additional governing immigration laws and provisions.

[377] Immigration and Nationality Act § 1151.

[378] *Id*.

employment and family-based immigration[379] as well as specific classes within each.[380] The diversity lottery program also has numerical limitations.[381] There is a noted absence of limitation in certain categories, such as individuals who receive legal relief for living in the U.S. for a long amount of time deemed to have good moral character[382] or special immigrants,[383] such as abused spouses[384] or juveniles.[385] It states that there is no numerical limitation for immediate family relatives,[386] and describes who qualifies as an immediate relative.[387]

Section 202 of the INA states "no person shall receive any preference or priority or be discriminated against in the issuance of an immigrant visa because of the person's race, sex, nationality, place of birth, or place of residence."[388] The INA proceeds to describe the technical rules of per country numerical limitations within the employment[389] and family categories.[390] Thus, the INA's two opening provisions delve directly into the nanoscale realm.

Most often, family immigration is based on a genetic familial relationship, with exceptions for adoption and marriage—non-biological but legal relationships. Employment, as discussed above, is also deemed nanotechnological because those with employment skills have skills measurable at the nanoscale.

Most important, the outset of the INA states that it does not discriminate based on the genetic criteria of sex and race.[391] Although nationality and place of birth do not appear generally as nanoscale qualifiers, nationality is typically defined by nanoscale components to include genes, or at least minimally by language and culture[392] (which are certainly nanoscale attributes). Ethnicity is defined by language, culture, and often genetic

[379] *Id*. at § 1151(a); *see* 8 C.F.R. §§ 204.1, 204.4 (detailing immigration petitions respectively for family-sponsored and employment-based immigrants).
[380] Immigration and Nationality Act § 1153.
[381] *Id*. at § 1151.
[382] *Id*.
[383] *Id*.
[384] *See id*.
[385] *Id*.
[386] *Id*.
[387] *Id*.
[388] *Id*. at § 1152(a)(1)(A).
[389] *Id*. at § 1151.
[390] *Id*. at § 1152.
[391] *Id*.
[392] Nationality is defined as "[a] group of people of the same race, religion, traditions," etc. *Nationality*, CAMBRIDGE DICTIONARY (Cambridge Univ. Press 2019). In regard to legal definitions by refugees, a top legal scholar, Professor Guy Goodwin-Gill, finds the term "national" to be odd; "[t]he reference to persecution by reasons of *nationality* is somewhat odd, given the absurdity of a state persecuting its own nationals on account of their membership in the body politic." GUY S. GOODWIN-GILL & JANE MCADAM, THE REFUGEE IN INTERNATIONAL LAW 72 (Oxford Univ. Press 2007). "[N]ationality in article 1A(2) of the 1951 Convention is usually interpreted more loosely, to include origins and the membership of a particular ethnic, religious, cultural and linguistic communities." *Id*. at 73.

relationships,[393] while race is better-known as a social construct.[394] Similarly, while place of birth appears to be entirely geographic or circumstantial, place of birth will almost always coincide with a particular language, culture, and common alleles or genes with others born in the area or who share the same migration pattern.[395] Again, these are all nanoscale components regardless of the mix of language, memes shared, memories shared, or genetic relationships.

Section 203 goes further to describe the degree of family relationships[396] and employment categories[397] that are attached to limited visa quantities.[398] For example, brothers and sisters of U.S. citizens are allocated a certain number of visas per year, but parents[399] and children under twenty-one have no limitation.[400] Again, spouses and adoptees[401] are not considered genetic relationships, but they are exceptions, and are based on relationships akin to genetic. Section 203 also discusses visa allocation between the employment categories[402] such as those who hold advanced degrees,[403] those who do work in the national interest,[404] aliens with extraordinary ability,[405] skilled workers,[406] and unskilled workers.[407] While one cannot state that any worker has more or less skill or brain development, certainly there are different types of skill, experience, memory, and personality characteristics—all of which are nanoscale qualities. In sum, the INA law sets out who it wants to immigrate and how many people it wants to immigrate by incorporating: specific family relationships; corresponding employment skill sets; and asylees, refugees, and other migrants.

Section 207 discusses the annual numerical limitation of refugees,[408] including which family members can be brought with them,[409] which at the minimum outlines nanoscale considerations. Additionally, section 217

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[393] "Ethnicity" can be defined as, "a large group of people who have the same national, racial, or cultural origins, or the state of belonging to such a group." *Ethnicity*, CAMBRIDGE DICTIONARY (Cambridge Univ. Press 2019). Ethnicity can be difficult to define. It can be defined by language, culture, racial, common myth, political orientation and even geographic correlation, but attempts to universally define it can be problematic. THOMAS HYLLAND ERIKSEN, ETHNICITY AND NATIONALISM: ANTHROPOLOGICAL PERSPECTIVES 1–13 (2002). In regard to legal definitions, in the refugee context, ethnicity is increasingly being considered by tribunals to be a social construct, similar to race. *See* GOODWIN-GILL &MCADAM, *supra* note 392, at 70. However, within the scope of this article it is not important to have a complete non-controversial definition, only that most definitions will include primarily nanoscale components.

[394] "Race" is also a social construct that is often similar to nationality and ethnicity. It may be delineated by genetic relations, but linguistic and collective identities are not defined by social facts, but rather by "contingent perceptions." *See* GOODWIN-GILL &MCADAM, *supra* note 392, at 70.

[395] *See* RAJ S. BHOPAL, MIGRATION, ETHNICITY, RACE, AND HEALTH IN MULTICULTURAL SOCIETIES 78–79 (2nd ed. 2014).

[396] Immigration and Nationality Act, 8 U.S.C. § 1153 (1952).

[397] *See id*.

[398] *See id*.

[399] *Id*. at § 1151.

[400] *Id*. Adoptees can meet the definition of "child." *Id*. at § 1101(b)(1)(E).

[401] *Id*. at § 1151.

[402] *Id*. at § 1153.

[403] *Id*.

[404] *Id*.

[405] *Id*.

[406] *Id*.

[407] *Id*.

[408] *Id*. at § 1157.

[409] *Id*.

discusses the visa waiver program,[410] a reciprocal program exempting certain countries from the visitor visa requirements.

Nationality determinations can be measured on the nanoscale because they will also necessarily involve language and cultural nanoscale characteristics.[411] There are other sections of the INA not directly discussed in this article, but many are procedural in nature, such as the process or infrastructure of issuing visas.[412] Correspondingly, the processes and structure are secondary or incidental to the main process.

The INA also specifically identifies who will not be admitted into the U.S., and who will be subject to deportation. These identifications are also generally reflective of nanoscale properties. Section 212 outlines who is inadmissible and sections 237 and 238 outline who may be removed or deported.[413] For those seeking admission to the U.S., there are health- ,[414] criminal-, [415] and security-related grounds to refuse admission.[416] There are also more serious nonwaivable grounds to refuse admission, such as: individuals involved in espionage, sabotage, illegal exportation of technology or sensitive information; weak unlawful overthrow or opposition to the U.S. government;[417] and engagement in terrorist activities.[418] Additionally, Nazi persecutors, those engaged in genocide,[419] or individuals who have an adverse foreign policy impact are also refused admission.[420] Every country uses a similar process to determine who it wishes to include and exclude in its immigration process.[421]

C. REFUGEE AND ASYLUM NANOLAW

1. Textual Analysis of Nanoscale Targeting

Refugee and asylum law, subclasses of immigration law, are almost entirely nanoscale. They present a basis for streamlined protection for an infinite array of persecutory treatment in other environs. The guiding definition of refugee as a reference in U.S. law is found in the INA:

> The term "refugee" means (A) any person who is outside any country of such person's nationality or, in the case of a person having no nationality, is outside any country in which such person last habitually resided, and who is unable or unwilling to return to, and is unable or unwilling to avail himself or herself of the protection of, that country because of persecution or a well-founded fear of persecution on

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[410] *Id*. at § 1187.
[411] *See supra* text accompanying note 392 (discussing definition of nationality).
[412] Immigration and Nationality Act §§ 1181, 1183, 1183a.
[413] Although "deported" is the common term of art, legally the INA only used "deportation" in older versions of the Act; "removed" is now the legal term. *See id*. at §§ 1182, 1227, 1228.
[414] *See id*. at § 1182(a)(1) (health-related grounds of admissibility).
[415] *See id*. at § 1182(a)(2) (criminal-related grounds of admissibility).
[416] *See id*. at § 1182(a)(3) (security-related grounds of admissibility).
[417] *See id*. at § 1182(a)(3)(A)(iii).
[418] *See id*. at § 1182(a)(3)(B).
[419] *See id*. at § 1182(a)(3)(E).
[420] *See id*. at § 1182(a)(3)(C).
[421] *See, e.g*., MARY CROCK, IMMIGRATION & REFUGEE LAW IN AUSTRALIA § 4.2, 4.4 (1998).

> account of race, religion, nationality, membership in a particular social group, or political opinion . . . .[422]

Consequently, refugee law provides protection pursuant to five categories: ethnicity, nationality, political opinion, religion, or particular social group. If one can demonstrate that he or she has been persecuted on one of these bases, or has a well-founded fear of future persecution under one of these protected grounds, then he or she may be entitled to refugee status or asylum.[423] This definition also excludes someone who has persecuted others along these same lines.[424]

Ethnicity and race can be genetic, but within a plethora of definitions it is at least primarily related to language and cultural identity.[425] Thus, it is at the minimum memetic,[426] or neurologically-based with memories, experiences, and beliefs.[427] Nationality can be tied to genes, but less often[428] and is less related to experiences, memories and beliefs.[429] Thus, it is also tied to the brain and to the body, like ethnicity, if there are learned skills or processes the individual has[430] as a particular national, or in a certain ethnic group. This includes language,[431] but could also include dancing, singing, playing music, storytelling, political beliefs, and cooking skills.[432] Definitions of nationality have similar applications and analogies. Nationality has also been associated more with a major linking to a certain range of political beliefs.

Religion and political opinion are at least similarly tied neurologically but may also have some genetic or skill levels attached if the religious or political beliefs are tied to nationality and ethnicity (which is often the case). "Particular social group"[433] can be a range of groups from tribes to gender,[434]

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[422] Immigration and Nationality Act § 1101(a)(42).

[423] Asylum law utilizes the same definition; the only difference is that asylum is the process within U.S. national boundaries whereas the refugee process is outside of country.

[424] "The term "refugee" does not include any person who ordered, incited, assisted, or otherwise participated in the persecution of any person on account of race, religion, nationality, membership in a particular social group, or political opinion." Immigration and Nationality Act § 1101(a)(42).

[425] *See supra* notes 393–97 and accompanying text (defining and discussing ethnicity and race).

[426] *See* DAWKINS, *supra* note 6, at 245–60 (discussing memes as new replicators in Chapter 11).

[427] *See* Han et al., *Neuronal Competition*, *supra* note 284, at 457 (discussing physical neurologically at the nanoscale), Josselyn, *supra* note 282, at 221, LaLumiere, *supra* note 281, at 236–37, Reijmers et al., *supra* note 283, at 1230.

[428] *See supra* text accompanying note 392 (discussing and defining nationality).

[429] *See supra* notes 279–87 and accompanying text (discussing memories and experiences).

[430] *See* Han et al., *Neuronal Competition*, *supra* note 284, at 457 (discussing skills as neurological and physical development), Josselyn, *supra* note 282, at 221, LaLumiere, *supra* note 281, at 236–37, Reijmers et al., *supra* note 283, at 1230.

[431] *See* DeYoung et al., *supra* note 290, at 820 (discussing language and its physical neurological development), Habibi et al., *supra* note 289, at 4336, Watson, *supra* note 288, at 530–32. *See generally* Lehr, *supra* note 272.

[432] *See* DAWKINS, *supra* note 6, at 245–60 (discussing memes as new replicators in Chapter 11), SEAN GERRISH, HOW SMART MACHINES THINK (1st ed. 2018), Han et al., *Neuronal Competition*, *supra* note 284, at 457 (discussing skills as neurological and physical development), Josselyn, *supra* note 282, at 221, LaLumiere, *supra* note 281, at 236–37, Reijmers et al., *supra* note 283, at 1230, PROMETHEUS, *supra* note 271.

[433] *See* Immigration and Nationality Act, 8 U.S.C. § 1101(a)(42) (1952).

[434] For full discussion on "particular social group," see T.S. Twibell, *The Particular Social Group Definition* in *The Development of Gender as a Basis for Asylum in the United States Immigration Law and Under the United Nations Refugee Convention: Case Studies of Female Asylum Seekers from Cameroon, Eritrea, Iraq and Somalia*, 24 GEO. IMMIGR. L.J. 189, 206–08 (2010).

which are nanoscale, or other groups that would be tied to beliefs[435] or a neurological factor. The list can be exhaustive within a particular social group category,[436] however, for this paper's thesis, it is sufficient that a large number of these groups constitute nanoscale qualities.

Thus, refugee and asylum law demarcate reciprocal legal protection for nanoscale qualities, religion, political beliefs, nationality, ethnicity, and particular social groups, which can be mistreated in a multitude of ways by other types of law, policies, and environs. The list is not theoretically exhaustive of who can be a "refugee" because there is some controversy surrounding the other qualities left out of this definition.[437] However, for purposes of this article, only the nanoscale aspects are relevant.[438]

2. Nanoscale Characteristic Position

In refugee and asylum analysis, as the law demarcates a particular qualitative analysis—such as political opinion or religion[439]—the persecutor must be aware of such nanoscale characteristics.[440] Beyond this legal definition and analytical framework, history and human rights reports reflect that humans discriminate and persecute along these grounds utilizing a variety of means—such as skin color, eye color, hair color, association with other humans with the same or distinguishing characteristics, and behavioral cues from simple to complex (ex. observation of what they write or say)[441]—which is of course more controversial. For example, the First Amendment's freedom of expression[442] exists to prevent this type of analysis of freedom.[443] Of course, physical attributes such as skin color or eye color are phenotypic traits and are not necessarily associated with certain genes.[444] However, genes ultimately provide a pivotal role in the expression of phenotype (most of these issues are social constructs regardless).[445]

Recently, legal documents like passports or birth certificates have been used to determine phenotypic, nanotech or genetic demarcations in terms of nationality, ethnicity or even religion. Rumors, reports of various types, and intelligence may also be utilized. Importantly, admission or claims for the target herself or himself may assist, such as voluntary or involuntary admission of the trait, although true suspicion may derive from one's nationality, ethnicity, social group, or another stereotype. Historically, laws may have been overt in how they targeted individuals, but today they may

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[435] *See* GOODWIN-GILL & MCADAM, *supra* note 392, at 73–85. *See generally* Twibell, *supra* note 434.

[436] *See* Twibell, *supra* note 434, at 199–201.

[437] *See id*. at 206–09.

[438] *See generally id*.

[439] *See* Immigration and Nationality Act, 8 U.S.C. § 1101(a)(42) (1952).

[440] *See Matter of Acosta,* 19 I&N Dec. 211 (BIA 1985) (referring a four-part analysis for refugee claims, but did not discuss "nanoscale"), *Matter of Mogharrabi,* 19 I&N Dec. 439 (BIA 1987).

[441] *See, e.g*., Trina Jones, *Intra-Group Preferencing: Proving Skin Color and Identity Performance Discrimination,* 34 N.Y.U. REV. L. & SOC. CHANGE 657, 657, 664–69 (2010).

[442] U.S. CONST., amend. I.

[443] *See generally* GERALD GUNTHER, CONSTITUTIONAL LAW 994 (1991) (Chapter 11, discussing freedom of expression).

[444] *See* THOMAS BAECK, D.B. FOGEL & Z. MICHALEWICZ, EVOLUTIONARY COMPUTATION 1: BASIC ALGORITHMS AND OPERATORS 23 (2018) (Chapter 4, discussing principles of the evolutionary process).

[445] *See, e.g*., Richard Dawkins, *Forward*, *in* GEORGE C. WILLIAMS, ADAPTATION AND NATURAL SELECTION: A CRITIQUE OF SOME CURRENT EVOLUTIONARY THOUGHT ix-xvi (2018).

be more obscure and target more benign or less controversial characteristics. Efficiency may also dictate otherwise, such as in the case of the industrial scale of Holocaust.

3. Nanoscale Characteristic Targeting

a. Self-Admission

Self-admission is an effective tool under the law. The analysis of the credibility and nuances of answers to basic questions can illustrate the presence of experiences and beliefs or predisposition to desired or targeted nanoscale traits. The application and entry processes under these general legal provisions also include this analysis and provide better illustration linking the legal provision to the nanoscale component.

Questions and instructions on immigration form the authority of regulations.[446] The most recent I-590 Application for Refugee Status asks applicants if they have ever "[k]nowingly committed any crime . . . for which you have not been arrested?"[447] It also asks about engagement in espionage or terrorism,[448] Including whether one's spouse or parent ever engaged in terrorist activity.[449] It asks if one has

> EVER been a member of, or in any way affiliated with, the Communist party or any other totalitarian party . . . [or] EVER ordered, incited, called for, committed, assisted, helped with, or otherwise participated in . . . [a]cts involving torture or genocide . . . , [k]illing any person . . . , [i]ntentionally and severely injuring any person . . . , engaging in any kind of sexual contact or relations with any person who was being forced or threatened . . . , [or] [l]imiting or denying any person's ability to exercise religious beliefs . . . .[450]

The refugee application also asks if one has ever been a member of a military, paramilitary or related unit, worked in a prison camp or labor camp, or been part of any group or organization that has used any threat or weapons against others.[451]

The I-589 Application for Asylum Status is very similar.[452] It ask questions related to admissibility and other forms of relief and is broader for family members.[453] It asks applicants, "Have you or your family members ever been accused, charged, arrested, detained, interrogated, convicted and sentenced, or imprisoned in any country other than the United States?"[454] It

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[446] *See* 8 C.F.R. § 103.2(a)(1) (2011).

[447] USCIS Form I-590, *Registration for Classification as Refugee* (OMB No. 1615-0068, exp. 12/31/2019), at 10 (question 1), https://www.uscis.gov/sites/default/files/files/form/i-590.pdf.

[448] *See id*. at 10–11 (question 5.A–D).

[449] *See id*. at 11 (questions 6–7).

[450] *Id*. (questions 9–10).

[451] *See id*. (question 11.A–C),.

[452] *See generally* USCIS Form I-589, *Application for Asylum and for Withholding of Removal* (OMB No. 1615-0067, exp. 05/31/2019), https://www.uscis.gov/sites/default/files/files/form/i-589.pdf.

[453] *See generally id*., USCIS Form I-590, *supra* note 447. The I-590 requires separate applications for each family member; they are asked these questions independently whereas the asylum applicant files and application and dependents are included.

[454] USCIS Form I-589, *supra* note 452, at 6 (question 2).

asks about the applicant's organizational memberships[455] and history of discriminatory practices.[456]

Form I-485, the Application for Permanent Residence,[457] encompasses most applications for permanent residence for those residing in the U.S. from family, employment, diversity, and investment, as well as refugees, asylees, and a multitude of others, and has similar questions.[458] The form asks about criminal history,[459] in particular: controlled substance violations, drug trafficking offenses, engagement in prostitution, gambling, human trafficking, and money laundering convictions.[460]

The form also asks about national security and any history or future intentions of espionage.[461] For criminal issues, it asks the applicant numerous questions about participation in criminal activities, terrorist groups, or militaries, and any received combat training.[462]

Although it is a Department of State ("DOS") form, the immigrant visa application, the equivalent application for those applicants who seek to enter the U.S. as an immigrant, or permanent resident, has very similar questions.[463] The DOS non-immigrant visa application,[464] which is for those entering the U.S. in the full range of temporary classifications,[465] uses similar questions as well.[466] The I-539 Change of Status form,for those who are physically present in the U.S.[467] and wish to obtain or extend a temporary or non-immigrant classification,[468] also contains these types of questions. This sort of analysis is also present in citizenship applications, as seen on the N-400 application for citizenship.[469]

Thus, all major immigration forms ask key eligibility questions about a person's memories, experiences, proclivities, intentions, and associations. These questions are often political, but nonetheless target nanoscale

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[455] *Id*. (questions 3A, 3B).

[456] *See id*. at 7 (question 3).

[457] *See generally* USCIS Form I-485, *Application to Register Permanent Residence or Adjust Status* (OMB No. 1615-0023, exp. 06/30/2019), https://www.uscis.gov/system/files_force/files/form/i-485.pdf.

[458] *See* Immigration and Nationality Act, 8 U.S.C. §1154 (1952), 8 C.F.R. §§ 204.1–204.13 (2011), *Green Card Eligibility Categories*, USCIS, https://www.uscis.gov/greencard/eligibility-categories (last updated June 20, 2018).

[459] *See* USCIS Form I-485, *supra* note 457, at 10–14 (questions in Part 8).

[460] *See id*. at 11 (questions 31–45).

[461] *See id*. (question 46.a–d).

[462] *See id*. at 12–13 (questions 48–69).

[463] U.S. Department of State Form DS-230, *Application for Immigrant Visa and Alien Registration* (OMB No. 1405-0015, exp. 07/31/2018), at 3–4 (questions 40–41), https://eforms.state.gov/Forms/ds230.pdf. For an exemplar of the online immigration visa form, see U.S. Department of State Form DS-260, *Immigrant Visa and Alien Registration Application*, https://travel.state.gov/content/dam/visas/DS-260_Exemplar.pdf.

[464] *See* DOS Form DS-160, *Electronic Nonimmigrant Visa Application*, at Parts 1–5 (Security and Background questions), https://travel.state.gov/content/travel/en/us-visas/visa-information-resources/forms/ds-160-online-nonimmigrant-visa-application.html, https://travel.state.gov/content/dam/visas/PDF-other/DS-160_Example.pdf.

[465] *See* Immigration and Nationality Act, 8 U.S.C. § 1184 (1952), 8 C.F.R. §§ 214 *et seq*. (2011).

[466] *See* USCIS Form I-485, *supra* note 457, at 12 (question 56).

[467] *See* USCIS Form I-539, *Application to Extend/Change Nonimmigrant* Status (OMB No. 1615-0003, exp. 04/30/2018), https://www.uscis.gov/sites/default/files/files/form/i-539.pdf.

[468] *See* Immigration and Nationality Act § 1184, 8 C.F.R. §§ 214 *et seq*.

[469] *See* USCIS Form N-400, *Application for Naturalization* (OMB No. 1615-0052, exp. 03/31/2019), https://www.uscis.gov/system/files_force/files/form/n-400.pdf.

qualities. Thus, on a larger scale, political and legal decisions are made utilizing nanoscale qualities.

b. Presumed Possession

In the U.S. and other countries, targeting continues to exist via certain presumptions. For example, in the U.S. a suspicion of potential revolt, terrorism, or security concerns have been used to target African Americans[470] and Native Americans.[471] During World War I and World War II, within the United States, Germans, Italians, and Japanese were targeted.[472] Today, many western countries target Arabs, Muslims, Persians, and others from the Middle East.[473] Countries in the Middle East are also guilty of targeting foreigners.[474] Historically, all countries have linked nationality to a particular set of belief systems or potential contra-government attitude.

This framework was what entrapped Benjamin, and other German Jews, in France, simply for being Jewish. As an example, in the former Soviet Union and today in the Ukraine, those who are Protestant or Baptist, may be accused of being pro-U.S. or anti-Russian. Alternatively, in the U.S. and other western countries,[475] Orthodox Christians tend to be associated with Russia or accused of being anti-West.[476]

Similarly, Muslims and mosques can be negatively associated with terrorism.[477] Jews and synagogues may be legally targeted in western countries, such as in Belgium,[478] Denmark,[479] Iceland, Norway, Sweden,[480]

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[470] *See* MARY FRANCES BERRY, BLACK RESISTANCE/WHITE LAW: A HISTORY OF CONSTITUTIONAL RACISM IN AMERICA 1–13 (1995).

[471] *See generally* T.S. Twibell, *Rethinking* Johnson v. M'Intosh *(1823): The Root of the Continued Forced Displacement of American Indians Despite* Cobell v. Norton *(2001)*, 23 GEO. IMMIGR. L.J. 129 (2008) (discussing *inter alia* the use of stereotypes to obtain land or financial benefit).

[472] *See* Twibell, *supra* note 434, at 411–12.

[473] *See generally id*.

[474] *See, e.g.*, *infra* Part IV Section C(3)(c)(ii), "Internationally—Other States" (including specifically Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates).

[475] *See generally* DOMINIQUE AREL & BLAIR A. RUBLE, REBOUNDING IDENTITIES: THE POLITICS OF IDENTITY IN RUSSIA AND UKRAINE (2006), Catherine Wanner, *Missionaries of Faith and Culture: Evangelical Encounters in Ukraine*, 63 SLAVIC REV. 732 (2004), and Cory Flintoff, *Ukrainian Protestants Say Religious Intolerance Rising In Donetsk,* NATIONAL PUBLIC RADIO (NPR) (Mar. 29, 2015), https://www.npr.org/2015/03/29/396128363/ukrainian-protestants-say-religious-intolerance-rising-in-donetsk.

[476] *See generally* Jeremy W. Lamoreaux & Lincoln Flake, Comment, *The Russian Orthodox Church, the Kremlin, and Religious (il)Liberalism in Russia*, 4 NATURE: PALGRAVE COMMS. 1, (2018).

[477] *See generally* Nicholas Adams, *Architecture as the Target*, 52 J. SOC'Y ARCHITECTURAL HISTORIANS 389 (1990).

[478] Samuel Osborne, *Belgium Votes to Ban Kosher and Halal Slaughter in Its Biggest Territory*, THE INDEPENDENT (May 8, 2017), https://www.independent.co.uk/news/world/europe/belgian-region-walloon-bans-kosher-halal-meat-islam-jewish-a7723451.html ("European Jewish Congress condemns decision as 'the greatest assault on Jewish religious rights in Belgium since the Nazi occupation of the country in World War II.'").

[479] Adam Withnall, *Denmark Bans Kosher and Halal Slaughter as Minister Says "Animal Rights Come Before Religion"*, THE INDEPENDENT (Feb. 18, 2014), https://www.independent.co.uk/news/world/europe/denmark-bans-halal-and-kosher-slaughter-as-minister-says-animal-rights-come-before-religion-9135580.html ("New law, denounced as 'anti-Semitism' by Jewish leaders, comes after country controversially slaughtered a giraffe in public and fed him to lions.").

[480] Katrina Lantos Swett, *The Disturbing Persistence of Antisemitism in Europe*, THE GUARDIAN (Mar. 31, 2013), https://www.theguardian.com/commentisfree/2013/mar/31/disturbing-persistence-antisemitism-europe ("A number of European governments and political parties have added fuel to the fire by backing restrictions on vital religious practices. At least four countries–Iceland, Norway, Sweden, and Switzerland–ban kosher slaughter.").

and Switzerland[481] where, for example,both Halal and Kosher foods are banned[482] and mosques[483] and synagogues are targeted or limited.[484] Additionally, in Saudi Arabia, ancient Jewish villages were recently razed and Jews forcefully expelled.[485]

From a protection perspective, the annual refugee quota takes into account which regions the U.S. will take refugees from.[486] By doing so, it outlines the broader picture of who is being targeted under the refugee law, which as illustrated above, entirely focuses on nanoscale qualities and presumes quotas based on past and future targeting.

c. Explicit Targeting and Presumed Possession

i. The United States

Though the United States' refugee provisions currently adhere to the United Nations Refugee Convention, they did not prior to 1980 and, for practical purposes, did not until 1990.[487] Also, the U.S. refugee program was only directed toward "defectors" fleeing communist countries.[488] Thus, it was a political focus and excluded all other refugee protection, including those fleeing U.S. wars in South America, Vietnam, and Korea.[489] The remaining Lautenberg program[490] lightly sustains that decade-long pattern, although much of it was pragmatic, rational, and sought to return long promised protections, (such as Jews who were promised refuge in the U.S. or Israel when the Soviet Union fell). Although many were finally able to leave more freely to the U.S. or Israel, the doors to the U.S. appeared to close—and the promise of refuge had to be restored.[491] The road to this recent protection was historically long and difficult, and paved through deep

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[481] Ariel David, *Oldest Jewish Community in Switzerland Is Disappearing, but Not Without a Fight,* THE HAARETZ (Oct. 4, 2018), https://www.haaretz.com/world-news/europe/.premium-oldest-jewish-community-in-switzerland-is-disappearing-but-not-without-a-fight-1.6554118 ("For three centuries, the Jews of Switzerland were only allowed to live in two villages. This is their unique story of resistance and survival in the face of persecution.").

[482] *See generally* Pablo Lerner & Alfredo Mordechai Rabello, *The Prohibition of Ritual Slaughtering (Kosher Shechita and Halal) and Freedom of Religion of Minorities*, 22 J. L. & RELIGION 1 (2006–2007).

[483] Ian Traynor, *Swiss Vote to Ban Construction of Minarets on Mosques*, THE GUARDIAN (Nov. 29, 2009), https://www.theguardian.com/world/2009/nov/29/switzerland-bans-mosque-minarets ("The surprise result, banning minarets in a country that has only four mosques with minarets and no major problems with Islamist militancy, stunned the Swiss establishment . . . .").

[484] David, *supra* note 481.

[485] *See, e.g.*, *infra* Part IV Section C(3)(c)(ii), "Internationally—Other States" (specifically discussing Saudi Arabia).

[486] *See Admissions and Arrivals,* RPC: REFUGEE PROCESSING CENTER, http://www.wrapsnet.org/admissions-and-arrivals/.

[487] *See* IRA J. KURZBAN, IMMIGRATION LAW SOURCEBOOK 5 (16th ed., 2018) (discussing to Refugee Act of 1980), Gregg A. Beyer, *Establishing the United States Asylum Officer Corps: A First Report,* 4 INT'L J. REFUGEE L. 455, 455–60 (1992).

[488] " . . . [T]he Cold War colored the U.S. definition of "refugee." This definition stressed ideology and geography (i.e., "persons fleeing from communist or communist dominated countries, or countries in the Middle East") . . . ." Gregg A. Beyer, *Reforming Affirmative Asylum Processing in the United States: Challenges and Opportunities,* 9 AM. U. INT'L L. REV. 43, 58–59 (1994).

[489] *See, e.g.*, NOAM CHOMSKY & EDWARD S. HERMAN, THE WASHINGTON CONNECTION AND THIRD WORLD FASCISM: THE POLITICAL ECONOMY OF HUMAN RIGHTS, VOL. 1 (1979).

[490] Elizabeth Keyes, *Unconventional Refugees*, 67 AM. U. L. REV. 106, 106–07 (2017) (discussing the Lautenberg program and related issues).

[491] *See* Gregg A. Beyer, *The Evolving United States Response to Soviet Jewish Emigration*, 3 INT'L J. REFUGEE L. 30, 36–42 (1991). *See generally* SOL TETELBAUM, THE DOOR SLAMMED IN LADISPOLI: UNKNOWN PAGES OF THE SOVIET IMMIGRATION TO AMERICA (2011).

nanoscale conscientiousness. From the beginning of the U.S. onward, since at least 1786, the U.S. government focused on certain types of humans with specialized regulations based on ethnicity, race or nationality.[492] This includes Native Americans, enemy aliens, African slaves and other foreigners including Japanese, Chinese and other nationalities to encourage migration or assist their resettlement.[493]

Recall that ethnicity and nationality are terms related to groups of people who have similar nationalities, races, cultures, political orientations, languages, or other shared belief systems,[494] all of which are nanoscale traits such as by genes, phenotypic expression or thought. This became even more pronounced in U.S. history with more delineation such as Haitians, Syrians, Iraqis, Afghans, Cubans, Guatemalans, Eastern Europeans and many others such as Irish.[495] Finally in 1952, Congress enacted the Immigration and Nationality Act of 1952, which serves as today's main source of immigration law; it allowed "all races" to naturalize but contained quotas from the Eastern and Western Hemispheres.[496] It allowed the origin quota system to remain but decreased the quota percentages.[497] It also established the employment skills levels still in effect today, and provided political grounds for exclusion.[498] The Bureau of Indian Affairs also began selling 1.6 million acres of Native American land to developers.[499] African Americans were given more rights when the U.S. Supreme Court announced in *Brown v.*

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[492] *Immigration Timeline*, LIBRARY OF CONGRESS, http://www.loc.gov/teachers/classroommaterials/presentationsandactivities/presentations/immigration/timeline.html (last visited Sept. 10, 2019) [hereinafter Library of Congress Immigration Timeline]; *see* KURZBAN, *supra* note 487, at 1–13.

[493] S*ee* KURZBAN, *supra* note 487, at 1–13, Library of Congress Immigration Timeline, *supra* note 492.

[494] *See supra* notes 392–96 and accompanying text, ERIKSEN, *supra* note 393, at 1–13, GOODWIN-GILL & MCADAM, *supra* note 392, at 72.

[495] They include: the Chinese Student Protection Act of 1992; the Soviet Scientist Immigration Act of 1992; the Haitian Refugee Immigration Fairness Act of 1988 (HRIFA); the Nicaraguan Adjustment and Central American Relief Act (which also applied to Salvadorans, Guatemalans, Cubans and Eastern Europeans); the Syrian Adjustment Act; the Vietnamese, Cambodian and Laotian Adjustment; the Refugee Crisis of Iraq Act; the Afghan Allies Protection Act; the Irish Peace Process Cultural and Training Program of 1998; and the Iraqi and Afghan Extension and Improvement of the Special Immigrant Visa Program. There were also other nanoscale related acts to labor skills such as the Employ American Workers Act. *See generally* KURZBAN, *supra* note 487 (citing Chinese Student Protection Act of 1992, P.L. 102-404, 106 Stat. 1969 (Oct. 9, 2992), Soviet Scientists Immigration Act of 1992, P.L. 102-509, 106 Stat. 3316 (Oct. 24, 1992), Haitian Refugee Immigration Fairness Act of 1998 (HRIFA), P.L. 105-277, div. A, title IX; 112 Stat. 2681-538 to 542 (allowed adjustment of status of permanent residence for Haitians under certain conditions), Nicaraguan Adjustment and Central American Relief Act (NACARA), P.L. 105-100, title II; 11 Stat. 2160, 2193-201 (Nov. 19, 1997), amended by P.L. 105-139, 111 Stat. (Dec. 2, 1997), Syrian Adjustment Act, P.L. 106-378, 114 Stat. 1442 (Oct. 27, 2000); 20000 HR 4681, P.L. 106-429, § 586; 114 Stat. 1900, 1900A-57 to 58 (Nov. 1, 2000); 2000 HR 4811, Refugee Crisis in Iraq Act of 2007 (Title XII, Subtitle C of National Defense Authorization Act for FY 2008, P.L. 110-181 (HR 4986), 122 Stat. 3 (Jan. 28, 2008) (amending P.L. 110-242 (HR 3233))], Afghan Allies Protection Act of 2009 [Div. F, Title VI of Omnibus Appropriations Act, 2009, P.L. 11-8, 123 Stat. 524 (Mar. 11, 2009), Irish Peace Process Cultural and Training Program Act of 1998, P.L. 105-319, 112 Stat. 3013 (Oct. 30, 1998); P.L. 108-449, 118 Stat. 3469 (Dec. 10, 2004)], 65 F.R. 14764, 17768 (Mar. 17, 2000); 22 C.F.R. pt. 139, The Iraqi and Afghan Extension and Improvement of the Special Immigrant Visa Program, P.L. 113-66, 127 Stat. 672, 910-16 (Dec. 26, 2013), and Employ American Workers Act (Div. A, Title XVI, § 1611 of the American Recovery and Reinvestment Act of 2009, P.L. 111-5, 123 Stat. 364 (Feb. 17, 2009)).

[496] S*ee* Library of Congress Immigration Timeline, *supra* note 492.

[497] *See* KURZBAN, *supra* note 487, at 4 (discussing the McCarran Walter Act (Immigration and Nationality Act of 1952)).

[498] *See id*.

[499] *See id*.

Topeka Board of Education that separate facilities for whites and blacks are not equal.[500]

The Cuban Revolution in 1959 prompted a mass exodus into the U.S. (four hundred thousand Cubans entered the U.S.) and supported the U.S. Cuban Refugee Program.[501] 1964 brought the end to housing discrimination against African Americans and instilled voting rights for them.[502] The Immigration Act of 1965 abolished the old quota system in favor of quota systems with twenty thousand immigrants per country limits.[503] Preference is given to immediate families of immigrants and skilled workers.[504] Finally, in 1988, "[t]he Civil Liberties Act provide[d] compensation of $20,000 and a presidential apology to all Japanese-American survivors of the World War II internment camps."[505]

There were also numerous other nationality-specific acts that followed.[506] There were also acts related to other nanoscale features, like labor skills, such as the Employ American Workers Act.[507] Many types of humans were focused.

One can see how Walter Benjamin's story fits almost seamlessly into such tales given an obsession with genes, skills, and mental constituents under the guise of nationality, national security, or conflict. This is not specific to the United States but rather applies on a global scale.

ii. Internationally—Other States

Despite this alternating protection with hypocritical or ironic paradoxical targeting, most other states have similar or worse records; hence, Benjamin's "barbaric" quote on civilization receives support. In looking at other states' human rights reports alone, particularly as analyzed by the U.S. Department of State, but also including Amnesty Internal, Human Rights Groups, UN protection groups, or other human rights or news organizations to which the Department of State often refers—they all indicate large scale targeting of race, genes, languages or proclivity towards an alleged security issue because of a nanoscale quality.[508] Most all do it in the name of law enforcement or security in appearance or in justification.

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[500] *See id*.

[501] *See id*.

[502] *See id*.

[503] *See id*. at 5 (discussing the Immigration and Nationality Act of 1964), Library of Congress Immigration Timeline, *supra* note 492.

[504] *See* Library of Congress Immigration Timeline, *supra* note 492.

[505] *See id*.

[506] Examples include: the Chinese Student Protection Act of 1992; the Soviet Scientists Immigration Act of 1992; the Haitian Refugee Immigration Fairness Act of 1998; the Nicaraguan Adjustment and Central American Relief Act; and the Syrian Adjustment Act. *See* KURZBAN, *supra* note 487, at 7, 10–11, 13 (citing to various nationality-specific acts in the late-twentieth century).

[507] *Id*. at 28.

[508] With an overview for mass example, the author worked as an Overseas Adjudications Officer or conducted military naturalization in six countries, including Bahrain, Greece, Jordan, Kuwait, Qatar, and Russia. He served as Acting Field Office Director in Kenya and has conducted refugee details or processed refugees at some level in Albania, Austria, Kenya, Kuwait, Malta, Mauritania, Oman, Pakistan, Romania, Russia, Sudan, Ukraine, United Arab Emirates, and Zambia. He also worked in the USCIS Athens Field Office for almost five years, which has jurisdiction over Bulgaria, Greece, Bahrain, Cyprus, Egypt, Iran, Iraq, Israel, Kuwait, Lebanon, Oman, Qatar, Romania, Saudi Arabia, Syria, Turkey, United Arab Emirates, and Yemen. The office also works with refugees in Greece, Cyprus, Iran, Kuwait, Lebanon, Romania, Turkey, United Arab Emirates, and Yemen. While practicing immigration law, he

The following are some examples. Any country in the world will yield similar results. Australia has a very similar human rights record to the U.S. with similar issues such as treatment of ethnic migrants and indigenous persons.[509] In Russia, "[t]here were credible reports of political prisoners in the country and that authorities detained and prosecuted individuals for political reasons. Charges commonly applied to political prisoners included 'terrorism,' 'extremism,' 'separatism,' and 'espionage.'"[510] In Kenya, unprotected domestic violence against women is pervasive and "[t]here were numerous reports the government or its agents committed arbitrary and unlawful killings, particularly of known or suspected criminals, including terrorists" including a reported "80 cases of individuals killed by police" of which "at least 33 of these were summary execution."[511]

In Pakistan and Romania, there are large numbers of Afghan refugees who have fled from Afghanistan or from Iran (where they were temporarily allowed to be in refugee camps and settlements) because of ethnic, political, or religious targeting.[512] Pakistan has its own targeting: "Islam as the state religion [] requires all provisions of the law to be consistent with Islam" and the "courts continued to enforce blasphemy laws, whose punishment ranges from life in prison to the death sentence for a range of charges, including 'defiling the Prophet Muhammad.

In Romania, Roma are often targeted as well as minorities, such as ethnic Hungarians.[513] In Saudi Arabia, Shi'a Muslims, religious minorities, non-citizens, women, political dissidents,[514] and Jews are targeted.[515] In Somalia, females and minority clans (ethnical or national groups) are typically

represented over 30 asylee cases from Somalia, Iran, Iraqi, Israel/Palestine, Cameroon, Tanzania, Zimbabwe, Azerbaijan, and India before Immigration Court or with USCIS. The author also lived in Australia. Consequently, these countries and most others' records in regard to support for this proposition, and their country reports and analysis, current and historical, can be found at the following locations: U.S. DEP'T OF STATE, BUREAU OF DEMOCRACY, HUMAN RIGHTS AND LABOR, COUNTRY REPORTS ON HUMAN RIGHTS PRACTICES, https://www.state.gov/j/drl/rls/hrrpt/ (visited Apr. 11, 2018) [hereinafter DOS HUMAN RIGHTS REPORT]; U.S. DEP'T OF STATE, BUREAU OF DEMOCRACY, HUMAN RIGHTS, AND LABOR, INTERNATIONAL RELIGIOUS FREEDOM REPORT, https://www.state.gov/j/drl/rls/irf/ (last visited Apr. 11, 2018) [hereinafter DOS RELIGIOUS FREEDOM REPORT]; U.S. DEP'T OF STATE, TRAFFICKING IN PERSONS REPORT 2018, *Country Narratives*, https://www.state.gov/j/tip/rls/tiprpt/countries/2018/index.htm (last visited Apr. 11, 2018). *See generally* DAVID VAN REYBROUCK, CONGO: THE EPIC HISTORY OF A PEOPLE (HarperCollins, 2010), Ty S. Twibell, *Immigrant Nations: A Comparison of the Immigration Law of Australia and the United States*, 19 UNIV. TAS. LAW REV. 57 (2000).

[509] *See generally* CROCK, s*upra* note 421, Twibell, *supra* note 508.

[510] 2017 DOS HUMAN RIGHTS REPORT, RUSSIA 2017 HUMAN RIGHTS REPORT 14 (2017), (https://www.state.gov/documents/organization/277495.pdf (last visited Feb. 20, 2019).

[511] 2017 DOS HUMAN RIGHTS REPORT, KENYA 2017 HUMAN RIGHTS REPORT 2, 34 (2017), https://www.state.gov/documents/organization/277255.pdf (last visited Feb. 20, 2019).

[512] *See generally* 2017 DOS HUMAN RIGHTS REPORT, AFGHANISTAN 2017 HUMAN RIGHTS REPORT 1 (2017), https://www.state.gov/documents/organization/281260.pdf (last visited Feb. 20, 2019) (including discussion *inter alia* of Shi'a persecution and apostasy or anti-Muslim beliefs of behavior).

[513] *See* 2017 DOS HUMAN RIGHTS REPORT, ROMANIA 2017 HUMAN RIGHTS REPORT 1, 9, 20, 30 (2017), https://www.state.gov/documents/organization/277453.pdf (last visited Feb. 20, 2019).

[514] *See generally* 2017 DOS HUMAN RIGHTS REPORT, SAUDI ARABIA 2017 HUMAN RIGHTS REPORT (2017), https://www.state.gov/documents/organization/281248.pdf (last visited Feb. 20, 2019).

[515] *See, e.g.*, Ellen R. Wald, *America's Hypocrisy on Saudi Arabia,* WASH. POST (Nov. 3, 2018), https://www.washingtonpost.com/outlook/2018/11/13/americas-hypocrisy-saudi-arabia/?utm_term=.29ddd76fa750 (visited Feb. 20, 2019) ("After the founding of the state of Israel, Saudi Arabia banned Jews. That meant the U.S. government was not allowed to station Jews at the U.S. air base in Dhahran, and no Jews could work for Aramco. Soon after the ban on Jews was decreed, two American Jewish diplomats on official business were denied entrance to Saudi Arabia.").

targeted.[516] In Sudan, there are large numbers of refugees from Eritrea and Ethiopia who fled and have lived in refugee camps for decades and are themselves living in a state in which "security forces reportedly continued to torture, beat, and harass suspected political opponents," and there too exists ethnic minority targeting.[517] In Turkey, political dissidents are targeted.[518] In Zambia, where political dissidents can be targeted,[519] there are large camps of Congolese who are fleeing because of ethnic targeting.[520]

In each country, analyzed country reports document targeting of race, genes, and languages, or a proclivity towards an alleged security issue because of a nanoscale quality such as people's beliefs—which include configurations of memories and ideas all stored in neurons. Hence, the law, policy, and societal behavior that is reflective of legal formation and implementation, with minor exception, focuses on nanoscale components—whether they be genes, physical skills, or certain types of neurological formation.

4. Genes, Memes, and Nanomachines in Legislative History and Old Law

a. Legislative History

Despite the text of the law Congress enacted and the President signed, centuries of legislative history and implementation of the law make it clear that nanoscale qualities, such as race, ethnicity, language, and thought, were the priorities of legislators. Even a century ago, immigration law and policy discussions delved heavily into the genes and biology and Congressional committees explored these issues in depth.[521] For example, note analysis and testimony in the Congressional legislative history: "The argument behind the national origins system was given forceful expression by a former anthropologist . . . in a book published more than thirty-five years ago; he said:

> These new immigrants were no longer exclusively members of the Nordic race as were the earlier ones … The new Immigration … contained a large and increasing number of the weak, the broken, and the mentally crippled of all races drawn from the lowest stratum of the Mediterranean basin and the Balkans, together with hordes of the wretched, submerged populations of the Polish ghettos. Our jails, insane asylums, and almshouses are filled with this human flotsam,

[516] *See generally* 2017 DOS HUMAN RIGHTS REPORT, SOMALIA 2017 HUMAN RIGHTS REPORT (2017), https://www.state.gov/documents/organization/277289.pdf (last visited Feb. 20, 2019).

[517] *See* 2017 DOS HUMAN RIGHTS REPORT, SUDAN 2017 HUMAN RIGHTS REPORT 4–5, 45 (2017), https://www.state.gov/documents/organization/277295.pdf (last visited Feb. 20, 2019).

[518] *See generally* 2017 DOS HUMAN RIGHTS REPORT, TURKEY 2017 HUMAN RIGHTS REPORT (2017), https://www.state.gov/documents/organization/277471.pdf (last visited Feb. 20, 2019).

[519] *See generally* 2017 DOS HUMAN RIGHTS REPORT, ZAMBIA 2017 HUMAN RIGHTS REPORT (2017), https://www.state.gov/documents/organization/277305.pdf (last visited Feb. 20, 2019).

[520] *See generally* VAN REYBROUCK, *supra* note 508.

[521] OSCAR M. TRELLES & JAMES F. BAILEY, III, IMMIGRATION AND NATIONALITY ACTS, LEGISLATIVE HISTORIES AND RELATED DOCUMENTS 92 (1950–1978). *See generally* OSCAR WILLIAMS, AFRICAN AMERICANS AND COLONIAL LEGISLATION IN THE MIDDLE COLONIES (1998).

> and the whole tone of American life, social, moral, and political, has been lowered and vulgarized by them."[522]

Other anthropologists disagreed and believed all humans had the same potential. In fact, they stated that being willing and able to relocate, from anywhere in the world, was a positive attribute. "We want that good ancestry in human stocks from wherever it comes in the world."[523]

There is also reference to a 1922 report by a doctor regarding biology and immigration:

> We in this country have been so imbued with the idea of democracy, or the equality of all men, that we have left out of consideration the matter of blood or natural inborn hereditary mental and moral differences. No man who breeds pedigreed plants and animals can afford to neglect this thing.[524]

A Congressman, Albert Johnson from the Senate Judiciary Committee believed that this testimony was "both biologically and statistically thorough, and apparently sound."[525]

Additionally, legislative history also highlights nanoscale regulation. For example, a bill authorization included the following: "persons of races indigenous to India may naturalize and become a citizen.[526] Others provided for visas for ethnic Germans and anti-communists.[527] Ethnicity and religion were considered in analyzing visa allocation, such as if individuals were Jews, Catholics, Protestants and even Greek Orthodox.[528] The memes of Communism in human minds were regulated in immigration law around the 1950s and discussed by Congress.[529] Nazis were targeted with a focus on

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[522] TRELLES & BAILEY, *supra* note 521, at 92.

[523] *Id*.

[524] MATTHEW FRYE JACOBSON, WHITENESS OF A DIFFERENT COLOR: EUROPEAN IMMIGRANTS AND THE ALCHEMY OF RACE 21 (1999).

[525] *See* TRELLES & BAILEY, *supra* note 521, at 92.

[526] Committee of the Whole House, House Committee on Immigration and Naturalization, 79th Congress, House of Representatives, 18th Session, No. 854, Report, Doc. No. 10934 H.rp.854 (accompanying H.R. 3517) (discussing bill to "authorize the admission into the United States of persons of races indigenous to India, to make them racially eligible for naturalization").

[527] Emergency Immigration Program, Hearings Before Subcommittee No. 1 of the Committee on the Judiciary House of Representatives, 83rd Congress, 1st Sess. On H.R. 361, 1707, 2076, 2991, 3201, 3845, 4044, 4842, 4925, 4935, 5001, H.J. Res. 178, Bills to Provide for an Emergency Immigration Program, May 21, 22, June 8, 9, 10 and July 9, 1953, Serial No. 4 (U.S. Gov't Printing Office, 1953) (discussing legislation for 240,000 special quota visas for ethnic Germans under Soviet result and others fleeing Communist repression from totalitarian governmental environment in areas under Soviet or Communist control).

[528] Legislative History of the Amendment to the Displaced Persons Act of 1948: P.L. 81-555 : 64 Stat. 219 : Ch. 262, 2d Sess.: June 16, 1950. (1950), at 113–14 (finding that during World War II, that in the hundreds of thousands displaced after World War II, 4/5ths were Jewish and in 1945 alone, it included 23,594 visas for Jews and 3,906 visa for protestants, and 19,283 visas for persons of the Greek Orthodox faith in 1949).

[529] TRELLES & BAILEY, *supra* note 521, at 781–87 (discussing *inter alia* that communism appears more to be an alien movement with directives from Moscow and that that many native Americans began dissociating themselves with it for these reasons, and that "an international conspiracy, communism has organized systematic infiltration of our borders for the purpose of overthrowing the democratic Government of the United States by force, violence, and subversion" and that "[o]ccasionally aliens who come to this country as immigrants do not leave behind em their loyalties to foreign governments and foreign ideologies"). *See generally* WILLIAMS, *supra* note 521.

mens rea.[530] English language was a criterion for migration and initially, migrants were organized by the languages they spoke in the early 1900s.[531]

After these archaic considerations, issues considered became sounder but nanoscale nonetheless. For example, in 1976, the Domestic Council on Illegal Aliens created a report chaired by the U.S. Attorney General, with committee members comprising mostly of the President's Cabinet.[532] The report discussed the main purposes of the 1952 Act;[533] the 1952 Act's basic structure serves as the basis of today's U.S. immigration law.[534] It was designed to limit immigration for certain family relatives of U.S. citizens and residents, lay out visa requirements for visitors, lay out guidelines for excluding certain aliens, deport aliens, and protect the U.S. labor force.[535]

The 1965 Amendments[536] removed the national origins quota system,[537] replacing it with family relationships and worker classes needing certain skills and talents as prerequisites for immigration,[538] and preference categories.[539] Categories had been made for "Eastern" and "Western" Hemisphere natives.[540] Western Hemisphere natives were on a "first come, first served" basis.[541] Labor certification was still protected; protected work skills and other aspects were regulated as needed.[542]

The legislative history showed that the U.S. does less analysis of prospective immigrants or their "quality" compared to other countries like Australia or Canada, who have more discretion to seek who they want, for evolving nationalistic reasons. The U.S. tends to be more mechanical; for example, a visa will be issued if one meets the criteria, is not a criminal, nor

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[530] *See* 95th Congress, 2nd Session (1978), 92 Stat. 2065; 8 U.S.C. § 1182; 8 U.S.C. § 1227; 8 U.S.C. § 1253; 22 U.S.C. § 2601; Public Law 95-549 95th Congress (disallowing those aliens or associated or cooperated with the Nazi party in Germany who engaged in persecution by amending INA § 101(a) and § 212(a) but authorizing deportation).

[531] *See* KUNAL M. PARKER, MAKING FOREIGNERS: IMMIGRATION AND CITIZENSHIP LAW IN AMERICA, 1600–2000 (NEW HISTORIES OF AMERICAN LAW) 154, 163 (Cambridge Univ. Press, 1st ed. 2015).

[532] *See generally* U.S. Domestic Council Committee on Illegal Aliens, Preliminary Report, Edward H. Levi (Dec. 1975) Section 1: hearings, Reports, Commissioner Studies, Doc. No. 15, Dc. 1976.

[533] Other legislative history also discusses the purposes of this Act. TRELLES & BAILEY, *supra* note 521, at 2 (discussing that the 1952 Act "involves an undertaking which has never before been accomplished, namely the revision and codification of all the immigration and naturalization laws."). Among the minor and technical changes the bill makes, there are:

(1) A system of selective immigration within the national origins quota system is established, geared to the needs of the United States.

(2) Racial discriminations and discriminations based upon sex are removed.

(3) Afore thorough screening especially of security risks is provided.

(4) Structural changes made in the enforcement agencies for greater efficiency.

(5) The exclusion and deportation procedures are strengthened.

(6) Naturalization and denaturalization procedures are strengthened to weed out subversives and other undesirables from citizenship. *Id*. at 3.

[534] *Id*. at i–v.

[535] *Id*. at 11.

[536] *Id*. at 12.

[537] TRELLES & BAILEY, *supra* note 521, at 1–3. *See generally* WILLIAMS, *supra* note 521. "The ethnocentric country-of-origin quota system was repealed in 1965, after sustained controversy, and at the same time (virtually without debate) numerical limits were placed for the first time, on Western Hemisphere emigration." TRELLES & BAILEY, *supra* note 521, at 5.

[538] *See* TRELLES & BAILEY, *supra* note 521, at 12.

[539] *See id*. at 13.

[540] *See id*.

[541] *See id*.

[542] *See id*. at 15–19.

falls within an excludable class. Other legislative history indicates it was important that immigrants from the Western or Eastern hemispheres be considered.[543]

Legislative history and related reports later into the twentieth century began focusing more on work skills.[544] It lamented that other countries properly focused on this issue in their national interests and that the U.S. should follow suit.[545] Too much emphasis was placed on family immigration and fighting xenophobia, which detracted focus from labor considerations in immigration.[546] Although it appeared that the law promoted attracting qualified workers, the workers tended to be "self-selected" and were part of the labor pool already illegally present in the U.S., and family dominated.[547] Thus, not only do nanoscale components appear in the law but also when formulating the law.

In the 1980s, reports continued to highlight the preference for skilled workers. An Immigration and Refugee Final Report stated, "[o]ur Immigration Act is intended as one of economic opportunity to the needs and capabilities of man . . . throughout the world."[548] It highlighted that at the time, most immigration to the U.S. was family based: "94 percent of all immigrants who enter the U.S. come through part of the Family Reunification program established under our Immigration Law."[549] The Commission said "'new seed' immigrants are those who can make the

[543] *See generally id*.; William S. Hein Co. Bailey, Inc. Immigration and Nationality Acts, Legislative Histories and Related Documents (1978), Legal and Illegal Immigration to the United States, Report, Select Committee on Population, U.S. House of Representatives, 95th Congress, 2nd Session, Serial C, Dec. 1978 (U.S. Gov't Printing Office, 1978) (discussing legislation and immigration policy including what the history and is desirable in terms of language, crime, migration from Mexico, the Western Hemisphere, the Eastern Hemisphere, settlement pattern, financial implications such as public assistance, taxes, employment, economic development of sending countries and other issues including one recommendation that "[t]he United States should make renewed efforts to help those countries reach their fertility reduction goals and to achieve their family planning and population objectives (at 6) and includes charts or resettlement and analysis of those resettling in the U.S. with ethnic demographics, for example, including that "Western Hemisphere" males and females "tend to be older, better educated, more fluent in the English language. and possess more occupational skills than illegal migrants from Mexico (at 22).").

[544] *See generally* TRELLES & BAILEY, *supra* note 521, WILLIAMS, *supra* note 521.

[545] "Our existing formal immigration policy–unlike those of other major immigrant-receiving nations, such as Canada and Australia-has little to do with the nation's manpower needs. Clearly, non-manpower considerations must play a major role in any nation's immigration decision making process, but a balance is needed, and it is not now present." Manpower and Immigration Policies in the United States, A Special Report of the National Commission for Manpower Policy, Special Report. No. 20 (Feb. 1978), or Manpower and Immigration Policies in the United States (1978), at 10.

[546] Manpower considerations have had little effect on the making of immigration policy over the years. Such factors as xenophobia, on the one hand, and arguments for family reunification, on the other, have been more powerful. Immigration policy making has often been negative in to nature (seeking to avoid perceived harm to the society rather than seeking to attain a benefit for it). Such policy has been highly legalistic and often has not produced the anticipated results. *Id*. at 5.

[547] Thus the great majority of immigrants, although most come to the United States to work, most are admitted because of familial considerations unrelated to the labor market. Most working non-immigrants are admitted at the request of either an employer or an educational institution. The influx of illegal aliens regarded as preferred workers by many employers, is, in effect, permitted to a resource allocation system that places a low priority on reducing this flow of self-selected migrants. *Id*. at 5–6.

[548] Final Report of the Select Commissioner on Immigration and Refugee Policy, Joint Hearings before the Subcommittee on Immigration, Refugees and International Law of the house Committee in the Judiciary, 97th Congress, First Session, on the First Report of the Select Commissioner on Immigration and Refugee Policy (May 5, 6, 1981); Serial No. J-97-38 P.L. 97-363 (Oct. 25, 1982), Doc. 50-May 5, 6, 7, 1981, at 7.

[549] *Id*.

maximum contribution to our country."[550] The Commission wanted the law to target certain types of humans: "[I]t is not inappropriate to try to accept those who are likely to merge rapidly and easily"[551] into our political, economic, and community life and to make maximum contributions to it.[552] It believed that the lack of English language skills could indicate a lack of intention to be assimilated to the community.[553] Later, reform had other concerns. Enforcers of immigration law, such as employer sanctions, rest on one of the ways to determine genetic differences, such as looking into the legislative history of the INA reformation where critics believed that "employer sanctions, could result in discrimination against 'foreign looking' job applicants who would be rejected on the basis of their appearance because of their employer fears that they were illegal."[554]

b. Historical Law

In the early part of the twentieth century, the law contained extensive details on phenotypic human attributes including race and ethnicity.[555] For example, in 1935, the state of Georgia defined a "negro" as a "person of color"[556] who comprised of: "All Negroes, mulattos, mestizos and their descendants, having any ascertainable trace of either Negro or African, West Indian, or Asiatic Indian blood in their veins, and all descendants of any person having either Negro or African, West Indian, or Asiatic Indian blood in his or her veins shall be known in this state as persons of color."[557] Similarly, a "white person" was defined as a "person[] of the white or Caucasian race, who [has] no ascertainable trace of either Negro, African, West Indian, Asiatic Indian, Mongolian, Japanese or Chinese blood in their veins. No person, any one of whose ancestors has been duly registered with the State Bureau of Vital Statistics as a colored person or a person of color, shall be deemed to be a white person."[558]

Going further back in history, the U.S. colonies and Europe, focused the law on phenotypic human differences from genes.[559] As far back as 1664, laws treated blacks differently; New York and Pennsylvania had "Duke's Law," based on an English law, the "Duke of York's Law,"—which prohibited certain types of slavery[560] during the transition of state control from Dutch to English rule (e.g., if an individual was Christian).[561] There was actually some protection in a 1686 law, which states that willful "killing of Indians or Negroes may be punished by death and a fit penalty imposed for

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[550] *Id*.
[551] *Id*.
[552] *Id*. at 8.
[553] *Id*. at 6.
[554] NANCY HUMEL MONTWIELU, THE IMMIGRATION REFORM LAW OF 1986 46 (Bureau of National Affairs, 1987).
[555] STATES' LAWS ON RACE AND COLOR 3 (Pauli Murray, ed., Univ. Georgia Press, 1997) (discussing and serving as a reference for different state policies in regard to "race and color" when one "crosses state borders").
[556] *Id*.
[557] *Id*. at 90.
[558] *Id*. at 90.
[559] *See generally* WILLIAMS, *supra* note 521.
[560] *Id*. at 42.
[561] *Id*.

maiming them."[562] When the Dutch began to colonize, they experienced their own labor issues and needs; they found their own native Dutch labor to be "scarce, expensive, and undependable," and often "rebellious."[563] This caused strong resolve for "negro" labor or slaves, who were then offered to emigrate with the Dutch to New Netherlands and other colonies to work in areas such as agriculture.[564]

Scholars studying historical law noted additional nanoscale regulation, such as religious belief regulation in both Congress and the courts.[565] "[A]lthough the U.S. Supreme Court has issued opinions and Congress passed laws grounded in this legacy, a would-be immigrant's religion often acted to bar entry into the United States."[566] Congress did pass exceptions to the yearly quotas when it began restricting immigration, but it also barred aliens based on religion.[567] The Supreme Court similarly often provided support for Christians in cases and controversies, siding with bias or favoritism with Christians.[568] Congress then introduced literacy tests that intended to curtail certain immigrants of Catholics from southern or eastern Europe, Eastern European Jews, and immigrants from the Middle East in the Immigration Act of 1917.[569] Scholars point out the ironic exception to this curtailment—they claimed immigrants were fleeing persecution on account of the same basis.[570]

The 1917 Act remained the basic law until the 1921 Immigration Act which established the quota system and the 1952 Act established the INA. The quotas for Northern and Western Europeans were much higher than Southern or Eastern Europeans, as "the system was specifically aimed at excluding Catholics, Jews, and other non-protestants."[571] However, "[i]n response to the ever-increasing levels of immigration of these 'undesirables,' Congress since adopted a more restrictive quota system—the National Origins Act of 1924."[572] This Act "further limited what Congress deemed were undesirable ethnic groups and religions."[573] "Current immigration policy continues to reflect the special status of religious practitioners."[574]

It must be said that during the 1930s and 1940s, when masses of Jews were leaving Europe, exceptions to quotas were sometimes made if persecution was established. Also, "Huguenots, Quakers, Mennonites, Amish, and Jews fleeing persecution in the seventeenth century, Jews escaping pogroms in the late nineteenth century and Armenians fleeing Turkish pogroms in the first decades of the twentieth century all found refuge

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[562] *Id*. at 45 (citing THE LAWS OF THE COLONY OF NEW YORK, VOL. 1 (1958)).
[563] *Id*. at 6.
[564] *See id*. at 5–7 (citation omitted).
[565] *See generally* RELIGION AND AMERICAN LAW, AN ENCYCLOPEDIA (Garland Publishing, Inc., Paul Finkelman, ed., 2000).
[566] *Id*. at 231.
[567] *Id*.
[568] *See id*.
[569] *Id*.
[570] *Id*.
[571] *Id*.
[572] *Id*. at 232–33.
[573] *Id*. at 232 (describing masses of people leaving Eastern and Southern Europe from pogroms during World War I, Nazism in the 1930s and World War II).
[574] *Id*. (citing the Immigration Acts of 1965 and 1990).

in [the U.S.] with relatively few legal obstacles."[575] But at the time, there were few exceptions to the quota system and "no right to asylum existed based on religious persecution until the adoption of the Refugee Act of 1980."[576] Aliens did not have a right to refuse to bear arms similar to citizens, which was later allowed under nationalization law.[577] Labor issues, the labor market, and enforcement in this arena were also considered by legislators.[578]

V. THE LAW ON THE NANOSCALE: NANOLAW

A. THE LAW IS ALREADY NANOSCALE

The word "nanotechnology" need not be verbatim in a law regulating at the nanoscale, in order for it to be nanolaw or nanotechnology regulation. However, the law must grow more sophisticated to correspond with the growing sophistication of new nanotechnology. It requires a deeper understanding. Humans use new techniques with old and new substances for dramatic new ends. Nanotechnology will change society so dramatically that the law must naturally change too. However, this has been a continued human course. Humans have radically altered their own DNA via culture and law to target DNA or behavior variances through visual and behavioral analysis, or cultural assumptions based on synonymous characteristics or stereotypes. Humans now understand the underlying causes or genotypic variances behind phenotypic expression or the neurology or psychology behind behavioral differences or proclivities.

Hundreds of years ago, regulating an individual was possible because of race, without understanding the underlying genetic or nanoscale differences. Nevertheless, within the past couple of centuries, as people increasingly understood these differences, the law evolved to better consider the nanoscale. Although our understanding of the insignificance of genetic differences helped erode discrimination and support civil rights movements, laws continue to regulate similarly with varying intensity. Increased scientific understanding of the role genes play in human phenotype and behavior has helped demonstrate that race, ethnicity and nationality, as examples, are less reliant on genes, and racism, persecution, and discrimination have become taboo. Today in the U.S., legal measures tend to counter past discrimination of nanoscale features.

Nanotechnology today uses new substances in new ways with unprecedented results, and in some instances creates novel environmental, health, workplace, or ethical concerns with radical soon-to-come possibilities. But, this is only in relation to certain narrow classes of

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[575] *Id*.

[576] *Id*.

[577] *Id*. at 234–35 (citing Girouard v. United States, 328 U.S. 61 (1946) (rights for citizens to be applied to aliens per Justice Douglas) and Naturalization Act of 1952, 8 U.S.C. § 12 (1952)).

[578] Igor I. Reams & Bernard D. Jr. Kavass, *Immigration Act of 1990: A Legislative History of Pub. L. No. 101-649, U.S. Immigration Policy and the National Interest*, Appendix E to the Staff Report of the Select Commission on Immigration and Refugee Policy, Papers on Illegal Migration to the United States, Supplement to the Final Report and Recommendations of the Select Commission on Immigration and Refugee Policy (discussing the difficult in quantifying the presence of illegal aliens in the U.S. along with labor issues, the labor market, enforcement and labor issues).

nanotechnology. It is not possible to have a wait-and-see approach because nanotechnology has long been regulated. Humans will continue to regulate as they always have, based on need and controversy. But it must be improved and has never been more important.

Additionally, patent regulation should promote nanotechnology, utilizing soft law. There should be more bridges between the scientific and legal communities, as well as improved awareness, self-regulation, and government intervention to promote and protect the nanotechnology industry while proper concerns and strategies are explored simultaneously.

In regard to a need for new law, however, new understanding is needed. Today, when one eats steak or other red meat, he or she now understand the microscale effects on their internal organs, their heart, their blood cholesterol, and the bacteria that helps digest it in their gut.One also has an increased understanding of the vast neural network in one's gut and intestines, likened to a second brain of sorts. Similarly, when some individuals seek to migrate, some are allowed entry while others, like Benjamin, are excluded because they are Jewish or do not possess the proper beliefs of the receiving country; this is only because of their genes, their brain development, memories, or training—all of which are nanoscale traits. (Of course, there will always be some individuals who are targeted for legitimate law enforcement reasons.)

One need not have an electron microscope to see these nanoscale qualities. One can use his or her eyes and analyze the person or their documents to detect what can be considered genetic differences. It can be inaccurate, unproductive and even oppressive to regulate based on, for example, race, ethnicity, or even political beliefs. If the technology is developed to detect certain thoughts or experiences in someone's brain, or the skills in their body, and this information is used at borders for immigration regulation, it may be more accurate. It also would need to be analyzed between the costs and benefits of security, ethics, privacy and other factors.

B. THE BENEFITS OF A NANOSCALE PERSPECTIVE

1. Making New Law and Policy

Similar to teaching and making new law, formulating the policy behind legal change, implementing law or thinking, and describing or advocating policy should also include the nanoscale approach because it better reveals the motivation behind the law. Making new immigration law should follow the same method. It should look at the subject first and then seek to either rewrite or amend the law with the nanoscale in mind. This would force the question: Do we really want to regulate by genes, or are we promoting certain skills or psychological predisposition? Also, it will raise the questions: "How can we achieve those traits in our own population?" and "What costs and policies would be associated in obtaining that goal?" One example could be providing opportunities to high tech workers or individuals with masters' level of education. It is important that the nanoscale approach is good for not

only revealing motivations but also making the law more effective, including law enforcement.

Law enforcement seeks to keep the peace and promote a stable, supportive society. Terrorist attacks, crimes, or fraud in benefit programs are not desired. A nanoscale approach will provide tools to ensure that laws are drafted, and policy is made in the best manner to meet its aim. Such an approach must utilize science and must inevitably use trial and error as the science evolves.

For example, historically and currently, governments use simple and overly inclusive methods when finding threats to peace or stability. As noted by the aforementioned country reports, membership in certain ethnic groups, speaking certain languages, certain nationalities, and certain political predispositions are not correlated to criminal or terrorist tendencies by science. Yet law enforcement in immigration or domestic crime often targets these areas. This includes U.S. immigration law, security, and criminal law. There is no science that supports this correlation. Thus, the law can and should include experiential analysis, such as investigation regarding someone's experience (charging or convictions) and asking direct questions. But, the analysis must include only that which is relevant to the regulated areas. By teaching, analyzing, and focusing on nanotechnological aspects, society will become better trained to focus on the relevant and exclude the irrelevant. A society can focus on whether a migrant is a criminal or a terrorist, or might become a criminal, undertake fraud, or otherwise violate the law, rather than focus on areas such as race, ethnicity, or language. These traits all share a nanoscale quality.

2. Preparation for Future Nanotechnological Advancement

As this article is written, new developments persist that require a nanoscale perspective. Recently, it was reported that a researcher in China altered the genes of a newborn baby.[579] Also, during this period nanotechnology has been said to be dramatically improving human vision.[580] Despite debate surrounding whether babies' genes were actually edited, there are indications that such procedures took place and certainly will take place in the future. Human nanotechnology is revealing the most important changes and challenges to U.S. society. If the law is already focused on the nanoscale and can better focus on this component in self-awareness, making law and formulating policy will allow society to better address technological change.

3. Future Application of Legal Nanoscale Analysis

New nanotechnological applications include DNA sequencing, medicine and other tools, and restructuring for disease and other constituents of nanomedicine.[581] This implicates revisiting what it means to be human as human genome engineering progresses. From disease to cognitive ability and

[579] *See* Tsuruoka, *supra* note 50.

[580] *See* Ma et al., *supra* note 339, at 243 ("This new method will provide unmatched opportunities for a wide variety of emerging bio-integrated nanodevice designs and applications.").

[581] *See e.g.*, *Nanotechnology at Ames*, *supra* note 255.

physical and mental conditioning from DNA augmentation, the respective areas of law could be applied or changed. This also holds true for cybernetic augmentation.

It would include introduction of nanorobots into the body who may not only change DNA but also work at the nanoscale toward disease prevention, attack, cellular repair, and—at some point—cellular and organic augmentation. As a prelude, this will at first be viewed as nanotechnology, initially being introduced into non-organic nanoscale products and commodities and later to organic—plant and animal—self-replicating systems. Nanotechnology itself will, at some point, become self-replicating. Before that, however, it will enter and change humans in many ways, certainly with new forms of medical treatment at the minimum. Humans are already one kind of self-replicating or self-reproducing nanotechnology.

Health and healthcare law will be the first area affected. Humans may be more or less protected from nanotechnology, which will affect health-related inadmissibility and disease. It may affect regulation of viral infection and vaccination (or the types or methods of disease prevention), and who could be permitted to immigrate. It could increase a draw for business interests for cognitively or physically enhanced humans, as well as trafficking and smuggling as nanotechnologically-enhanced physical and cognitive traits are exploited. Societies and governments will seek to protect businesses and themselves from economic, physical, and security threats while also grappling with new ethical considerations and political motivations. Humans could represent new security threats in terms of protecting enhancement, affecting political consolidation or power and new types of biological threats and social upheaval.

Which countries are going to participate in augmentation? China? Japan? Germany? The U.S.? Japan and the U.S. are making great strides in nanotechnology and may be the first to involve their nationals, and as previously mentioned, China has already altered the DNA of their citizens[582] (although China has declared this illegal).[583] The political and ethical issues are dramatic in nanotechnology.

Today, an individual can likely visit the U.S. or other countries with artificial red blood cells in their veins or technical nanorobots[584] to help cure their medical condition, after a medical treatment in Russia or South Africa. Organized crime may be involved, given its relationship with human smuggling, human trafficking, and organ trafficking. Women and children living in vulnerable countries and economies may be the first to be affected negatively by nanotechnology—their skills or appearance could be enhanced or changed for economic benefit. As drugs and physical control may be used

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[582] *See* Tsuruoka, *supra* note 50.

[583] Grossman, *supra* note 345.

According to Xinuha, Chinese officials are accusing He of organizing 'a project team that included foreign staff, which intentionally avoided surveillance and used technology of uncertain safety and effectiveness to perform human embryo gene-editing activity with the purpose of reproduction, which is officially banned in the country.' . . . Such an accusation would have the potential for the death penalty. *Id*.

[584] *See* Amir et al., *supra* note 328, at 353.

to lessen a victim's ability to escape,[585] nanotechnological tools could be utilized to prevent escape or enhance performance, allowing some people to work longer hours or with limited diets. In this regard, the U.S. INA regulation could cover these issues and class nanotechnology scenarios.

However, because immigration and refugee laws already govern at the nanoscale, laws can be more easily drafted or amended to incorporate how nanotechnology affects these present nanoscale qualities. As previously illustrated, law already regulates innumerous replicating entities, so these laws would probably look to other similar, replicating systems as guidance. Understanding the law's political consolidation effect can teach everyone—children, jurists, lawyers, scientists, politicians, social workers, and public administrators—to think about who they want to be and where they want to go. It begins with truly seeing one's own nature.

VI. CONCLUSION

To improve law, a new approach is required to improve nanotechnology. It is not regulating the nanotech developments in artificial blood, medicine, the environment, the food and agricultural industries, nor military applications and nanorobots or grey goo scenarios. To promote and regulate nanotechnological solutions to urgent areas such as energy needs, food supply, environmental degradation, human longevity and quality of life, we must look again at the nanotechnology facing us in the mirror. This is the nanotechnology we must improve and it can be done through the law. We must understand what we see in that reflection and be cognizant of the law that already regulates its smaller scale. It may be something that we have not wanted to see in our own reflection.[586] Genes and other nanoscale processes affect what we see, our reaction, how we process our own image, and, perhaps, even our reaction to our own image.[587]

"New" nanotechnology makes this critical. It is not exactly as Walter Benjamin articulated but perhaps, what he meant. It is not nanotechnology or documents of civilization *per se* that we need to confront when we discuss genes, behavior or regulation of nanotechnology. It is our own human nature. Nanotechnology may reveal it better and even explain human nature one day, at least to some degree. This is what is really controversial about nanotechnology. Nanoscale biofunctions help one read and comprehend this article. It also enables readers to think about what this means and how to approach law as it regulates genes, memes, language and, human beings.

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[585] *See* Twibell, *supra* note 434, at 229–34 (discussing the case example of Gaia, an Eritrean asylum seeker who was at the service of a Saudi Arabian princess in the U.S. on a visitor visa, who abused and threatened her while using drugs to keep Gaia tired and confused so she would be unlikely or unable to escape).

[586] The general discussion in this paper and legal history support this proposition. For discussions specifically about the controversy surrounding human nature, including denial and the degree to which genes may play a role, see PINKER, *supra* note 9, at 23, 31–32, 50–67.

[587] *See generally id*.