Maternal–Fetal Microchimerism and Genetic Origins: Some Socio-legal Implications

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Abstract
What are the implications of microchimerism in sociocultural and ethico-legal contexts, particularly as they relate to the destabilization of genetic origins? Conventional biomedicine and related law have been reluctant to acknowledge microchimerism—the existence of unassimilated traces of genetic material that result in some cells in the body coding differently from the dominant DNA—despite it becoming increasingly evident that microchimerism is ubiquitous in the human population. One exception is maternal–fetal microchimerism which has long been recognized, albeit with little consideration of the nonmedical implications. Most immediate issues concern the ongoing biomedical debate around whether microchimerism is beneficial in terms of enhancing the body’s range of immunological responses, harmful in provoking autoimmune diseases, or simply neutral with respect to subsequent health. That controversy remains unresolved, but whichever way it develops, I want to extend consideration by insisting that changing biological concerns cannot be separated from

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sociocultural and ethico-legal effects. Once the diversity of DNA coding in a singular body has been established, relations of kinship, the identification of legal parenthood, and the operation of surrogacy laws are of direct interest. The overriding problematic asks whether our ethical and legal apparatus is able to address such newly emerging questions.

**Keywords**

microchimerism, surrogacy, DNA, law, ethics, immunology

My paper explores the implications of microchimerism in sociocultural and ethico-legal contexts, particularly as they relate to the destabilization of genetic origins in the postgenomic era, and most especially in the relations of surrogacy. Microchimerism refers here to parallel traces of genetic material—derived from genetically distinct organisms—that result in small numbers of cells in the same body coding differently to the dominant DNA. Given that DNA is conventionally identified as the marker of a unique self, the phenomenon throws up all sorts of generally unaddressed questions about personal identity. It is now becoming increasingly evident that microchimerism is triggered by a range of causes, is probably ubiquitous in the human population, and has potentially far-reaching consequences, yet biomedicine and related law have remained reluctant to acknowledge it. One exception to that widespread disavowal is maternal–fetal microchimerism which has long been recognized, albeit with little consideration of its non-medical implications. Whichever way the ongoing bioscientific controversy around the putatively beneficial, harmful, or neutral effects of microchimerism develops, I want to extend consideration by insisting that emerging biological concerns cannot be separated from sociocultural and ethico-legal effects. Once the diversity of DNA coding in a singular body has been established, the boundaries of self and other, health and illness, and even life and death are displaced. In the ethico-legal sphere, doubts about the singularity of DNA-determined identity complicate the operation of criminal or immigration cases, transgender attribution, the operation of surrogacy laws, and the identification of legal parenthood and other relations of kinship. Although biomedical, legal, philosophical, and political discourses remain indebted to the supposed stability of identity, and as yet postgenomics has limited impact on the relevant paradigms, I believe microchimerism will eventually oblige a reordering of the Western imaginary.
The hope is that the recent explosion of postgenomics signals a less blinkered approach that far from celebrating scientific “certainty” and reductionism opens onto a time of destabilization and contestation of authoritative discourses. Where research methodologies and disciplinary assemblages are fluid and provisional across both the humanities and postconventional life sciences, the advent of postgenomics signals the opportunity of reconfiguring what is meant by certain previously taken-for-granted categories such as heath and disease, reproduction, or bodily anomaly. We need an approach where disciplines work together rather than in parallel, that understands the importance of the sociopolitical and environmental context, and that is committed to the intersectionality of multiple factors of difference across geography, race, gender, age, and much else. The earlier sequencing of the human genome was never definitive, but it has delivered a certain continuity of interest in genetic factors that the postgenomic impetus can build on as well as exposing some significant breaks. Microchimerism, and indeed the microbiome, are central to my critical focus as I attempt to occupy that somewhat ambivalent space and open up a conversation between my academic background in postconventional philosophy, my fascination with the legal theory, and my curiosity about the life sciences. My aim is to explore the microchimeric disruption of singular personhood and identity with particular regard to surrogacy and to ask whether our ethical and legal apparatus can adequately address newly emerging concerns.

Classically, chimerism denotes a combination of living beings—such as a geep (sheep/goat)—that nevertheless displays genetic and usually morphological distinctions within a single body. More ubiquitous than whole body chimerism is the unseen microchimerism that occurs at the cellular level where no more than 1 in 1,000 cells is genetically divergent from the majority, although such cells may gather in a higher density in particular organs as well as circulating in low numbers in the peripheral blood supply. The full prevalence remains unknown and is constantly revised upward. In a true chimera, the genetic components of the parents remain distinct in a patchwork of cells such that each individual cell comprises genes from just one of the originating organisms. Unlike interspecies—and possibly artificially induced—chimeras like the geep, the divergent DNA of same species occurrences is most likely, but not exclusively, to derive from close relations. Human chimeric states can be either iatrogenic resulting from biomedical interventions such as transplantations—which can introduce cellular material from entirely unrelated bodies—or natural, such as the fusion of dizygotic twins in utero or the common incidence of mutual
maternal–fetal cell engraftment. Bioscientific explanations are evolving and uncertain, but the implications for the conventional model of bodies as biologically distinct—where each organism gives rise to a single genome—are transformatory. The commonly unquestioned belief that individual human DNA is unvarying and temporally persistent is no longer reliable (Kelly 2012; Lappé and Landecker 2015). The concept of genomic multiplicity makes it difficult to predict the limits of human plasticity or the integrity of any category of organism, and it raises awkward questions equally for the biological sciences, biopolitics, and ethico-legal thought which all remain rooted in a model of self/other conflict and human exceptionalism.

The emerging theorization of (micro)chimerism has been overshadowed by the more familiar concept of the human microbiome which similarly disrupts the closed circuit of human exceptionalism. We now know that human bodies host a complex community of bacterial, fungal, parasitical, and viral components on a cellular level in which cells designated as human are probably outnumbered. It is difficult to claim that we are individuals in the anatomical sense, if microbes, measured by cell number, constitute a high percentage of bodies (Gilbert, Sapp, and Tauber 2012) and we are materialized as genetically multiple. There is no unvarying state and each individual interacts epigenetically both with the external environment and within the body where a plethora of diverse microbial communities flourish. Such complex and highly specific communities form adaptive ecosystems that are finely in tune with the ever-changing physiology of the host. What bioscience reveals is not just coexistence but a high degree of mutual benefit between differential systems, as is the case with microchimerism. It is now evident that many microbes depend on the body for survival and that the human could not develop without maintaining active microbial viscera. In short, host–microbial relationships are symbiotic (Lloyd-Price, Abu-Ali, and Huttenhower 2016, n.p.). It is also well-established that gut microbiota promote immune tolerance and influence a range of psychological states through their effect on neurotransmitters (Dinant and Cryan 2017). As holobionts, then, human beings can no longer claim conventional individuality, biologically based on a singular genetic code, but figure instead a far more complex uniqueness generated by the intra-actions of variable microbial communities. Both the microbiome and microchimerism have implications for reproduction, with Takeshita (2017), for example, stressing that bacteria are essential participants in the process of pregnancy, which itself develops the existing holobiont.
Infants are not born with a genetically predetermined microbiome; it is gradually built up both pre- and postbirth. The placenta itself is a low abundance microbiomic tissue (Aagaard et al. 2014), and at birth the neonate passes through the gestational mother’s vaginal canal gathering microflora that are essential for infant development (Mueller et al. 2015). Although infants do inherit many aspects of their genetic parents’ DNA profile, there is much else that disrupts the teleology of successive generations passing down definitive genes. In place of a simple heredity mix of chromosomes from one male and one female progenitor that determine the genetic makeup of their offspring, the human genome is fluid throughout life. As Warin and Martin (2018) note: “The genetic code is not a closed and inviolable nugget passed on from cell to cell over years of growth but undergoes constant change in response to its multiple environments [including the microbiome] and to errors in replication” (p. 717, my insertion). An older person will not have precisely the same genome as her younger self, and it may be that the status of genetic testing as a decisive marker of biological “truth”—for paternity or maternity, identification in criminal or immigration cases, and so on—will be increasingly challenged. The more disruptive scenario, however, is that the impact of postgenomic knowledge must eventually disorder the Western sociocultural imaginary—which underpins our ethico-juridical systems—of the individual as autonomous, self-complete, and clearly defined. Although the contestation of the sovereign self is long-standing in the Global North (Derrida 1981; Grosz 1994; Shildrick 1997), the stability of specifically genetic identity is largely taken for granted. Consider, then, some initially perplexing stories that have circulated in the popular media as well as bioscientific report.

The concept of microchimerism had little leverage before the late twentieth century, despite the first human case being reported in 1953 (Dunsford et al. 1953). In the case of a Mrs. McK, who had donated blood of two different types, it was determined there must have been an in utero transfer of DNA between the female fetus and her twin brother. The resulting female infant carried both her own original DNA and that of the nonidentical twin, thus creating a chimera. A similar explanation was proposed in a more recent case that touched on legal implications. A welfare applicant in the United States, Lydia Fairchild, whose maternity of her own children could not be verified through standard genetic testing of the blood was suspected of fraud. A subsequent birth under observation again showed the same DNA mismatch between the infant and mother. It was finally determined that the DNA of the mother’s blood was quite different to that of her reproductive organs: she had extensive tetragametic chimerism. It is most likely that like
Mrs. McK, Fairchild had been conceived as a dizygotic twin, and that her embryonic self-absorbed the other undetected twin in utero, giving the remaining singleton two sets of DNA. Current research indicates that genetic chimerism may develop quite commonly as a result of what is known as the vanishing twin syndrome in which dizygotic twin embryos may fuse or one may absorb the other. There are suggestions that many pregnancies that deliver a singleton begin as unrecognized multiple gestations, and although one fetus disappears, its DNA does not.

At present, the prevalence of microchimerism is unclear, but it is widely accepted that far from being transient as was first thought, it can persist for decades and probably for life (Maloney et al. 1999; Kamper-Jørgensen et al. 2014). And as the known causes multiply—nonirradiated blood transfusions, bone marrow, tissue and organ transplants, pregnancy, generational genetic transfer, human dizygotic fusion, and possibly lactation and fluid sexual exchanges (Yan et al. 2005)—the claim that it may be ubiquitous no longer seems so strange. The cases highlighted are unusual in the degree to which microchimerism is present in the body and it may be that lower levels have little effect, but either way there is cause for concern. Maternity and paternity testing for social and domestic legal purposes is becoming increasingly familiar, but it impacts too on the cross-border migration of refugees and asylum seekers whose only hope may be to establish a genetic/kinship link with residents of the countries to which they travel. Justice is hard to achieve with the best knowledge, the more so if one potentially significant input is casually overlooked. If chimerism occurs more frequently than is generally acknowledged, then it raises some urgent questions. The conventional reliance on DNA in both social and legal contexts would warrant reconsideration, and the possible fallibility of identification “could undermine the very basis of the forensic DNA system” (Krimsky and Simoncelli 2010). On a more abstract basis, such startling instances of genetic translocation (as the cited cases show) indicate both that genetic markers may be complex and multiple and that the permeability of borders necessitates a new appreciation of intracorporeal malleability. It further contests the Western sociocultural imaginary of a pure, integrated, and stable identity established at birth and fixed until death.

Consider now the problematic of pregnancy where the well-established operation of microchimerism underlines the slow shift, equally in biology and biopolitical discourse, from the notion of rigid and enduring corporeal boundaries—both external and internal—to permeable and leaky bodies. Until relatively recently, the conventional view has persisted that bodies operate as immunologically discrete entities in opposition to one another.
rather than mutually supportive. The placenta itself has long been recognized as a site of material exchanges between mother and fetus, with oxygen, nutrients, and hormones passing in one direction and products of excretion in the other, but it was primarily thought of as a protective barrier keeping apart the distinct nature of maternal and fetal bodies. And it is precisely that supposed distinction that has justified some biopolitically driven interventions into pregnant women’s lives, particularly in the context of abortion politics and surrogacy, for example. For immunologists, the puzzle has been why a healthy pregnancy—as a self/other interface interior to the body—does not normally provoke the expected immune response of mutual rejection. Substantial research has now shown beyond doubt that far from functioning as a defensive cordon separating one entity from another, the placental “barrier” is crossed by both fetal and maternal DNA, without obvious pathological effect to produce, as a matter of course, signs of microchimerism within each body. To date, the research is usually conducted, for ease of assay, by tracing the incidence of—conventionally out of place—Y-coded (male) cells within the female body, but microchimeric exchanges are to be expected whatever the gender of the fetus.

This paradoxical observation of the active circulation of maternal and fetal cells in the body of the other was long dismissed as a phenomenon of very short duration that was insignificant in terms of ongoing health. Clinical research now shows, however, that far from being ephemeral, divergent maternal and fetal DNA can remain in the mother or offspring’s body for decades after pregnancy (Bianchi et al. 1996; Maloney et al. 1999). A further possibility is that the chimeric relationship between mother and child could encompass the translocation of human leucocyte antigens (HLA) deriving from a previous pregnancy in which fetal markers (effectively traced as male) had entered the maternal body. Any subsequent female offspring of the same mother could then carry nonself-coded HLA, not from her own gestation but from the circulation of an older sibling’s cells in the maternal body (Guettier et al. 2005, Yan et al. 2005). Even more unexpected has been the discovery that women who have never been pregnant can carry male DNA (Yan et al. 2005), that is, their XX sex chromosomes are supplemented by XY cells, clearly indicating that microchimerism may result from the cellular exchanges between previous generations. For example, any male DNA circulating in my body may originate from a great uncle whose gestation period preceded that of his sister (my grandmother). She in turn passed on microchimeric XY cells to any subsequent female fetuses, including my mother. Each of us—regardless of pregnancy status—may carry nonself cells from a variety of genetic
relations. In principle, it becomes difficult to see why microchimerism—if it can be detected at all ages—should not persist indefinitely. The radical challenge to one of biomedicine’s central tenets—the immunological distinction between self and other—further contests the plausibility of genetic inviolability.

The phenomenon of intercorporeal cellular motility remains mired in controversy particularly in relation to maternal or fetal/infant ill-health (Shildrick 2015). The recognition that embryonic stem cells can repair and regenerate damaged tissue, bone, or muscle is by now widely familiar, but at the same time, microchimerism has also been marked as a contributing cause of unexplained autoimmune diseases—such as rheumatoid arthritis, psoriasis, and lupus—where the immune system appears to misrecognize the self (Nelson 2002; Bianchi 2007; Kelly 2012). The common factor is that nonself cells are more frequently found in greater concentrations at the site of lesions than in circulating blood and in higher frequencies than in “healthy” control groups. It suggests either a causal association in the disease process or that differential HLA—the gene-encoded protein set that underpins the immune system—gathers to offer enhanced protection and restoration in the face of damage (Kallenbach, Johnson, and Bianchi 2011). Although opposing rationales seem fairly entrenched on either side, one exception is clinical researcher Lee Nelson (2002, 2008) who has moved from an initial skepticism with regard to any beneficial effects of microchimerism to a careful consideration of both the positive and negative effects, and even a speculative rejection of the exclusionary self/nonself model of human health. What is striking about most of the research, however, is the persistence of metaphors that pitch the relation between the different cell lines as though they represented two distinct people.7 Regardless of decades of feminist research that has stressed the phenomenological relationality—the simultaneity of the one and the two—of a gestational mother and fetus (Young 1984; Diprose 1994; Dolezal 2017), the association is still framed, at best, as that of separate entities and, at worst, as oppositional.

It is not that an erasure of difference is called for, but rather recognition that mother and fetus, and later mother and child, are mutually entangled at multiple levels and become unstable terms. The bioscience of microchimerism is not about the hybrid assimilation—and hence disappearance—of “alien” cells but about their coterminous existence within the host’s body. Like the microbia of the microbiome, they play an active part in conjoint development and problematize the assumption that self and other are distinct. It makes little sense to characterize fetal and maternal microchimeric
cells as out of place, as though they “belong” to an original location, yet sociocultural normativities persist (Martin 2007). Such personalizing allusions are particularly evident in the harm/benefit debate where the linkage of microchimerism to both regeneration and disease has been of interest to evolutionary biologists who slip easily into positing the maternal and fetal entities as figures in a modernist scenario each acting in their own interests. The strengthening of immune tolerance through exposure to “foreign” antigens is generally taken to enhance future reproductive success in both mother and offspring, but typically Boddy et al. (2015) refer to fetal microchimerism as manipulating maternal tissues. More specifically Haig (2014) suggests that fetal cells in mothers’ bodies benefit their own interests by promoting lactogenesis or by extending the interbirth interval and that maternal cells in fetal bodies might suppress sibling rivalry. One intriguing lay example of the appeal to liberal individualism comes on the website of a surrogacy agency in the United States which advises potential gestational mothers that being a surrogate can increase life expectancy. Explaining that surrogate mothers carrying a male fetus were likely to host Y chromosomes for life, it claims: “Over 80% of women with the chromosome lived until the age of 80, while just over 65% of those without...lived an equal amount of time” (Physician’s Surrogacy, 2019). The message is clear: surrogacy is good for you because microchimerism confers individual benefit.

In the more measured realms of bioscience, the debate about the nature of intracorporeal cell mobility may remain unresolved, but the simple observation that microchimeric exchanges during pregnancy have biological effects for both mother and fetus that exceed the period of gestation, birth, and neonatality has implications beyond bioscience, not least for bioethical and legal inquiry into the dimensions of gestation. If, in the normal course of pregnancy, each body carries plural and durable populations of differentially active noninherited antigens, then there is much that needs to be revised. The very existence of microchimerism and the probability that it is ubiquitous deeply disorders any Western-based notion that I am verified as an autonomous entity because each cell in my body carries the same unique genetic code. As Martin (2007) puts it, existential individuality is taken to be prefaced on genetic essentialism, but when this can no longer be asserted biologically, how can we understand kinship claims based on DNA identification? Once there is an awareness that the event of pregnancy has a temporal resonance beyond the nine-month conjunction of maternal and fetal selves, the ongoing split between the supposed pathological or beneficial effects that microchimerism might have on health takes
on a different significance. Questions concerning what it means for either mother or child to carry within themselves allogenetic antigens—are they persist after birth, are they tolerated by the host body or simply unrecognized? Are the future effects neutral, benign or harmful? Does the aging of maternal cells in the bodies of progeny pose any risk—are relevant to all gestational mothers whether they have a prior genetic relation or not. Such concerns initially operate within a biomedical problematic, but they raise serious concerns about the adequacy of conventional ethical and legal approaches to the relationship between “natural” mothers, surrogates, and their fetuses.

To date, the issue of surrogacy has been largely investigated through a human rights perspective that is both necessary and insufficient. Although some arguments support surrogacy as women taking control of their own bodies (van Zyl and van Niekerk 2000), there are undoubtedly many instances of exploitation, particularly in relation to commercial gestational surrogacy where the additional risks to the carrying mother of multiple implantations are well-recognized. In biolegal studies, the emphasis is often on contract law, starting with the much-analyzed case of Baby M through to more recent instances such as Baby Gammy. In the context of global neoliberalism, where exercising reproductive choice can entail paying another woman to undergo a proxy pregnancy, the racialized, colonialist, and gendered imbalances of power are all too evident. Reproductive tourism is big business (Deonandan 2015). Across both pro- or anti-surrogacy positions, and regardless of whether the emphasis is on the surrogate or on the intending parents, the arguments employed are most often based in the notion of autonomous rights-bearing individuals whose interests may or may not conflict (Sifris 2015). Specifically feminist commentary has tended to be more reflective of issues such as affect, responsibility, and relationship and is wary of fitting surrogacy into an existing ethico-legal framework that takes little account of the technological changes that have supported the practice, yet postgenomic thinking plays little part. Vora (2015) does move in that direction and has persuasively set out the grounds on which gestational surrogacy is putatively divorced from genetic, affective, and legal parenthood—particularly with respect to the Indian subcontinent—but although she gestures toward the phenomenon of chimerism, she does not follow through the implications.

The problematic of disordered genetic links is at its most acute in the work of a small number of feminist scholars such as van Wichelen (2016) and Payne (2016) who have recognized that microchimerism sheds a very different light on the process of surrogacy. Although we might need to
rethink the responsibility that exists between any pregnant woman or genetic parent and her child, the phenomenon throws up particular issues for a full gestational surrogate, who supposedly has no genetic links with the fetus she carries. Surrogacy already provokes legal and ethical conflicts over who is entitled to be recognized as the mother, but until now the issue has devolved on what value to give genetic and gestational links when the two are seemingly opposed. Whether the process is altruistic or commercial, the general Western expectation is that the commissioning genetic parents may establish legal claim to the infant once it is born and that the surrogate should forego any emotional attachment to the fetus. What has been overlooked is that new biosocial understandings of epigenetics, and more recently microchimerism, might demand a radical rethinking of the relation between a gestational surrogate, and the developing fetus and subsequent child. In both cases, the processes of gestation and birth clearly contribute much more than a nurturing environment and will persistently impact mother and child alike. Both epigenetic changes to the expression of genes—which it is now accepted can be heritable—and the exchange across the placenta of differential noninherited DNA encapsulated in cellular material indicate that fetal and maternal bodies have significant and enduring links post birth that may emerge in multiple contexts of genetic identity, gene expression, and lifelong health and disease. What, then, does it signify, ethically and legally, when a surrogate mother asserts the permanency of her relation to the neonate? As a further complication, it is now apparent that the genetic parents, through the fetal transmission of microchimerism, are also tied into a complex biological relationship with the gestational mother as well as with the fetus. Who then is ethically and legally responsible for the possible diffusion of states of ill-health, congenital anomalies, or susceptibility to disease?

None of these questions have been substantially addressed in a legal context. The closest indicator is an Irish case of disputed motherhood in which the issue of the epigenetic input of the gestational surrogate was aired in court. Briefly, the genetic parents of twin babies—fully supported by the surrogate who was the sister of the genetic mother—applied to reverse the refusal of the Registrar General to register the genetic parent as the legal mother. In M.R. v. An tArd Chlaraithoir (2013), Abbott J. considered the customary legal principle of mater semper certa est and heard evidence from experts in epigenetic biology, the majority of whom agreed that gestation conferred an unbreakable epigenetic link that justified the nomination of motherhood, even if that posited more than one mother. Nonetheless, the judge rejected the Registrar General’s reliance on the common law maxim

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of *mater semper certa est* and found in favor of the genetic parents. Regarding the epigenetic elements, he ruled that their influence was not sufficient to override the significance of chromosomal DNA for the purpose of determining identity and inherited characteristics, adding that it was unlikely that that the “deterministic quality of chromosomal DNA” would ever be trumped. The State subsequently appealed on the grounds that the judgment had not placed appropriate weight on the biological role of the gestational mother. The Supreme Court duly overruled the argument that genetic links conferred primacy and reinstated the surrogate as the reluctant legal mother. It did not, however, cite the epigenetic—still less microchimeric—evidence as a reason for the reversal, simply saying that any change in the customary approach was a matter for the legislature, not the courts.

Although the biological evidence in this specific case focused on epigenetics, microchimerism—as the placental transfer of cells between fetus and gestational mother—was raised by one expert witness, Dr. Molony. Nonetheless, her surprising assertion was that microchimerism “does not change the core DNA of the child,” which while it may reflect an everyday understanding, relies on agreement as to what constitutes “core DNA.” In any case, there is manifold evidence that microchimerism in the peripheral blood supply may change to macrochimerism in specific organs, as happened in the Fairchild case. Dr. Molony’s evidence made little distinction between epigenetic and microchimeric changes and was broadly accepted by Abbott J. who opined:

> Even where the epigenetic influences are endogenous to the mother, (such as the migration of cells including microchimeric cells from the mother’s body to the body of the foetus) ... (they) are not such as to interfere with the inheritable characteristics of the child and are capable of treatment or correction if understood. In the case of microchimeric cells, at least, it was conceded by one scientific expert that they were ... “red herrings” in the genetic scenario. (R. v. AtC. 98 (3), my emphasis)

Contemporary bioscience disagrees, both epigenetics and microchimerism have life-long and heritable genetic effects. What were dismissed as merely “interesting” phenomena have the potential to force a rethinking of gestational surrogacy. As one of the Irish Supreme Court judges recognized, there is a serious disjunct between the potential of bioscientific developments and the state of the law that is called on to mediate in cases of dispute. The Supreme Court left no doubt that statute law concerning reproduction was outdated, but my contention is that far more than simple adjustments
need to be made. On the level of both law and bioethics, it is surely incumbent to recognize that recourse to normative categories such as motherhood or genetic determinacy is inadequate. The role, value, and enduring influence of gestational motherhood demand radical reappraisal, not simply because sociocultural views change but because biology itself cannot provide the static and certain grounding in genetics that it has hitherto seemed to offer.

Few legal theorists are currently addressing the issue of microchimerism, or even epigenetics, and of those who do, there is a pronounced tendency to read the problematic through the lens of conventional bioethics and law. If, as now seems clear, surrogate mothers not only directly exchange genetic material with their fetuses but through intergenerational transmission are also opened up to the DNA and HLA templates of the genetic parents, then the standard surrogate contract and issues of consent on both sides become very unstable. While the flourishing arena of developmental origins of health and disease (DOHaD) habitually cites epigenetics as an explanatory framework, microchimerism itself is scarcely considered, but its implications should not be ignored. Alongside the influence of a mix of exogenous social and political inequities around poverty, race, education, and so on that underpin epigenetic changes, endogenous biological effects encompass both epigenetics and microchimerism and the microbiome. The potential penalization of surrogate mothers on grounds of potential fetal harm is already loud and clear and should not be taken lightly, but calls to monitor such mothers belong to a strictly modernist understanding of responsibility. Along with other feminist scholars (Diprose 2002; Karpin 2016), I would critique the notion of individual responsibility per se with its implicit stress on the illusory notion of autonomous life-style choices, and the complication of maternal–fetal microchimerism surely further disrupts any simplistic response. DOHaD can in all cases be critiqued for its concentration on ill-health and disease with little recognition that certain changes in DNA or its expression could be protective or enhancing. Moreover, I would stress again that epigenetic and microchimeric factors are not simply operative in the prenatal period but in the pregestational context too, which implicates all parents, including gestational surrogates and genetic mothers and fathers (Bianco-Miotto et al. 2017).

The authorized bioethical frameworks typically associated with maternal–child health are deeply unproblematized, and uncritically rely on notions such as reproductive autonomy and its off-shoot, informed consent, and the principle of nonmaleficence. The canonical pedagogical text, Principles of Biomedical Ethics (Beauchamp and Childress 1983), still sets the
tone, and it seems that most legislation is similarly ill-matched to the realities of the contemporary bioscience. If contracts are to be enforceable, it sounds sensible that all parties to a surrogacy arrangement should be enabled to make informed choices through the provision of information about the epigenetic and microchimeric dimensions of the maternal–fetal relationship. Fischbach and Loike (2014), for example, recommend that “a suitable and heuristic framework must be established to protect all parties involved without extinguishing the cooperation of the surrogate and the hopes and dreams of the expectant couple” (p. 36). Conventional ethics or law cannot be entirely superseded, but I see such approaches as finally inadequate in their desire to find categorical certainty and predictability in issues that are themselves intrinsically indeterminate. The Irish case of disputed maternity indicates that even had microchimerism been more fully taken into account, it would not have trumped the search for the “true” mother. Social policy and legal theory continue to take a pragmatic approach, but my interest as a speculative philosopher is to ask the “what if” questions without losing sight of indeterminacy. It is not simply that the bioscience is still developing and is as yet poorly understood, and that in time there will be definitive answers, but that biology is chaos. We can no more read off new biology than the old. How, then, could we begin to think differently?

One way forward is to think of pregnancy as a phenomenological state that figures neither singularity nor duality, but irreducible connection, as in the reciprocal, embodied, and feminist ethics of “corporeal generosity” developed by Ros Diprose. The term intends a bodily coming together which engages in a mode of giving and receiving that is not dependent on the reduction to sameness implied by exchange. Indeed, corporeal generosity can only emerge in the context of difference, which must be both protected and responded to. As Diprose (2002) writes, “intercorporeal generosity maintains alterity and ambiguity in the possibilities it opens [. . . ] generosity is only possible if neither sameness nor unity is assumed as either the basis or the goal of an encounter with another” (pp. 90-91). Her point is that human life is contingent on multifarious openings to other lives that in turn invoke a fluid array of connections that undermines the concept of an atomistic self. In effect the coming together of corporeal generosity may be both risky to the modernist illusion of the integrity of bodies and conducive to opening up new possibilities, and what her model offers is a further philosophical challenge to the feasibility of the normatively entrenched biomedical and legal narratives of a constant and autonomous self. Diprose makes no mention of either chimerism or epigenetics, but Hird (2007)
extends the notion of the “affective material offering of our body to the
other” (Diprose 2002, 191) to the specific relations of pregnancy. Hird
proposes that the transfer of inherited parental DNA, and the variety of
viruses, antibodies, nutrients, bacteria, biochemical substances, and other
cellular material in transit between maternal and fetal bodies, could all be
characterized as instances of “corporeal generosity.” Surprisingly, Hird
does not explore the issue that the microchimerism of pregnancy is bidirec-
tional, but like Diprose, she insists that all such embodied gifting is irregular
and potentially disruptive, citing Donna Haraway’s observation that the
neonate is a “randomly associated genetic package” (Haraway 1989,
352). Where bioscience considers the potential of both beneficial and harm-
ful consequences in maternal–fetal microchimerism, corporeal generosity
goes beyond binary thinking. It is clear that neither corporeal generosity nor
chimerism necessarily imply any form of assimilation or merging where a
new singular form materializes; instead bodies and micro-parts of bodies
are conjoined, constituting an irreducible, yet inseparable difference.

The critical point is that chimerism overcomes the interval between self
and other and demonstrates mutual interaction, entanglement, and influence
without transcending a Deleuzian understanding of difference in itself. The
ethical and juridical task, then, is to recognize the implications of such
coterminous existence by thinking in terms of postindividuality and giving
recognition to the one in the other and to the unbounded potentiality of life’s
becoming. Postconventional philosophy is rich with possible take-off points
and I will simply signpost some brief speculations on where a Deleuzian
approach might take us in engaging with wholesale chimerism.10 The rad-
ical break with binary knowledge pursued by Deleuze and Guattari (1987)
not only contests the boundaries of embodiment per se but throws new light
on some of the troubling aspects of pregnancy and maternity which are so
entangled with postgenomic thought. The move is from the unitary para-
digm of mother/womb/fetus/infant in the formulation that still dominates
bioscience and law to an understanding of all life as constitutively chimeric.
In place of the fixity of “being”—particularly of self and other—Deleuzian
philosophy celebrates a state of becoming in which each of us is constituted
through multiple and unpredictable webs of connection that exceed the
individual (see Braidotti 2006; Shildrick 2013). What counts for Deleuze
is not familiar pattern of growth and development through arborescent
branching which preserves a central origin that remains essential to the
whole—as in the conventional heredity model—but the endless generation
and elaboration of ever new forms of life through the rhizomatic spread of
nODULES and connective channels. The Western sociocultural disposition to
identify the maternal, as exemplified in each individual mother, as the root of life, bears less weight than the generative power sustained, not through the closure and self-sufficiency of the maternal–infant dyad but through multiple connections.

I have found the Deleuzian notion of what are called assemblages highly effective for recognizing what is at stake in chimerism, and as feminist scholars have suggested, contemporary biosocial assemblages compel new ways of thinking about pregnancy (Shildrick 2010). Taking her lead from research into the commensal microbial activities at work in the human body—rather than into microchimerism—Takeshita (2017), for example, rejects maternal–fetal dualism in favor of the term motherfetus and positions pregnancy as “a process integrated in a larger symbiotic circulation of matter” (p. 4). In a somewhat different direction, the specific arena of gestational surrogacy could be thought through a similar analysis: assemblages unsettle the whole question of kinship and that entails moving beyond what Lewis (2017) calls “unitary maternal authenticity” (p. 120). The point is to appreciate multiple and entangled sites of motherhood rather than allotting the status to one woman alone. Equally, it should be recognized that the models of parenting prevalent in the Global North are already at odds with non-Western patterns of thought and practice around reproduction, and as Amrita Pande’s (2009) research shows, Indian women who act as gestational surrogates may express their links to the fetus in ways I have not touched on here. What is common across cultures is that surrogacy is a highly complex biological and phenomenological experience that undoes any distinction between natural and artificial and speaks instead to connections, disjunctions, and transformations.

In the end, biology, philosophy, and sociology all contribute to understanding the assemblage, and I want to stress that despite my extensive description of the processes at work in microchimerism, the biosciences—like politics, ethics, and the law—offer no objective truths but are impermanent discourses. Their insights, however, cannot be ignored or sequestered from sociopolitical issues. On a theoretical level, the emerging importance of biophilosophy which is responding to and thinking through the implications of the materialities of transformed life should be matched by similar moves in the legal field. The fluid and dynamic interplay between genetically distinct cells in a single body, and particularly the entanglements between mother and fetus, raises the question of how a postgenomic knowledge could be implemented. In the widest sense, that entails a slow, but finally inevitable, process toward a new imaginary. The task ahead, then, is to build on the hitherto marginalized network of
relations, interconnections, and assemblages that are being uncovered in the realm of pregnancy and maternity and reimagine the concept of living beyond singularity. The problematic of surrogacy, which so often has revolved around the limited question of competing rights, demonstrates how the material and theoretical together can open up radically new approaches. If ethics and law are to exceed present normative structures, we need to think the bioethical and juridical conditions not of individual and distinct existences but of an endlessly proliferating chimerical coexistence.

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Notes
1. I am grateful to Aryn Martin for pointing out that it is not known for certain that no assimilation occurs. Burlingham (2014) posits that a host cell may fuse or become “cross-dressed” with the antigen complexes of a nonself cell. In general, however, such cells are identified because they remain distinct.
2. A recent analysis suggests that the ratio may be as low as 1:1 (Greshko 2016).
3. Tetragametic chimerism occurs when two zygotes fuse and develop into a single body with two distinct sets of DNA. See Yu et al. (2002) and Norton and Zehner (2008) for a highly bioscientific report of the phenomenon and a cultural studies take, respectively.
4. Sheets et al. (2018) outlines a case of disputed negative DNA paternity testing. After repeated negative results, the claimant father’s paternity was confirmed when further investigation showed he hosted congenital tetragametic chimerism.
5. See Murdoch (2008) and Holland (2011) for how microchimerically driven misidentification could impinge on immigration-related cases.
6. A case in point, reported by the Alaska State Scientific Crime Detection Laboratory, has direct implications for criminal law. Following a serious sexual assault, forensic evidence matched the blood DNA of a man already imprisoned
at the time of the attack. It subsequently transpired that his brother, the actual attacker, had an identical DNA profile from a sibling bone marrow transplant. Possible misidentification in the event of criminality should be of concern (Aldous 2005) and the assumption made by Kaye (2013) that because such cases are exceptional, they present no obstacle to legal practice seems wilfully complacent.

7. Nelson’s “popular” article for Scientific American (2008) uses a plethora of metaphors describing microchimeric cells, variously calling them interlopers, undesirable aliens, masqueraders, stowaways, migrants, two-way traffic, émigrés, adopted cells, and seeds that take root.

8. In conventional immunology, the intrinsic antigens carried by both self and other are not mutually tolerant.

9. Mater semper certa est literally means that the mother is always certain and is irrefutably established at the moment of birth. It takes no account of contemporary reproductive technologies nor of new discoveries in microbiology, both of which problematize the genetic and gestational dimensions of motherhood.

10. See Shildrick (2015) for a fuller account.

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