

KANT'S VIEWS ON PREFORMATION AND EPIGENESIS

A visão de Kant sobre pré-formação e epigênese

Ina Goy 

Beijing Normal University – Beijing, China
inagoy@bnu.edu.cn

Abstract: How does Kant respond to the early modern preformation-epigenesis controversy? In part 1 of the paper, I will introduce the historical context: I provide an overview of important systematic characteristics of ovistic and animalculist preformationist (1.1) and mechanical and vitalistic epigenetic (1.2) early modern accounts of reproduction and heredity. In part 2 of the paper, I will introduce the scholarly debate (2.1) about Kant's reception of the early modern controversy: while no one considers Kant a radical defender of preformation, some scholars consider him a more or less radical defender of epigenesis. A greater number of scholars read Kant's position as a combination of preformationist and epigenetic elements. Others ignore or even deny any influence of the preformation-epigenesis controversy on Kant. Based on an analysis of preformationist (2.2) and epigenetic elements (2.3) in Kant's relevant writings, I will support scholars (2.4) who claim that Kant's position contains both, preformationist and epigenetic elements, but will do so on a far more comprehensive analysis of criteria. I will also go beyond existing discussions deciding whether Kant's account was closer to ovistic or animalculist variants of preformation, and mechanical or vitalistic variants of epigenesis.

Keywords: Kant's biology; epigenesis; preformation.

Resumo: Como Kant responde à controvérsia pré-formação-epigênese do início da era moderna? Na parte 1 do artigo, apresentarei o contexto histórico: forneço uma visão geral das características sistemáticas importantes dos relatos pré-formacionistas ovísticos e animalculistas (1.1) e epigenéticos mecânicos e vitalísticos (1.2) da reprodução e hereditariedade do início da modernidade. Na parte 2 do artigo, por sua vez, apresentarei o debate acadêmico (2.1) acerca da recepção de Kant da controvérsia do início da era moderna: embora ninguém considere Kant um defensor radical da pré-formação, alguns estudiosos o consideram um defensor mais ou menos radical da epigênese. Um número maior de estudiosos lê a posição de Kant como uma combinação de elementos pré-formacionistas e epigenéticos. Outros ignoram ou mesmo negam qualquer influência da controvérsia pré-formação-epigênese sobre Kant. Com base em uma análise dos elementos pré-formacionistas (2.2) e epigenéticos (2.3) nos escritos relevantes de Kant, apoiarei os estudiosos (2.4) que afirmam que a posição de Kant contém elementos pré-formacionistas e epigenéticos, mas o farei em uma análise mais abrangente de critérios. Também irei além das discussões existentes, decidindo se a descrição de Kant estava mais próxima de variantes ovísticas ou animalculistas de pré-formação, e variantes mecânicas ou vitalísticas de epigênese.

Palavras-chave: Biologia de Kant; epigênese; pré-formação.

In this paper, I would like to answer the question if and how Immanuel Kant's accounts of reproduction and heredity relate to one of the most important debates of the early modern life sciences: the preformation-epigenesis controversy. I will argue that in his account Kant combines strengths of both, preformationist and epigenetic models of reproduction and heredity, and at the same time tries to avoid some of their flaws and

weaknesses. I will present my argument in two main steps. In part 1 of the paper, I will distinguish early modern models of reproduction and heredity into preformationist (1.1) and epigenetic (1.2) models, a distinction, which I will further divide into ovistic (1.1.1) and animalculist (1.1.2) preformationist models, and mechanical (1.2.1) and vitalistic (1.2.2) epigenetic models. I will present the most widely shared systematic characteristics of these models, and will illustrate them with historical examples. The preformation-epigenesis controversy lasted one and a half centuries and included a variety of complex accounts. If one wants to characterize Kant as either preformationist or epigenetic, or both, or neither, one needs to be clear which sets of characteristics are addressed as 'preformationist' or 'epigenetic'.

With a classification of the historical background at hand, I will introduce the scholarly debate about Kant's relationship to his predecessors in part 2 of the paper. I will argue (2.1) that no one considers Kant a radical defender of preformation, though some scholars consider him a more¹ or less² radical defender of epigenesis. A major number of scholars hold that Kant's position combines preformationist and epigenetic elements³. And some scholars ignore or even deny any influence of the preformation-epigenesis debate on the development of Kant's account⁴. For the sake of improvement the scholarly debate needs more detailed historical analyses of different periods of Kant's thoughts, in order to capture the changing systematic approximations and tensions between Kant and his predecessors. Thus, in part 2 of the paper, I will first consider preformationist elements (2.2) in Kant's *Ground of Proof* essay (1963) (2.2.1) and his three writings on races (1775, 1785, 1788) (2.2.2), followed by the same investigation in his third *Critique* (1790) (2.2.3). I will then try to identify epigenetic elements (2.3), again, in Kant's *Ground of Proofs* essay (2.3.1) and his writings on races (2.3.2), and in Kant's third *Critique* (2.3.3). My analysis (2.4) will support the scholars who claim that Kant's position contains both, preformationist and epigenetic elements, but it will do so on the basis of a transparent set of systematic criteria. I will argue against scholars who completely deny any influence of the preformation-epigenesis controversy on Kant, and will reject the negation of a radical preformationist interpretation and the affirmation of a

¹ So, for instance, Clarke Zumbach (1984), Hans Peter Reill (2005, p. 246), and Philippe Huneman (2006, pp. 651–54 and 2007, p. 12).

² This position has been defended by Jennifer Mensch (2013) and Boris Demarest (2017).

³ This view has strong defenders in Phillip Sloan (2002) and John Zammito (2003, pp. 83–88, 95–98; 2006; 2007, p. 51, pp. 56–66; 2016), and further advocates, who have provided less comprehensive argumentations, like Marjorie Grene and David Depew (2004, p. 95), Joan Steigerwald (2006, p. 716), Siegfried Roth (2008, p. 284), and Mark Fisher (2014).

⁴ So in another way, again, Mark Fisher (2014).

radical epigenetic interpretation of Kant's account of reproduction and heredity. I will also go beyond the existing scholarly debate when I will not only say whether Kant's account was preformationist or epigenetic or both or neither-nor, but will also say whether it was closer to ovistic or animalculist variants of preformation, or closer to mechanical or vitalistic variants of epigenesis.

1. Biological theories of the seventeenth and eighteenth centuries—a classification

Let us begin with a classification. The early modern preformation-epigenesis controversy lasted about one and a half centuries (1650–1800) and involved a wide variety of accounts and figures.⁵ The most significant positions divided into two main fields: defenders of preformation or epigenesis, whereby advocates of preformation held either ovistic or animalculist variants of preformation, and defenders of epigenesis either mechanical or vitalistic variants of epigenesis.⁶ William Harvey (1578–1657), Marcellus Malpighi (1628–1694), and Jan Swammerdam (1637–1680) developed ovistic variants of preformation in the seventeenth, Albrecht von Haller (1708–1777), Charles Bonnet (1720–1793), and Abbé Lazzaro Spallanzani (1729–1799) in the eighteenth century. Animalculist variants of preformation had been defended by Antoni van Leeuwenhoek (1632–1723), Gottfried Wilhelm Leibniz (1646–1716), and Nicolaas Hartsoeker (1656–1725). Pierre-Louis Moreau de Maupertuis (1698–1759), Georges-Louis Leclerc de Buffon (1707–1788), and John Turberville Needham (1713–1781) argued for mechanical, Caspar Friedrich Wolff (1734–1794) and Johann Friedrich Blumenbach (1752–1840) for vitalistic variants of epigenesis.

1.1. Characteristics of preformation

Despite a wide variety of preformationist accounts, which often were not as clearly distinct from their alternatives and opposites as one would want them to be, I would like to suggest that there is a set of characteristics that preformationist models of reproduction and heredity tend to share. Though scholars have often pointed out some of these criteria,⁷ so

⁵ William Harvey's *De generatione animalium* (1651) can be considered the beginning of early modern preformation-epigenesis controversy, which came to an end with Johann Friedrich Blumenbach's *Über den Bildungstrieb und das Zeugungsgeschäfte* (1781), in Immanuel Kant's writings on races (1775, 1778, 1785), Kant's third *Critique* (1790), and Johann Wolfgang Goethe's biological writings, especially Goethe's *Metamorphose der Pflanzen* (1790).

⁶ For valuable historical work, which helped to shape this classification, see Shirley Roe (1981), Ilse Jahn (1982, pp. 226–65), Jörg Jantzen (1994, pp. 375–668), Clara Pinto-Correira (1997), Phillip Sloan (2002, pp. 232–34), Philippe Huneman (2007), Jennifer Mensch (2013), and Ina Goy (2017, pp. 284–344).

⁷ Phillip Sloan (2002), for instance, focuses mostly on germs and dispositions.

far no one has tried to give a detailed and comprehensive account of the most important of these characteristics. Preformationist theories share

- the assumption of divine creation and a divine creator, and the denial of the autonomy of nature,
- the assumption of a God who preforms the germs out of which the generation and development of living beings takes place,
- the assumption of preformed germs which contain in small all characteristics of the future living being, so that the development of a living being appears as an unfolding, unwrapping, and enlargement of characteristics, which are already present in the germ,⁸
- the assumption of the simultaneous generation of all characteristics of an offspring,
- the interpretation of the germ as either the female egg (ovistic preformation) or the male sperm (animalculist preformation), and
- the assumption of unisexual inheritance, that is of the view, that either the male or the female parent's properties get transferred to the offspring, and that the offspring either inherits the properties of the mother through the female egg (ovistic preformation) or inherits the properties of the father through the male sperm (animalculist preformation).

In order to provide evidence for these characteristics, I would now like to illustrate some of them with a few historical examples.

⁸ Jacques Roger (1963) and Peter J. Bowler (1971) try to claim that there is a difference between the notions of preformation and pre-existence in the characterization of preformationist theories, which has been taken up (often reluctantly) by later historians of science. Bowler (1971, p. 222) formulates the distinction as follows: "All theories based upon the belief that organisms have been in existence in the form of miniatures since the creation of the universe will be called pre-existence theories". "The term "preformation" will be retained only for the belief that the miniature which grows into the full organism is actually within the body of the parent." Shirley Roe (1981, p. 174) rephrases Roger's and Bowler's distinction such that preformation designates "early seventeenth-century theories that held that the embryo is preformed in the parent before conception", whereas pre-existence meant "eighteenth-century beliefs that all embryos have existed from the Creation". Roe nevertheless decides to use both terms interchangeably. Clara Pinto-Correira (1997, p. xxi) describes the same debate on a conceptual distinction such that preformation is "the assumption that the primordial organism already contains inside itself all other organisms of the same species, perfectly preformed, minus only though they might be", whereas pre-existence means that "the primordial organism contains only the basic blueprints of all related organisms to come". Pinto-Correira opts to not "dwell upon th[is] distinction". Phillip Sloan (2002) mentions the distinction and names Charles Perrault as an example of a pre-existence theory of germs, according to which germs are divinely created and are "generally dispersed in nature at creation". They "are taken in by organisms with their food", and unfold under proper conditions "in the parental organism" (Sloan, 2002, p. 233). As is visible, Bowler, Roe, Pinto-Correira, and Sloan have similar, but slightly different approaches of both terms. I do not want to discuss this distinction further here, since it never spoke to me, but would like to mention it for those who are aware of these subtleties.

1.1.1. Historical examples of ovistic preformation

A first example of ovistic preformation is Marcellus Malpighi's (1628–1694) account of the reproduction and heredity of plants in his *Anatome plantarum* (1675/9). In an important passage of this book, Malpighi states that the generation of plants is caused by preformed germs that already contain all parts of the plant in little. Malpighi emphasizes that the germ *is* the actual plant in all its parts, with leaves, mostly two, a stalk or stem, and a bud (Malpighi, 1675/9, p. 9).⁹ Similarly, in another passage of the *Anatome*, Malpighi writes that the seedling, which is enclosed in the semen, already represents the entire plant with all its essential parts: roots and a stem that will elongate, and two leaves that will unfold as cotyledons during the germination. Since the semen of larger animals that can be observed more easily consists in eggs, Malpighi conjectures that the semen of plants that can be observed less easily consists in eggs as well. Malpighi claims that the foetus and its essential parts unfold when outer moisture penetrates the semen and causes pressure to the foetus (Malpighi, 1675/9, pp. 80–81).¹⁰

A second example of ovistic preformation is Jan Swammerdam's (1637–1680) analysis of the reproduction and heredity of insects, above all of bees, as described in his *Biblia naturae* (1737/8). In this book, Swammerdam mentions a similar ovistic preformationist view as Malpighi. Swammerdam writes that the smallest animals (such as mites) emerge out of an egg which is nearly invisible, and that the origin of the largest animals is no other (Swammerdam, 1737/8, p. 2a).¹¹ In a reflection on butterflies Swammerdam remarks that nothing is more astonishing among all natural things than a caterpillar that develops into a winged animal (a butterfly). Swammerdam thinks that this astonishment is caused by the nature of the puppet, in which the entire animal is concealed, as an entire flower is concealed in a bud (Swammerdam 1737/8, p. 5a).¹² The puppet not only contains all parts of the future

⁹ “Tantum partium apparatus in gratiam conditi seminis à Natura fabricatus est. Hoc autem est foetus, vera scilicet planta, suis integrè conformata partibus, foliis videlicet, ut plurimum binis, caudice seu caule & gemmâ” (Malpighi, 1675/9, p. 9).

¹⁰ “Contentus foetus, seu plantula, suis integrata partibus, taliter custodita in longum etiam servatur tempus. In hac itaque plantæ vera species compendio elucescit, & viri emancipati filii status innuitur; conicum enim, quandoque oblongum, & interdum breve, occurrit corpus, quod vegetando radículas promit, unde radicum truncus erit: Caulis autem, & Caudicis major portio sub specie adhuc gemmæ latitare videtur, à cujus principio & exortu gemina pendere vidimus seminalia folia, suis ligneis fistulis, tracheis, & utriculis constantia, quæ diu servatum succum iterum plantulæ reaffundunt, ut auctior redditus truncus, gemmâ scilicet & elongatis radículis, sensim adolescat. In Vegetantibus, quorum seminales plantulæ laxatis foliis privantur (ut in aliis deprehendimus) multiplices utriculorum ordines, in plantulam inclinati, activum succum præbent, qui in iisdem primò maceratur, & postremò effluit” (Malpighi, 1675/9, pp. 80–81).

¹¹ “Accedit, quod, uti minima Animantium, Acari v. g. ex ovuloprae tenuitate vix conspicuo nascuntur; sic & maxima Animantium haud insigniores, vel magis manifestos, ne dicam obscuriores potius, magisque a visu remotos ortus obtineant” (Swammerdam, 1737/8, p. 2a).

¹² “Quemadmodum inter omnes, quæ in rerum natura notatu dignæ occurrunt, mutationes nulla vulgo magis admiranda censetur, quam qua Eruca alati Animalis formam adsciscit Ut adeo omnis hujusce admirationis

animal, but *is* the future animal itself (Swammerdam, 1737/8, p. 9a).¹³ Swammerdam also mentions a divine creator and claims that it is the will and wisdom of God that fashions the eggs of animals in specific ways, so that the egg of one species is different from that of another (Swammerdam, 1737/8, p. 15ab).¹⁴

A third example of ovistic preformation can be found in Charles Bonnet's (1720–1793) *Considérations sur les corps organisés* (1762). In this book, Bonnet assumes the preformationist principle of development and presupposes that every organized body preexists before fecundation, while the fecundation does nothing else than developing an organized whole which had been looming before in little in the semen or egg. Bonnet believes that in the closer future the preexistence of the germ in the female will be proven, while it will become obvious that the male semen generates nothing (Bonnet, 1762, p. VI).¹⁵ Also another passage of the *Considérations* confirms this view. There Bonnet claims that every organized body grows through development: when it becomes visible one can see in it in very small the same essential parts that one will see later in it in large. This leads Bonnet to the conclusion that the organized bodies were present already in the germs before their development into larger bodies (Bonnet, 1762, pp. 14–15).¹⁶ Bonnet thinks that the germ is the foundation and model of the organized body and that it contains in little all essential parts of the plant or the animal that it represents (Bonnet, 1762, p. 20).¹⁷ And Bonnet also points explicitly to a divine creator. He states that when the supreme architect arranged the

fons in sola consistat ignoratione indolis & naturae Nymphae aut Chrysalidis, utpote in quibus Animalculum ipsum, ceu flos in suo folliculo, absconditum haeret. Bina autem isthaec Nymphae & Chrysalidis vocabula non duntaxat unum idemque significant" (Swammerdam, 1737/8, p. 5a).

¹³ "[H]aec, inquam, Chrysalis haud secus, ac modo de Nymphis prioribus adferuimus, non solum omnes in se partes futuri Animalculi continet, sed etiam ipsum illud futurum Animalculum jam revera est" (Swammerdam, 1737/8, p. 9a).

¹⁴ "Huic equidem respondeo, vix ac ne vix quidem ist-haec posse explicari; quum eorum rationes in arcana Summi Conditoris, qui alio alia Animantia vestitu donavit, sapientia atque arbitrio oclusae lateant" (Swammerdam, 1737/8, p. 15ab).

¹⁵ "J'avois admis l' Evolution, comme le principe le plus conforme aux Faits & à la saine Philosophie. Je supposois que tout Corps Organisé préexistoit à la Fécondation, & que celle-ci ne faisoit que procurer le Développement du Tout organique dessiné auparavant en miniature dans la Graine ou dans l'Oeuf. J'essayois d'expliquer comment la Fécondation opéroit cet effet, & à mesure que j'analysois, je me persuadois de plus en plus qu'on démontreroit un jour la préexistence du Germe dans la Femelle, & que l'Esprit séminal n'engendroir rien" (Bonnet, 1762, p. VI).

¹⁶ "Tout Corps organisé croît par Développement. Au moment, où il commence d'être visible, on lui voit, très en petit, les mêmes Parties essentielles qu'il offrira plus en grand dans la suite. . . . Nous sommes donc conduits à penser, que les Corps Organisés qui existent aujourd'hui, existoient avant leur naissance, dans des Germes, ou Corpuscules Organiques" (Bonnet, 1762, pp. 14–15).

¹⁷ "ON dit que le Germe est une ébauche ou une esquisse du Corps Organisé. . . . Ou il faut admettre que le Germe contient actuellement en raccourci toutes les Parties essentielles à la Plante ou à l'Animal qu'il représente" (Bonnet, 1762, p. 20).

generation and development of plants and animals in this way he completed his work to the highest degree of perfection (Bonnet, 1762, p. 112).¹⁸

1.1.2. Historical examples of animalculist preformation

A first example of animalculist preformation is Antoni van Leeuwenhoek's (1632–1723) detection of a homunculus in the male sperm as described in his letters to the Royal Society in 1677 and subsequent years. In his first report of his detection, Leeuwenhoek notes that when a Mr. Ham visited him, he brought with him in a small glass phial, the spontaneously discharged semen of a man who was suffering from gonorrhoea; saying that, after very few minutes, he had seen living animalcules in it. These animalcules possessed tails, and did not remain alive above twenty-four hours. Leeuwenhoek then confesses that he himself has divers times examined the same matter (human semen) from a healthy man, and that he has seen so great a number of living animalcules in it, that sometimes more than a thousand were moving in an amount of material the size of a grain of sand. Their bodies which were round, were blunt in front and ran to a point behind. They were furnished with a thin tail, about five or six times as long as the body, and very transparent (Leeuwenhoek, 1677 in 1939ff., II, pp. 280–89).¹⁹ Based on these observations, Leeuwenhoek notes, that he now is more certain than before that human beings originate not from an egg but from an animalcule that is found in male sperm (Leeuwenhoek 1677 in 1939 ff., IV, p. 11). He insists that it is exclusively the male semen that forms the foetus, and that everything a female can contribute only serves to receive the semen and feed it (Leeuwenhoek, 1677 in 1939 ff., II, p. 335).²⁰

A second example of animalculist preformation appears in a passage of Nicolaas Hartsoeker's (1656–1725) *Essay de dioptrique* (1694, p. 320) in which Hartsoeker says that he

¹⁸ “C'est ainsi que le SUPREME ARCHITECTE a porté son Ouvrage au plus grand degré de perfection qu'il pouvoit recevoir. SA SAGESSE a revêtu la Matière d'un nombre presque infini de modifications, dont le Monde physique est la somme” (Bonnet, 1762, p. 112).

¹⁹ “Toen deze heer Ham voor de tweede maal bij mij kwam, bracht hij met zich mee, in een glazen fleschje, het van zelf onloopen teelzaad van een man, die aan gonorrhoea leed, zeggende dat hij na zeer weinige minuten, . . . levende diertjes had gezien, waarvan hij oordeelde, dat zij staartjes hadden en niet langer dan 24 uur leefden. . . . Dezelfde materie (mannelijk teelzaad) heb ik verscheidene malen geobserveerd, . . . maar van een gezond mensch, terstond na de ejaculatie, zoodat zelfs geen zes polsslagen zijn verlopen, en ik heb daarin een zoo groote menigte levende diertjes gezien, dat soms meer dan 1000 van die diertjes zich in de grootte van een zandkorrel bewegen . . . Hun lichamen, die ron waren, hadden een voorste deel dat stomp was, en een achterste deel dat spits toeliep; zij waren voorzien van een dunnen staart, die in lengte 5 a 6 maal het lichaam overtrof en zeer doorschijnend was . . .” (Leeuwenhoek 1677 in 1939ff., II, pp. 280–89).

²⁰ “Soo stel ik nu veel sekerder als voor deesen, dat een Mensch niet uijt een eij, maer uijt een Dierken, dat int mannelijk saet is voort komt” (Leeuwenhoek 1677 in 1939ff., VI, p. 10). “[H]et saet vanden man, alleen de vrugt formeert, en al wat de vrouw soude mogen toe brengen, alleen is, omme het mannelijck saet te ontfangen, off de voeden” (Leeuwenhoek 1677 in 1939ff., II, p. 334).

has detected a little homunculus in male semen. A related illustration can be found at the end of the *Essay de dioptrique* (1694, p. 320). It shows a cowering homunculus who is wrapping his arms around his legs and is sitting in the head of a male sperm. Hartsoeker emphasizes in the *Essay* (1694, p. 227) that he had published on his (!) detection of animalcules already in August 1678, in the *Journal des Sçavans* 30.²¹ Said journal indeed contains a small note in which Hartsoeker states that he has found tiny animals in the shape of little eels or frogs in the urine and semen of a cock.²²

A third example of animalculist preformation can be found in Gottfried Wilhelm Leibniz's (1646–1716) writings. In his *Monadology* (1714) Leibniz writes that as natural scientists once recognized that natural organic bodies always origin out of semen in which a kind of preformation took place, they came to the conclusion that not only has the organic body been in the semen before generation, but that a soul also has been in this body, and, in a word, the animal itself. They assumed that such an animal is furnished with a disposition for transformation into an animal of another kind. Something similar, they thought, appears even in other processes than reproductive ones when, for instance, a worm becomes a fly or a caterpillar a butterfly (Leibniz, *Monadologie* §74).²³ In another passage of the *Monadology* Leibniz notes that animalcules are those few animals that become elevated to the level of larger animals through generation. Most animals, however, remain of the same kind: they get born, reproduce, and get destroyed. The number of those selected animals who transform into larger animals is very small (Leibniz, *Monadologie* §75).²⁴

²¹ Hartsoeker, who is believed to be Leeuwenhoek's co-founder of the doctrine of animalculist preformation, argued with the latter about the priority of the detection of animalcules. Since Leeuwenhoek's first letter about his detection of animalcules to the Royal Society had been written in November 1677, but had been published in the *Philosophical Transactions* not before the year 1679, Hartsoeker indeed was the first who published on animalcules in 1678.

²² "De cette maniere outre les observations dont nous avons déjà parlé, il a découvert encore nouvellement que dans l'urine qui se garde quelques jours il s'y engendre de petit animaux qui sont encore beaucoup plus petits que ceux que l'on voit dans l'eau de poivre, & qui ont la figure de petit anguilles. Il en a trouvé dans la semence du Coq, qui ont paru à peu près de cette même figure qui est fort differente, comme l'on voit de celle qu'ont ces petit animaux dans la semence des autres qui ressemblent, comme nous l'avons remarqué, à des grenouilles naissantes" (Hartsoeker, 1678, *Journal des Sçavans* 30, p. 380).

²³ "[M]ais aujourd'hui lorsqu'on s'est apperçu par des recherches exactes, faites sur les plantes, les insectes et les animaux, que les corps organiques de la nature ne sont jamais produits d'un Chaos ou d'une putrefaction, mais toujours par des semences, dans lesquelles il y avoit sans doute quelque prefomation, on a jugé que non seulement le corps organique y étoit déjà avant la conception, mais encor une Ame dans ce corps et en un mot l'animal même, et que par le moyen de la conception cet animal a été seulement disposé à une grande transformation pour devenir un animal d'une autre espèce. On voit même quelque chose d'approchant hors de la generation, comme lorsque les vers deviennent mouches et que les chenilles deviennent papillons" (Leibniz, *Monadologie* §74).

²⁴ "Les animaux, dont quelques uns sont élevés au degré des plus grands animaux par le moyen de la conception, peuvent être appellés spermatiques; mais ceux d'entre eux, qui demeurent dans leur Espèce, c'est à dire la plupart, naissent, se multiplient, et sont détruits comme les grands animaux, et il n'y a qu'un petit nombre

1.2. Characteristics of epigenesis

As in the case of preformation there also existed a wide variety of epigenetic accounts.²⁵ In order to complete the classification of historical accounts in part 1.1 of my paper, I will now present the corresponding set of characteristics of epigenetic models of reproduction and heredity. Also with regard to epigenetic models, so far scholars have pointed out some of the criteria, but no one has provided a more detailed and comprehensive, systematic list of epigenetic features.²⁶ I would like to suggest that defenders of epigenesis shared²⁷

- the assumption of the autonomy of nature (and a decreasing importance of God's creation),
- the assumption of an undifferentiated matter at the beginning of the generation and development of the embryo,
- the assumption of creative, generative powers and laws of nature that explain the generation and development of the living being,
- the assumption that these powers and laws of nature were either mechanical (mechanical variant of epigenesis) or vitalistic (vitalistic variant of epigenesis),
- the assumption of the successive development of the characteristics and parts of the living being, and

d'Elûs, qui passe à un plus grand theatre" (Leibniz, *Monadologie* §75).

²⁵ Epigenetic theories began to replace preformationist theories in the middle of the eighteenth century. For reasons that led to this transition, see Ilse Jahn (1982, pp. 226–65), Peter McLaughlin (1989, pp. 16–20), and Ina Goy (2017, pp. 308–15). McLaughlin argues, first, that a scientific reinterpretation of geological and cosmological theories replaced theological explanations of the macrocosmos, second, that the emergence of a specific biological species criterion helped to consider belonging to the same kind to be no longer based on the similarity of the form but on the common descent and reproductive ability, third, that the enforcement of philosophical atomism in natural and social theory was incompatible with preformation, and, fourth, that the origin of a general concept of the reproduction of an organic system replaced divine interventions in nature.— Goy names three reasons: first, that preformation theories faced the problem of an infinite regress of germs, second, that Abraham Trembley's polyp experiments gave proof of the self-regeneration of organized beings, and third, that bastards showed clearly that offspring is generated by both parents and not only the mother (ovism) or the father (animalculism). Also monstrosities posed a challenge to preformationists, since their 'reproductive failures' would have been intentionally created by God.

²⁶ John Zammito (2003, p. 87 and 2007, pp. 54–55) discusses the three criteria of epigenetic accounts that Arthur Genova (1974) mentions: "*autonomy, community, and reflexivity*". Zammito comments on these criteria: "In my terms, I would stress the radicality of emergence by replacing autonomy with spontaneity. By *community* Genova signifies the mutuality of cause and effect and of parts and whole which is central to the notion of organic form, especially as Kant articulated it. *Reflexivity*, finally, has to do with the self-regulating, self-forming dimension as a persistent feature of life-forms, over and above the question of their emergence *de novo*". I share with Genova and Zammito the criterium of the autonomy of nature (as opposed to nature's dependence on the divine), and the emphasis on natural forces and laws, which are responsible for the generation and growth of an organism. However, as mentioned in my list, one can provide further criteria, especially in direct contrast with and comparison to characteristics of preformation.

²⁷ For a variety of historical uses of the term 'epigenesis' apart from the early modern period, see the special collection on the history of the notion by Charles Wolfe and Antonine Nicoglou (2018).

- the assumption of a bisexual explanation of the offspring's inherited resemblances and hereditary patterns.

I will now illustrate also some of these epigenetic characteristics with historical examples.

1.2.1. Historical examples of mechanical epigenesis

Though William Harvey's (1578–1657) account of the development of a chicken out of a fertilized egg in his book *The Generation of Animals* (1651) is no unambiguous example of epigenesis, since Harvey's account contains characteristics of ovistic preformation as well, he is the first, or one of the first, early modern thinkers who coined the term 'epigenesis'. The chick, Harvey notes, is produced by epigenesis, or by an addition of the parts that successively arise (Harvey, 1651 engl. 1965, p. 372).²⁸ In another passage of *The Generation of Animals* he notes: "Now it appears clear . . . that the generation of the chick from the egg is the result of epigenesis . . ., and that all its parts . . . emerge in their due succession and order . . .; also that the generation of some parts supervenes on others previously existing, from which they become distinct; lastly, that its origin, growth, and consummation are brought about by the method of nutrition; and that at length the foetus is thus produced. For the formative faculty of the chick rather acquires and prepares its own material for itself than only finds it when prepared, and the chick seems to be found and to receive its growth from no other than itself. . . . [T]he same efficient and conservative faculty is found in the egg as in the chick; and of the same material of which it constitutes the first particle of the chick, out of the very same does it nourish, increase, and superadd all the other parts. Lastly, in generation . . . by epigenesis the whole is put together out of parts in a certain order, and constituted from them" (Harvey, 1651 engl. 1965, p. 336).²⁹

²⁸ "[P]er epigenesin, sive partium superexorientium additamentum, pullum fabricari certum est" (Harvey, 1651, p. 189).

²⁹ "Liquidò itaque ex historia nostra constat, pulli generationem ex ovo, fieri potiùs per epigenesin quàm per metamorphòsin; neque omnes ejus partes simul fabricari, sed successivè, atque ordine emergere, eundèmq; simul, dum augetur, formari; & augeri, dum formatur; partèsque alias aliis prioribus supergenerari, & distingui; principiùmque, augmentum & perfectionem procedere per modum crescendi, tandèmq; exoriri foetum. Facultas enim pulli formatrix, materiam potiùs sibi acquirit, & parat, quàm paratam invenit: videtúrque pullus haud ab alio fieri, vel augeri, quàm à se ipso. Et quemadmodum omnia, ex quo fiunt, ab eodem augentur: ità similiter, à quo pullus conservatur, & augentur ab initio (sive id anima, sive facultas animæ fuerit) ab eodem quoque (ut suprà diximus) eum fieri credibile est. Idem enim reperitur tum in ovo, tum in pullo, efficiens, ac conservans; ex qua materia primam pulli particulam constituit, ex eadem nutrit, auget, & superaddit reliquas omnes. Denique, in generatione per metamorphòsin, totum in partes distribuitur & discernitur; per epigenesin verò, totum es partibus certo ordine componitur, ac constutuitur" (Harvey, 1651, pp. 155–56).

A second historical example of the mechanical variant of epigenesis is Pierre-Louis Moreau de Maupertuis's (1698–1759) account of reproduction and heredity in his *Venus physique* (1745). In this book Maupertuis writes mysteriously that when silver and the spirit of salpeter are mingled with mercury and water, the parts of these matters merge into something that equals an arbor so much that one actually must call it an arbor—arbor Diane (Maupertuis, 1745/1777, p. 130).³⁰ And though it seems that these generations are less organic than the bodies of most animals they seem to be dependent, Maupertuis writes, upon the same mechanical orders and laws, and seem to require the same laws of motion and powers (Maupertuis, 1745/1777, pp. 132–33), namely those powers that others call 'attraction' (and repulsion) (Maupertuis, 1745/1777, p. 134).³¹ About bisexual reproduction of inherited resemblances, Maupertuis remarks that if two parts that are supposed to connect, are connected, a third part which could have filled the same place, finds no place in such a composite, and remains without a purpose. Consequently, offspring is formed from parts of the father and the mother, and often has visible characteristics of both (Maupertuis, 1745/1777, pp. 136–37).³²

A third example of mechanical epigenesis can be found Georges-Louis Leclerc de Buffon's (1707–1788) account of reproduction and heredity in the second volume of his *Histoire naturelle générale et particulière* (1749). According to Buffon the body of an animal or plant has an inner form (*moule intérieur*) the shape of which cannot change, but whose mass and size can properly expand. The growth or unwrapping of an animal or plant takes place when the inner form expands in all its inner and outer measures. This expansion takes place due to additional outer matter, which ingresses the plant or animal and gets assimilated to the form and shape and the already existing matter (Buffon, 1749, pp. 42–43).³³ In another

³⁰ "Lorsque l'on mêle de l'argent & de l'esprit de nitre avec du mercure & de l'eau, les parties de ces matieres viennent d'ellesmêmes s'arranger pour former une végétation si semblable à un arbre, qu'on n'a pu lui en refuser le nom.*", "Arbre de Diane" (Maupertuis, 1745/1777, p. 130).

³¹ "Et quoique celles-ci paroissent moins organisées que les corps de la plupart des animaux, ne pourroient-elles pas dépendre d'une même mécanique & de quelques loix pareilles ? Les loix ordinaires du mouvement y suffiroient-elles, ou faudroit-il 133 appeller au secours des forces nouvelles?" (Maupertuis, 1745/1777, pp. 132–33). "Je ne puis m'empêcher d'avertir ici, que ces forces & ces rapports ne sont autre chose que ce que d'autres Philosophes plus hardis appellent Attraction" (Maupertuis, 1745/1777, p. 134).

³² "Mais les deux parties qui doivent se toucher, étant une fois unies, une troisieme qui auroit pu faire la même union, ne trouve plus sa place, & demeure inutile. C'est ainsi, c'est par ces opérations répétées, que l'enfant est formé des parties du pere & de la mere, & porte souvent des marques visibles qu'il participe de l'un & de l'autre" (Maupertuis, 1745/1777, pp. 136–37).

³³ "Il nous paroît donc certain que le corps de l'animal ou du végétal est un moule intérieur qui a une forme constante, mais dont la masse & le volume peuvent augmenter proportionnellement, & que l'accroissement, ou, si l'on veut, le développement de l'animal ou du végétal, ne se fait que par l'extension de ce moule dans toutes ses dimensions extérieurs & intérieurs, que cette extension se fait par l'intussusception d'une matière accessoire & étrangère qui pénètre dans l'intérieur, qui devient semblable à la forme identique avec la matière du

passage of the *Histoire naturelle* Buffon writes that it is impossible to sufficiently explain the reproduction and development of organisms by something other than penetrating (mechanical) forces and affinities, or by (the mechanical force of) attraction, forces that Buffon himself uses in order to mechanically explain the similarities of the formation of smaller organisms to that of larger ones (Buffon, 1749, p. 66).³⁴

Buffon writes that all animals, males as much as females, all who have both genders or neither of both, all plants of whatever kind, and all bodies living or growing, consist in living organic particles (“parties organiques vivantes”) that can be observed. These organic particles can be found in larger amounts in the semen of animals, in the germs of fruits, and in the essential parts of plants and animals. When they are sent out by essential parts of growing animal’s bodies their unification causes the reproduction and generation of a body that equals the plant or animal, in which this emission of organic particles takes place. The reason for this is that the unification of organic particles takes place due to an inner form, and thus cannot take place in another order than the form of the plant or animal which reproduces it. And in this consists the nature of the unity and continuous reproduction of the species, which can never come to an end and will endure as long as its creator wants it to endure (Buffon, 1749, p. 258).³⁵

1.2.2. Historical examples of vitalistic epigenesis

A first historical example of a vitalistic variant of epigenesis can be found in Caspar Friedrich Wolff’s (1734–1794) account of plant reproduction in his dissertation *Theoria generationis* (1759). In this writing Wolff notes that there must be a force in plants by means of which liquids get collected from the surrounding earth, get forced to penetrate the roots, get distributed through the entire plant, and get partly stored at various places, and partly

moûle” (Buffon, 1749, pp. 42–43).

³⁴ “La première se tire de l’analogie qu’il y a entre le développement & la reproduction, l’on ne peut pas expliquer le développement d’une manière satisfaisante, sans employer les forces pénétrantes & les affinités ou attractions que nous avons employées pour expliquer la formation des petits êtres organisés semblables aux grands” (Buffon, 1749, p. 66).

³⁵ “Tous les animaux, mâles ou femelles, tous ceux qui sont pourvus des deux sexes ou qui en sont privés, tous les végétaux, de quelques espèces qu’ils soient, tous les corps en un mot, vivans ou végétans, sont donc composés de parties organiques vivantes qu’on peut démontrer aux yeux de tout le monde: ces parties organiques sont en plus grande quantité dans les liqueurs séminales des animaux, dans les germes des amandes des fruits, dans les graines, dans les parties les plus substantielles de l’animal ou du végétal, & c’est de la réunion de ces parties organiques, renvoyées de toutes les parties du corps de l’animal ou du végétal, que se fait la reproduction, toujours semblable à l’animal ou au végétal dans lequel elle s’opère, parce que la réunion de ces parties organiques ne peut se faire qu’au moyen du moule intérieur, c’est-à-dire, dans l’ordre que produit la forme du corps de l’animal ou du végétal, & c’est en quoi consiste l’essence de l’unité & de la continuité des espèces qui dès lors ne doivent jamais s’épuiser, & qui d’elles-mêmes dureront autant qu’il plaira à celui qui les a créées de les laisser subsister” (Buffon, 1749, p. 258).

excreted again (Wolff, 1759, p. 1).³⁶ Wolff adds that this force cannot be a mere attractive force, as the plant's transpiration shows (Wolff, 1759, p. 1);³⁷ and continues that whatever the character of this force might be—be it an attractive or a driving force, be it that it exists as a consequence of the expanded air, or that it is composed out of all these and other factors—this force is capable of all the effects mentioned, and one has to presuppose this force. Wolff calls it an 'essential force' (*vis essentialis*) (Wolff, 1759, p. 1).³⁸

Wolff discusses the same matters in his *Theorie der Generation* (1764 in 1966). In §67 of this book Wolff gives an account of the epigenetic successive formation of organic bodies. Wolff claims that the different parts of organic bodies all arise one after another. They emerge in such a way that one part is always either excreted from another if it is a free and self-sufficient part, that is dependent only upon the one whom it owes its production, or is deposited after another if it is enclosed within it; as has been shown by plants and animals. It follows that every part is, in the first place, an effect of another preceding part, and then in turn becomes the cause of other succeeding parts. Each part is in the beginning, when it is excreted or deposited, inorganic, and it is only organized when it has already excreted other parts. That excretion of one part by the other, thus goes on for some time, but ceases at last. And those parts which have finally been excreted remain the last, and do not excrete other parts. These last parts are thus for example the fingers of the animals, or their toes; in the plants, the small spaces between the last and smallest ribs in the leaves, when they are fully grown (Wolff, 1764 in 1966, pp. 210–11).

A second example of a vitalistic variant of epigenesis is Johann Friedrich Blumenbach's (1752–1840) description of the reproduction and heredity of organisms in his writing *Über den Bildungstrieb und das Zeugungsgeschäfte* (1781). Blumenbach is especially well-known for his vitalistic notion of a formative drive. He observes that there is a particular inherent drive in all living beings to achieve their form, to preserve it, and if destroyed to regenerate it. This drive, Blumenbach writes, is different from all general characteristics of bodies and from all particular powers of organized bodies. It is one of the first causes of generation, nutrition, and reproduction. Blumenbach calls this drive 'formative drive (*nisus*

³⁶ “§1. [O]btinere in vegetabilibus absorptionem humorum, distributionem eorundem per universam plantam, tandemque ipsorum exhalationem, adeoque: Vim, qua humores ex circumiacente terra, vel aliis corporibus colliguntur, subire radicem coguntur, per omnem plantam distribuuntur, partim ad diversa loca deponuntur, partim foras expelluntur” (Wolff, 1759, p. 1).

³⁷ “§2. Hanc vim non esse mere attracticem, demonstrat: transpiratio” (Wolff, 1759, p. 1).

³⁸ “§4. Quaecunque vero sit haec vis, sive propulsiva, sive aëri expanso debita, sive composita ex omnibus hisce & pluribus; modo praestet enarratos . . . effectus, & ponatur, posita planta & humoribus nutritiis applicatis, id quod experientia confirmatum est . . . [V]ocabitur a me vis vegetabilium essentialis” (Wolff, 1759, p. 1).

formativus)' in order to distinguish it from other natural powers (Blumenbach, 1781, pp. 12–13).³⁹ Blumenbach emphasizes that this drive is neither similar to a *vis plastica* nor to Wolff's *vis essentialis* nor does it equal forces of chemical fermentation nor that of blind expansion nor other mere mechanical forces that others assumed in order to explain the reproduction of organisms (Blumenbach, 1781, pp. 13–14).⁴⁰ Blumenbach also develops a typical epigenetic notion of successively emerging embryonic parts. He notes that scholars widely agree that offspring (of humans or animals) does not appear immediately after impregnation and that human embryos cannot be seen prior to the third week of pregnancy. He explains this on the basis of male and female seminal juices that mingle in the process of impregnation, and need some time to achieve an inner connection or to ripen before the formative drive can be activated in them and can begin the formation of the so far unformed matter (Blumenbach, 1781, pp. 40–42).⁴¹

2. Is Kant a defender of preformation or epigenesis?

2.1. *The controversy*⁴²

In the scholarly debate about Kant's relationship to his predecessors no one considers Kant a radical defender of preformation, but some scholars consider him a more

³⁹ “§2. [Ich sage,] [d]aß in allen belebten Geschöpfen . . . ein besondrer, eingebohrner, lebenslang thätiger wirksamer Trieb liegt, ihre bestimmte Gestalt anfangs anzunehmen, dann zu erhalten, und wenn sie ja zerstört worden, wo möglich wiederherzustellen. Ein Trieb . . . der sowol von den allgemeinen Eigenschaften der Körper überhaupt, als auch von den übrigen eigenthümlichen Kräften der organisirten Körper ins besondere gänzlich verschieden ist; der eine der ersten Ursachen aller Generation, Nutrition und Reproduction zu seyn scheint, und den ich hier um aller Misseutung zuvor zu kommen, und um ihn von den andern Naturkräften zu unterscheiden, mit dem Namen eines Bildungs-Triebes (Nisus formativus) belege” (Blumenbach, 1781, pp. 12–13).

⁴⁰ “§3. . . . Doch muß ich auf diesen Fall nur warnen, daß man ja nicht etwa diesen Trieb mit der *vis plastica*, oder mit der *vis essentialis* oder gar mit den chimischen Fermentationen und der blinden Expansion, oder andern blos mechanischen Kräften, die einige zum Zeugungsgeschäfte angenommen haben, vermenge” (Blumenbach, 1781, pp. 13–14).

⁴¹ “§23. . . . Es ist eine durchgehends bestätigte Erfahrung, daß sich . . . doch nie sogleich . . . nach der Befruchtung die erste Spur des neuempfangenen Menschen oder Thiers oder Gewächses zeigt. . . . Kein vorsichtiger und zuverlässiger Beobachter wird vor der dritten Woche der Schwangerschaft einen ungezweifelt wahren [menschlichen] Embryo . . . gesehn haben. Vor diesem . . . Termin ist schlechterdings ihre neuempfangene Brut nicht zuverlässig zu erkennen: ein Umstand . . . der sich hingegen von selbst erklärt so bald man annimmt, daß die väterlichen und mütterlichen zur Zeugung bestimmten Säfte, eine bestimmte Vorbereitungszeit zu ihrer Mischung und innigen Verbindung . . . , mit einem Wort zu ihrer Reife brauchen, ehe der Bildungstrieb in ihnen erregt werden und die Formation des bis dahin ungeformten Stoffs beginnen kann” (Blumenbach, 1781, pp. 40–42).

⁴² In the following discussion I will solely focus on Kant's biological uses of the terms 'preformation' and 'epigenesis', but not on their analogical, metaphorical, epistemological, or moral-practical applications, which have been discussed by a number of scholars, for instance Arthur Genova (1974), Hans Ingensiep (1994), François Duchesneau (2000), Phillip Sloan (2002), Marcel Quarfood (2004, pp. 77–117), Angela Breitenbach (2009, pp. 84–108), John Zammito (2003, pp. 83–84 and 2007, pp. 57–58), and Jennifer Mensch (2013).

or less radical defender of epigenesis. A greater number of scholars hold that Kant's position combines preformationist and epigenetic elements. And several scholars ignore, and a few even deny any influence of the preformation-epigenesis debate on the development of Kant's account.

Among the defenders of epigenetic claims in Kant is Clark Zumbach (1984). In one of the now classical interpretations of Kant's philosophy of biology, he negates traditional variants of vitalism but defends a new version of vitalist epigenesis in Kant. As traditional vitalists Zumbach considers people who claim that "a living thing is not only made up of physical inanimate parts, but also consists of a non-material entity which brings with it the activities characteristic of living organisms. This vital entity, in animating the organism, distinguishes the organic from the inorganic" (Zumbach, 1984, p. 83). Zumbach negates that Kant holds a vitalism of this kind. Nevertheless he thinks that Kant holds on to a different type of anti-mechanism or -reductionism when he assumes forces in organisms which are analogous to the causality of human freedom and are operative besides mechanical causation. In some passages Zumbach even identifies these forces with freedom itself.

Another defender of epigenetic claims in Kant is Hans Peter Reill (2005, p. 246), who places Kant, Buffon, Daubenton, Robinet, Herder, and Goethe into a group of thinkers whose philosophical charism he describes as "Enlightenment Vitalism". Philippe Huneman (2006, p. 651) follows Reill and writes: "I thus support Reill's (2005) contention that Kant's *Critique of judgment* belongs to the 'program' of those who have come to be called 'Enlightenment vitalists'". Huneman bases his view on a reading of passages in §81 of the *KU*, in which Kant outlines and praises the epigenesis doctrine: "Kant's theory . . . asserted an epigenesis disposed to reach a type. It characterized germs and dispositions . . . as 'reproductive powers' inherited by the offspring of an individual". Germs and predispositions "were used by Kant to provide an epigenetic answer to the problems of the conversation and the variation of form through the generations" (Huneman, 2006, p. 653).

Boris Demarest (2017) in a provocative paper suggests a less radical epigenetic reading of Kant. He argues that Kant adopted a position that is "akin to classical accounts of epigenesis" as defended by Aristotle and Harvey, "although he does reject the more radical forms of epigenesis proposed in his own time, and does make use of preformationist sounding terms". Demarest thinks that Kant's account is epigenetic for three reasons: since what is pre-formed is pre-formed as a species only, not as an individual, since Kant has no qualm with the idea of a specific, teleological principle underlying generation, and since Kant

conceives of germs and predispositions as specific constraints on such a principle or force. These three conceptions, Demarest argues, are not in strict opposition to classical accounts of epigenesis.

Another group of scholars defend synthetic preformationist-epigenetic readings of Kant's position. In a carefully researched paper, Phillip Sloan (2002) reconstructs the notions of germs and dispositions (*Keime und Anlagen*) in their preformationist and epigenetic contexts in Kant's published writings and shows how Kant's position develops from rather preformationist to epigenetic readings of germs and dispositions. Sloan includes non-biological epistemological theoretical and moral practical applications of both terms into his discussion of Kant's writings.

In a variety of intense papers, John Zammito (2003, 2006, and 2007) describes various epoches of the adaption to preformationist and epigenetic accounts in Kant's thought, and captures the ambivalence of Kant's position, especially in the *KU*. Zammito (2003, p. 88) focuses on the influences that Johann Friedrich Blumenbach, his student Christoph Girtanner, Georg Forster, and Johann Gottfried Herder had on Kant's accounts of reproduction, especially on his notions of preformation and epigenesis, and notes: "First, Kant had to insist that even epigenesis implied preformation: at the origin there had to be some inexplicable (transcendent) endowment, and with it, in his view, some determinate restriction in species variation. Thereafter, the organized principles within the natural world could proceed on adaptive lines. This made *epigenesis* over into Kant's variant of *preformation*. Even so, this seemed to postulate the objective *actuality* of these forces for natural science. Hence Kant faced the ultimate need for a second step: to transpose the whole matter from the constitutive to the regulative order". Zammito (2006, p. 317) discusses the relationship between Pierre Louis Maupertuis and Kant and states: "I suspect that Kant was *never* comfortable with epigenesis, that it was a strain for his critical philosophy even when he explicitly invoked it", and claims that Kant remained committed to both, preformation and epigenesis. And Zammito (2007, p. 51) conjectures how Pierre Louis Maupertuis, Georges-Louis Leclerc Buffon, Johann Gottfried Herder, Georg Forster, and Johann Friedrich Blumenbach shaped Kant's accounts of reproduction and heredity and claims that Kant was never "entirely comfortable" with the idea of epigenesis. In his most recent reconsideration of Kant's relationship to preformation and epigenesis, Zammito (2016) repeats and refines this account, insisting that Kant combines preformationist and epigenetic elements.

Joan Steigerwald (2006), Siegfried Roth (2008), Marjorie Grene and David Depew (2004), and Mark Fisher (2014) hold synthetic views as well, but based on much narrower textual evidence. Steigerwald (2006, p. 716) writes on §81 of the *KU*: “In accounting for the development of an individual organized being, Kant now favored epigenesis over preformation as it minimizes the appeal to the supernatural”, the preformationist element in Kant’s account. Similar to Steigerwald, Roth (2008, pp. 284–85) notes on §81 of the *KU* that Kant’s innovative concept ‘generic preformation’ uncovers the entire problem of the discussion of Kant’s time demonstrating that neither epigenesis nor preformation alone suffice to describe ontogenetic processes. Kant, Roth thinks, defends a theory of epigenesis, however in the sense of generic preformation. Grene/Depew (2004) have defended similar statements.

In a paper on Kant and Maupertuis, Mark Fisher (2014, pp. 25–41) writes in view of Kant’s §81 of the *KU*: “According to Kant, the physiologist is warranted in providing an epigenetic account of generation, but is also constrained by the need to appeal to the vital functioning of organic bodies in such an account. The metaphysician or the transcendental philosopher is warranted in appealing to immaterial principles as grounds of this possibility, but is also constrained by the requirement to do so in a way that will not undermine a natural-causal account of the production of these bodies from other bodies of the same kind. Malebranche and other adherents to *preexistence* fail to recognize this latter constraint, and Kant agrees with Maupertuis that this failure provides us with non-empirical reasons for rejecting *preexistence*. The commitment to a fundamental generative or formative power, by contrast, allows Kant to offer a model of organic generation that recognizes both of these constraints. That model involves adherence to a version of *epigenesis* that can also be described as *generic preformation*”.

In a certain way one could quote Mark Fisher also for a reading that even denies an influence of the preformation-epigenesis debate on the development of Kant’s account, since Fisher negates an impact of the biological side of the preformation-epigenesis controversy on Kant, and claims that the dispute is rather a metaphysical one. But one could list here also many of the familiar traditional interpreters like Peter McLaughlin, Hannah Ginsborg, Paul Guyer, Marcel Quarfood, Rachel Zuckert, and Angela Breitenbach who leave the preformation-epigenesis debate in their interpretations aside (leaving this discussion aside is, of course, no fault, and just a choice of focus).

As is visible, the debate is in a developed state, but can still be improved in some regards. I have addressed the lacking comprehensive analysis of preformationist and epigenetic early modern models of reproduction and heredity in part 1 of the paper, and have suggested a set of systematic preformationist and epigenetic characteristics, which will, as I hope, help to determine Kant's philosophical relationship to his predecessors. I will now search for the selected characteristics in different periods of Kant's thoughts, in order to capture the changing systematic approximations and tensions between Kant's account and those of his predecessors.⁴³ I will, first consider ovistic and animalculist preformationist elements (2.2) in Kant's *Ground of Proof* essay (2.2.1) and his three writings on races (2.2.2), followed by the same investigation in his third *Critique* (2.2.3). Then I will proceed to mechanical and vitalistic epigenetic elements (2.3), and will again, first identify epigenetic elements in Kant's *Ground of Proof* essay (2.3.1) and his writings on races (2.3.2), and then in his third *Critique* (2.3.3).⁴⁴ Finally (2.4), I will return to the literature and will respond to scholarly positions.

2.2. *Is Kant a defender of preformation?—Characteristics of preformation. A reminder*

As mentioned in part 1.1, preformationist models of reproduction and heredity shared the assumption of divine creation and a creator and the negation of the autonomy of nature; the assumption that this God preforms germs out of which the generation and development of living beings takes place; the assumption that these preformed germs contain in small all characteristics of the future living being, so that the development of a living being appears as an enfolding, unwrapping, and enlargement of the characteristics that are already contained in the germ; and the assumption of the simultaneous generation of these characteristics. Two main directions of preformationist interpretations of reproduction and heredity developed, since its defenders either held that the germ is the female egg (ovistic preformation) or is the male sperm (animalculist preformation); connected to the views that either the female or the male parent alone transfers properties to the offspring by means of

⁴³ Detailed historical discussions of preformationist and epigenetic biological models can be found in Philippe Huneman's (2008) book *Métaphysique and biologie. Kant et la constitution du concept d'organisme*, a book written in French, and in Jennifer Mensch (2013). But both books do not develop a clear set of systematic criteria which are present in preformationist and epigenetic accounts. Tobias Cheung's (2008) book *Res vivens* covers closely related historical materials but is not primarily concerned with the preformation-epigenesis controversy.—Phillip Sloan, John Zammito, and more recently Boris Demarest, try to sketch Kant's various positions in several of his writings.

⁴⁴ By 'writings on races' I mean Kant's *Of the Different Races of Human Beings* (1775), the *Determination of the Concept of a Human Race* (1785), and *On the Use of Teleological Principles in Philosophy* (1788). There is more relevant material, for instance in Kant's review of Herder's *Ideen*, but the limited space of this paper disallows its inclusion here.

unisexual inheritance. In the first case the offspring obtains the properties of the mother through the female egg (ovistic preformation), in the second the properties of the father through the male sperm (animalculist preformation).—I would like to consider now whether Kant adopts any of the characteristics of preformationist models of reproduction and heredity in his *Ground of Proof* essay, his three writings on races, and in his third *Critique*.

2.2.1. Preformationist characteristics in Kant's *Ground of Proof* essay

In 1763 Kant is a strong defender of the preformationist element of creation. He claims a constitutive notion of God as the creator of even the matter, that is, the possibility of nature, and argues against weaker accounts that consider God only a 'moral' cause or an architect of nature, that is, an organizer of nature's form through his will (*BDG*, 2: 100.20–32, *BDG*, 2: 110.24–26). Kant's idea seems to be that God's will is required in order to give nature that already exists its particular purposive and beautiful form, but more than God's will is required to bring about nature at all, to make nature possible. Thus, Kant considers God the unmoral cause of even nature's possibility, that is, nature's matter (*BDG*, 2: 103.27–104.7, *BDG*, 2: 108.15–20). Nevertheless Kant is not inclined to make the divine stronger than necessary and rejects the idea of permanent divine interventions in nature in form of miracles (*BDG*, 2: 96.35).

Kant's *Ground of Proof* contains a direct (positive) reference also to the preformationist notion of a God who preforms the germs of living beings out of which the generation and development take place. Kant is aware of the preformationist claim that these preformed germs contain in small all characteristics of the future living being, and reduces nature's role in the development of living beings to an enfolding, unwrapping, and enlargement of the characteristics that are already present in the germ. Kant is also familiar with the preformationist claim of the simultaneous generation of these characteristics (*BDG*, 2: 114.17–115.15).⁴⁵ Kant explicitly mentions and criticizes two of the main defenders of epigenetic theories: "Maupertuis" and "Buffon" (*BDG*, 2: 115.4, 7). This indicates that Kant was familiar already with the details of the preformation-epigenesis debate, since Maupertuis's and Buffon's writings contain enormous excerpts of the previous contributions to this debate. But Kant holds no explicit account of unisexual inheritance in either the ovistic or animalculist preformationist version.

⁴⁵ See "development [Auswicklung]" (*BDG*, 2: 114.23) and "merely to unfold [blos auszuwickeln]" (*BDG*, 2: 114.27).

2.2.2. Preformationist characteristics in Kant's writings on races

In Kant's writings on races a first preformationist feature, again, is the strong constitutive concept of creation. But Kant is far more adapted to the terminology of the preformation-epigenesis debate. Kant talks about the nature of "created germs [anerschaffene Keime]" (*BBMR*, 8: 103.2) and "created predispositions [anerschaffene Anlagen]" (*BBMR*, 8: 96.35) or about the fact that the germs and natural predispositions of organized beings have been "preformed [vorgebildet]" (*VvRM*, 2: 435.3), whereby the terms "created" and "preformed" contain apparent references to a creator as a 'preformer'.

A second preformationist feature is Kant's adoption of the notion of preformed germs and preformed natural predispositions. Kant mentions such germs and predispositions at several places, above all in his writing *ÜGTP* (*ÜGTP*, 8: 166.2–3; 8: 168.30–32; 8: 169.4–5; 8: 169.12, 14; 8: 170.12–13),⁴⁶ and claims that organized beings bring about their characteristics and properties by means of "unfolding [Auswicklung]" (*VvRM*, 2: 435.18),⁴⁷ a claim in which Kant again adopts preformationist ideas.

However, though Kant seems to approach some of the preformationist views, in his writings on races he neither specifies the germ as egg (ovistic preformation) nor as animalcule (animalculist preformation), even though several of Kant's early notes confirm that he was familiar with ovism and animalculism. Kant obviously did not want to share unisexual explanations of inherited resemblances.⁴⁸

⁴⁶ See "original predispositions [ursprüngliche Anlagen]" (*ÜGTP*, 8: 166.2–3), "hereditary peculiarities . . . originally implanted [erbliche Eigenthümlichkeiten . . . ursprünglich eingepflanzt]" (*ÜGTP*, 8: 168.30–32), "a development of purposive first predispositions implanted in one phylum [sie als Entwicklung in einem Stamme eingepflanzter zweckmäßiger erster Anlagen anzusehen]" (*ÜGTP*, 8: 169.4–5), "germs [Keime]" (*ÜGTP*, 8: 169.12, 14), "original germs that are purposively implanted in the phylum [ursprüngliche, zweckmäßig dem Stamme eingepflanzte Keime]" (*ÜGTP*, 8: 170.12–13).

⁴⁷ See also "unfolded [ausgewickelt]" (*VvRM*, 2: 435.26); "unfolding [Auswicklung]" (*VvRM*, 2: 436.26), "unfolding [Auswicklung]" (*BBMR*, 8: 104.26).

⁴⁸ In a reflection on metaphysics (*Ref*, 17: 416.8–15) from the year 1769 Kant raises the question whether everything in the character of a child is dependent upon the man or the woman, and considers answers from perspectives of both kinds of preformation. The „system of eggs [System der ovulorum]", he thinks, presupposes that a woman would have the same children with another man; the system of "sperms [animalculorum]" that a man would have the same children with another woman. Kant comments ironically on the embarrassing results of both theories: parents who are preformationists enjoy the practical advantage that in view of their reproductive success they need to consider the race and constitution of one of both parents only. In ovism the male parent has to consider the constitution and race only of the prospective mother, in animalculism the female parent the constitution and race only of the prospective father (*Ref*, 17: 416.8–15). In another reflection on anthropology (*Ref*, 15/2: 554.1–5) from the mid 1760s to the mid 1770s, Kant notes: "If everything were laying in the egg the male would have no reasons for jealousy; if everything in the sperm, the female not. In the first case children would not belong to the father, in the second not to the mother. Him or her would provide the primal nutrition only, or the primal warmth, as if the child were a frozen man [Wenn alles in den ovulis wäre, so hätte der Mann nicht Ursache ialous zu seyn; oder wenn in den animalculis: die Frau nicht. Im ersten Falle gehoreten die Kinder nicht dem Vater, im zweyten nicht der Mutter; sondern es wäre nur die erste Ernährung, die er ihnen gäbe, oder erste Erwärmung, wie bey einem erfrohrenen Menschen]".

2.2.3. Preformationist characteristics in Kant's *KU*

In the *KU* Kant is still close to preformationist views when he uses a now weaker, regulativ concept of creation. Though he describes the preformation of natural objects by God, he emphasizes that this concept of God is no empirical, constitutive, but a hypothetical, regulative concept. Other than in his writings on races, in which Kant focuses on aspects that interpret God as the 'preformer' of germs and natural predispositions, a designer who acts at the beginning of creation, Kant's attention in the *KU* (§§ 85–91) shifts towards a concept of God that is the final cause of the unity and purposiveness of the creation. This God directs the purposes of all things towards himself as the ultimate purpose and original highest end of all things.

The preformationist idea of preformed germs and natural predispositions is less apparent in the *KU* than in Kant's writings on races. The *KU* contains only a few remarks on natural dispositions, for instance in §58, when Kant notes about the formation of plants and animal bodies, that it is dependent upon a "certain original predisposition directed at ends [einer gewissen ursprünglichen auf Zwecke gerichteten Anlage]", a predisposition which is "teleologically [teleologisch]" (*KU*, 5: 349.23–25). But in the *KU* Kant no longer uses the preformationist concept of a 'germ'.

A new aspect in the *KU* is that Kant includes among man's original predispositions a moral predisposition, which is a predisposition that directs man to the ultimate purpose of humanity, the moral good (*KU*, 5: 298.16–17). This moral teleological perspective hardly plays any role in Kant's writings on races and is nothing that Kant adopted from his predecessors, but is decisive in Kant's *KU*. One could say that at this point Kant invents a new preformationist characteristic that he had not found in the traditional literature on the subject written before his *KU*.

In §81, Kant distinguishes between generic and individual preformation, a terminology that was not popular among defenders of preformation before Kant. Kant describes advantages of the assumption of the preformation of the genus (generic preformation) over the assumption of the preformation of the individual (individual preformation). The typical feature of generic preformation is that the "specific form [specifische Form]" of the genus is "preformed virtualiter [virtualiter präformirt]", when the "productive capacity of the progenitor [das productive Vermögen der Zeugenden]" contains the internally purposive predispositions that were imparted to its stock [die inneren zweckmäßigen Anlagen, die ihrem Stamme zu Theil wurden]" (*KU*, 5: 423.6–8). Kant

appreciates the reduction of the strong preformationist characteristic of the creation of each individual to a weaker notion of the creation of the species, but he clearly appreciates a weaker preformationist notion of creation.

2.3. *Is Kant a defender of epigenesis?—Characteristics of epigenesis. A reminder*

As mentioned in part 1.2 of the paper, epigenetic models of reproduction and heredity shared the assumption of the autonomy of nature (and a decreasing importance of God's creation); the assumption of undifferentiated matter at the beginning of the generation and development of the embryo; the assumption of creative, generative powers and laws of nature of this matter, which explain the generation and development of the living being; and the assumption of the successive rather than the simultaneous development of the characteristics and parts of the living being. Two main directions of epigenetic interpretations of reproduction and heredity appeared, since its defenders interpreted the powers and laws of nature as either mechanical powers and laws in the mechanical, or vitalistic powers and laws in the vitalistic variant of epigenesis. In both directions advocates of epigenesis defended bisexual explanations of inherited resemblances in the offspring.—I would like to consider now whether Kant adopts any of the characteristics of epigenetic models of reproduction and heredity in his *Ground of Proof* essay, his three writings on races, and in his third *Critique*.

2.3.1. Epigenetic characteristics in Kant's *Ground of Proof* essay

Despite being a strong advocate of creation, in the 1763 *Ground of Proof* essay, Kant defends the autocracy of a created nature to some extent. Since nature is grounded in a single divine ground, beauty and harmony of the otherwise contingent nature can be found in the created mechanical orders of nature, not only when they appear in the inorganic, but also in the organic realm (*BDG*, 2: 98.22–27). In several examples Kant shows on the basis of a few, simple forces and mechanical laws how much order and beauty can be found in the mechanisms of nature. One of these examples is that the same elasticity of the air enables the respiration of man and animals, the suction of small children, the possibility of pumps, the generation of clouds, and the maintenance of fire and of winds (*BDG*, 2: 97.9–28, *BDG*, 2: 106.12–18).

Kant defends the same idea of the autocracy of a created nature with regards to the generation of species and individuals. While Kant tends to say that divine creation generates each and every species *at all*, and that the individuals of the species are brought about by nature (*BDG*, 2: 114.21–115.15)—an idea that foreshadows Kant's distinction between

individual and generic preformation and his support for the latter in his third *Critique* (*KU*, 5: 422.36–423.11)—Kant is still somewhat undecided whether this implies divine involvement to a lesser degree.

It is significant also that the Kant of the *Ground of Proof* essay rejects two variants of mechanical epigenetic accounts explicitly: Maupertuis's laws of desire and aversion and Buffon's internal forms (*BDG*, 2: 115.4–8), a fact that shows that he was aware of variants of epigenetic accounts and their advantages and disadvantages. But in 1763 Kant does not yet praise vitalistic epigenetic accounts (as Blumenbach's, which was published in 1781, and which Kant admires in his third *Critique*, *KU*, 5: 424.19–34).

2.3.2. Epigenetic characteristics in Kant's writings on races

As defenders of epigenesis, Kant emphasizes the importance of powers and laws of nature, whereby it is obvious that Kant does not consider mechanical powers and laws of nature creative, and rather mentions them for what they cannot achieve. He claims that, “physical-mechanical causes [physisch-mechanische Ursachen]” cannot “produce an organic body [einen organischen Körper (nicht) hervorbringen]”; they can add nothing to its “generative power [Zeugungskraft]” in order to “bring about something that propagates itself [etwas bewirken, was sich selbst fortpflanzt]” (*VvRM*, 2: 435.9–12). Mechanical powers and laws cannot cause the “agreements [Zusammenpassungen]” (*VvRM*, 2: 435.1–2) between organized beings and the environments, in which they live; they also cannot pose ends and purposes (*VvRM*, 2: 435.30–32). Mechanical powers and laws only bring about modifications that do not belong to the essential and persisting characteristics of organized beings.

Kant defends the notion of vitalistic creative powers and laws of nature. Though preformed, he claims a relative autonomous and creative force that he describes as the “unity of the generative power [die Einheit der . . . Zeugungskraft]” (*VvRM*, 2: 430.1–2). This power is the “source [*Quelle*]” of organized beings; and contains the “first principles of . . . (the) animal set-up and movement [die ersten Principien (d)er thierischen Einrichtung und Bewegung]” (*VvRM*, 2: 436.6–7) and all that, what belongs to the “original and essential destiny [ursprünglichen und wesentlichen Bestimmung]” (*VvRM*, 2: 435.32) of an organized being. The “unity of the generative power [Einheit der zeugenden Kraft]” (*VvRM*, 2: 429.8) generates the continuity and “unity of the species [Einheit der Gattungen]” (*VvRM*, 2: 430.7–8); it causes the species and its adaptation to the environment. Kant also describes the generative power as end-directed and teleological; it is a “producing (cause) [hervorbringende

Ursache()]" (*VvRM*, 2: 435.8), which brings about the "purposive [Zweckmäßige()]" (*VvRM*, 2: 435.4) out of the predisposition of the living being, that is the proportional, the suitable, the fitting, in accordance to the relevant conditions. Kant names this fit "organization [Organisation]" (*VvRM*, 2: 439.20). The generative power defines the characteristics of the phylum, for instance the predispositions of all four inheritable skin colours of human beings.

The Kant of the writings on races also shares the epigenetic idea of bisexual inheritance. As defenders of epigenesis he supports the idea of the "unfailing heredity of peculiarities from both parents [unausbleibliche Anartung beiderseitiger Eigenthümlichkeiten der Eltern]" (*BBMR*, 8: 102.28–29). For instance, he thinks that a white man (father) and a Negro woman (mother) reproduce a "*mulatto* [Mulatten]" (*BBMR*, 8: 95.9), since the "white father impresses on it the character of his class and the black mother that of hers [(d)er weiße Vater drückt . . . (dem Kind) den Charakter seiner Klasse und die schwarze Mutter den ihrigen ein]" (*BBMR*, 8: 95.18–20).

2.3.3. Epigenetic characteristics in Kant's *KU*

Also in the *KU* Kant defends the idea of a relative though not absolute autonomy of nature. For Kant, powers and laws of nature are relatively independent secondary causes, which are dependent only upon the hypothetical idea of a singular, extraterrestrial creator as their primary cause. God preforms nature to follow its own mechanical and physical teleological powers and laws (*KU*, 5: 399.37–400.6).

As in the writings on races, in the *KU* Kant does not defend creative mechanical powers and laws of nature. According to the *KU*, by means of mechanical powers and laws nature can conduct random mechanical adaptations of the matter of organized beings to random mechanical influences in the environment of the organized body or in the organized body, and nature can adapt mechanically to superordinate physical teleological powers and laws (Kant gives an example of nutrition in §64, *KU*, 5: 371.17–29). But these mechanical variants have no enduring character and do not change the essential nature of organisms.

As in the writings on races, Kant defends creative vitalistic powers and laws of nature in the *KU*. In a famous passage in §65 of the *KU*, Kant describes a vitalistic epigenetic "*formative* power [*bildende* Kraft]" (*KU*, 5: 374.23) and, for instance, in §70 he describes physical teleological laws, which generate the purposive form of the matter of organized

beings (*KU*, 5: 387.6–9).⁴⁹ In §64 of the *KU* Kant demonstrates how the vitalistic powers and laws of nature creatively and productively cause the persistence of the various species (that have been ultimately created by God), the generation and persistence of the individuals of the various species, and the reproduction of injured parts of the individuals of the various species (*KU*, 5: 370.32–372.11).

As in *HR*, in §82 of the *KU* it becomes clear, that Kant defends an epigenetic bisexual account of reproduction and the generation of inherited resemblances. He notes that in the reproduction of the species both sexes form a pair and “*organizing* whole [*organisierendes Ganze(s)*]” (*KU*, 5: 425.32), which reproduces an offspring.⁵⁰

2.4. *Is Kant a defender of preformation or epigenesis?—Answers and responses to the scholarly controversy*

The results of my investigation reveal that Kant defends a stronger variant of preformation in his *Ground of Proof* essay and in his writings on races, since he presupposes God’s creation in a constitutive sense. He still adheres to a weaker variant of preformation in the *KU*, where Kant’s account of the reproduction and heredity of organized beings no longer includes a dogmatic notion of a divine creator, but a regulative one. In his writings on races, Kant uses the notion of preformed germs and natural predispositions, but neither determines the germ as the female egg, as ovists, nor as the male animalcule, as animalculists did. In the *KU* the notion of preformed germs disappears completely, even though Kant still speaks of natural predispositions in a wider sense. In no phase of his biological theories Kant holds performanceist unisexual accounts of reproduction and heredity, but votes for epigenetic bisexual view(s) instead.

⁴⁹ See in §70: “Some products of material nature cannot be judged as possible according to merely mechanical laws (judging them requires an entirely different law of causality, namely that of final causes) [Einige Producte der materiellen Natur können nicht als nach bloß mechanischen Gesetzen möglich beurtheilt werden (ihre Beurtheilung erfordert ein ganz anderes Gesetz der Causalität, nämlich das der Endursachen)]” (*KU*, 5: 387.6–9).

⁵⁰ See in §82: “There is only a single external purposiveness that is connected with the internal purposiveness of organization and is such that, without raising the question of for what end such an organized being must exist, nevertheless serves in the external relation of a means to an end. This is the organization of the two sexes in relation to one another for the propagation of their kind; for here one can always ask, just as in the case of an individual, why must such a pair have existed? The answer is that this is what here first constitutes an *organizing* whole, although not one that is organized in a single body [Es giebt nur eine einzige äußere Zweckmäßigkeit, die mit der innern der Organisation zusammenhängt und, ohne daß die Frage sein darf, zu welchem Ende dieses so organisirte Wesen eben habe existiren müssen, dennoch im äußeren Verhältniß eines Mittels zum Zwecke dient. Dieses ist die Organisation beiderlei Geschlechts in Beziehung auf einander zur Fortpflanzung ihrer Art; denn hier kann man immer noch eben so wie bei einem Individuum fragen: Warum mußte ein solches Paar existiren? Die Antwort ist: Dieses hier macht allererst ein *organisierendes* Ganze aus, obzwar nicht ein organisirtes in einem einzigen Körper]” (*KU*, 5: 425.24–34).

Besides more or less weakened preformationist elements such as a constitutive assumption of God in the writings on races or the regulative idea of God in the *KU*, Kant accepts weakened epigenetic elements, when he adopts the existence of mechanical and vitalistic powers and laws of nature as secondary causes of the generation of living beings. In Kant's writings on races, the creative aspect of these natural powers and laws lies in the generative power; in the *KU* in the formative power and in physical teleological laws of nature. With epigenetic accounts Kant also shares the bisexual explanation of heredity. In general, Kant remains closer to vitalistic than mechanical variants of the epigenesis.

In his synthesis of epigenetic and preformationist elements, Kant liberates nature to some extent epigenetically when he attributes to nature creative generative and formative powers and physical teleological laws, but at the same time restricts them as final causes through preformationist elements: through the idea of God at the beginning and at end of the creation. The most creative moment of nature, the intentionality of natural purposes in physical teleological powers and laws, remains dependent upon intentions that are not natural, but divine.

Based on these results, my responses to the debate are the following. Clark Zumbach (1984, pp. 79–113) who admits that Kant is a vitalist with regard to something in organisms, which is analogous to human freedom, is right if these vitalist epigenetic elements in Kant's account are the generative or the formative power and physical teleological laws of nature, but there is no freedom and volition in nature, and even in men the formative power is a force besides freedom. Hans Peter Reill's (2005, p. 246) and Philippe Huneman's (2006, pp. 651–54; 2007, p. 12) assumption that Kant partakes in the program of 'enlightenment vitalism' is justified. However, Reill and Huneman underestimate or even ignore the preformationist elements in Kant's approach. Boris Demarest (2017) is right to point out epigenetic features in Kant's account, however, his attempts to assimilate preformationist to epigenetic features is historically troubling. Demarest (2017, p. 3) argues that Kant is leaning towards classical epigenetic models—to Harvey and Aristotle, the "major fixist epigenesists"—and claims that these traditional epigenetic models already contain preformationist elements, and then tries to show that the preformationist features in Kant's account do not contradict an overall traditional epigenetic tendency. But Aristotle developed his theory of reproduction at a time in which the preformation-epigenesis controversy did not exist yet, at least not in a literal sense, and never called or even considered himself a defender of epigenesis. Aristotle is not, what Demarest calls a 'fixist epigenesist', as Goy (2018) has

shown. Harvey, an ovist who believed in God as the supreme creator (Harvey, 1651 in 1965, Lat. pp. 183–84, Engl. pp. 367–68), did not describe his entire account as ‘epigenetic’ or ‘epigenesis’ though he coined the terms ‘epigenesis’ or ‘epigenetic method’ in relation to particular characteristics of embryonic development, namely the successive development of the parts of the embryo (Harvey, 1651 in 1965, Lat. p. 154, Engl. p. 334; see also Lat. pp. 155–56, Engl. p. 336; Lat. p. 189, Engl. p. 372). Instead of deriving the terms ‘preformation’ and ‘epigenesis’ from one or two particular thinkers who use these terms in certain ways (or even, did not use them) in their accounts, as Demarest does, I suggest to rather see preformation and epigenesis as abstract explanatory models (similar to the rationalism-empiricism constellation) that represent opposing features of reproduction theories of a certain epoch, and then to say how the characteristics of theories of particular historical thinkers relate to the characteristics of these models.

Marjorie Grene, David Depew (2004, p. 95), and Siegfried Roth (2008, p. 284) who try to show that Kant combines preformation and epigenesis, in particular in §81 of the *KU*, and Joan Steigerwald (2006, p. 716) who argues that Kant favors an epigenetic explanation of the generation of the individual animal but prefers a preformationist explanation of the generation of the animal species, also with a focus on §81 of the *KU*, face the problem that Kant’s classification of embryological accounts in §81 of the *KU* concerns positions of earlier times, but not his own account, at least not explicitly. Kant does not identify his own view with one of the accounts that he discusses in §81, even though he praises Blumenbach’s view. Nevertheless I agree with Grene/Depew, Roth, and Steigerwald that Kant’s own systematic account in the *KU* is very close to the position that Kant names ‘generic preformation’ in §81 of the *KU*. Another disadvantage of Grene/Depew’s, Roth’s and Steigerwald’s interpretation is that their interpretations are only concerned with a very small period of Kant’s thought, and in particular the rise and fall of preformationist elements in Kant’s account cannot be fully understood without an analysis of Kant’s earlier writings.

Kant’s changing views throughout the years are well captured in Phillip Sloan’s (2002) carefully researched paper, a paper, which at the same time follows Kant’s changing views through the years, but also manages to focus on the notion of germs and predispositions that, as Sloan thinks, change significantly when placed in either preformationist or epigenetic accounts, and, can therefore serve as indicators of Kant’s changing views. However this focus is also to some extent limiting, since it does, for instance, not so well capture insights into Kant’s accounts of unisexual preformationist or bisexual epigenetic hereditary patterns.

John Zammito (2003, 2006, 2007, and 2016) points out that Kant holds ambivalent views with regard to preformationist and epigenetic accounts of reproduction and heredity in different periods of his thought and that Kant was never entirely comfortable with epigenesis. Zammito bases his arguments often on detailed and learned reconstructions of Kant's relations to thinkers who held preformationist or epigenetic views, and investigates their mutual influences. But Zammito rarely attempts to develop a systematic set of criteria of preformationist and epigenetic models, and if so, these attempts are not entirely original (see Zammito, 2003, p. 87; 2007, pp. 54–55).

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