ARTICLES

SHOULD EVERYONE NOW USE THE "ROYAL WE?" THE MICROBIOME'S IMPLICATIONS FOR FOURTH AMENDMENT RIGHTS

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"Do I contradict myself?
Very well then I contradict myself,
(I am large, I contain multitudes.)"

—Walt Whitman[1]

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[1] WALT WHITMAN'S SONG OF MYSELF: A SOURCEBOOK AND CRITICAL EDITION, 194 (Ezra Greenspan ed., 2005). "[I]f [the microbiome] study proves anything it's that all of us, as Walt Whitman would have it, contain multitudes." Jeffrey Kluger, *Congratulations, You Have Your Own Personal Germ Cloud*, TIME MAG. (Sept. 23, 2015), http://time.com/4044393/microbe-cloud-microbiome/.

I. Introduction

Who are you? How many are you? Where do you, the individual, stop and the world outside, start? In the wake of the discovery of the human "microbiome," these questions have suddenly become much more difficult to answer.[2] The microbiome, a term coined by Nobel Laureate, Joshua Lederberg,[3] is a collection of microscopic life forms, including "bacteria, archaea, viruses, and fungi" that live in, on, and around our bodies.[4] Each person hosts "trillions" of these "microscopic germs."[5] The advent of microbiome research transforms each of us from individuals into walking "ecosystem(s)"—akin to coral reefs or tropical jungles.[6] Instead of being "individual organisms," we are an "amalgam of us and them."[7] Rather than a self, each person is, or are, selves.

Law enforcement hopes to use microbes to capture and prosecute criminals.[8] This exploitation of a person's microbiome could represent a significant inroad on personal privacy, one that is even more intrusive than the collection and analysis of an individual's DNA. DNA left by a criminal at a crime scene

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[2] *See generally* The Human Microbiome: Ethical, Legal and Social Concerns 1–2 (Rosamond Rhodes, Nada Gligorov & Abraham Paul Schwab eds., 2013) [hereinafter Rhodes et al.].

[3] Jane Peterson et al., *NIH Human Microbiome Project*, 19 Genome Res. 2317, 2317 (2009); Pankaj Shrivastava, Toshi Jain & Mahendra K. Gupta, *Microbial Forensics in Legal Medicine*, 1 Scholars Acad. & Sci. Soc'y J. Med. 33, 33 (2015) [hereinafter Shrivastava et al.].

[4] Mohsin Ali, *Bacteria Make Us Human*, 385 Lancet 1718 (2015) (reviewing Martin J. Blaser, Missing Microbes: How the Overuse of Antibiotics Is Fueling Our Modern Plagues (2015)). "The term microbiome is a combination of 'micro,' from microorganism, and 'biome.' A biome is 'a major *community* of plants and animals having similar life forms or morphological features and existing under similar environmental conditions . . . [and] may contain several types of ecosystems." Rhodes et al., *supra* note 2, at 30.

[5] Jade Salyards, *Microbiomes Germ Clouds and the Future of DNA Jurisprudence*, 16 U. Pitt. J. Tech. L. & Pol'y 58 (2015). "Your body is home to *trillions* of microscopic critters, including viruses, bacteria, and fungi, living on or inside you. Collectively, these communities of microbes constitute what is called your 'microbiome.'" Bill Sullivan, *6 Things You Need to Know About Your Microbiome,* Scope (Sept. 24, 2014, 5:00 AM), http://thescopepopculturescience.blogspot.com/201409201409201409201409201409201409201409//6-things-you-need-to-know-about-your.html.

[6] Sullivan, *supra* note 5, at 1.

[7] Rhodes et al., *supra* note 2, at 2.

[8] Anna Williams, *Your Death Microbiome Could Catch Your Killer,* New Scientist (Aug. 27, 2014), https://www.newscientist.com/article/mg22329842-500-your-death-microbiome-could-catch-your-killer/; *see* Rachel Feltman, *Could a Bacterial 'Fingerprint' Solve a Sexual Assault Case?, Speaking of Science*, Wash. Post (Dec. 16, 2014), https://www.washingtonpost.com/news/speaking-of-science/wp/2014/12/16/could-a-bacterial-fingerprint-solve-a-sexual-assault-case/ [hereinafter Feltman I].

provides a genetic fingerprint of the wrongdoer.[9] A particular genome, however, provides little help if it cannot be matched to another sample in a database identifying the criminal, thus connecting him or her to the crime. In contrast, a sample of a person's microbiome provides a series of clues—whether regarding daily habits (such as smoking or drinking),[10] pet ownership,[11] sexual partners,[12] or location of residence[13]—which law enforcement might immediately exploit to hunt down their quarry.[14] Further, while DNA supplies information about genetic predisposition, say for certain conditions or diseases, the microbiome offers a glimpse into *behavior*—how individuals act and relate to others. The microbiome, unlike DNA, thus potentially offers police immediately actionable intelligence on a person's conduct.

With the discovery of the human microbiome come questions about the privacy each individual has in his or her own collection of microorganisms. Precisely how and when should the microbiome be protected from government collection and analysis? Is the answer to such questions somehow dependent on where the microbiome is, whether around, on, or in our bodies? These privacy concerns implicate the Fourth Amendment, which provides in part that, "The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated."[15] The finding that the human body includes trillions of other organisms that colonize our hair,[16] mouths, genitals, and fingertips will require a reassessment of what

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[9] *See* Maryland v. King, 133 S. Ct. 1958, 1967 (2013) (noting that DNA can identify an individual "with near certainty").

[10] *See* Kai Kupferschmidt, *How Your Microbiome Can Put You at the Scene of the Crime*, SCIENCE (Mar. 8, 2016), http://www.sciencemag.org/news/2016/03/ how-your-microbiome-can-put-you-scene-crime.

[11] *See* Maggie Fox, *Microbiomes: You Live in Your Own Germ Cloud, Study Finds*, NBC NEWS, (Aug. 28, 2014, 4:49 PM), http://www.nbcnews.com/health/health-news/microbiomes-you-live-your-own-germ-cloud-study-finds-n191366.

[12] *See* Feltman I, *supra* note 8.

[13] *See* Kupferschmidt, *supra* note 10; *In Forensics, Microbiome May Become Next Fingerprint*, SEEKER (May 12, 2015, 9:40 AM), http://www.seeker.com/in-forensics-microbiome-may-become-next-fingerprint-1769830447.html.

[14] Peer Bork, who is a computational biologist for the European Molecular Biology Laboratory in Heidelberg, Germany, thinks that individuals' microbial "signatures" might be used to identify persons. Kupferschmidt, *supra* note 10.

[15] The Fourth Amendment provides:

> The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no Warrants shall issue, but upon probable cause, supported by Oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized.

U.S. CONST. amend. IV.

[16] Silvana R. Tridico et al., *Metagenomic Analyses of Bacteria on Human Hairs: A Qualitative Assessment for Applications in Forensic Science*, 5 INVESTIGATIVE GENETICS 16 (2014), http://investigativegenetics.biomedcentral.com/articles/10.1186/s13323-014-0016-5.

constitutes an intrusion on the Fourth Amendment "person."[17] The fact that people abandon microbes on every surface touched, whether it is a computer keyboard or a cell phone, and further discard biological particles in each room they enter, whether at home or work, will necessitate a reconsideration of what privacy expectations are included in a Fourth Amendment "search."

This article, in Part II, will examine the current understanding of our microbiome, including its discovery, extent, and impact on the human body. The potential usefulness of the microbiome in helping police to identify criminals or learn clues about their behavior will also be explored. Part III will review the Supreme Court's understanding of the Fourth Amendment fundamentals of "person" and "search." Finally, Part IV will consider the potential Fourth Amendment issues raised by government collection and analysis of this microbial community in its pursuit of criminal investigations. This article suggests that, while the Court will likely uphold the warrant requirement for invasions into and onto a citizen's "person," its rulings regarding investigations of the microbiome around a person are far less certain.

II. MICROBES AND THE HUMAN MICROBIOME

The study of the human microbiome is not only new, but ongoing. "In 2007, the National Institutes of Health (NIH) launched the Human Microbiome Project [HMP]" investing $140 million with the aim to "characterize the microbial communities that inhabit the human body."[18] By exploring the relationships between these microscopic life forms and their "human hosts," the NIH planned to learn about the microbiome's impact on "human health and disease, development, physiology, immunity, and nutrition."[19] Researchers working on this "massive international collaboration"[20] will exploit both new and emerging technologies[21] to examine microorganisms that have never before been success-

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[17] Gina Kolata, *In Good Health? Thank Your 100 Trillion Bacteria,* N.Y. TIMES, June 14, 2012, at A24.

[18] Rhodes et al., *supra* note 2, at 32–33.

[19] *Id.* at 32.

[20] *Id.* at 72. The study of the human microbiome is so recent that development of rules for managing information is ongoing. "Right now, it's a little bit of a Wild West as far as microbiome data management goes." *Id.*; *see also* Ewen Callaway, *Microbiome Privacy Risk: The DNA of Microorganisms Living on a Person's Body Could Identify that Individual,* 521 NATURE 136 (2015) (summarizing a study finding that the microbiome can reveal extensive data, but that the current management of microbiome research is limited).

[21] New and emerging technologies include both DNA sequencing and "metagenomics," (which studies a sample of genetic material "extracted directly from an environmental sample" rather than culturing an individual bacterial species in the lab). Rhodes et al., *supra* note 2, at 32, 35–36. In other studies, researchers are using "machine-learning and parallel processing techniques to 'teach' computers to characterize microbiotic colonies, and to recognize patterns that would link a colony in one sample with another." Melissa Healy, *Paging 'CSI': Microbiome Analysis May be the New Fingerprint,* L.A. TIMES (May 12, 2015),

fully studied.[22] The HMP, "which has been compared to the Human Genome Project," involves "200 scientists at 80 institutions" delving into the genetics of bacteria taken from nearly 250 people.[23] These researchers have already collected "a deluge of data" which has created a "huge computational challenge."[24] The promise of human microbiome research is "a new age" of personalized medicine and nutrition based on knowledge of individual patients' personal microbiomes.[25]

The scientific community did not always appreciate the effects of the microorganisms in and on our bodies. Only in 1683, while viewing through his microscope, "material he scraped off his teeth," did Anton van Leeuwenhoek see what he called "'animalcules" and "wretched beasties."[26] The resulting "animalcular" hypothesis of infectious disease was one step along the way to Cotton Mather supporting smallpox inoculation in the 1700's, and Thomas Jefferson obtaining cowpox material in 1800 for use at Monticello.[27] In the nineteenth century, Louis Pasteur helped create the germ theory of disease while a German doctor, Robert Koch, linked specific bacteria to particular diseases, such as "anthrax, cholera, and tuberculosis."[28] By the mid-nineteenth century, some "30% to 50% of children" in cities were still dying before age five, often due to infectious disease.[29] Pasteur, however, sensed the complexity of the human-microorganism relationship, claiming "that without microbes, the human body could not function."[30] It still took time for a more nuanced picture of microorganisms to emerge.

It is now recognized that in the "ecological community" that exists in and on our bodies, some organisms can be commensal (beneficial to one organism while not harming the other), symbiotic (a relationship of mutual benefit), and pathogenic (harmful).[31] Microbes are now seen as "essential for human life,"

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http://www.latimes.co/science/sciencenow/la-sci-sn-microbiome-analysis-fingerprint-20150512-story.html.

[22] Rhodes et al., *supra* note 2, at 33.

[23] Kolata, *supra* note 17, at A24. The HMP is not the only project pursuing the microbiome, as "similar projects" are underway in "Canada, France, China, Japan, Singapore, and Australia." Rhodes et al., *supra* note 2, at 33. After the HMP, the "second-largest project" is the European Commission's Metagenomics of the Human Intestinal Tract (MetaHIT), "which will study the microbiota of the human intestinal tract and their relationship to obesity and inflammatory bowel disease." *Id.*

[24] Kolata, *supra* note 17, at A24.

[25] Rhodes et al., *supra* note 2, at 1.

[26] *Id.* at 23.

[27] *Id.* at 24.

[28] *Id.* at 25, 26.

[29] *Id.* at 16.

[30] *Id.* at 26.

[31] NIH HMP Working Group et al., *NIH Human Microbiome Project*, 19 GENOME RES. 2317, 2317 (2009).

for people need them to "digest food, to synthesize certain vitamins, (and) to form a barricade against disease-causing bacteria."[32] Scientists are learning that bacteria help regulate energy balance,[33] "build anti-inflammatory compounds" and might play a role in fighting allergies, obesity,[34] anxiety, and depression.[35]

Today, the microbiome appears to be so central to human health that scientists are bemoaning "modern plagues" inadvertently created by doctors' assaults on microbes.[36] Overuse of antibiotics contribute to the devastation of "our inner ecosystem," leading to such ailments as asthma, childhood diabetes, food allergies, and coeliac disease.[37] Increasingly, medicine has responded by using "bacteria themselves as living drugs."[38] Doctors have made "fecal transplants" from one person to another to resolve resistant gut infections.[39] Further, since modern caesarian sections prevent newborns from receiving beneficial bacteria from their mothers that usually occurs via vaginal birth,[40] some doctors have slathered "babies just after birth with a gauze pad that soaked up the microbes in their mothers' birth canal"[41] to partially "restore" and "normalize" the babies' microbiome.[42]

The cells making up the microbiome's various organisms, whether helpful or harmful, dwarf in number the cells composing the human body. There are "10 times more microbes than human cells in our bodies."[43] Specifically, there are

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[32] Kolata, *supra* note 17, at A24.

[33] Rhodes et al., *supra* note 2, at 2.

[34] Sullivan, *supra* note 5, at 2, 3; Kolata, *supra* note 17, at A24.

[35] Brian Krans, *6 Surprising Facts About the Microbes Living in Your Gut,* HEALTHLINE (Sept. 7, 2013), http://www.healthline.com/health-news/strange-six-things-you-didnt-know-about-your-gut-microbes-090713.

[36] Ali, *supra* note 4, at 1718.

[37] *Id.*

[38] Carl Zimmer, *Our Microbiomes, Ourselves,* N.Y. TIMES (Dec. 3, 2011), http://www.nytimes.com/2011/12/04/opinion/sunday/our-microbiomes-ouselves.html?_r=0 [hereinafter Zimmer I].

[39] *Id.*

[40] Carl Zimmer, *How Microbes Defend and Define Us*, N.Y. TIMES (July 10, 2010), http://www.nytimes.com/2010/07/13/science/13micro.html?_r=0 [hereinafter Zimmer II]. Babies initially are sterile due to coming from a "germ-free" womb. *Id.*

[41] Rob Stein, *Researchers Test Microbe Wipe to Promote Babies' Health After C-Sections*, NAT'L PUB. RADIO (Feb. 1, 2016), http://www.npr.org/sections/health-shots/2016/02/01/464905786/researchers-test-microbe-wipe-to-promote-babies-health-after-c-sections. Exposing caesarian-born infants to the vaginal microbiome might "help restore the microbes a baby naturally gets that help fight off disease and foster normal development." *Id.*

[42] *Id.* Babies receive further infusions of microbes from their mothers' breast milk, containing "900 species of bacteria." Sullivan, *supra* note 5, at 1. While babies begin as "microbe magnets," their microbiome "appears to stabilize" by age 3. Kolata, *supra* note 17, at 2; Sullivan, *supra* note 5, at 1.

[43] Zimmer I, *supra* note 38, at 3. "In current understanding, the human body is made up

500 to 1000 species of microbes in the human mouth alone.[44] Some microorganisms have adapted themselves so perfectly to live in our body cavities or on our body surfaces that "many could not be cultured and grown in the lab."[45] Microbes are ubiquitous, for they not only follow us "from birth to death," but "flow between us."[46] Microbes have significance beyond one individual's lifetime. One such organism, Helicobacter pylori, has "coevolved with us over millennia."[47] The microbiome has likely accelerated the evolution of our own species because "the collective genomes of the microbiome endow us with physiologic capabilities that we have not had to evolve on our own."[48] Since humans "in some sense are made mostly of microbes . . . 'we may just serve mostly as packaging.'"[49]

Distinct microbe communities reside all over our bodies; HMP researchers have sampled microorganisms in the stool, gum, nostril, palate, throat, tonsil, vagina, saliva, teeth, and even the "crook of the elbow and folds of the ear."[50] Not all of these bacteria stay with the individual; for example, the bacteria on a person's skin "can be readily dislodged and transferred to surfaces upon touching."[51] Furthermore, each person is surrounded with his or her own "personal germ cloud" which distributes microbes "onto nearby—and not so nearby—surfaces."[52] In a 24-hour day, a person sheds "at least 24 million biological particles—bacteria, viruses, spores, and more—into the air."[53] Beyond their control, "people shed bacteria constantly and indiscriminately," whether from the face, mouth, or nose.[54] The dissemination of microbes is so automatic that one couple studied by scientists had caused a hotel room to become "microbiologically identical to their home within 24 hours."[55] This day-old microbial community is quite potent, for "no matter what you do to clean . . . [the]

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of about 10 times more microbial cells (around 10^{14}) than human cells (around 10^{13})." Shrivastava et. al., *supra* note 3, at 34.

[44] Zimmer I, *supra* note 38, at 3.

[45] Kolata, *supra* note 17, at 1.

[46] Zimmer I, *supra* note 38, at 2.

[47] Ali, *supra* note 4, at 1.

[48] Rhodes et al., *supra* note 2, at 2.

[49] Kolata, *supra* note 17, at 24.

[50] *Id.* at 2. Essentially, "half of your stool . . . is microbial biomass." *Id.*

[51] Noah Fierer et al., *Forensic Identification Using Skin Bacterial Communities*, 107 PROC. NAT'L ACAD. SCI. 6477, 6477 (2010).

[52] Kluger, *supra* note 1.

[53] *Id.*

[54] Kupferschmidt, *supra* note 10. Clothes cannot confine these microbes, "[a]s soon as you sit down, your bottom or your vaginal microbiota is expelled onto that surface and it is actually reasonably persistent until the next person sits down." *Id.*

[55] Rachel Feltman, *Hotel Rooms Aren't Yucky—You Colonize Them with Your Own Personal Bacteria within Hours*, WASH. POST (Aug. 28, 2014), https://www.washingtonpost.com/news/speaking-of-science/wp/2014/08/28/cops-could-use-bacterial-signatures-to-catch-a-murderer/ [hereinafter Feltman II].

room, your microbial signature has wiped out basically every trace of the previous resident."[56]

Each individual's microbiome, whether left on a surface or dispersed in a cloud, is a personally unique "biological calling card," as particular to the person as fingerprints or DNA.[57] Researchers measuring "the airborne bacteria surrounding volunteers in a sanitized chamber were able to identify some of the subjects by their microbial cloud."[58] This microbial signature can remain somewhat stable over time. Although babies are initially "microbe magnets,"[59] by age three even identical twins have "a unique coat" of microbes that "changes somewhat but remains largely consistent at its core and over time."[60] Therefore, "researchers have successfully matched smartphones and keyboards to the people who used them by analyzing their microbial signatures."[61]

Both the microbiome's uniqueness and its stability "could have [significant] implications for . . . criminal forensics."[62] Just as with fingerprints or DNA, law enforcement might use the specific "mix of species and strains in a person's microbiome" to place a criminal at a crime scene.[63] The microbiome also can supply police with information that traditional biological samples, including DNA, cannot. A person's microbes could inform the government about a person's gender,[64] "age, . . . geographic location, and overall health."[65] In addition, the microbiome might aid profilers in constructing a picture of a suspect because it holds clues regarding a person's lifestyle, such as whether a person of interest lives in the city, suburbs, or out in the country, or whether he or she is a smoker, a drinker, a migraine sufferer,[66] or a pet owner.[67]

Studies have begun to assess the effectiveness of using the microbiome to identify criminals. Scientists "swabbed individual keys from three personal computer keyboards and compared the communities on those keys to the bacterial communities on the fingerprints of the keyboard owners."[68] The scientists, finding that the bacterial communities on the owner's fingers "resembled the

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[56] *Id.*

[57] Kluger, *supra* note 1, at 1.

[58] Kupferschmidt, *supra* note 10, at 3.

[59] Kolata, *supra* note 17, at 2.

[60] Mandy Oaklander, *A Strange New Way to Solve Crimes*, TIME, Aug. 31, 2015, at 44, 46.

[61] *Id.*

[62] Kluger, *supra* note 1.

[63] Kupferschmidt, *supra* note 10, at 2.

[64] *Id.* "The presence of one bacteria family alone—Lactobacillus—was sufficient to determine the gender of (an) occupant, because it is a microbe most commonly found in vaginal samples from healthy women." Kluger, *supra* note 1, at 2.

[65] *In Forensics, Microbiome May Become Next Fingerprint*, *supra* note 13.

[66] *See id.*

[67] *See* Fox, *supra* note 11, at 2.

[68] Fierer et al., *supra* note 51, at 6479.

communities on the owner's keyboards," concluded that "bacterial DNA can be recovered from relatively small surfaces.[69] Additionally, the composition of the keyboard-associated communities are distinct across the three keyboards, and that individuals leave unique bacteria 'fingerprints' on their keyboards."[70] The microbes on touched surfaces can potentially be used for a variety of items because human skin "harbors large numbers of bacteria that can readily be dislodged and transferred to surfaces upon touching."[71] This bacteria will likely leave a "persistent 'trail'" because they can remain on surfaces "for prolonged periods" due to being "highly resistant to environmental stresses, including moisture, temperature, and UV radiation."[72] Criminals will not simply wash their hands of their guilt because the stability of the bacterial communities persists; "palm surface bacterial communities recover within hours after hand washing."[73] Furthermore, the bacterial variation between people exceeds the variation of bacteria on one person over time.[74] The skin bacteria, being "unique, temporally stable, and transferable," could provide bacterial fingerprints of the criminal who last touched the relevant surface.[75]

Microbes might also aid in identifying rapists; for instance, microbes on pubic hair might link a suspect to a person with whom he or she has recently had sexual intercourse.[76] In one small study, researchers considered whether "microbes on pubic hair—which vary from person to person—could be used as evidence in sexual assault cases."[77] Pubic hair, which houses over 70 kinds of bacteria, could potentially "provide a new way of linking the offender with the victim" due to the "transfer of bacteria between victim and the attacker.[78] Such an identification technique is of particular importance in light of rapists' increased use of condoms in order to prevent DNA transmission.[79] Of particular note, two people in the study who had engaged in intercourse "18 hours before the sample collection" showed a sudden increase in the similarity of "their pubic hair bacteria."[80] This finding could foreshadow another way to forensically

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[69] *Id.* at 6477–78. This technique may distinguish identical twins since they "harbor substantially different microbial communities." *Id.* at 6479.

[70] *Id.*

[71] Shrivastava et al., *supra* note 3, at 37.

[72] *Id.*

[73] *Id.*

[74] *See id.*

[75] *Id.*

[76] *See* Jenna McLaughlin, *Could Bacteria Help Convict Rapists?*, MOTHER JONES (Dec. 19, 2014), http://www.motherjones.com/politics/2014/12/microbiome-bacteria-forensics-rape.

[77] Feltman I, *supra* note 8.

[78] *Id.* at 1–2.

[79] *See id.*

[80] *Id.* at 2.

link offender and victim.[81]

There are no guarantees that the microbiome can ultimately fulfill all of these promises.[82] As *Science* noted, "The field is in its infancy; so far, the only crime it has helped solve occurred on the hit TV show *CSI: Miami*."[83] The potential of microbes "must be evaluated carefully"[84] because "you don't want to start accusing and messing up the lives of many people just because they have a microbiome similar to the one found at the crime scene."[85] Particular dangers include cold cases, since an individual's microbiome might change over decades or with a move to a different country.[86] It has even been speculated that a criminal might successfully hide his or her signature by ingesting antibiotics, just as "criminals who used to burn their fingertips with acid" sought to avoid identification.[87] Still, the potential implications of this new technology should not be ignored.[88] Particularly, it is important to realize that law enforcement's collection and use of individuals' microbiomes could have a significant impact on Fourth Amendment rights.

III. FOURTH AMENDMENT PRIVACY FUNDAMENTALS

In analyzing government investigation of a person's microbiome, the Court will not be writing on a blank slate. The Court has already established fundamental principles that offer guidance for assessing a Fourth Amendment "search" of a "person."[89] A full understanding of the privacy implications involving official exploration of microbes around, on, and in a person must begin with an overview of certain fundamental cases.

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[81] *Id.* Scientists have considered the "forensic potential of the salivary microbiome" in saliva-transferring crimes. Alan Gunn & Sarah J. Pitt, *Microbes as Forensic Indicators*, 29 TROPICAL BIOMEDICINE 311, 315 (2012). Bacteria from skin and clothing bites could be identification tools. *Id.* The salivary microbiome is influenced by such identifying factors as "oral hygiene, diet, geography, and genetics." *Id.* Post-mortem gut microbes can determine length of decomposition and place of death. Williams, *supra* note 8.

[82] The microbes humans "shed outdoors can be quickly dispersed by weather." Kluger, *supra* note 1, at 1. In contrast, microbes from crimes committed indoors, "in what environmental scientists call the built environment," can collect. *Id.* at 2. Criminals providing germ clouds would have to spend hours in a location without heating and air conditioning. *See id.*

[83] Kupferschmidt, *supra* note 10, at 2.

[84] Salyards, *supra* note 5.

[85] Kupferschmidt, *supra* note 10.

[86] *Id.*

[87] *Id.*

[88] *Id.*

[89] Terry v. Ohio, 392 U.S. 1, 6–7 (1968); Katz v. United States, 389 U.S. 347, 351 (1967).

A. *A Fourth Amendment Intrusion Around a Person Amounting to a "Search"*

Rather than dealing with every official observation of an item, person, or activity, Fourth Amendment privacy only involves those intrusions that amount to a "search."[90] Therefore, to ask whether the Fourth Amendment right to privacy exists is to ask whether there is a "search."[91] That question leads to a more fundamental inquiry: what constitutes a Fourth Amendment "search?" Since 1967, the definition favored by the Court is supplied in *Katz v. United States*.[92]

In *Katz*, FBI agents electronically eavesdropped on Katz's side of a telephone conversation that occurred in a Los Angeles phone booth.[93] In considering whether the federal agents had performed a search of Katz's phone conversation, the Court declared that the "Fourth Amendment protects people, not places."[94] The Court further reasoned, "[W]hat a person knowingly exposes to the public, even in his own home or office, is not a subject of Fourth Amendment protection. . . . But what he seeks to preserve as private, even in an area accessible to the public, may be constitutionally protected."[95] Therefore, under *Katz*, Fourth Amendment protection extends to various locations, including a business office, a friend's apartment, a taxicab, or a phone booth.[96] The Court thus ruled that the government committed a search against Katz by violating the "privacy upon which he justifiably relied."[97]

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[90] U.S. CONST. amend. IV.

[91] *Id.* Since the Fourth Amendment also applies to "seizures," questions can also arise regarding whether an official act amounts to a Fourth Amendment seizure. Such issues, however, are beyond the scope of this article.

[92] *Katz*, 389 U.S. at 350–51 (defining a Fourth Amendment search as a government intrusion upon an individual's reasonable expectation of privacy). In United States v. Jones, the Court offered a physical intrusion definition for a Fourth Amendment search. United States v. Jones, 132 S. Ct. 945, 949 (2012). The *Jones* Court concluded, "[W]here, as here, the Government obtains information by physically intruding on a constitutionally protected area, such a search has undoubtedly occurred." *Id.* at 951 n.3. In relying on physical trespass, *Jones* harkened back to the "physical invasion" test in Olmstead v. United States. Olmstead v. United States, 277 U.S. 438, 466 (1928). In *Olmstead*, a case involving electronic eavesdropping during the prohibition era, the Court ruled, "There was no searching" because "there was no entry of the houses and offices of the defendants." *Id.* at 464. The Court in *Katz* criticized the "constitutionally protected" area test for deflecting "attention from the problem presented by this case" and offering a "narrow view." *Katz*, 389 U.S. at 351, 353. The *Olmstead/Jones* definition of a Fourth Amendment search is beyond the scope of this article.

[93] *Katz*, 389 U.S. at 348.

[94] *Id.* at 351.

[95] *Id.*

[96] *Id.* at 352.

[97] *Id.* at 353.

Justice Harlan, in his concurrence, provided *Katz's* definition of a Fourth Amendment search, holding that "there is a twofold requirement, first that a person have exhibited an actual (subjective) expectation of privacy and, second, that the expectation be one that society is prepared to recognize as 'reasonable.'"[98] Justice Harlan therefore determined that a person's home would offer privacy while "objects, activities, or statements" exposed to "plain view" would fall outside any protection as lacking a reasonable "expectation of privacy."[99] The Court has subsequently embraced Justice Harlan's "reasonable expectation of privacy" formulation of a Fourth Amendment search as the "touchstone"[100] and "lodestar" test.[101] The Court has applied the *Katz* test to determine whether searches have occurred in various situations, including a freight accident exposing transported goods,[102] a government informant's radio broadcasts of a conversation,[103] an inmate's prison cell,[104] and burned buildings.[105] In light of the Court's long reliance upon *Katz's* definition of a Fourth Amendment "search", any government collection, analysis, and use of a person's microbiome will likely be measured against this Fourth Amendment "touchstone."[106]

B. *A Fourth Amendment Intrusion on a Person*

In *Terry v. Ohio*, the Court considered whether an officer's touching of a person's body, through the outer clothing, amounted to a Fourth Amendment intrusion on the "person."[107] In *Terry*, a detective grabbed Terry, patted down his clothes, and found a pistol in his overcoat.[108] Emphasizing the Fourth Amendment's "inestimable right of personal security[,]"[109] *Terry* declared, "[n]o right is held more sacred, or is more carefully guarded, by the common law, than the right of every individual to the possession and control of his own person, free from all restraint."[110] The Court deemed that the detective did

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[98] *Id.* at 361.

[99] *Id.*

[100] Oliver v. United States, 466 U.S. 170, 177 (1984) (declaring, "the touchstone of Amendment analysis has been the question whether a person has a 'constitutionally protected reasonable expectation of privacy.'").

[101] Smith v. Maryland, 442 U.S. 735, 739 (1979) ("In determining whether a particular form of government-initiated electronic surveillance is a 'search' within the meaning of the Fourth Amendment, our lodestar is *Katz v. United States*.").

[102] United States v. Jacobsen, 466 U.S. 109, 111, 113 (1984).

[103] United States v. White, 401 U.S. 745, 746–47 (1971).

[104] Hudson v. Palmer, 468 U.S. 517, 524–25 (1984).

[105] Michigan v. Clifford, 464 U.S. 287, 292 (1984).

[106] Oliver v. United States, 466 U.S. 170, 177 (1984).

[107] Terry v. Ohio, 392 U.S. 1, 6–7 (1968).

[108] *Id.* at 7.

[109] *Id.* at 8–9.

[110] *Id.* at 9.

search Terry,[111] for "it is nothing less than sheer torture of the English language to suggest that a careful exploration of the outer surfaces of a person's clothing all over his or her body in an attempt to find weapons is not a 'search.'"[112] Further, *Terry* saw such a street frisk to be "a serious intrusion upon the sanctity of the person, which may inflict great indignity and arouse strong resentment, and it is not to be undertaken lightly."[113] In emphasizing the severity of this intrusion, *Terry* offered that, for a standard frisk, "[t]he officer must feel with sensitive fingers every portion of the prisoner's body. A thorough search must be made of the prisoner's arms and armpits, waistline and back, the groin and area about the testicles, and entire surface of the legs down to the feet."[114]

Despite the intrusive nature of a frisk, the Court, balancing the interests of both the citizen and the government, found the detective's pat down of Terry's person reasonable.[115] The officer's need to neutralize any danger outweighed the individual's concerns, even though the search for weapons constituted an "intrusion upon the sanctity of the person."[116] Later discussing the *Terry* stop and frisk in *Adams v. Williams* the Court candidly noted, "The Fourth Amendment does not require a policeman who lacks the precise level of information necessary for probable cause to arrest to simply shrug his shoulders and allow a crime to occur or a criminal to escape."[117] In fact, it is "the essence of good police work" to employ the "intermediate response" of an investigative stop.[118] The level of certainty needed for such a seizure and search short of arrest has since come to be known as "reasonable suspicion."[119]

Even though the *Terry* Court ultimately found the detective's frisk reasonable, the Court also established that the government need not touch a person's skin, nor even penetrate beneath it, in order to create a search of a citizen's "person."[120] Law enforcement officers who wish to collect microbes from the surface of a person's skin will thus have to contend with *Terry's* conclusion that they are intruding on a "sacred" Fourth Amendment right.[121]

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[111] *Id.* at 19 ("In this case there can be no question, then, that Officer McFadden 'seized' petitioner and subjected him to a 'search' when he took hold of him and patted down the outer surfaces of his clothing.").

[112] *Id.* at 16.

[113] *Id.* at 17.

[114] *Id.* at 17 n.13 (citing L.L. Priar & T.F. Martin, *Searching and Disarming Criminals*, 45 J. CRIM. L. CRIMINOLOGY & POLICE SCI. 481 (1954)).

[115] *Id.* at 30.

[116] *Id.* at 26.

[117] Adams v. Williams, 407 U.S. 143, 145 (1972).

[118] *Id.*

[119] Minnesota v. Dickerson, 508 U.S. 366, 374 (1993) (noting that if police have "reasonable suspicion based on specific and articulable facts" to believe a person "may be armed and dangerous, they may conduct a protective search for weapons").

[120] *Terry*, 392 U.S. 1.

[121] *Id.* at 9.

C. *A Fourth Amendment Intrusion In a "Person"*

A half-century ago, in *Schmerber v. California*, the Court confronted the Fourth Amendment implications of a government intrusion inside an individual's body.[122] In *Schmerber*, the defendant was hospitalized after crashing his car into a tree.[123] Noting Schmerber's "symptoms of drunkenness" both at the accident scene and at the hospital, police directed a physician to draw Schmerber's blood for the purposes of blood-alcohol testing.[124] Schmerber objected to the blood test as a violation of his Fourth Amendment rights.[125]

Noting the Fourth Amendment's explicit protection of "persons," *Schmerber* cautioned that the Amendment's "overriding function" was "to protect personal privacy and dignity."[126] The Court understood the uniqueness of *Schmerber*[127] because it involved "intrusions beyond the body's surface."[128] Moreover, *Schmerber* emphasized that the "integrity of an individual's person is a cherished value of our society."[129] Despite these weighty considerations, the Court allowed the non-consensual blood withdrawal so long as this intrusion was justified under the circumstances and carried out in a reasonable manner.[130] The Court reasoned that securing Schmerber's blood for blood alcohol content evidence was appropriate because the police officer demanding the blood draw had probable cause that alcohol remained in Schmerber's veins,[131] and with each pump of his heart, Schmerber's bodily "functions" threatened to destroy evidence by eliminating the alcohol in his system.[132] Finally, the Court determined that the police officer obtained the blood evidence in a reasonable manner because he ordered a physician to perform a highly effective and commonplace test in a hospital environment.[133] Thus, even though law enforcement

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[122] Schmerber v. California, 384 U.S. 757, 766–67 (1965) (declaring, when considering "the extraction of blood . . . [t]he question is squarely presented . . . whether the chemical analysis introduced in evidence in this case should have been excluded as the product of an unconstitutional search and seizure").

[123] *Id.* at 758, n.2.

[124] *Id.* at 758, 769.

[125] *Id.* at 759, 766–67.

[126] *Id.* at 767.

[127] *Id.* at 768 (noting that the Court "write[s] on a clean slate" in this case of first impression).

[128] *Id.* at 768–69.

[129] *Id.* at 772.

[130] *Id.* at 768 ("[T]he questions we must decide in this case are whether the police were justified in requiring petitioner to submit to the blood test, and whether the means and procedures employed in taking his blood respected relevant Fourth Amendment standards of reasonableness."). *Schmerber* also declared "the record shows that the test was performed in a reasonable manner." *Id.* at 771.

[131] *Id.* at 768–69.

[132] *Id.* at 770–71.

[133] *Id.* at 771.

invaded a citizen's own body, implicating a right "basic to a free society[,]"[134] the *Schmerber* Court allowed the intrusion since it was performed reasonably and with probable cause.[135]

For the most part, *Schmerber* remains good law. In *Missouri v. McNeely*, a 2013 drunk driving case, the Court found that *Schmerber* still "fits comfortably within our case law."[136] However, the *McNeely* Court offered a qualification to *Schmerber*, holding that "in drunk-driving investigations, the natural dissipation of alcohol in the bloodstream does not constitute an exigency in every case sufficient to justify conducting a blood test without a warrant."[137] In requiring a warrant for non-emergency blood withdrawals, *McNeely* reiterated, "any compelled intrusion into the human body implicates significant, constitutionally protected privacy interests."[138] The *Schmerber-McNeely* precedent will thus limit microbiome hunters seeking to intrude within a person's body.

IV. MICROBES AND THE HUMAN MICROBIOME

A. *The Shedding of the Skin Microbiome, the Microbial "Cloud," and the Definition of a Fourth Amendment "Search" Around and Beyond the Person*

1. A Person's Exposure or Conveyance of Information to Third Parties Might Undermine Any Reasonable Privacy Expectations in the Shared Information

The concept of a reasonable expectation of privacy has evolved over the five decades that the Court has employed *Katz's* definition of a Fourth Amendment search. In one refinement of *Katz*, the Court has allowed an individual's own actions to diminish privacy expectations.[139] Therefore, privacy expectations, and consequently what is meant by a "search" and its corresponding Fourth Amendment protections, have become fragile. It is possible that one thoughtless act could result in an abandonment of Fourth Amendment protection. As discussed below, the case law limiting Fourth Amendment protection due to sharing information with third parties could have profound implications for individuals, given that a person continuously sheds, on average, one million microscopic beings an hour.[140]

As early as 1973 in *United States v. Dionisio*, the Court determined that

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[134] *Id.* at 767.

[135] *Id.* at 768, 772.

[136] Missouri v. McNeely, 133 S. Ct. 1552, 1560 (2013).

[137] *Id.* at 1568.

[138] *Id.* at 1565.

[139] United States v. Miller, 425 U.S. 435, 443 (1976) (ruling that a bank depositor "takes the risk, in revealing his affairs to another, that the information will be conveyed by that person to the Government").

[140] Kluger, *supra* note 1.

sharing information could erode Fourth Amendment rights.[141] In this case, a grand jury ordered Dionisio to supply a voice exemplar for comparison with recordings made as part of a federal investigation of illegal gambling.[142] When *Dioniso* raised Fourth Amendment concerns, the Court reiterated *Katz's* maxim that no protection existed for what "a person knowingly exposes to the public, even in his own home or office."[143] Once a person chooses to open his or her mouth, he or she broadcasts both tone of voice and manner of speech.[144] Thus, one cannot have "a reasonable expectation that others will not know the sound of his voice, any more than he can reasonably expect that his face will be a mystery to the world."[145] Since "nothing is being exposed to the grand jury that has not previously been exposed to the public at large," Dioniso undermined his own Fourth Amendment rights by previously speaking "in casual contacts with strangers."[146] The Court equated Dionisio's voice to his fingerprints, the collection of which did not involve a search.[147] *Dionisio* even declared that the only person who could make a Fourth Amendment privacy claim regarding the identifying characteristics of speech was "the rare recluse who chooses to live his life in complete solitude."[148]

Dionisio could have alarming implications for privacy of the microbiome. As we speak, even in the most "casual contacts,"[149] we not only share the distinct characteristics that identify our voices as our own, but we also breathe out a myriad microbes.[150] If the human voice is essentially the same as fingerprints "exposed to the public at large,"[151] so too could be the bacteria and other life forms abandoned each time a person opens his or her mouth to speak or sigh. In one study, most people "could be clearly detected by their airborne bacterial emissions, as well as (by) their contribution to settled particles" around them.[152] Presumably, *Dionisio's* advice to those who wish to maintain privacy in such "personalized microbial cloud(s)" would be as unhelpful as it was to those concerned about the privacy of their voice: Shut up and seek solitude.

The Court again relied on *Katz's* "knowingly exposes" language to limit the

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[141] *See* United States v. Dionisio, 410 U.S. 1 (1973).

[142] *Id.* at 2–3.

[143] *Id.* at 14.

[144] *Id.*

[145] *Id.* (noting that in our daily lives, we constantly share the "identifying characteristics" of our voices "for all to see or hear").

[146] *See generally id.*

[147] *Id.* at 15.

[148] *Id.* at 14.

[149] *Id.*

[150] *See generally* Kupferschmidt, *supra* note 10 (explaining that scientists have found that humans continually shed microbes with each exhale).

[151] *Dionisio*, 410 U.S. at 14.

[152] James F. Meadow et al., *Humans Differ in Their Personal Microbial Cloud,* PEERJ (2015), https://peerj.com/articles/1258.pdf.

scope of a Fourth Amendment search in *United States v. Miller*.[153] Mitchell Miller, found in possession of 175 gallons of whiskey, was facing charges of intending to defraud the government of whiskey tax.[154] As a bank depositor, Miller argued that the government's collection of his banking records, such as checks and deposit slips, intruded upon his reasonable expectation of privacy.[155] However, the Court found "no legitimate expectation of privacy" in documents containing "only information voluntarily conveyed to the banks and exposed to their employees in the ordinary course of business."[156] *Miller* blamed the lack of Fourth Amendment protection on the depositor who, by making use of the banking system, took "the risk, in revealing his affairs to another, that the information w[ould] be conveyed by that person to the Government."[157] The rationale in *Miller* left the citizenry with a stark reality: the only person deserving of Fourth Amendment protection is the one who shuns all banking in favor of stuffing the mattress with cash.[158] However, banking records are not the only vulnerable financial papers. Adhering to its knowing-exposure doctrine, in *Couch v. United States* the Court found no reasonable privacy expectation in income tax returns, noting "there can be little expectation of privacy where records are handed to an accountant, knowing that mandatory disclosure of much of the information therein is required in an income tax return."[159]

The Court continued with this understanding of reasonable privacy expectations in *Smith v. Maryland*.[160] In *Smith*, Baltimore police used a pen register to recover the numbers a robber dialed from his phone.[161] The Court found no expectation of privacy in numbers dialed from a telephone since callers realize "that they must 'convey' phone numbers to the telephone company, since it is through telephone company switching equipment that their calls are completed."[162] Any privacy expectation was considered unreasonable given that "[t]his Court consistently has held that a person has no legitimate expectation of privacy in information he voluntarily turns over to third parties."[163] In noting that one must convey a number to the phone company "if he wished to complete his

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[153] United States v. Miller, 425 U.S. 435, 435 (1976) (declaring there was no reasonable expectation of privacy in bank records because they contained "only information voluntarily conveyed to the banks and exposed to their employees in the ordinary course of business").

[154] *Id.* at 436.

[155] *Id.* at 442.

[156] *Id.* (internal quotation marks omitted).

[157] *Id.* at 443 (concluding that "no Fourth Amendment interests of the depositor are implicated here").

[158] *Id.* at 151.

[159] Couch v. United States, 409 U.S. 322, 335–36 (1973).

[160] Smith v. Maryland, 442 U.S. 735, 742 (1979).

[161] *Id.*

[162] *Id.* at 742.

[163] *Id.* at 743–44.

call," *Smith* effectively established an unrealistic option for anyone wishing to preserve the privacy of dialed numbers: to simply not make any calls.[164]

Soon after, the Court provided a similarly unrealistic choice for drivers in *United States v. Knotts*.[165] In Knotts, narcotics agents used a "beeper" tracking device to follow a car as it drove to an amphetamine lab.[166] The Court in *Knotts* found that the driver lacked an expectation of privacy from law enforcement surveillance[167] because, as he travelled on the public streets, "he voluntarily conveyed to anyone who wanted to look the fact that he was traveling over particular roads in a particular direction, the fact of whatever stops he made, and the fact of his final destination when he exited from public roads onto private property."[168] As in *Dionisio*, the Court in *Knotts* left any citizen wishing to be free from government surveillance with the impractical option of operating as a solitary recluse.[169]

Miller, Couch, Smith, Dionisio, and *Knotts* instruct that, in knowingly conveying or revealing information to any other entity, person, or group, one loses any reasonable expectation of privacy against the government obtaining that information.[170] The cumulative impact of these precedents presents troubling implications for microbiome privacy, for a "unique fog of germs" that may "be better at identifying someone" than a person's own fingerprints, follows each citizen wherever he or she goes.[171] Beyond our will, we are Hansels and Gretels leaving a trail of 10^6 breadcrumbs available to all others.[172] Therefore, conveying these microbes to anyone is to convey them to all, including the government.

The Court carried its conveyance to third parties doctrine to its logical extreme in *California v. Greenwood*, where snoops, tabloid reporters, and dogs influenced reasonable expectations of privacy.[173] In *Greenwood*, police

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[164] *Id.* at 743.

[165] United States v. Knotts, 460 U.S. 276 (1983).

[166] *Id.* at 278–79 (1983).

[167] *Id.* at 276 ("A person traveling in an automobile on public thoroughfares has no reasonable expectation of privacy in his movements from one place to another.").

[168] *Id.* at 281–82.

[169] *Id.*; *see also* United States v. Dionisio, 410 U.S. 1, 15 (1973) (finding that only a "rare recluse" could have the reasonable expectation of privacy from surveillance over characteristics of his voice).

[170] *See Knotts*, 460 U.S. 276; Smith v. Maryland, 442 U.S. 735 (1979); United States v. Miller, 425 U.S. 435 (1976); Couch v. United States, 409 U.S. 322 (1973); *Dionisio*, 410 U.S. 1.

[171] Jim Algar, *Your Own Personal Germ Cloud: How Your Microbes Follow You Around,* TECH TIMES (Sept. 16, 2016), http://www.techtimes.com/articles/ 14373/20140829/ you-own-personal-germ-cloud-how-your-microbes-follow-you-around.htm.

[172] Meadow et al., *supra* note 152, at 1–2 ("[H]umans shed approximately 10^6 particles (> .05 μm diameter) per hour").

[173] California v. Greenwood, 486 U.S. 35, 40 n.2 (1988).

searched through garbage that was left on the curb for trash collection.[174] Ultimately, the Court found that police did not commit a search because the residents relinquished their own Fourth Amendment claim by "expos[ing] their garbage to the public."[175] *Greenwood*, in declaring that it was "common knowledge" that leaving out one's trash on the curb left it "readily accessible to animals, children, scavengers, snoops, and other members of the public," came uncomfortably close to labeling the execution of this household chore as a cavalier assumption of risk that a home's refuse may become available for "public inspection" and "public consumption."[176] *Greenwood* thus transformed the act of leaving trash out for weekly pickup into an act of outright abandonment since anyone who placed garbage "at the curb for the express purpose of conveying it to a third party, the trash collector," gambled that the collector might rummage through the trash or allow the police to do so.[177]

Greenwood could prove most troubling for those wishing to preserve the privacy of their microbiomes, because the Court limited the scope of Fourth Amendment protection based on speculations about legitimate invasions of privacy.[178] Furthermore, some individuals have already conveyed their microbiomes to third parties as directly as any homeowner has rolled his trash to the curb. As previously noted, almost 250 people have allowed the HMP to genetically sequence the bacteria found on their bodies.[179] Additionally, "biobanks," or "biorepositories," hold collections of biological health specimens for "research purposes."[180] Such facilities already hold the following:

> tissue samples, body fluids (e.g., blood, serum, plasma, and saliva), waste products (e.g., hair, nail clippings, urine, and feces), cells, (e.g., from cheek and skin swabs), and genetic material (both DNA and RNA).[181]

Microbiome samples are collected "as part of a medical intervention during which tissues or fluids are already being sampled for diagnostic or treatment purposes," during "routine medical procedures," and by "individuals who consent to participate in a research study."[182] Applying the logic of current Fourth Amendment conveyance to third party precedent could lead the Court to refuse Fourth Amendment protection for microbiome samples on two possible grounds. First, the persons who supplied these specimens "voluntarily con-

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[174] *Id.* at 37–38.

[175] *Id.* at 40.

[176] *Id.*

[177] *Id.*

[178] *See generally id.*

[179] Kolata, *supra* note 17, at 1.

[180] Rhodes et al., *supra* note 2, at 182.

[181] *Id.* at 183. One of the largest biobanks proposed, UK Biobank, plans to collect samples from nearly "500,000 British residents." *Id.*

[182] *Id.* at 183–84.

veyed"[183] information "to third parties."[184] Second, by turning over this information to another person, nothing stops an immoral "snoop" from purchasing this information from an unprincipled scientist or biobank record keeper.[185]

In order to usher in the "new age" of personalized medicine promised by scientists' research of the microbiome, the Court might have to reassess its knowing-exposure-to-third-parties doctrine. Patients, upon learning that handing over information in the normal course of medicine, or donating it to advance scientific knowledge, effectively destroys any reasonable expectations of privacy, might balk at giving up samples for any purpose other than their own medical necessity. This in turn might slow or stifle medical progress. Instead of being guided by the potential privacy invasions committed by our worst neighbors, perhaps the Court should interpret Fourth Amendment rights in light of the need to advance scientific progress for all.

The Court might be awakening to the need for such reassessment. In her concurring opinion in *United States v. Jones*, Justice Sotomayor acknowledged, "it may be necessary to reconsider the premise that an individual has no reasonable expectation of privacy in information voluntarily disclosed to third parties."[186] Justice Sotomayor proposed to narrow the third party disclosure doctrine by refusing to "assume that all information voluntarily disclosed to some member of the public for a limited purpose is, for that reason alone, disentitled to Fourth Amendment protection."[187] While Justice Sotomayor made this suggestion in the context of digital information shared through cell phones and the Internet, such an argument would be even more powerful in the context of the microbiome, which involves individuals' own health, behavior, and bodies.[188]

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[183] United States v. Miller, 425 U.S. 435, 442 (1976).

[184] Smith v. Maryland, 442 U.S. 735, 743–44 (1979).

[185] California v. Greenwood, 486 U.S. 35, 40–41 (1988).

[186] United States v. Jones, 132 S. Ct. 945, 957 (2012) (Sotomayor, J., concurring).

[187] *Id.*

[188] *Id.* Moreover, the Court's third party doctrine could have implications beyond scientific research. There seems a reasonably good chance that the information in one's microbiome could become monetized, as personal information has already become in other realms of life. *See generally* Charles Duhigg, *How Companies Learn your Secrets*, N.Y. TIMES (Feb. 16, 2012), http://www.nytimes.com/2012/02/19/magazine/shopping-habits.html?_r=2&hp=&pagewanted=all; Kara Brandeisky, *7 Ways to Protect your Privacy Online,* TIME (June 5, 2014), http://time.com/money/2819049/data-brokers-online-privacy-tools/. If retailers can track buying histories to predict whether a shopper might be expecting a baby, and data brokers can employ search data to aid online advertisers, certainly insurers might find the predictive value of microbiomes useful. *See generally* Duhigg, *supra*; Brandeisky *supra*. An example of the monetary use of private information comes from data that indicates that "human gut microbiota fall into three enterotypes." Rhodes et al., *supra* note 2, at 107. If it turned out that "some enterotypes are less conducive to good health, information about them could be stigmatizing to the individuals with that enterotype." *Id.* at 108. This could translate into higher premiums from a life insurer. *Id.* Businesses could have an incentive to learn the most private information about us that we have "conveyed" only for medical, donative,

From *Dionisio* to *Greenwood*, the Court has given citizens a choice, however extreme, to either opt out of certain activities in order to keep the government at bay or to live as a recluse.[189] The problem, of course, is that participation in these activities is a normal part of living in society. *Dionisio* and its progeny would not only require that a person refrain from handing over tax records to an accountant, financial paperwork to a banker, and trash to a garbage collector, but also prevent the most basic interactions of driving, dialing a phone, or even speaking. To choose privacy from government intrusion here is to cut one's self off from the greater world.

When it comes to one's microbiome, however, people cannot even make this choice, no matter how stark. Individuals are not in control of their dispersal of microscopic life forms. Everyone must breathe, and therefore is forced to "constantly and indiscriminately"[190] broadcast "microbial assemblages" as "bioaerosols."[191] The fact that our shedding of bacteria, viruses, and spores is beyond any person's volition, however, might not impress the Court, since arguments about the unwilling loss of privacy has found little favor in the past. In *Oliver v. United States*, the Court refused to find that officers committed a Fourth Amendment search by walking onto landowners' large tracks of land, because "open fields do not provide the setting for those intimate activities that the Amendment is intended to shelter from government interference or surveillance."[192] The Court reached this conclusion in *Oliver* despite the landowners' dedicated efforts to preserve their privacy.[193]

In *Oliver,* Kentucky State Police entered a farm finding a marijuana field over a mile away from the landowner's home.[194] The landowner "had posted 'No Trespassing' signs at regular intervals and had locked the gate at the entrance to the center of the farm."[195] Moreover, the landowner's field was highly secluded, "bounded on all sides by woods, fences, and embankments," and therefore could not "be seen from any point of public access."[196] Police only found the marijuana by walking "for several hundred yards" beyond the 'No Trespassing' signs, which provoked a shouted warning that, "[n]o hunting is allowed."[197] The District Court in *Oliver* concluded that the landowner had a "reasonable expectation that the field would remain private" because he "had

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or business purposes. Duhigg, *supra*; Brandeisky *supra*. Under the third-party doctrine, the government would not be far behind.

[189] *See* United States v. Dionisio, 410 U.S. 1 (1973); California v. Greenwood, 486 U.S. 35 (1988).

[190] Kupferschmidt, *supra* note 10.

[191] Meadow et al., *supra* note 152, at 1.

[192] Oliver v. United States, 466 U.S. 170, 179 (1984).

[193] *Id.* at 173.

[194] *Id.*

[195] *Id.*

[196] *Id.* at 174.

[197] *Id.* at 173.

done all that could be expected of him to assert his privacy in the area of farm that was searched."[198]

Meanwhile, in *Oliver's* companion case, *Maine v. Thornton*, police officers followed a path into the woods to find fenced-in patches of marijuana.[199] The trial court in *Thornton* also granted a motion to suppress because the "'No Trespassing' signs and the secluded location of the marihuana [sic] patches evinced a reasonable expectation of privacy."[200]

However, the Supreme Court in *Oliver* gave little deference to either of the state trial courts in considering whether the landowners had reasonable expectations of privacy. *Oliver* rejected the lower courts' findings of reasonable expectations of privacy by declaring the following *per se* rule: "an individual may not legitimately demand privacy for activities conducted out of doors in fields, except in the area immediately surrounding the home."[201] This was because open fields never provided the setting for any private activity.[202] Despite the "No Trespassing" signs posted and fences built, the Court considered open fields vulnerable to public view.[203] The only consequence of finding in either of the landowners' favors here would have been to encourage the police to up the technological surveillance ante by flying an airplane over the area in question.[204] "[A]s a practical matter,"[205] these lands are open to the public, so any efforts to create privacy are of no avail.[206]

Privacy could remain beyond one's practical reach even on small plots of land not so open to the public.[207] In *California v. Ciraolo*, police following up on a tip about marijuana cultivation, were unable to see over a "6-foot outer fence and a 10-foot inner fence completely enclosing" the suspect's yard.[208] Undaunted, the officers flew over the yard in navigable airspace, enabling them to observe marijuana in the owner's "15- by 25-foot plot."[209] Even though the Court deemed this small piece of land to be within the homeowner's "curtilage"—an area so connected with the "sanctity of a man's home"[210] that it held the "most heightened" privacy expectation—the Court still found the flight did

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198 *Id.*

199 *Id.* at 174.

200 *Id.* at 175.

201 *Id.* at 178.

202 *Id.* at 179.

203 *Id.*

204 *Id.* at 179 n.9; *see* California v. Ciraolo, 476 U.S. 207 (1986).

205 *Oliver*, 466 U.S. at 179.

206 *Id.* at 179 (concluding that, "the asserted expectation of privacy in open fields is not an expectation that 'society recognizes as reasonable'").

207 *Ciraolo*, 476 U.S. at 224 (Powell, J., dissenting).

208 *Id.* at 209.

209 *Id.*

210 *Id.* (citing *Oliver*, 466 U.S. at 180).

not constitute a Fourth Amendment search.[211] The two fences, one disturbingly tall at ten feet, offered the homeowner no protection from this official intrusion; "the mere fact that an individual has taken measures to restrict some views of his activities" did not fend off this "physically nonintrusive" observation.[212] Even these "normal precautions to maintain . . . privacy" would not shield the eyes of an officer "perched on the top of a truck or a two-level bus."[213] Thus, according to the Court, the maintenance of reasonable expectation of privacy might actually require a level of paranoia that causes persons to factor in the possibility that police, outside of London, choose to employ double-decker buses.

Further, as previously noted, an individual cannot even take measures to gain a reasonable expectation of privacy in something as small as a trashcan. In *Greenwood*, the residents did not simply toss out their trash.[214] They placed their refuse in "opaque plastic bags" which were deposited only temporarily on the curb "at a fixed time," at which the collector was expected to pick it up, mingle it with the trash of others, and deposit it at the garbage dump.[215] The residents in *Greenwood* failed to account for dogs dragging garbage to neighbors, dumpster divers looking for "proofs of purchase," and trash-picking journalists hunting down statesmen, such as the Secretary of State.[216] While *Greenwood* explicitly rejected the notion that it based its ruling on Henry Kissinger's trash alone, the Court's language makes any attempt to seek privacy in trash at the curb an exercise in futility.[217]

Any person attempting to prevent the spontaneous dispersal of millions of microbes as they go about in public is in a far worse position than the defendants in *Oliver*, *Ciraolo*, and *Greenwood*. These cases dealt with a person's real property or personal effects being moved just outside of real property. The area needing protection was essentially fixed and confined. In contrast, with the microbiome, which disperses wherever one goes, there is no way to limit the area requiring protection.[218] Further, it is at least theoretically possible, however impractical, to build a large structure encompassing a yard or even a tract of land as big as many open fields. On the other hand, it is impossible to stop

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[211] *Ciraolo,* 476 U.S. at 212–14.

[212] *Id.* at 213.

[213] *Id.* at 211.

[214] California v. Greenwood, 486 U.S. 35, 39 (1988).

[215] *Id.* at 39.

[216] *Id.* at 40 n.4 ("Even the refuse of prominent Americans has not been invulnerable. In 1975, for example, a reporter for a weekly tabloid seized five bags of garbage from the sidewalk outside the home of Secretary of State Henry Kissinger . . . . A newspaper editorial criticizing this journalistic 'trash-picking' observed that 'evidently . . . everybody does it.").

[217] *Id.* at 40.

[218] Kupferschmidt, *supra* note 10 (noting that "people shed bacteria constantly and indiscriminately").

one's body from shedding millions of microbes each day.[219]

Following the example of *Dionisio's* hermit,[220] the one place where an individual can maintain privacy about his or her germ cloud is in the home. The Court considers any situation in which officers "thrust themselves into a home" to be a matter of "grave concern" to any "society which chooses to dwell in reasonable security and freedom from surveillance."[221] The Court has declared, "[f]reedom from intrusion into the home or dwelling is the archetype of the privacy protection secured by the Fourth Amendment."[222] The Court has also drawn a clear and bright line that, "[i]n the home . . . *all* details are intimate details, because the entire area is held safe from prying government eyes."[223] In the sanctum sanctorum of one's own home, a person can spread their microbiome beyond their own body, secure in the knowledge that any collection of microscopic life will occur only with a warrant previously issued by a judge.[224] To step outside the home, however, could be to step outside of Fourth Amendment protection. In focusing on the right to "retreat" into the home, the Court has drifted far from *Terry's* declaration that the "inestimable right" to be secure against unreasonable searches and seizures "belongs as much to the citizen on the streets of our cities as to the homeowner closeted in his study to dispose of his secret affairs."[225]

Birchfield v. North Dakota is perhaps the most revealing case about the Court's possible view of privacy in a person's involuntarily dispersed microbiome.[226] In this 2016 case, the Court considered whether "motorists lawfully arrested for drunk driving may be convicted of a crime or otherwise penalized for refusing to take a warrantless test measuring the alcohol in their bloodstream."[227] In analyzing this issue, *Birchfield* noted that the Fourth Amendment's text did "not specify when a search warrant must be obtained."[228] The first choice in deciding whether to require a warrant was to seek "guidance from the founding era."[229] The Court then weighed a procedure's intrusion on individual privacy against the importance of government interests in pursuing the practice.[230] Such balancing led *Birchfield* to consider the impact of breath

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219 *Id.*

220 United States v. Dionisio, 410 U.S. 1, 14 (1973).

221 United States v. Knotts, 460 U.S. 276, 282 (1983).

222 Payton v. New York, 445 U.S. 573, 587 (1980). Moreover, at the Fourth Amendment's "very core" stands "the right of a man to retreat into his own home and there be free from unreasonable governmental intrusion." Kyllo v. United States, 533 U.S. 27, 31 (2001).

223 *Kyllo*, 533 U.S. at 37, 40.

224 *Payton*, 445 U.S. at 576.

225 Terry v. Ohio, 392 U.S. 1, 8–9 (1968).

226 *See* Birchfield v. North Dakota, 136 S. Ct. 2160 (2016).

227 *Id.* at 2172.

228 *Id.* at 2173.

229 *Id.* at 2176.

230 *Id.*

and blood tests on "individual privacy interests."[231]

Birchfield's analysis of the privacy in breath provided mixed signals about the Court's future view of privacy in exhaled microbes. *Birchfield* found that breath tests did "not implicate significant privacy concerns" because any "physical intrusion" was "negligible" as it did not "pierce the skin."[232] The Court discounted the requirement of having to blow for as many as 15 seconds as "no more demanding than blowing up a party balloon."[233] *Birchfield* was not impressed by the fact that breath tests necessitated the collection of "(deep lung) air" because "[h]umans have never been known to assert a possessory interest in or any emotional attachment to *any* of the air in their lungs."[234] A motorist could not complain about having to breathe out because exhalation, being "a natural process," would require that he breathe out his "lung air, sooner or later . . . even without the test."[235] For *Birchfield*, the inevitability of exhaling seemed akin to the futility of preserving privacy in open fields. The very inability of preserving privacy—here in holding one's breath for more than a few minutes—argued against a privacy interest.[236] *Birchfield* next noted the limited information revealed in a breath test; the police only learn "the amount of alcohol in the subject's breath."[237] Not only did breath tests provide only a "BAC reading on a machine" and "nothing more," they did not collect samples "from which a wealth of additional, highly personal information could potentially be obtained."[238] Finally, the breath test was not likely to enhance "the embarrassment" a person already suffered by being arrested in the first place.[239]

Some of *Birchfield's* reasoning would undermine privacy interests in the microbiome found around a person. *Birchfield's* "physical intrusion" test would make any collection of the microbiome exhaled from the mouth or shed from the skin a "negligible" invasion of privacy interests.[240] Police, in sampling only the air around a person or the surfaces a germ cloud has touched, could rightly assert that they have avoided crossing any biological barrier, such as piercing the skin. Moreover, *Birchfield's* emphasis on the inevitability of

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231 *Id.*

232 *Id.* at 2164.

233 *Id.* at 2177.

234 *Id.*

235 *Id.*

236 *Id.* Further, the Court found "nothing painful or strange" about the fact that the breath test required a motorist to put a mouthpiece into his or her mouth, likening it to the "common practice" of sucking on a straw. *Id.*

237 *Id.*

238 *Id.*

239 *Id.* at 2164, 2177.

240 *Id. Birchfield's* dismissal of privacy due to government failure to cross a physical barrier harkens back to *Ciraolo,* where the Court permitted officers to fly over the curtilage of a citizen's home without first obtaining a warrant. California v. Ciraolo, 476 U.S. 207, 213 (1986).

exhalation would undermine the privacy interest in aerosolized microbes; it is just as futile to hold one's breath to conceal microorganisms as it is to hide alcohol vapors.[241] If, as surmised in *Birchfield*, people do not have "any emotional attachment" to the air in their lungs, they likely also lack any strong feelings about the microbes wafting along in that air.[242] *Birchfield's* consideration of embarrassment occasioned by the breath test would also harm a claim of privacy in the microbiome.[243] While *Birchfield's* breath test added little embarrassment beyond that suffered by the initial arrest, a microbiome sampling would involve no embarrassment at all. The initial germ cloud sample would often be collected without any arrest whatsoever, for the test at a crime scene would be administered for the purpose of identifying a person as a suspect in the first place. In most cases, the suspect would not be aware of, let alone be embarrassed by, the microbiome sampling.

However, *Birchfield's* discussion of other privacy interests in breath samples could advance privacy in the microbial cloud surrounding a person. The fact that breath tests were "capable of revealing only one bit of information" contrasts sharply with tests of the microbiome, which can reveal countless details about not only health and gender but also the most intimate behaviors, such as sexual activity.[244] Further, *Birchfield's* concerns about law enforcement's retention of a sample are of great relevance to assessing the privacy concerns of the microbiome.[245] As demonstrated by both scientists working with the HMP and elsewhere, the microbiome is regularly stored for future study.[246] Government agents could also maintain a microbiome data bank of samples collected. The volume of information housed in the microbiome, along with the potential to indefinitely store all of the intimate details it reveals, create significantly greater privacy interests in the germ cloud than in a breath test.

Any assessment of an individual's reasonable expectation of privacy in his or her own microbial cloud would be subject to the Court's precedent concerning the conveyance of information to third parties. As noted, the Court has not been kind to Fourth Amendment claimants who have previously shared information the government seeks.[247] Just as one offers up his or her speech to a listener or trash to a garbage collector, every person who shares his or her microbial community with those nearby could be dispensing their Fourth Amendment rights along with their microorganisms.[248] The Court will not hear a plea that there is nothing more a person can do to preserve privacy in his or

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[241] *Birchfield,* 136 S. Ct. at 2177.

[242] *Id.*

[243] *Id.*

[244] *Id.*

[245] *Id.* at 2178.

[246] Kolata, *supra* note 17, at A24.

[247] United States v. Miller, 425 U.S. 435, 443 (1976).

[248] *See* California v. Greenwood, 486 U.S. 35, 40 (1988); United States v. Dionisio, 410 U.S. 1, 14 (1973).

her microbiome; indeed the Court has used this very futility in protecting privacy, whether in one's land, curtilage, or breath, as a reason to deny Fourth Amendment protection.[249] Additionally, if a person's microbiome is gathered in a "physically nonintrusive" manner, the Court is likely to determine that this only has a slight impact on that person's privacy, as it did with the use of breathalyzer tests to determine a person's BAC.[250] However, there are still some factors that suggest that microbiomes should be awarded Fourth Amendment protection and not doing so would constitute a severe intrusion on privacy. For example, there is an enormous amount of personal information in a microbiome sample, and a sample could be stored for law enforcement use at any time.[251] How the Court will ultimately balance these competing factors cannot be known, for understanding the Court's balancing of interests is notoriously difficult.[252]

2. The Fourth Amendment Might, for a Time, Protect the Privacy of the Microbiome Due to the Sophistication of the Government Technology Used in Obtaining the Microbes

In *United States v. Kyllo,* the Court announced, "[i]t would be foolish to contend that the degree of privacy secured to citizens by the Fourth Amendment has been entirely unaffected by the advance of technology."[253] One's reasonable privacy expectations, therefore, are impacted not only by personal actions, but also by the kinds of tools the government uses to collect information. The relative sophistication of technology could have a distinctly important effect on police collection and analysis of microbes, as this investigative technique is highly reliant on the most recent advances in technology.[254]

Some technology is so much a part of "general public use"[255] that it does not implicate a Fourth Amendment search. In *United States v. Lee,* use of a searchlight to illuminate an area or a "marine glass" to amplify an image did not violate the Fourth Amendment.[256] *Knotts* was unconcerned with the government's use of a tracking device on a vehicle, blandly stating, "[n]othing in the Fourth Amendment prohibited the police from augmenting the sensory faculties bestowed upon them at birth with such enhancement as science and technology afforded them in this case," even though members of the public were not

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[249] *See Birchfield*, 136 S. Ct. at 2177; California v. Ciraolo, 476 U.S. 207, 213 (1986); Oliver v. United States, 466 U.S. 170, 179 (1984).

[250] *Birchfield*, 136 S. Ct. at 2184; *Ciraolo*, 476 U.S. at 213.

[251] *Birchfield*, 136 S. Ct. at 2178.

[252] *See generally* George M. Dery III, *Are Politicians More Deserving of Privacy than Schoolchildren? How* Chandler v. Miller *Exposed the Absurdities of Fourth Amendment "Special Needs" Balancing*, 40 ARIZ. L. REV. 73, 74 (1998).

[253] Kyllo v. United States, 533 U.S. 27, 33–34 (2001).

[254] *See* Gunn & Pitt, *supra* note 81.

[255] *Kyllo,* 533 U.S. at 40.

[256] United States v. Lee, 274 U.S. 559, 563 (1927).

known to routinely place beepers on each other's cars.[257] Moreover, the *Ciraolo* court did not wring its hands when police looked down from a plane into Ciraolo's yard because it found "private and commercial flight in the public airways" to be "routine."[258] *Ciraolo*, however, did offer some caveats that could inform the question of microbiome privacy: the Court noted that the government observations were from "navigable airspace," performed "in a physically nonintrusive manner," and relied only on "the naked eye."[259] Even though government investigation of a person's microbiome would involve sophisticated technology, *Ciraolo*'s analysis would inform microbe hunters to limit their searches to the analogue of "navigable airspace"—essentially areas where investigators would be permitted to be, such as public places rather than private homes.[260] *Ciraolo* would also favor the "nonintrusive" collection of microbes, such as the sampling of a person's germ cloud.[261]

Ciraolo's "naked eye" caveat could cause microbiome collectors some difficulty for, by its very definition, the microbiome is microscopic.[262] *Ciraolo* recognized that "modern technology" could disclose "those intimate associations, objects or activities otherwise imperceptible to police or fellow citizens."[263]

The increasing sophistication of surveillance technology might provide citizens with the strongest ground from which to fight for privacy of the microbiome. In *Dow Chemical Co. v. United States*, the Court surmised, "highly sophisticated surveillance equipment not generally available to the public, such as satellite technology, might be constitutionally proscribed absent a warrant."[264] *Dow* feared technological advancements that could penetrate walls to overhear a confidential conversation or aerial photography that could capture a human face or read secret documents.[265] The Court, however, found government use of enhanced aerial photography of an industrial complex to fall short of being a Fourth Amendment search.[266]

The wall-penetrating technology predicted by *Dow* became reality in *Kyllo,* where a federal agent, while sitting in his vehicle, aimed a "thermal imager" at a home he suspected was a site of marijuana cultivation.[267] The official used

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257 United States v. Knotts, 460 U.S. 276, 282 (1983).

258 California v. Ciraolo, 476 U.S. 207, 215 (1986).

259 *Id.* at 213–15.

260 *Id.*; *see also* Florida v. Riley, 488 U.S. 445, 449 (1989) ("As a general proposition, the police may see what may be seen 'from a public vantage point where [they have] a right to be.'").

261 *Ciraolo*, 476 U.S. at 213.

262 *Id.* at 215.

263 *Id.* at 215 n.3.

264 Dow Chem. Co. v. United States, 476 U.S. 227, 238 (1986).

265 *Id.* at 238–39, 238 n.5.

266 *Id.* at 239.

267 Kyllo v. United States, 533 U.S. 27, 29 (2001).

the imager's measurement of heat emanating from the home to obtain a warrant that recovered over 100 marijuana plants.[268] Confronted with the capabilities of this imager, the Court worried about the "power of technology to shrink the realm of guaranteed privacy."[269] *Kyllo* found the use of "sense-enhancing" technology to be a Fourth Amendment search, "at least where (as here) the technology in question is not in general public use."[270] *Kyllo* considered the "not in general public use" standard to be so important that it was repeated in the holding.[271]

Kyllo's ruling, however, is limited by its context: the Court's equation of sense-enhancing technology with a search was based in large measure on the fact that the infrared imager gave the government information that otherwise would only be available by physical entry.[272] Indeed, much of *Kyllo*'s opinion centered on the fact that the government intruded on a home, where, "*all* details are intimate details, because the entire area is held safe from prying government eyes."[273] *Kyllo* might therefore provide little guidance for the broader use of the microbiome in criminal investigations.

Ciraolo, *Dow*, and *Kyllo* have demonstrated that the Court has been consistently cautious in weighing the Fourth Amendment implications of "modern"[274] and "highly sophisticated"[275] technology that is unavailable to the public.[276] While the Court might therefore label the collection and analysis of the microbiome around a person to be a search requiring a warrant, such a result is far from certain. Since sampling a germ cloud involves no physical intrusion, the Court might liken it to the enhanced aerial photography it allowed in *Dow*.[277] Because law enforcement can collect microbes left by a person's cloud outside the home,[278] microbiome technology might avoid running afoul of *Kyllo* as well. Finally, as microbiome science advances, its daily benefits for health might speed its acceptance into the mainstream, thus making its use less cutting-edge. This, in turn, could undermine any protection offered by the

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268 *Id.* at 31.

269 *Id.* at 34.

270 *Id.*

271 *Id.* at 40 ("Where, as here, the Government uses a device that is not in general public use, to explore details of the home that would previously have been unknowable without physical intrusion, the surveillance is a 'search' and is presumptively unreasonable without a warrant.").

272 *See id.* at 34, 40.

273 *Id.* at 37 ("We have said that the Fourth Amendment draws 'a firm line at the entrance to the house' . . . . That line, we think, must be not only firm but also bright . . . .") (citation omitted).

274 California v. Ciraolo, 476 U.S. 207, n.3 (1986).

275 Dow Chem. Co. v. United States, 476 U.S. 227, 238 (1986).

276 *Kyllo*, 533 U.S. at 40.

277 *See Dow*, 476 U.S. at 239.

278 *See Kyllo*, 533 U.S. at 42–43.

Court's precedent against government use of sophisticated technology. As medicine inevitably exposes the secrets of microbes, police, in lock step, might gain easier access to the private information from our microbiota.

3. Individuals, in Abandoning Microbes as they Breathe and Speak, Might be Squandering any Right to Complain about Government Intrusion into Their Microbiome

Any future challenge to law enforcement use of the microbiome might hinge on a case involving a sawed-off rifle and a box of shells found in a suspected getaway car.[279] In *Rakas v. Illinois*, a police officer stopped a car suspected of being involved in a robbery.[280] The officer found the rifle under the passenger seat and the shells in the glove compartment and used them to connect the passengers of the car to the robbery.[281] Although the passengers neither owned nor drove the car, they sought to exclude the incriminating items as recovered in violation of the Fourth Amendment.[282] The prosecution challenged whether these mere passengers even had "standing"—the right to complain about any Fourth Amendment violation—since "neither the car, the shells nor the rifle belonged to them."[283]

Rakas noted that a person seeking Fourth Amendment protection had "the burden of establishing that his own Fourth Amendment rights were violated"[284] by showing that he had "a personal stake or interest in the outcome of the controversy."[285] Fourth Amendment rights were "personal" and so could not be "vicariously asserted."[286] Therefore, "standing," or, more properly, the substantive question of whether the person asserting a Fourth Amendment violation actually suffered an intrusion on his or her own Fourth Amendment rights, came down to a two-part test: "first, whether the proponent of a particular legal right has alleged 'injury in fact,' and, second, whether the proponent is asserting his own legal rights and interests rather than basing his claim for relief upon the rights of third parties."[287]

The inquiry into these two questions might not benefit a person seeking to prevent government intrusion upon his or her microbiome. First, the Court might not see a genuine "injury in fact" by the collection of a thing that a person has so clearly abandoned. When a person breathes, he or she disperses the breath out of the body and into the atmosphere, where anyone has access to

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279 *See* Rakas v. Illinois, 439 U.S. 128, 130 (1978).

280 *Id.*

281 *Id.*

282 *Id.*

283 *Id.* at 130–31.

284 *Id.* at 130 n.1 (citing Simmons v. United States, 390 U.S. 377, 389–90 (1968)).

285 *Id.* at 132 n.2 (citing O'Shea v. Littleton, 414 U.S. 488, 493–94 (1978)).

286 *Id.* at 133–34 (quoting Alderman v. United States, 394 U.S. 165, 174 (1969)).

287 *Id.* at 139–40 (citing Singleton v. Wulff, 428 U.S. 106, 112 (1976)).

it. In fact, "if you take a deep breath right now, at least one of the molecules entering your lungs literally came from Caesar's last breath."[288] Since our exhalations are mixed in the atmosphere, only to be breathed by others, we can inhale "any breath exhaled long ago—Shakespeare's, Cleopatra's, Lincoln's, your great-great-grandma's . . . ."[289] If police collect our breathed-out (and therefore abandoned) microbiome, perhaps we have only as much privacy to protect exhaled microbes as would Caesar or Shakespeare.

The individual seeking microbiome privacy might fair little better in addressing *Rakas'* second inquiry about "whether the proponent is asserting his own legal rights."[290] The DNA the government is collecting from the microbiome is not that of the individual person, but of all the organisms—the "bacteria, archaea, viruses, and fungi"—that use the person as a host.[291] When law enforcement collects one's microbiome, the person is not intruded upon, for he or she is only "packaging" for such lifeforms.[292] Because one's own genetic code is not being probed, the person might lack a right to complain about whatever intrusion is made on other beings' DNA. Of course, the collection and analysis of DNA from a person's microbes could provide fodder for all sorts of inferences about the individual who had previously possessed the microbes, such as gender, residence, and lifestyle. The Fourth Amendment, however, does not protect persons from inferences that can be drawn by others' actions.[293] The individual who took his trash to the curb in *Greenwood* was at the mercy of inferences that could be drawn from the actions of "animals, children, scavengers, snoops, and other members of the public" that had access to it.[294]

The fact that the information provided comes from species other than homo sapiens offers no safe harbor for the microbes' host, for law enforcement has long relied on inferences from the behaviors of other species.[295] In any event, the individual, having literally dashed all privacy in this DNA to the winds in breathing out the organisms, would again fall afoul of *Rakas'* first inquiry.

B. *The Microbiome on the Human Body and the Definition of a Fourth Amendment "Person"*

Government intrusions can cross the boundary *around* a person to invade the

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[288] *See* Robert Krulwich, *Wonders Commemorate Caesar: Take a Deep Breath!*, NAT'L PUB. RADIO (Mar. 15, 2006, 5:32 PM), http://www.npr.org/templates/story/story.php?storyId=5280420.

[289] *Id.*

[290] *Rakas,* 439 U.S. at 139–40 (citing *Singleton*, 428 U.S. at 112).

[291] Ali, *supra* note 4.

[292] Kolata, *supra* note 17, at A24.

[293] *See* California v. Greenwood, 486 U.S. 35, 40 (1988).

[294] *Id.*

[295] *See* Florida v. Harris 133 S. Ct. 1050, 1059 (2013); United States v. Place, 462 U.S. 696, 699 (1983).

area *on* the person, where much of the microbiome is located.[296] The Court considered such searches of a person's body in *Ybarra v. Illinois*, where an officer executing a search warrant for a tavern patted down Ybarra, a patron, and found heroin in a cigarette packet in his pants pocket.[297] *Ybarra* declared, "each patron" in the bar "was clothed with constitutional protection against an unreasonable search or an unreasonable seizure."[298] The Court's inclusion of a pants pocket in its discussion of the person brought the clothing an individual wears into the ambit of a Fourth Amendment "person."[299] This reading was reinforced in *Maryland v. Pringle*, where the Court, in mentioning *Ybarra*, noted, "[w]e held that the search warrant did not permit *body searches* of all of the tavern's patrons and that the police could not *pat down the patrons for weapons,* absent individualized suspicion."[300]

In *Wyoming v. Houghton*, the Court found searches of the person to be deserving of "unique, significantly heightened protection."[301] *Houghton* deemed even a limited pat down of outer clothing to constitute a "severe, though brief, intrusion upon cherished personal security, and it must surely be an annoying, frightening, and perhaps humiliating experience."[302] The Court therefore reiterated its equation of a search of clothing worn with a search of the person's own body. Instead of drawing a Fourth Amendment line between searching a body and searching the clothing worn on the body, *Houghton* made its Constitutional distinction between searching a clothed person and searching property not worn by a person.[303] *Houghton* thus distinguished the intrusion of a law enforcement search of a purse left on the backseat of a car as lesser than the search of clothing actually worn by a person.[304] The Court even warned that failure to include pockets and clothing as part of a search of a person would allow only "strip searches" to qualify as "searches of the person."[305]

If one's clothing is part of the "person," then the microbiome "worn" on the outside surface of the body should constitute a search of the "person." Further, the organisms living on our clothes and on the items in our pockets, such as

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[296] *See* Terry v. Ohio, 392 U.S. 1, 8–9, 30 (1968) (allowing an officer to search inside a suspect's pockets after feeling a weapon during a pat down of the man's clothing).

[297] Ybarra v. Illinois, 444 U.S. 85, 88–89 (1979).

[298] *Id.* at 91.

[299] *Id.* at 92–93 (interpreting a "patdown of a *person*" to include what is in the person's clothing) (emphasis added).

[300] Maryland v. Pringle, 540 U.S. 366, 373 (2003) (emphasis added).

[301] Wyoming v. Houghton, 526 U.S. 295, 303 (1999).

[302] *Id.* (quoting Terry v. Ohio, 392 U.S. 1, 24–25 (1968)).

[303] *Id.* at 303 n.1 (describing the constitutional distinction as between the "search of the person and search of property").

[304] *See id.*

[305] *See id.* The Court has only permitted non-suspicious strip searches in the narrow context of admitting arrestees into the custody of jails and prisons. Florence v. Bd. of Chosen Freeholders, 132 S. Ct. 1510, 1523 (2012).

wallets, keys, and cell phones, should also receive the "unique, significantly heightened protection" granted to our bodies.[306] Being part of a person, the microbiome benefits from all corresponding Fourth Amendment protections. *Terry* would not provide police with authority to collect a suspect's microbiome from his or her person because it considered a simple public pat down of the "outer surfaces" of a person's clothing[307] for weapons[308] to be a "serious intrusion upon the sanctity of the person."[309] *Terry* only allowed an officer to believe" that the suspect was "armed and dangerous."[310] Therefore, police would not have authority to collect a suspect's microbiome at a *Terry* stop because *Terry*'s safety rationale is not triggered by the suspect's possession of microorganisms.

Cupp v. Murphy also provides helpful insight into government collection of microbes from a body's surface.[311] In *Cupp*, police had probable cause to believe Murphy murdered his wife by strangling her to death.[312] Noticing a dark spot on Murphy's finger and aware that the victim had marks on her throat, officers sought to "take a sample of scrapings from his fingernails."[313] The samples that police obtained, with neither consent nor warrant, contained "traces of skin and blood cells, and fabric from the victim's nightgown."[314]

In weighing the Fourth Amendment implications of this search, *Cupp* was ambivalent about the intrusiveness of police scraping under Murphy's fingernails. At one point, the Court deemed this procedure to be a "severe, though brief, intrusion upon cherished personal security," while at another point it found that the scraping was a "very limited intrusion."[315] Going under fingernails, however, differed from collecting fingerprints or voice exemplars, which only uncovered physical characteristics that were already "constantly exposed to the public."[316] Fingerprinting in particular lacked the "probing into an individual's private life and thoughts that marks an interrogation or search."[317] *Cupp* found the fingernail scraping to be "constitutionally permissible" as a kind of lesser form of a search incident to arrest.[318] Since the officers did not formally arrest Murphy, the Court hesitated to permit a "full" search incident to arrest, allowing instead a "very limited search necessary to preserve the highly

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306 *Houghton*, 526 U.S. at 303.
307 Terry v. Ohio, 392 U.S. 1, 19 (1968).
308 *Id.* at 27.
309 *Id.* at 17.
310 *Id.* at 27.
311 Cupp v. Murphy, 412 U.S. 291 (1973).
312 *Id.* at 292, 296.
313 *Id.* at 292.
314 *Id.*
315 *Id.* at 295, 296.
316 *Id.* at 295.
317 *Id.* at 294.
318 *Id.* at 295, 296.

evanescent evidence" under the fingernails.[319] *Cupp's* reference to the perishable evidence under Murphy's fingernails provided a potentially important limit on the Court's ruling—the existence of the exigency of the destruction of evidence.[320] *Cupp* noted that once Murphy knew the police wished to collect fingernail scrapings, "he put his hands behind his back and appeared to rub them together."[321] On the specific facts of this case—the limited nature of the intrusion, the existence of probable cause, and the "ready destructibility of the evidence"—the Court upheld the intrusion under the nails.[322]

Cupp offers clues as to how the Court will view law enforcement's collection of the microbiome on the person. *Cupp* clearly ruled that government entry under the fingernail was a Fourth Amendment search.[323] Swabbing the skin to collect a person's microbial genetic information should likewise constitute a search, especially since accessing the wealth of information in the microbiome truly amounts to "probing into an individual's private life."[324] The Court would likely require a warrant for collection of the microbiome, since *Cupp* needed both search incident to arrest and exigent circumstances[325] to justify its lesser intrusion of scraping underneath the suspect's fingernails.

Riley v. California, which unlike *Cupp*, clearly dealt with a search incident to arrest, finally foreclosed the possibility that this warrant exception would enable access to an arrestee's microbiota.[326] In *Riley*, police seized a cell phone from Riley's pants pocket after arresting him for possession of concealed firearms.[327]

In *United States v. Wurie*, *Riley's* companion case, officers collected two cell phones from Wurie's person.[328] In language foretelling microbiome privacy issues, *Riley* considered cell phones to be "such a pervasive and insistent part of daily life" that a visitor from Mars "might conclude they were an important feature of human anatomy."[329] *Riley* found that the traditional rationale for permitting a search incident to arrest—officer safety—was simply lacking with

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[319] *Id.* at 296.

[320] *Id.*

[321] *Id.* at 296, 305. The Court also cited to *Schmerber*, which also discussed the potential for loss of evidence in the context of forced blood tests. *Id.* (citing Schmerber v. California, 384 U.S. 756, 770–71 (1965)).

[322] *Id.* at 296.

[323] *Id.* at 295.

[324] *See id.* at 294.

[325] *Id.* at 296.

[326] Riley v. California, 134 S. Ct. 2473, 2480 (2014). As previously noted, *Cupp* was less than certain whether its facts justified a traditional search incident to arrest. *Cupp*, 412 U.S. at 296. However, in *Riley* (unlike *Cupp*), there was no question about the existence of an arrest in *Riley*. *Riley*, 134 S. Ct. at 2480.

[327] *Riley*, 134 S. Ct. at 2480.

[328] *Id.* at 2481.

[329] *Id.* at 2484.

cell phones, which held only "digital data," something officers knew "could not harm them."[330] Any safety justification for searching the microbiome would be similarly lacking. While government interests in a search incident to arrest were diminished, the privacy interests in a cell phone were heightened because cell phones "implicate privacy concerns far beyond those implicated by the search of a cigarette pack, a wallet, or a purse."[331] This was due to the fact that "90% of American adults who own a cell phone keep on their person a digital record of nearly every aspect of their lives—from the mundane to the intimate."[332] *Riley*, in noting the ubiquity, importance, and intimate nature of information associated with cell phones, could have been talking about an individual's microbiome. Thus, *Riley's* ruling that arresting officers should "get a warrant" when seeking the contents of cell phones would apply equally to police seeking the contents of our microbiota.[333]

For a half century, the Court has consistently aimed to protect intrusions on the person, even those only involving the "outer surfaces" of the clothing, with the Fourth Amendment's full weight.[334] The Court has allowed exceptions to the warrant requirement in certain circumstances, such as officer safety,[335] where "the answer to the police may be a bullet,"[336] or where evidence is being destroyed within the very presence of officers.[337] Beyond these circumstances, the Court requires the police to get a warrant.[338] In collecting the microbiome found on a person, a scenario threatening officer safety is unlikely, as the microbiome would pose as little threat to an officer as would a cell phone's digital data.[339] Evidence destruction is unlikely as well, since microbial communities on a palm's surface recover within hours of hand washing.[340] Thus, once the police move beyond the microbiome hovering around a person to the microbes on an individual's body, these officials would be conducting a search that would need the traditional protection of a warrant.[341]

C. *The Microbiome in the Human Body and the Definition of a Fourth Amendment "Person"*

Government intrusion into the human body implicates an individual's "most

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330 *Id.* at 2485.

331 *Id.* at 2488–89.

332 *Id.* at 2490.

333 *Id.* at 2495.

334 Terry v. Ohio, 392 U.S. 1, 19 (1968).

335 *Riley*, 134 S. Ct. at 2485.

336 *Terry*, 392 U.S. at 8.

337 Cupp v. Murphy, 412 U.S. 291, 296 (1973).

338 *Riley*, 134 S. Ct. at 2495.

339 *See id.* at 2485.

340 Shrivastava et al., *supra* note 3, at 37.

341 *Riley*, 134 S. Ct. at 2495.

personal and deep-rooted expectations of privacy."[342] At the same time, the most important microbes might be those that reside deep within the human body in the gut. Human stool, which turns out to have an "exceptionally stable" bacterial community, has been used to identify its "owner" eighty-six percent of the time.[343] The "collective DNA" of these microbes has even been called a "gut print."[344] Scientists have also probed other body cavities including the vagina, nostril, and mouth, the latter so deeply as to collect samples from palates and throats.[345] Initially, it might seem that gut bacteria residing in feces, or saliva, might have little relevance in placing a criminal at a crime scene. Such an assumption, however, may be unfounded. Microbial ecologist Jack Gilbert at the University of Chicago minced no words in describing how bacteria, even from the most intimate places inside a person's body, could be released into the environment:

> "You're shedding them from your face, spitting them out from your mouth, breathing them out though your nose," Gilbert says. They aren't confined by gloves or clothes. "Your trousers or your pants are like a loose fish net material to bacteria. As soon as you sit down, your bottom or your vaginal microbiota is expelled onto that surface and it is actually reasonably persistent until the next person sits down."[346]

Perhaps the case that seems most relevant to government collection of the microbiome from inside a person is *Maryland v. King*, which considered the Fourth Amendment implications of mandatory collection of DNA.[347] In *King*, as "part of a routine booking procedure for serious offenses," officers collected a DNA sample of an arrestee who had been charged with assault for "menacing a group of people with a shotgun."[348] Law enforcement took the DNA by "wiping a small piece of filter paper or a cotton swab similar to a Q-tip against the inside cheek of . . . [the] mouth to collect some skin cells."[349] *King* thus confronted the issue of "whether the Fourth Amendment prohibits the collection and analysis of a DNA sample from persons arrested, but not yet convicted, on felony charges."[350] The Court permitted the collection of DNA as rea-

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[342] Winston v. Lee, 470 U.S. 753, 760 (1985).

[343] Eric A. Franzosa et al., *Identifying Personal Microbiomes Using Metagenomic Codes*, 112 PROC. NAT'L ACAD. SCI. 22, 9 (2015).

[344] Callaway, *supra* note 20, at 136.

[345] Kolata, *supra* note 17, at A24.

[346] Kupferschmidt, *supra* note 10.

[347] Maryland v. King, 133 S. Ct. 1958, 1970 (2013) ("The Maryland DNA Collection Act provides that, in order to obtain a DNA sample, all arrestees charged with serious crimes must furnish the sample on a buccal swab applied . . . to the inside of the cheeks."). A full analysis along this line is offered in Salyards, *supra* note 5, at 58.

[348] *King*, 133 S. Ct. at 1965.

[349] *Id.* at 1967–68.

[350] *Id.* at 1966.

sonable in the following narrow context: "[w]hen officers make an arrest supported by probable cause to hold for a serious offense and they bring the suspect to the station to be detained in custody."[351]

King reached this conclusion by balancing privacy concerns against law enforcement interests.[352] The existence of an arrest in *King* was central to weighing the government's side of the balance because probable cause permitted the arrest, and the arrest in turn allowed for the search of the person.[353] Further, formal processing permitted ascertainment of identity because "the law is in the act of subjecting the body of the accused to its physical dominion."[354] DNA collection, in playing a "critical role" in confirming identity, ensured that an individual was held accountable for current and past crimes.[355] The government also had an interest in maintaining the safety of all persons in the detention facility, whether staff or inmates.[356] DNA collection aided this interest by alerting corrections officials to those whose records indicated gang membership, mental disorders, or a history of violence.[357] DNA identification was even probative for bail decisions because it offered clues regarding who would show for trial or who would be a danger to the community.[358] Thus, because government interests in proper stationhouse processing were so important, they arguably outweighed those supporting search incident to arrest.[359]

In comparison, *King* had minimal concerns for the individual's side of the scales.[360] An arrestee's "relationship with the State" consequently diminished his or her expectations of privacy.[361] Therefore, an arrestee's privacy rights differed from the privacy rights of "the public at large."[362] Since law enforcement limited its use of DNA to identification purposes, it only examined the "noncoding parts of the DNA that do not reveal the genetic traits of the arrestee."[363] *King* thus concluded, "DNA identification of arrestees is a reasonable search that can be considered part of a routine booking procedure."[364]

The balancing analysis behind *King*'s acceptance of DNA collection from felony arrestees could undermine its usefulness as a guide for government gathering of individuals' microbiota. *King* could rightly provide some help in the

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351 *Id.* at 1980.
352 *Id.* at 1970.
353 *Id.* at 1980.
354 *Id.* at 1971.
355 *Id.* at 1971–72.
356 *Id.* at 1972.
357 *Id.*
358 *Id.* at 1972–73.
359 *Id.* at 1974.
360 *Id.* at 1977.
361 *Id.* at 1978.
362 *Id.*
363 *Id.* at 1979.
364 *Id.* at 1980.

narrow context of jailers collecting microbe swabs from felony arrestees entering jail. Outside the jailhouse bars, *King* offers much less direction; *King* involved a person not only arrested but also placed in custody at a station house jail. The potential forensic benefits envisioned for microbe hunting could occur before an arrest is even made. A study by the Argonne National Laboratory provided an example of the microbiome's hoped-for use in the early stages of an investigation.[365] Jarrad Hampton-Marcell, a research coordinator at the laboratory, led a team in going "room by room collecting cotton-tipped swabs" of microorganisms left by a group of playacting burglars.[366] Such an experiment envisions government collection and analysis of persons' microbiota well before any probable cause for arrest in particular exists. Indeed, the purpose of collecting microbes in such circumstances is to establish the very probable cause that already existed in *King*.[367] Thus, all of *King*'s government interests in identifying an arrestee or inmate, whether in protecting those in jail, ensuring attendance at trial, or considering future dangerousness, are simply nonexistent in the microbiome context. With the pursuit of microorganisms, an individual's interests, already very dependent on the relationship with the State,[368] suddenly become much greater, since the unknown suspect is not an arrestee saddled with probable cause or an inmate who could harm staff or fellow prisoners. Thus, the dissimilar contexts for interest-balancing presented in *King* and future microbiome investigations drain *King* of much of its helpful guidance in determining the Fourth Amendment reasonableness of collecting a microbiome from inside of a person.

Additionally, the privacy interest implicated by *King*'s DNA differed dramatically from the privacy interest in a person's microbiome. *King* understood that the DNA collected from inmates lacked any ability to "reveal genetic traits of the arrestee."[369] The Court doubted that the DNA collected from King would reveal medical data, and knew Maryland authorities were not testing it for such information.[370] The microbiome, in contrast, allows investigators to move beyond dispositions and potentialities provided by DNA to learn actual behavior. Even the most ambitious DNA investigators never claimed to determine whether a person is currently suffering the vices of smoking and drinking,[371] or surmised if a person had sexual intercourse, and further, with whom.[372] Therefore, the vast differences in the information provided by DNA

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[365] Oaklander, *supra* note 60, at 14.

[366] *Id.* These swabs are dependent on the second part of the investigation, which would ultimately involve a comparison of the collected samples with microbiome samples *on* or *in* the bodies of the playacting burglars. *Id.*

[367] *King*, 133 S. Ct. 1958.

[368] *Id.* at 1978.

[369] *Id.* at 1979.

[370] *Id.*

[371] Kupferschmidt, *supra* note 10, at 5.

[372] Feltman I, *supra* note 8, at 6.

and the microbiome further caution against relying on *King* for answers in assessing the reasonableness of intruding into the body for microbes.

Cases other than *King*, *Schmerber*, and *McNeely* could potentially limit Fourth Amendment searches of the collection of microbes from within the body to situations involving emergencies[373] or search warrants.[374] *Winston v. Lee*, a case in which the government sought to recover a bullet from a suspect to link him to a robbery, could shed further light on this issue.[375] Since the bullet was lodged under the suspect's collarbone, the surgery needed to recover it risked extensive probing of tissue, potential injury to nerves and blood vessels, and infection.[376] *Winston* also worried about the "individual's dignitary interests in personal privacy and bodily integrity"[377] occasioned by the government in taking "control" of a citizen's body when drugging him into a state of unconsciousness.[378] Since the individual's privacy interests were so "heightened" and the government interests were less than "compelling," *Winston* deemed the proposed surgery to be unreasonable.[379]

The collection of the microbiome from a within a body would hardly be dangerous, for doctors routinely intrude on body cavities such as the nose, vagina, and throat during office visits. Harvesting the microbiome would involve none of *Winston*'s surgery, anesthesia, or its associated risks to health and safety.[380] However, as previously noted, analysis of the organisms inhabiting the body certainly implicates the "most personal and deep-rooted expectations of privacy."[381] Moreover, few things tread on dignity interests more than the collection of certain microorganisms, such as those in a stool sample. An activity that triggers similar, if not greater, concerns is the collection of urine. The Court has recognized that urine tests force persons to "perform an excretory function traditionally shielded by great privacy."[382] To collect a person's microbiome within the body, where the interests in individual privacy and dignity are at their height, the Court would likely require a warrant.

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373 Schmerber v. California, 384 U.S. 756, 757, 770 (1965).

374 Missouri v. McNeely, 133 S. Ct. 1552, 1568 (2013).

375 Winston v. Lee, 470 U.S. 753, 756 (1985).

376 *Id.* at 756, 764.

377 *Id.* at 761.

378 *Id.* at 765–66 (declaring further that this "total divestment" of control over one's body amounted to a "severe" privacy intrusion).

379 *Id.* at 767.

380 *Id.* at 764.

381 *Id.* at 760.

382 Skinner v. Ry. Labor Exec. Ass'n, 489 U.S. 602, 626, 634 (1988) (holding that the biological sampling and testing of railroad employees satisfied Fourth Amendment reasonableness). *Skinner*, however, involved "special needs beyond law enforcement" because the government interests in the case were not in collecting evidence for criminal prosecution but in maintaining the safety of railroads. *Id.* at 620. *Skinner's* holding on collection of biological material is thus not helpful to our inquiry.

Birchfield, in its analysis of blood tests of motorists suspected of driving under the influence, could provide the definitive answer missing from prior case law.[383] While the Court found little privacy in breath tests, it deemed blood tests "a different matter" because they required "piercing the skin" to "extract a part of the subject's body."[384] *Birchfield* drew a graphic picture of blood tests, describing them as intruding into an individual's veins.[385] The Court also noted that shedding blood was not something people did continually, as they did with breathing.[386] Moreover, when people did provide a blood sample, "the process [was] not one they relish[ed]."[387] Furthermore, law enforcement, unlike with breath tests, could preserve blood tests and extract more intimate information beyond a BAC reading.[388]

Birchfield's analysis of blood tests provides a good, if imperfect, fit for microbiome collections inside the body. Some harvests of the microbiome, whether by swabbing the mouth, throat, or nose, will share more similarities with less intrusive breath tests, where the subject must "insert a mouthpiece of the machine into his or her mouth."[389] Still, certain sampling, such as that within the vagina, will be more akin to blood tests as a process no one relishes.[390] The key features shared by blood tests and microbiome collections are the preservation of a sample after initial testing and the ability to obtain a vast trove of information from the biological sample. Microbiomes, with their access to information regarding behavior, might implicate even more information than that contained in the blood. One aspect of blood testing that *Birchfield* considered important in its assessment of privacy was the fact that, in taking blood, police actually take a portion of the person's body.[391] The government could argue that microbiome sampling does not similarly involve the seizure of a body part. In seeking the genetic material of microorganisms, law enforcement is intruding on other beings—bacteria, fungi, viruses—rather than the human him or herself. Yet, in the particular context of intrusions inside the body to collect biological material, the government cannot avoid a benchmark the Court has relied upon for thirty years: physical intrusion.[392] The weight of the *Birchfield* factors thus points to microbiome collections inside the body requiring, as with blood tests, a warrant to support intrusion.

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383 Birchfield v. North Dakota, 136 S. Ct. 2160 (2016).

384 *Id.* at 2178 (quoting *Skinner*, 489 U.S. at 625 (quotation omitted)).

385 *Id.* (citing Missouri v. McNeely, 133 S. Ct. 1552, 1558 (2013)).

386 *Id.*

387 *Id.* at 23.

388 *Id.*

389 *Id.* at 20–21.

390 *Id.* at 23.

391 *Id.* at 22.

392 California v. Ciraolo, 476 U.S. 207, 213 (1986).

V. CONCLUSION

Theodore Rockwell, who once worked for the famously demanding Admiral Hyman G. Rickover, one time made the mistake of using the royal or editorial "we" in advising his boss that "we will get back to you by . . . ."[393] As told by Rockwell in *The Rickover Effect: How One Man Made a Difference*, the admiral lectured to him that "only three types of individual were entitled to such usage: '[t]he head of a sovereign state, a schizophrenic and a pregnant woman.'"[394] Despite his constant pursuit of perfection, Admiral Rickover has been proven wrong with the discovery of the human microbiome. Each person is not only a "we" containing trillions of microorganisms, but also, much like Pig Pen (Charlie Brown's acquaintance), constantly generating a cloud that spreads wherever he or she goes.

Law enforcement's recognition of the host of potential benefits promised by forensic analysis of the microbiome found in, on, and around the body requires consideration of the Fourth Amendment implications of this new technology. Official intrusion inside the body for microbes would trigger concerns regarding the dignity of the person,[395] and further would involve crossing a physical barrier—entry into the inside of the individual—that the Court has perceived as a line of demarcation requiring a warrant or a warrant exception limited to the circumstances, such as exigency.[396] As for an intrusion on a person's body in search of the microbiome, the government would have to contend with the Court's broad definition of the "person," which includes not only the body but also any clothing worn or items carried in clothing worn on the body.[397] In subsequent cases involving fingernail scrapings and recovery of data from cell phones found on an arrestee's person, the Court would generally require a warrant before allowing police to collect microbes on a person's body or clothing worn on the person.[398]

Once police moved beyond the boundary of the "person," however, they would also be leaving the relative certainty created by Fourth Amendment precedent regarding searches of the person. Rather than guaranteeing privacy in the area around a person, the Court has allowed people's own actions to limit their Fourth Amendment claims. The diminution of privacy has been particularly profound when the Court has found that persons have shared information with third parties. Once an individual exposes information to another, whether it is trash, a phone number, or even one's own voice, that information becomes

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393 Ben Zimmer, *We*, N.Y. TIMES (Oct. 1, 2010), http://www.nytimes.com/2010/10/03/magazine/03FOB-onlanguage-t.html?_r=0.

394 *Id.*

395 Winston v. Lee, 470 U.S. 753, 761 (1985).

396 *Birchfield*, 136 S. Ct. at 2173; Missouri v. McNeely, 133 S. Ct. 1552, 1568 (2013).

397 Wyoming v. Houghton, 526 U.S. 295, 303 n.1 (1999).

398 Riley v. California, 134 S. Ct. 2473, 2495 (2014).

fair game for government collection without Fourth Amendment protection.[399] The fact that a person did not wish to make such an exposure to anyone has not changed the Court's conclusion; indeed the Court saw the very futility of preserving privacy as a reason to deny Fourth Amendment protection.[400] Such reasoning does not bode well for anyone wishing to maintain privacy in his or her own microbial cloud, for each one of us sheds millions of microorganisms a day.[401]

The Court's precedent assessing privacy by the sophistication of the surveillance technology used to intrude upon it could offer some hope for protecting microbial clouds. The Court, however, has allowed police to employ relatively advanced technology in several instances, such as an aerial mapping camera and beeper tracking devices, only drawing the line when such modern technology intruded into a private home.[402] Further, any protection against sophisticated technology would only work while the technology is still deemed sophisticated, a time frame that is ever shrinking. Finally, in the very act of breathing—the traditional measure of the existence of life—people abandon millions of microbes in the area surrounding them. Police, in simply gathering what persons have discarded, could rely on the fact that people cannot complain about the collection of things they have thrown away. In light of *Rakas*, an argument could be made that the microbiome of other beings was never something about which persons could claim privacy in the first place.[403]

Science forever humbles humanity by displacing it from the center of the universe. Copernicus and Galileo replaced the earth with the sun as the point about which all revolves.[404] Darwin's theory of natural selection undermined the need for a divine creator to put humanity at the peak of life.[405] Now, scientists are questioning whether our own bodies are our own selves or mere "packaging" for countless other life forms, provoking the question whether each human is an individual "I" or instead a "we."[406] Science's latest demotion of humans is unique, for it has direct implications for our Fourth Amendment rights. Before police are permitted to pursue the microbiome, the implications of this intimate intrusion should be fully understood.

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[399] California v. Greenwood, 486 U.S. 35, 40 (1988); Smith v. Maryland, 442 U.S. 735, 743–44 (1979); United States v. Dionisio, 410 U.S. 1, 14 (1973).

[400] *Birchfield*, 136 S. Ct. at 2173.

[401] Kluger, *supra* note 1, at 4.

[402] Dow Chem. Co. v. United States, 476 U.S. 227, 239 (1986); United States v. Knotts, 460 U.S. 276, 282 (1983); Kyllo v. United States, 533 U.S. 27, 41 (2001).

[403] Rakas v. Illinois, 439 U.S. 128, 139–40 (1978).

[404] JOHN GRIBBIN, THE SCIENTISTS: A HISTORY OF SCIENCE TOLD THROUGH THE LIVES OF ITS GREATEST INVENTORS, 12, 97 (2002).

[405] *Id.* at 357.

[406] Kolata, *supra* note 17, at A24.