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Biology and Theology in Malebranche's Theory of Organic Generation

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1. Introduction

> The sketch by this philosopher [Descartes] can help us understand how the laws of motion suffice to cause the parts of animals to grow little by little. But that these laws are able to form them and connect them all together, is something no one will ever prove (OC XII, 264/ DMR XI, 205).[1]

In this passage from his *Entretiens sur la métaphysique et sur la religion*, Nicholas Malebranche has seized upon one of the problems in natural history (and later, biology) that has proven, historically, to be among the most difficult—the question of the origin of organic forms. In E. S. Russell's evaluation, it is the problem of explaining the development of a living individual from something seemingly simple and uniform to a complex and organized creature. Further, the problem is to explain how a living creature is able to be unified at a time and identical through times despite its evident material diversity and mutability.[2]

[1] All references to Malebranche's works are to the following editions with their respective abbreviations: Nicolas Malebranche, *Dialogues on Metaphysics and on Religion* (reprint, Cambridge, UK: Cambridge University Press, 1997), trans. David Scott, ed. Nicholas Jolley, cited as DMR with dialogue section and page number; Malebranche, *Oeuvres complètes de Malebranche*, 21 vols. (Paris: J. Vrin, 1958–66), series director Henri Gouhier, various editors, cited as OC with volume and page number; Malebranche, *The Search After Truth* (Columbus, OH: Ohio State University Press, 1980), trans. Thomas M. Lennon and Paul J. Olscamp, cited as ST with page number.

[2] E. S. Russell, *The Interpretation of Development and Heredity* (Oxford, UK: Clarendon Press, 1930), 1.

Malebranche 'solves' the problem by denying it altogether. Generation of new lives does not occur. Each animal, plant, and human body is preformed, fully created by God at the Creation as a miniature of the eventual adult it will become, awaiting only its appropriate moment to grow into its adult size.[3] All these preformed organisms are stored from the Creation in the ovaries of the first female of each species (ovism).[4] The process of growth or augmentation of these organisms, a sort of swelling, is entirely possible by mechanical means. What we observe as and even call generation is simply the becoming visible of what was previously invisible, but it is not a new becoming, a new formation, and there is no development in any meaningful sense of the idea of development. That is, there is no coming-into-being of the completed organic form itself—that complex, organized, and unified living being. Nor is there a problem of accounting for the simplicity or identity of a creature; it was created in order to be intrinsically unified. This theory, termed "preexistence" by some,[5] was a prevalent theory of organic generation in natural philosophy for about a century, from the 1670s when Malebranche first clearly sketched it in its early modern form.[6] Preexistence is often contrasted with epigenesis, the theory that

[3] On Malebranche's theory of preexistence, see, e.g., Karen Detlefsen, "Supernaturalism, Occasionalism, and Preformation in Malebranche," *Perspectives on Science* 11.4 (2003): 443–483; Andrew Pyle, *Malebranche* (London: Routledge, 2003), chapter 7; Andrew Pyle, "Malebranche on Animal Generation: Preexistence and the Microscope," in *The Problem of Animal Generation in Early Modern Philosophy*, ed. Justin Smith (Cambridge, UK: Cambridge University Press, 2006), 194–214; André Robinet, *Malebranche de l'académie des sciences* (Paris: Vrin, 1970), section VI, chapter 2; and Paul Schrecker, "Malebranche et le préformisme biologique," *Revue internationale de Philosophie* 1.1 (1947): 77–97.

[4] Ovism is proposed by Swammerdam, Régnier de Graaf, John Ray, Pierre-Sylvain Régis, Bernard Le Boyer de Fontanelle, and Albrecht von Haller in addition to Malebranche. The version of preexistence that maintains that the organisms are housed in the first male of each species is termed "animalculism" or "spermism." A third version of preexistence, panspermism, maintains that organisms are scattered throughout nature. Animaculism's most famous adherents include Leeuwenhoek, Hartsoeker, and Leibniz (usually). Panspermism is embraced by Claude Perrault and La Mettrie.

[5] For different terms used for the theory I call "preexistence"—most notably "preformation"—see Jacques Roger, *The Life Sciences in Eighteenth-Century French Thought*, trans. Robert Ellrich, ed. Keith R. Benson (Stanford, CA: Stanford University Press, [1963] 1997), 259–260; and Peter J. Bowler, "Preformation and Preexistence in the Seventeenth Century: a Brief Analysis," *Journal of the History of Biology* 4.2 (1971): 221–222.

[6] See, e.g., OC XII, 253-4/DMR XI, 196. There is some dispute as to whether Malebranche or Swammerdam (or even Malpighi) is to be credited with the revival of the theory in its 17th-century form. See Howard B. Adelmann, *Marcello Malpighi and the Evolution of Embryology*, 5 vols. (Ithaca, NY: Cornell University Press, 1966), vol. II, 869–870; Richard Aulie, "Caspar Friedrich Wolff and His 'Theoria Generationis,' 1759," *Journal of the History of Medicine* 16 (1961): 124–144; Bowler, "Preformation and Preexistence," 234, fn. 34, and 237; Peter J. Bowler, "The Changing Meaning of "Evolution," *Journal of the History of Ideas* 36.1 (1975): 95–114; Daniel C. Fouke, "Mechanical and 'Organical' Models in Seventeenth-Century Explanations of Biological Reproduction," *Science in Context* 3.2 (1989): 365–381; and Edward Ruestow, "Piety and the Defense of Natural

maintains that each new organism is formed anew, the parts emerging successively, and often due to a *self*-generative capacity.[7] Many believe that epigenesis finally triumphed near the end of the 18th century, putting an end to the reign (or tyranny) of preexistence.

Why would so many smart people in the early modern period embrace such a seemingly bizarre theory of generation? In this chapter, I answer that question by examining three general categories of reasons why early modern natural philosophers endorsed preexistence, categories I will call theological, scientific,[8] and non-theological metaphysical (for ease of expression, I will simply call this last "metaphysical"). Thinkers who endorse preexistence often have multiple reasons from more than one of the above categories for their endorsement of the theory. And crucially, these categories are not always neatly distinct from one another—a point that will become amply clear in the second part of this chapter. Nonetheless, these three categories of reasons encompass most of the arguments given by those in the early modern period for their embrace of preexistence. In the second part of the chapter, I turn to an examination of Malebranche, who holds all these motivations save one (the metaphysical) in his own embrace of preexistence. That is, Malebranche maintains preexistence for theological *and* scientific reasons, and his scientific reasons are both that he is committed to mechanism and that he acknowledges the biological nature of the organic being. Indeed, I argue that the best characterization we can give of Malebranche's argumentative strategy is that he draws on all three of these strategies in an "all things considered" approach to provide strong evidence (but not decisive arguments) for preexistence as the most likely theory of generation.

Order: Swammerdam on Generation," in *Religion, Science and Worldview*, eds. Margaret Osler and Paul Farber (Cambridge, UK: Cambridge University Press, 1985), 231ff. I say "revival" of the preexistence theory in the early modern period because it was in existence in medieval philosophers such as Augustine and Bonaventure as well.

[7] William Harvey coined the term "epigenesis" and developed that theory in the 17th century (see, e.g., William Harvey, *Disputations Touching the Generation of Animals*, trans. Gweneth Whitteridge (Oxford, UK: Blackwell Scientific Publications [1651] 1981), 204. Some commentators believe that epigenesis as a biological theory can be traced back to Aristotle (e.g., A. L. Peck, Introduction to *Generation of Animals*, by Aristotle, trans. A. L. Peck (Cambridge, MA: Harvard University Press, 1963); and Anthony Preus, "Science and Philosophy in Aristotle's *Generation of Animals*," *Journal of the History of Biology* 3.1 (1970): 1–52. Although it is true that Aristotle believes that foetuses generate by a sequential formation of parts, there are crucial theoretical differences between his and Harvey's theories, which make it problematic to conflate them.

[8] In using the term "scientific" for one of the categories of reasons, I am mindful that this is a modern term unfamiliar to those of the 17th and 18th centuries. Moreover, the closest 17th-century discipline to what we call "science" (i.e., natural philosophy) embodies not only modern-day science, but metaphysics and theology as well. For this reason, I emphasize that the three categories of reasons given for preexistence are not neatly distinct. Yet there are arguments for preexistence that emphasize natural explanations for phenomena above all else, and these arguments are those I will call scientific.

2. Why Preexistence? Three Categories of Reasons

In this section, I examine three broad forms of arguments in favor of preexistence, arguments found in the writings of those in the 17th and 18th centuries who embrace the doctrine of preexistence. I also underscore that, though one form may dominate in any given argument, these three general forms of argument are not neatly distinct, and this blending of the theological, metaphysical, and scientific is to be expected in the age of natural philosophy (as distinct from science).

2.1. Theological Arguments

There are two primary theological defenses of preexistence that I examine. The first is the original sin defense, and the second is essentially a version of the teleological argument for God's existence.

According to the original sin defense of preexistence, the thinker acknowledges the Biblical idea that we are all stained by original sin, and it was to remove this sin that Jesus Christ sacrificed his life for us. But one may wonder *how* we all came to be stained by original sin when we were not there at the moment of sin to be held responsible for it. Preexistence, however, holds that we *were* all present at the beginning to be stained by sin—indeed, we were all housed in the ovaries of Eve or the "loins" of Adam, the very individuals who committed that sin. And so, according to this argument, preexistence finds support from the fact that it can help explain the theological belief that we are all implicated in that free choice and action of Eve. As Swammerdam writes: "[E]ven original sin may stand on this principle [of seeds being present in the father's loins], since all mankind have been laid up originally in the loins of their first parents."[9]

The second theological argument I examine here is a version of the teleological argument for God's existence. Heeding the intricate and beautiful design of living bodies that are, moreover, organized to fulfill manifest purposes (e.g., eyes fulfill the purpose of seeing), a theologically minded early modern philosopher can point to these natural facts as the most obvious evidence to be found in the natural world for the direct role of a purposeful, powerful, and intelligent designer—that is, God—in the creation of these bodies. Many in the 17th century did argue in this way.[10] It is, of course, a further step to say that God created

[9] Jan Swammerdam, *Book of Nature, or the Natural History of Insects* (London: n.p., 1738).

[10] As just three examples, see Robert Boyle, "A Disquisition about the Final Causes of Natural Things," in *The Works of Robert Boyle*, vol. 11, eds. Michael Hunter and Edwards B. Davis (London: Pickering and Chatto, [1688] 2000), 79–151; Pierre Gassendi, "Fifth Set of Objections to Descartes' *Meditations in First Philosophy*," in *The philosophical Writings of Descartes*, vol. II, trans. John Cottingham, Robert Stoothoff, and Dugald Murdoch (Cambridge, UK: Cambridge University Press, [1641] 1984), 215; and Malebranche (e.g., OC XII, 247/DMR X, 189).

all organisms, fully formed, at the Creation, rather than throughout the duration of the natural world. But one possible way to this stronger conclusion is to claim that preexistence leaves a substantial role for God in the process of generation without thereby calling upon the deus ex machina each and every time a new organism is formed. This second theological argument is closely tied with the first of two scientific arguments I focus on, and I turn to these now.

2.2. Scientific Arguments

There are two primary scientific arguments for preexistence that I examine. The first is the argument from the limits of mechanism taken as a form of explanation of natural phenomena, and the second is the argument from biology, an argument that acknowledges the unique character of living beings.

In the early half of the 20th century, historians of science were not kind to the preexistence doctrine. For example, F. J. Cole, though generous in space in his discussion of preexistence is not generous in judgment, concluding that the "contributions of the early naturalists to the doctrine of generation [are]... too brief.... That this meagre record is the direct consequence of the paralysing influence of the Preformation [preexistence] Doctrine is beyond question.... A speculation which makes a picturesque or academic appeal to the imagination... is assured of the warmest reception. The Preformation Doctrine is an excellent illustration of this point."[11] Preexistence was rescued from ignominy in the 1960s by a series of historical studies that demonstrated its roots in the metaphysics and natural history of the early modern period. This was part of a general transition to more sympathetic, contextualized approaches to the history of science. Paramount among these studies is Jacques Roger's monumental study, *Les Sciences de la vie dans la pensée française du XVIIIe siècle: la génération des animaux de Descartes à l'Encyclopédie,* recently translated into English under the title *The Life Sciences in Eighteenth-Century French Thought.*[12]

[11] F. J. Cole, *Early Theories of Sexual Generation* (Oxford, UK: Clarendon Press, 1930), 201–202. Cf. Russell, *The Interpretation of Development,* 29ff.; Arthur William Meyer, *The Rise of Embryology* (Stanford, CA: Stanford University Press, 1939), 84ff.; and Joseph Needham, *A History of Embryology,* 2nd ed. (New York: Abelard-Schuman, 1959), 223ff.

[12] Roger, *The Life Sciences.* Other prominent studies in this early wave that dealt seriously with preexistence include books by Adelmann, *Marcello Malpighi;* Elizabeth Gasking, *Investigations into Generation, 1651–1828* (Baltimore, MD: Johns Hopkins University Press, 1967); Jane Oppenheimer, *Essays in the History of Embryology and Biology* (Cambridge, MA: MIT Press, 1967); and François Jacob, *The Logic of Life: A History of Heredity,* trans. Betty E. Spillmann (Princeton, NJ: Princeton University Press, [1970] 1993); and articles by Charles W. Bodemer, "Embryological Thought in Seventeenth-Century England," in *Medical Investigations in Seventeenth-Century England* (Los Angeles: William Andrews Clark Memorial Library, 1968); Bowler "Preformation and Pre-existence"; François Duchesneau, "Haller et les théories de Buffon et C.F. Wolff sur l'épigenèse,"

In his text, Roger builds the case that, faced with the limitations of the nascent and unsophisticated brand of mechanism to which many 17th- and 18th-century philosophers and natural historians were committed, preexistence was the most sensible answer to the problem of generation—the apparent new creation of a living being from parents of the same kind. For my purposes, I define mechanism as the belief that all changes at the phenomenal level—that is, all changes we experience—are due to the lawful motion and contact of sub-visible matter that is inherently inert and quantitatively, not qualitatively, defined. According to Roger's thesis, bits of matter this austerely defined, together with a few very simple laws of motion, could never give rise to phenomena as complex as the generation of living beings. The evidence for mechanism's inability to account for generation was produced by Descartes when he attempted to provide such an explanation and, many believed, failed abjectly. Descartes's explanation for the phenomenon of organic generation runs roughly as follows: The seminal fluid from the female and male mix in the uterus. They begin a rapid vortical motion due to extreme heat caused by a sort of fermentation upon the mixing, and from this mechanically moving liquid, the heart, then brain, and then other body parts emerge one by one until a living being is formed (e.g., AT XI, 253ff./ CSM I, 322ff.).[13]

Many natural philosophers who came after Descartes found this explanation entirely improbable. It is unlikely that a complex and well-organized being could develop this way just once, let alone with the frequency and respect for natural kinds that we regularly observe. The primary problem is one of chance. Should a living being with its incredible complexity be brought into existence through the movement of unorganized and homogenous matter according to a few simple laws, this would be a matter of sheer chance, here defined in contrast with purpose.[14] But the process of foetal formation happens all the time, quite regularly and in a highly deterministic fashion. One cannot realistically explain such a

History and Philosophy of the Life Sciences 1.1 (1979): 65–100; Shirley Roe, "The Development of Albrecht von Haller's Views on Embryology," *Journal of the History of Biology* 8.2 (1975): 167–190; and Shirley Roe, "Rationalism and Embryology: Caspar Friedrich Wolff's Theory of Epigenesis," *Journal of the History of Biology* 12.1 (1979): 1–43.

[13] All references to Descartes's works are to the following editions with their respective abbreviations: René Descartes, *Oeuvres de Descartes*, 11 vols., eds. C. Adam and P. Tannery (Paris: J. Vrin, 1964–1976), cited by AT followed by volume and page number; and Descartes, *The Philosophical Writings of Descartes*, 2 vols, trans. John Cottingham, Robert Stoothoff, and Dugald Murdoch (Cambridge, UK: Cambridge University Press, 1985), cited by CSM followed by volume and page number.

[14] Chance, here, is not contrasted with randomness. Descartes's account is fully deterministic, and therefore not random. But given the unorganized nature of the matter of the universe upon creation (according to Descartes's "chaos fable"), and given the indiscriminate nature of the laws of motion, then there is seemingly no purpose reflected in Descartes's theory of generation.

process in terms of something as chance-laden as initially unorganized matter in lawful motion. Generation, probably more than any other natural phenomenon, threatens early modern mechanism, here taken as a scientific theory (i.e., theory meant to explain natural phenomena). And so, in lieu of abandoning strict mechanism by positing some active and purposeful or intelligent agent in nature, many natural philosophers adopted the belief that God—and not something in the natural world—is responsible for the creation of these forms.[15] Stephen Jay Gould picks up this theme when explaining his own abandonment of the "silly student's view" that preexistence was a "nonsensical doctrine": "I came to understand that the leading preformationists had been, ironically, defenders of the general mechanistic attitude that modern science now honors, whereas the epigeneticists had tended to favor the vitalistic views now anathematized."[16]

The connection between science and theology is especially clear when thinking about this first scientific argument. The issue of chance—in contrast to *purpose*—just discussed establishes this, for purpose and a mind (God's) that must be present for there to be purpose, is at the heart of the second (teleological) theological argument previously mentioned. In fact, Catherine Wilson has noted (in conversation) that the supposed inability of mechanism to explain generation is not likely the primary reason at all for the prevalence of the preexistence doctrine in the early modern period. She believes that theological motivations—and not issues with mechanism—are at the core of the popularity of preexistence. She notes that some early moderns opposed to the mechanical philosophy for theological or moral reasons (e.g., More, Cudworth, and Kant) use the especially difficult problem of generation to undermine the mechanical philosophy generally. Others have noted that mechanism essentially secures a crucial role for God in natural philosophy—thus necessarily linking mechanism and theology—because a natural world comprised exclusively of passive matter must include God in order to explain basic phenomenological facts about that world, such as motion.[17] So the emergence of preexistence occurred because this theory was the only one that completely secured a role for God in 'natural' philosophy.

Nonetheless, I take the second theological (from teleology) argument and this first scientific (from mechanism) argument to be two distinct arguments, however closely related. The teleological argument for preexistence takes the goal to be the proof of God's existence, whereas the argument from mechanism takes the goal to be an account of generation (a natural phenomenon) from

[15] E.g., Roger, *The Life Sciences*, 128–129.

[16] Stephen Jay Gould, foreword to *The Ovary of Eve: Egg, Sperm and Preformation*, by Clara Pinto-Correia (Chicago: University of Chicago Press, 1997), xiv–xv.

[17] See Keith Hutchison, "Supernaturalism and the Mechanical Philosophy," *History of Science* 21 (1983): 297–333.

within the confines of mechanism (taken as an explanatory account of natural phenomena). For this reason, I treat them as two distinct kinds of arguments.

I will call the second scientific argument the "biological argument," and it runs as follows: Recognizing the unique kind of structural unity characteristic of living beings, and attributing that unity to the capacity of living beings to function to maintain that structure (i.e., to function toward the end of self-preservation), early moderns often located the origin of these functional capacities in God; God created living beings precisely so that they could function for the end of self-preservation. We find an example of this form of scientific argument in Charles Bonnet:

> One needs no Morgagni, no Haller, no Albinus [experimentalists who believed they had provided empirical proof for preexistence] to see that all constituent parts of the body are so directly, so variously, so manifoldly, intertwined as regards their function, that their relationship is so tight and so indivisible, that they must have originated all together at one and the same time. The artery implies the vein, their operation implies the nerves, which in their turn imply the brain and that by consequence the heart, and every single condition a whole row of other conditions.[18]

The further belief that *God* must create organisms in order to explain their biological functions is motivated by the following: First, these functional capacities are taken to be truly teleological, and second, among the teleological options available to the early modern thinker, those that would be acceptable to a devotee of mechanism posit God as the intelligent source of the purposeful functions of organisms. Further, as suggested by the passage from Bonnet, the organism's unique structural unity is premised on the assumption that all the essential parts already exist and are connected together so as to be able to function for the end of self-preservation. Thus, according to Bonnet, the particular *kind* of purposeful functioning found in organic bodies requires that organisms *not* develop epigenetically, part after part.

Albrecht von Haller is another proponent of preexistence who seems especially motivated by phenomena uniquely associated with living beings. He started his career as an anatomist, spending a lot of time examining the structure of organic bodies while also noticing the physiology of living beings, that is, the functioning permitted by the organic structure. When he later turned to the problem of generation, Haller concluded that one could not account for the functioning existence

[18] Charles Bonnet, *Contemplation de la nature*, selections translated by T. S. Hall in *Source Book in Animal Biology* (New York: Hafner Publishing Company, [1769] 1964), 377.

of the parts outside of the whole, and in these later works, he abandoned his early embrace of epigenesis in favor of preexistence.[19] It is crucial to note that, for Haller, the essential fact needing explanation is the nature of living organic bodies as functioning wholes; this biological fact is the starting point for this sort of argument, and it explains why I call this a biological-scientific argument in favor of preexistence, even though the theory of preexistence itself turns decidedly away from natural explanations toward a clearly supernatural one.

Again, it is a further step to say that God created all organisms, fully formed, at the Creation, rather than throughout the duration of the natural world. There are different ways to take this step, but one suggests that God's creating all organisms at the Creation rather than piecemeal upon every new generation avoids the deus ex machina that many early moderns would have wanted to avoid. The crucial point for my purposes is that this way of connecting preexistence with teleology starts with the acknowledgment that there is something unique about living beings, and then proceeds by showing that the only way of accounting for this unique character is through preexistence theory. This can be contrasted with the more straightforward theological use of teleology to argue for preexistence noted previously. That way was through a teleological argument that happens to focus specifically on the organism as the well-designed phenomenon to be explained by appeal to God, but which might have focused (as teleological arguments often do) on any number of other beautifully designed aspects of the natural world. The current argument starts with biological facts about organisms, and then goes on to reach the conclusion the preexistence must hold as the only way of accounting for these uniquely biological facts.

2.3. Metaphysical Argument

The final type of argument in favor of preexistence that I canvas is what I call the metaphysical argument. As noted before, I take this argument to be distinct from theological arguments, even though theological arguments are also metaphysical given their inclusion of God. But metaphysics includes much more besides a consideration of God's existence and nature,[20] and the specific issue I focus

[19] Karen Detlefsen, "Explanation and Demonstration in the Wolff-Haller Debate," in *The Problem of Animal Generation in Early Modern Philosophy*, ed. Justin E. H. Smith (Cambridge, UK: Cambridge University Press, 2006), 235–261.

[20] On the changing nature of metaphysics and the scope of topics that fit within metaphysics, see Alan Gabbey, "Disciplinary Transformations in the Age of Newton: The Case of Metaphysics," in *Between Leibniz, Newton, and Kant*, ed. Wolfgang Lefevre (Dordrecht, NL: Kluwer Academic Publishers, 2001), 3–23; and Gary Hatfield, "Metaphysics and the New Science," in *Reappraisals of the Scientific Revolution*, eds. David C. Lindberg and Robert S. Westman (Cambridge, UK: Cambridge University Press, 1990), 93–166.

on here is the metaphysical issue of individuation. Once again, there is overlap between this and the other categories of arguments. For example, the biological motivation noted before may well be considered an explanation to account for individuation; preexistence is called upon there to explain the unity and singularity of organic bodies. My concern here, however, is with a much more fundamental, specifically a metaphysical, conception of individuation. For at least one thinker—Leibniz—I contend that preexistence is called upon to account for the metaphysics of the individuation of corporeal substances.

Before turning to Leibniz himself, I will make just a few general comments about the metaphysics of individuation as I intend to discuss it here. Raymond Williams, in his *Keywords: A Vocabulary of Culture and Society*, traces the meanings attached to the word "individual." Crucial for my purposes is a contrast that Williams makes between the individual as distinct or different from others of its kind, and the individual as indivisible—that is "...'an individual'—a single example of a group... [and] 'the individual': a fundamental order of being."[21] Jorge Gracia captures this contrast in a different way by distinguishing between the concepts of singularity and particularity, and he argues that it is a mistake to equate the individual with both singularity and particularity as if they are one and the same thing. "For particularity has to do with an individual's 'participation in' or 'partaking of' a universal. In this sense the individual is considered as being a part of something else, or as partaking of it.... An individual is called singular... or is said to have singularity because it is not many."[22] Thus, singularity captures the idea of a being's oneness or unity (in spite of its complexity and through time) in a way that particularity does not.[23] It is this meaning, and therefore the problem of the individual as a fundamental order of being, and not as an example of a group—the problem of the individual as singular, and not the individual as particular—that is central to a consideration of Leibniz's preexistence theory. That is, Leibniz takes the living being to be a paradigmatic

[21] Raymond Williams, *Keywords: A Vocabulary of Culture and Society* (London: Flamingo Fontana Paperbacks, 1983), 163.

[22] Jorge Gracia, *Introduction to the Problem of Individuation in the Early Middle Ages* (München, DE: Philosophia Verlag, 1984), 25–26.

[23] My separation of the broader problem into two sub-problems is not meant to imply that these sub-problems are unrelated, nor is it meant to imply that this is the only way of dividing the broad problem of individuation into distinct concerns. Jorge Gracia provides a sustained conceptual and historical analysis of the various complexities at play in dealing with metaphysical and epistemological problems of the individual. Still, at the outset of his study, Gracia himself divides the problem into these two basic sub-problems (Jorge J. E. Gracia, *Individuality: An Essay on the Foundation of Metaphysics* (Albany, NY: SUNY Press, 1988), 2–3. This twofold division of the problem is found in more recent literature on individuation as well (e.g., E. J. Lowe, "Individuation," in *The Oxford Handbook of Metaphysics*, eds. Michael J. Loux and Dean Zimmerman (New York: Oxford University Press, 2003), 77.

metaphysical individual in the sense of being a paradigmatic example of a fundamental order of being.[24]

A number of commentators believe that Leibniz is motivated to hold the preexistence doctrine for largely the same reasons as his contemporaries, including the biological argument from the unity of organisms noted before.[25] But the usual explanations for embracing preexistence seem less compelling in Leibniz's case because he holds a particular version of that theory that is quite unlike any other version suggested in the 17th century. Certain aspects of his theory indicate that his commitment to mechanism is beside the point, and other aspects of his theory actually *undermine* the functional unity of organic wholes *as we commonly understand them.* Paramount among the unusual aspects of Leibniz's theory is that he maintains that preexistence is equally a theory about 'death' as it is about generation; just as a living body never comes into being, it also never dies (e.g., C 523/AG 34; see also G VI, 620/M §76).[26] No other preexistence theorist holds this, because they all believe that the laws of motion are quite capable of destroying a living body, which is how we experience the death of such a body. I contend that Leibniz's theory of preexistence is not only—maybe not even first and foremost—a theory about generation of new living beings;

[24] Taking the organism as a paradigmatic case of a singular individual has a long history. Aristotle, e.g., has a number of conceptions of what counts as a primary individual substance—what is, in some sense, indivisible. According to one conception, found in *Metaphysics,* book vii, individual substances are unities in the sense that they are intrinsic unities—they are a complex of features essential to each other, none of which can be considered a mere predicate of the others, and none of which can therefore exist apart from the rest (*Meta* vii, 4; 1030a3–6). If anything can be counted among true substances, it is the living being, "a man or a plant or one of the things of this kind" (*Meta* vii, 7; 1032a19–20), a being marked in part by its ability to produce another of its kind (*Meta* vii, 8; 1033a29ff.). Citations from Aristotle, *The Complete Works of Aristotle,* 2 vols., various translators, ed. Jonathan Barnes (Princeton, NJ: Princeton University Press, 1995). *Metaphysics* abbreviated as *Meta*; *Parts of Animals* cited as *PA* and identified by Bekker's 1831 texts by page and line number.

[25] See, e.g., Donald Rutherford, *Leibniz and the Rational Order of Nature* (Cambridge, UK: Cambridge University Press, 1995), 201–203.

[26] All references to Leibniz's works are to the following editions with their respective abbreviations: G. W. Leibniz, *Philosophical Essays,* eds. and trans. Roger Ariew and Daniel Garber (Indianapolis, IN: Hackett Publishing Company, 1989), cited as AG with page number; Leibniz, *Opuscles et fragments inédits de Leibniz,* ed. Louis Couturat (Paris: reprint; Hildesheim, DE: Georg Olms, [1903] 1966), cited as C with page number; Leibniz, *Correspondence with Arnauld,* trans. George Montgomery (La Salle, IL: Open Court Publishing Company, 1995), cited as CA with page number; Leibniz, *Die philosophischen schriften von Gottfried Wilhelm Leibniz,* 7 vols., ed. C. I. Gerhardt (Berlin: Weidman; reprint, Hildesheim, DE: Georg Olms, [1875–1890] 1965), cited as G with volume and page number; Leibniz, *Philosophical Papers and Letters,* trans. and ed. Leroy E. Loemker (Dordrecht, NL: D. Reidel Publishing Company, 1956), cited as L with page number; Leibniz, *Monadology,* trans. George Montgomery (La Salle, IL: Open Court Publishing Company, 1995), cited as M with paragraph number; and Leibniz, *Leibniz's New System and Associated Contemporary Texts,* eds. R. S. Woolhouse and Richard Francks (Oxford, UK: Clarendon Press, 1997), cited as NS with page number.

it is also—maybe first and foremost—a theory about the metaphysics of individuation. Focusing on the metaphysics of individuation helps make sense of the peculiar features of his unusual version of the theory. The bare sketch of the argument that would need to be made to maintain this claim is as follows.

First, Leibniz fairly early identifies the need for a strictly indivisible, indestructible, active, and infinitely complex substantial form in order to account for the unity, and therefore reality, of any substance (e.g., CA 135).[27] His concern here is with metaphysical individuation. Second, he claims that a substantial form is never found without a body (e.g., CA 230; cf. G VI, 619/M §§70 and 72; "New System": G IV, 480–481/NS 14; notes for a letter to Des Bosses, February 5, 1712: G II, 438ff./AG 199ff). Here, I don't think the argument needs to settle on whether that body is metaphysically real, or merely phenomenal, just that for every substantial form, there is a material counterpart always associated with it. Third, Leibniz settles on a living animal body that is infinitely complex as the appropriate material counterpart for the substantial form as he conceives it (e.g., G II, 118/CA 221; "First Explanation of the New System": NS 48; letter to de Volder, June 20, 1703: G II, 251/AG 176). Why? I think the reason is that, like the substantial form, the organic body as Leibniz conceives it is infinitely complex. It is also a true unity in the sense that Justin Smith (and Robert Sleigh, upon whom Smith draws) both indicate (i.e., it is not deconstructible component-wise).[28] Even though it is divisible, it is indestructible (like the substantial form) because no matter how much it is divided, an infinitely complex machine still survives. Like the substantial form, it is internally active (e.g., G II, 77/CA 162; letters to de Volder, especially November 10, 1703: G II, 257–259; and January 21, 1704: G II, 262–265). Fourth, because this animal machine is always associated with a substantial form, and because substantial forms were created by God at the beginning of the universe and will endure until the annihilation of the universe, the bodies associated with them must have been created by God at the Creation and they will also endure until the annihilation of the universe; they neither generate naturally nor die naturally.

And thus we reach Leibniz's own peculiar theory of preexistence, but it is motivated by a need to account for metaphysical individuals. This account also explains the feature of his theory I noted before, namely, preexistence for Leibniz is equally a theory about apparent death as it is about generation. It has to be because it is primarily a theory meant to account for the endurance of individual substantial forms and their bodies.

[27] I focus primarily on Leibniz's mid-1680s correspondence with Arnauld for evidence for my claims here, since this correspondence is where Leibniz's position as I see it emerges with full force.

[28] Justin E. H. Smith, *Divine Machines: Leibniz and the Sciences of Life* (Princeton, NJ: Princeton University Press, 2011), 110–115; R. C. Sleigh, *Leibniz and Arnauld: A Commentary on the Correspondence* (New Haven, CT: Yale University Press, 1990), 126.

If this account is right, then Leibniz's theory of preexistence is not motivated entirely (or even primarily) by a need to account for the generation of living bodies, even though it solves *that* problem too. Leibniz himself makes this order of thinking clear on at least two occasions. In a letter to Foucher regarding the doctrines of the "New System," Leibniz indicates that preexistence follows from the incorruptibility, and thus unity, of the soul (G I, 391/NS 54–55). Similarly, in the "Considerations on Vital Principles," after having explained that substances are autonomous from each other and from God, and are imperishable because of the need to keep them autonomous (G VI, 540ff./L 587–588), Leibniz notes that this issue of individual independence and unity distinct from others and from God has led him to his theory of generation by preexistence (G VI, 543–544/L 589). If the theory were meant merely to account for generation, it would surely be much simpler and more closely aligned with the versions offered by his contemporaries; it would not, for example, be equally a theory of 'death' as a theory of 'generation.'

3. Malebranche on Generation: Mechanism, Biology, and Theology

Malebranche's motivation to endorse preexistence includes all of the reasons just noted except one. I do not believe that he has the sorts of concerns with individuation in the rarified metaphysical sense (as opposed to the biological sense) that we find in Leibniz; indeed, I believe Leibniz alone among the early moderns links the metaphysics of individuation with the theory of preexistence. What is especially interesting about Malebranche is that in at least one place in his corpus, three arguments come together to jointly offer support for preexistence, even though none separately provides an especially powerful argument in favor of this theory of generation. That is, we find in Malebranche a sort of "all things considered" best theory, a theory in which a cluster of commitments typical of a 17th-century thinker can all cohere to give rise to the theory of preexistence. I turn to these three intertwined arguments after briefly noting the role original sin might play in Malebranche's theory of preexistence. I conclude with some thoughts on the status of the life sciences in Malebranche's work.

Malebranche has an easy route to using original sin as evidence in favor of the ovist theory of preexistence. He argues that one way in which original sin can be transmitted to generations beyond the first is through bodily communication, specifically during generation of new individuals (ST 120; ST 195). Specifically because women's bodies contribute so much to the generation of offspring, sin is transmitted by the woman in generation (ST 600). From here, it is an easy step to the original sin motivation in favor of preexistence: Since we are all stained by

Eve's original sin (per the Bible), one might reasonably conclude that the reason for this is that we were all present in Eve's ovaries at the moment of that sin.

I now turn to the passage in the *Search After Truth* in which the teleological-theological, mechanistic-scientific, and biological-scientific arguments come together to provide united support for the likelihood, in Malebranche's estimation, that preexistence is the correct theory of generation:

> ...this thought [that God had formed the world all at once... in the same order, and with the same arrangement of parts that it would have had if He had formed it gradually in the simplest of ways] is worthy of the power and wisdom of God: of His power, since in an instance He made all His works in their greatest perfection; of His wisdom, because... the order of nature could not subsist if the world had been produced in a manner contrary to the laws of motion by which it is preserved....
>
> Furthermore, there is a great difference between the formation of living and organized bodies, and that of vortexes of which the universe is composed. An organized body contains an infinity of parts that mutually depend upon one another in relation to particular ends, all of which must be actually formed in order to work as a whole. For it need not be imagined with Aristotle that the heart is the first part to live and the last to die. The heart cannot beat without the influence of the animal spirits, nor can these be spread throughout the heart without the nerves, and the nerves originate in the brain, from which they receive the spirits. Moreover, the heart cannot beat and pump the blood through the arteries unless they, as well as the veins that return the blood to it, are already complete. In short, it is clear that a machine can only work when it is finished, and that hence the heart cannot live alone.... It would be wrong then to pretend to explain the formation of animals and plants and their parts, one after the other, on the basis of the simple and general laws governing the communication of motion; for they are differently connected to one another by virtue of different ends and different uses in the different species. But such is not the case with the formation of vortexes; they are naturally born from general laws.... (OC II, 343–344/ST 465–466)

I will show how this passage presents an all-things-considered, coherence-of-multiple-rationales argument in favor of the theory of preexistence by discussing each of the three argumentative strands in turn.

First, Malebranche employs the teleological-theological argument for preexistence. This is clear in the first paragraph of the passage cited: That God created the world "with as much perfection as it now has" (ST 464) is evidence for the wisdom and power of God. That is, these features of the world provide evidence for the existence of a being with these features—the core of the teleological argument for God's existence. This argument occurs in the midst of Malebranche's defense of preexistence, the bulk of which occurs after this passage (as we see in the extended quotation above), but which begins before this teleological argument is offered. So, preexistence here is motivated by the teleological argument for God's existence—a theological form of argument.

Three important points should be noted. First, this is clearly an example of the theological argument (and not the biological-scientific argument that I shortly consider), since even though Malebranche offers this argument in the middle of a discussion of the generation of living bodies, the argument itself clearly welcomes the conclusion that *all perfection on the earth*, and not just the perfection of living beings, supports the conclusion that God as a powerful and wise being is the cause of those effects. This argument is motivated by the desire to prove the existence of God, and it relies upon the particularly noticeable perfection of living beings to provide this proof of God's existence. However, this argument does not draw a strong distinction between the living and the nonliving as perfect effects requiring reference to God as cause. Even nonliving things can be used in a teleological argument for God's existence. Nonetheless, the conclusion includes the claim that God produced *all perfection* at the Creation, and this leads to the further conclusion that all living things must have been fully formed, and thus perfect, when God created the world. Second, Malebranche suggests a separation between the metaphysical truth of the natural world (that God created it with all its perfection at the Creation, including the fact that organisms are all fully formed by God at that moment), and how we might study the world in order (as if we were naturalists) to better understand its (God-given) nature. That is, we may well study the generation of living things as "gradually formed in the wombs of their mothers" (ST 465) to better understand how God himself used his principles to create them in the first place. The metaphysical truth, as Malebranche sees it, that organisms are all preformed by God at the Creation, does not preclude the scientist from investigating organisms empirically to better understand their natures. Third, this second point—that we could presumably study the formation of organisms within the wombs of their mothers—shows why this teleological-theological argument in favor of preexistence cannot stand alone. For if we could give a complete and satisfactory account of the gradual formation of the fetus, while still maintaining the perfection of God as its cause, then

the teleological-theological argument cannot preclude preexistence's prime rival, the theory of epigenesis. Only by turning to the two scientific arguments found in this passage can we reject epigenesis.[29]

So Malebranche includes an acknowledgment of the particular perfection of living beings in his teleological-theological argument for God's existence, thus demonstrating that he has this motivation for embracing preexistence, but he is also committed to the two scientific arguments I have identified—arguments that we can attribute to him given his openness previously noted to scientific inquires into metaphysical facts about our world. Malebranche is clearly committed to mechanism, but he also clearly believes that mechanism cannot account for the existence of living beings (the mechanistic-scientific argument). Moreover, he is led to the conclusion that mechanism cannot account for the existence of living beings because of the unique feature of living bodies (the biological-scientific argument). I will treat these in turn.

Malebranche is committed to mechanism, both the form that suggests that the world and its parts are to be thought of as machines, and the form that suggests that all phenomena are the result of sub-visible parts of matter interacting and colliding in accordance with lawful motion (micro-mechanism). The explicit parallel between a living body and a machine in the long passage previously quoted establishes his commitment to machine mechanism. His discussion of the hypothetical formation of plants and animals due to simple and general laws of the communication of motion from body to body establishes his commitment to micro-mechanism. Moreover, it is his refusal to abandon micro-mechanism that leads him to preexistence: For it would be "wrong... to pretend to explain the formation of animals and plants and their parts, one after the other" in terms of micro-mechanism. Thus his refusal to abandon mechanism—his embrace of it—leads him to preexistence.

But the question arises: Why *cannot* micro-mechanism explain the formation of living bodies? And here Malebranche turns to the biological-scientific argument in order to supplement the mechanistic-scientific argument, which alone cannot provide an answer to that question—and so cannot bring us to the conclusion of preexistence. The reason why mechanism cannot explain the formation of living bodies is that a living body—unlike any other body—has characteristics unique to it. It is the recognition of the uniqueness of living bodies that makes this argument a *biological-scientific* argument, in distinction from

[29] A fourth, extremely interesting, historical point, which is not central to my line of argument here, is that evident here is a conclusion about the teleological argument that will eventually be made explicitly by Hume, namely, even if we grant that the teleological argument can establish the existence of God, all it can establish about God is that he is wise and powerful, but not that he is benevolent or good. See David Hume's *Dialogues Concerning Natural Religion*, part XII.

the teleological-theological argument that may recognize the extreme perfection of living bodies, but can also recognize the perfection of all of God's handiwork. The uniqueness, for Malebranche, of living bodies comes clear when he grants that mechanism *can* explain some forms of organization (vortices) but not other forms of organization (living bodies). It is the unique functioning wholeness of living beings that Malebranche underscores when he writes of the "parts that mutually depend upon one another in relation to particular ends, all of which must be actually formed in order to work as a whole." There are two senses of "purpose" at work in Malebranche's discussion of living bodies. First, there are *ends* served by parts suitably structured to *function* toward those ends. And second, the *whole* is sustained and preserved as a whole due to the proper functioning of the parts whose good function, in turn, is permitted by the *preservation of the whole*. The crucial step in his argument from the recognition of the unique, teleological unity of the organism to the conclusion that they must have always existed as such is the step from recognizing the *ontological* priority of the whole to the parts, to asserting a *temporal* priority of the whole to the parts. That is, since parts cannot live outside the whole, Malebranche concludes that the whole must have always been there to allow the parts to function and therefore live.

This final point is worth some expansion. Some preexistence theorists are motivated, even if they do not explicitly recognize this, by concerns about living beings that are essentially Aristotelian. As Aristotle argues, organs and other body parts outside of an organism cannot live or function and are therefore *different in kind* from those living, functioning parts found connected in a living whole. The point is underscored in the *Parts of Animals*:

> And yet a dead body has exactly the same configuration as a living one; but for all that is not a man. So also no hand of bronze or wood or constituted in any but the appropriate way can possibly be a hand in more than name. For like a physician in a painting, or like a flute in a sculpture, it will be unable to perform its function. Precisely in the same way no part of a dead body, such I mean as its eye or its hand, is really an eye or a hand. (*PA* i, 1; 640b35–41a5)

George Cuvier, for example, believes that the successive formation of the organism, part after part, implies the death of the individual *before* life even begins because parts outside of a whole are not living.[30] Other preexistence theorists, as

[30] W. Coleman, in writing on Cuvier's embrace of preexistence, states this idea nicely. For Cuvier, "successive development of the various parts would produce only physiological chaos and the death of the individual"; Coleman, *George Cuvier: Zoologist* (Cambridge, MA: Harvard University Press, 1964), 128. Of course, for Aristotle, the organism forms part after part, but the *whole* nonetheless preexists in the form that is passed from male to female.

we saw in the passage cited from Bonnet, and as we find in the current passage from Malebranche under discussion, are acutely aware of the unity—the oneness and wholeness—of living bodies, and the related fact that organic parts can function only inside a whole and, indeed, lose their characteristic nature as *living* parts outside of the whole. So, many preexistence theorists hold a similar conception of living beings that we find in Aristotle, the one that drives his criticisms of the part-after-part generation theories of his materialist predecessors such as Empedocles and Hippocrates. And many preexistence theorists hold this conception because they are either working scientists, like Haller,[31] or are alert to the findings of working scientists, like Malebranche,[32] and therefore acknowledge (like Aristotle) the empirical facts of fully formed organisms, facts that thus constrain the theory of generation that must account for these facts.

Still, many preexistence theorists are also materialists—and (perhaps) mechanists—with respect to nonhuman creatures, including living beings. So their materialist and mechanist commitments preclude an Aristotelian *ontological explanation* for their basically Aristotelian conception of living beings. Instead, they turn to a roughly Platonic account (i.e., God created organisms as unified wholes). Such organisms *cannot* be constructed as we construct a clock, for example. What we do when building a clock is to put together parts into a working whole in which the parts retain their original character. Living bodies cannot be built up out of preexisting parts in this fashion. That is why God must create them *miraculously* at the Creation. This, at least, is one major motivating factor in Malebranche's account of preexistence

Still, the conclusion that the whole must have always been there to allow the parts to function and therefore live does not follow from the biological-scientific argument. One could easily counter that, indeed, the whole cannot live without all the parts in place, interconnected and functioning, but that nonetheless, epigenesis is the correct theory, and the living being simply does not become alive until all the parts have finally formed and can work together as a whole. Here, the co-presence of the teleological-theological argument together with the scientific arguments could make the case for preexistence. As Malebranche writes in a theological mood: "God created the world with as much perfection as it now has," and fully functioning, living organisms are among the most perfect expressions of God's wisdom and power. So, in choosing between preexistence and epigenesis, the teleological-theological argument can help make the case that preexistence best explains the uniqueness—indeed unique perfection—of living bodies.

[31] Detlefsen, "Explanation and Demonstration."

[32] Detlefsen, "Supernaturalism, Occasionalism, and Preformation."

All three strands of argumentation—teleological-theological, mechanistic-scientific, and biological-scientific—are present in this long passage in Malebranche's *Search After Truth* in which he defends the ovist version of preexistence. Each of these three strands is too weak to convince the reader of the correctness of this theory of generation. But the three arguments working together do provide a fairly strong case for preexistence should the reader accept Malebranche's theological and mechanistic commitments and be working with the level of biological knowledge he had. That is, his argument for preexistence here is more of an "all things considered" approach to provide strong evidence (but not decisive arguments) for preexistence as the most likely theory of generation. At the same time, we can see in this argument a combination of some central 17th-century concerns and commitments. First is the commitment to mechanism, both machine mechanism and micro-mechanism, in explanation of natural phenomena. Second is the completely compatible commitment to teleology in the natural world. This teleology takes the form of God's purposes leading him to create natural machines such that they will be able to fulfill his purposes, including his purposes with respect to the parts of organisms and organisms as self-preserving wholes. It does not take the more Aristotelian form of a principle of change internal to bodies and striving toward ends intrinsic to those bodies—a form of teleology indeed at odds with mechanism. This teleology as manifest in the machines of the world permits both an important argument for God's existence and allows the recognition of the unique qualities of living bodies, thus indicating an alertness to the special character of living beings, an alertness that is very promising for a science of life even within this age of committed mechanists. So in this argument in Malebranche's *Search*, we see just why a smart mind of the 17th century would embrace preexistence, that the reasons go beyond the limits of mechanism, and that the reasons open up rich territory for scholars keen on understanding the importance of the life sciences in the 17th century.[33]

[33] This point is quickly becoming unnecessary to make. Historians of science displayed a much earlier openness to a study of the life sciences in the 17th century. See, e.g., Adelmann, *Marcello Malpighi*; Bodemer, "Embryological Thought"; B. Richard, *Descartes' Medical Philosophy: The Organic Solution to the Mind-Body Problem* (Baltimore, MD: Johns Hopkins University Press, 1983); Gasking, *Investigation*; T. S. Hall, *Ideas of Life and Matter*, 2 vols. (Chicago: University of Chicago Press, 1969); Oppenheimer, *Essays*; Roe, "The Development" and "Rationalism and Embryology"; and C. U. M. Smith, *The Problem of Life: An Essay in the Origins of Biological Thought* (New York: John Wiley & Sons, 1976). Historians of philosophy on the continent have also been attuned to the life sciences in this period. See, e.g., Georges Canguilhem, *La formation du concept de réflexe aux XVIIe et XVIIIe siècles* (Paris: Presses Universitaires de France, 1955); Canguilhem, *La Connaissance de la Vie*, 2nd ed. (Paris: J. Vrin, 1969); Canguilhem, *Idéologie et rationalité dans l'histoire des sciences de la vie: nouvelles études d'histoire et de philosophie des sciences* (Paris: J. Vrin, 1977); Annie Bitbol-Hespériès, *Le principe de vie chez Descartes* (Paris: J. Vrin, 1990); Marie-Noëlle Dumas, *La pensée de la vie chez Leibniz* (Paris: J. Vrin, 1976); Geneviève Rodis-Lewis, "Limitations of

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the Mechanical Model in the Cartesian Conception of the Organism," in *Descartes: Critical and Interpretive Essays*, ed. Michael Hooker (Baltimore, MD: Johns Hopkins University Press, 1978); and Vincent Aucante, *La Philosophie médicale de Descartes* (Paris: Presses Universitaires de France, 2006). Only more recently, however, has interest in early modern life sciences in the English-speaking world surged. See, e.g., Dennis Des Chene, *Spirits and Clocks: Machine and Organism in Descartes* (Ithaca, NY: Cornell University Press, 2001); Daniel Fouke, "Mechanical and 'Organical'"; Fouke, "Spontaneity and the Generation of Rational Beings in Leibniz's Theory of Biological Reproduction," *Journal of the History of Philosophy* 29.1 (1991): 33–45; Stephen Gaukroger, "The Resources of a Mechanist Physiology and the Problem of Goal-Directed Processes," in *Descartes' Natural Philosophy*, eds. Stephen Gaukroger, John Schuster, and John Sutton (New York: Routledge, 2000), 383–400; Gaukroger, *Descartes' System of Natural Philosophy* (Cambridge, UK: Cambridge University Press, 2002), chapter 7; Gary Hatfield, "Descartes' Physiology and its Relation to his Psychology," in *The Cambridge Companion to Descartes*, ed. John Cottingham (Cambridge, UK: Cambridge University Press, 1992); Justin Erik Smith, "On the Fate of Composite Substances after 1704," *Studia Leibnitiana* 30.2 (1998): 204–210; Justin E. H. Smith (ed.), *The Problem of Animal Generation in Early Modern Philosophy* (Cambridge, UK: Cambridge University Press, 2006); Smith, *Divine Machines*; Catherine Wilson, *The Invisible World: Early Modern Philosophy and the Invention of the Microscope* (Princeton, NJ: Princeton University Press, 1995); and Wilson, "Leibniz and the Animalcula," in *Studies in Seventeenth-Century European Philosophy* (Oxford, UK: Clarendon Press, 1997). See also, as just a few notable examples of his extensive work on the philosophy of early modern life sciences, the following by François Duchesneau: "Du Modèle Cartésien au Modèle Spinoziste d l'etre Vivant," *Canadian Journal of Philosophy* 3.4 (1974): 539–562; "Malpighi, Descartes, and the Epistemological Problems of Iatromechanism," in *Reason, Experiment and Mysticism in the Scientific Revolution*, eds. M. L. Righini Bonelli and William R. Shea (New York: Science History Publications, 1975); "Leibniz et la théorie physiologique," *Journal of the History of Philosophy* 15 (1976): 281–300; "Haller et les theories"; *La Physiologie de Lumieres Empirisme, Modeles et Theories* (The Hague, NL: Martinas Nijhoff Publishers, 1982).