Ina Goy

Epigenetic Theories: Caspar Friedrich Wolff and Immanuel Kant

Around the middle of the eighteenth century, a new interpretation of the origin of organic life arose and began to replace preformation theories: the doctrine of epigenesis. Defenders of preformation theories claimed that the origin of an organism is explained by a divine preformed germ, which—like a russian doll—contains in miniature all features of the prospective living being. Different preformation theorists held different views on the nature of the divine preformed germ: ovists believed the female egg to be the germ; animalculists, in contrast, the male sperm. Advocates of ovistic theories in the sixteenth and seventeenth centuries were William Harvey (1578–1657)—who at the same time was an eclectic Aristotelian and early defender of epigenesis—Marcellus Malpighi (1628–1694), and Jan Swammerdam (1637–1680). In the eighteenth century Albrecht von Haller (1708–1777), Charles Bonnet (1720–1793), and Abbé Lazzaro Spallanzani (1729–1799) advocated ovistic preformation. The most important animalculist theories were developed from the second half of the seventeenth until the beginning of the eighteenth centuries. Prominent animalculists include Antoni van Leeuwenhoek (1632–1723), Nicolaas Hartsoeker (1656–1725), and Gottfried Wilhelm Leibniz (1646–1716).

The theory of epigenesis belongs to the tradition of Aristotelian biology. William Harvey transferred it into early modern science. According to epigenetic theories, organic life begins with a self-organizing natural power that inheres in unstructured matter. Due to different views on the nature of organic matter and on the formative powers, a variety of forms of epigenetic accounts appeared. The earliest representatives of epigenesis in the seventeenth and eighteenth centuries, like Pierre-Louis Moreau de Maupertuis (1698–1759), Georges-Louis Leclerc de Buffon (1707–1788), and John Turberville Needham (1713–1781), understood epigenetic powers mechanically. Later defenders of this doctrine established increasingly vitalistic accounts of the formative power. Caspar Friedrich Wolff (1734–1794) marked the transition from mechanistic to vitalistic accounts of epigenetic powers. A version of the latter was advocated, for instance, by Johann Friedrich Blumenbach (1752–1840). Whereas most of the mechanical interpretations of epigenesis explained the self-organizing processes of organisms in Newtonian terms of attraction and repulsion, vitalistic accounts ascribed entirely new capabilities to the epigenetic powers, such as sensitivity, irritability, intelligibility, and spontaneity.

In this paper, I investigate the relation of Immanuel Kant's (1724–1804) theory of biology to epigenetic accounts of organic generation and development. In the lit-

erature, a dispute about similarities between Blumenbach's epigenetic account and Kant dominated the debate for many years (see Lenoir 1980, 1981, and 1982, 17–34, Richards 2000; 2002, 207–37; Look 2006, and van den Berg 2009). Some more recent interpreters claim that Wolff's, more than Blumenbach's account plays the pivotal role in the development of a vitalistic conception of epigenesis in Kant (see Dupont 2007 and Huneman 2007).

Although I myself hold the view that Kant's position contains preformistic and epigenetic characteristics, in the current paper I focus solely on an investigation of epigenetic elements in Kant's account and compare them to the corresponding epigenetic elements in Wolff's theory. Section I of the paper is devoted to an analysis of Wolff's most important epigenetic theorems: the notion of the essential power (*vis essentialis*) and the conception of the part-whole composition of organized matter. Although Wolff describes the essential power vitalisticly, as a principle of life, he understands it as the cause of mechanical motions explaining the generation, nourishment, and the growth of an organism. Wolff's model of the part-whole composition of organic matter is subtle, but committed to fundamental mechanistic assumptions, such as that the organism as a whole is composed of inorganic parts. In section II, I analyze the corresponding elements in Kant's theory: the notion of the formative power and the conception of the whole-part composition of organized materials. Kant describes the formative power as a principle that causes the purposive form of an organized being such that matter and mechanism are the means to the purpose of the being as their end. The purpose of the whole is a functional unit which is in principle superior to the form and matter of the subordinate parts. The parts are combined into such a whole in being mutually cause and effect of each other and in being related to the superior whole. In section III, I respond to the debate in the literature. Against Dupont (2007) and Huneman (2007) I argue that, according to Wolff, the *vis essentialis* accounts for mechanic effects in matter, whereas, according to Kant, the formative power explains the intentional order (form, end, purpose) of an individual organized being, its parts, and its species. Since this view is closer to Blumenbach than to Wolff, the ongoing comparison between Kant and Blumenbach in the literature is justified. However, the emphasis on the specific part-whole composition that Kant considers to be the determining feature of an organized being can be found only in Wolff and not in Blumenbach—though Wolff and Kant describe it in opposing ways. This increases the systematic importance of Wolff for Kant. Thus, a fresh look on the historical debate is required.[1]

1 A few historical remarks in advance: within the whole Kantian œuvre not a single passage refers to Caspar Friedrich Wolff (including the reference to a "vis essentialis" in *Lect. Met. Herder* XXVIII/1 49.18). However, Kant was indirectly aware of Wolff at least from the description of his account in Johann Friedrich Blumenbach's dissertation *Über den Bildungstrieb und das Zeu-*

1 Epigenetic Elements in Caspar Friedrich Wolff's Account of the Organism[2]

1.1 Wolff's Conception of the Essential Power (*vis essentialis*)

Organic bodies, according to Wolff, are "formed during the process of generation". Therefore a theory of epigenesis must investigate those "powers" that are the cause of this formation (Wolff 1764, 61–3). Wolff claims that living bodies have a certain power that "distributes the nutritive fluids through the parts of the

gungsgeschäfte, which Kant verifiably read (see *Teleological Principles* VIII 180.31–5; *CPJ* V 424.19–34; *Correspondence* XI 184.29–185.25, 211.1–23; see also Löw 1980, 175–80). But Blumenbach's writing (1781, 14, 17–8) contains only a few sentences on Wolff, in two short passages. And it is not clear what to make of those remarks: in the first passage, Blumenbach attributes a mechanistic account of the *vis essentialis* to Wolff, while in the second passage he attributes one that is vitalistic. In the first passage, he warns the reader not to "mingle th[e] [formative] drive with the vis plastica, with the vis essentialis, with chemical fermentation and blind expansion, or with other merely mechanical powers". He explicitly states that the *nisus formativus* cannot be reduced to mechanical powers, and names the *vis essentialis* among these mechanical powers. In the second passage, Blumenbach argues that the "distinction between the nisus formativus and the so-called vis essentialis is easier to overlook". He recommends to compare "the definition of the vis essentialis that its famous inventor [*H. Casp. Friedr. Wolf *Theorie von der Generation*, p. 160] introduced" with his own definition of the formative drive, and quotes Wolff's definition as follows: the *vis essentialis* "is that power through which, in vegetable bodies, all features are initiated that cause us to ascribe life to them. It is on these grounds that I have named this power a vis essentialis of these bodies; namely, because a plant would cease to be a plant if this force were removed from it. It is found in animals just as much as in plants, and everything that animals and plants have in common depends on this power alone". With regard to the second passage, it is not easy to grasp why Blumenbach did *not* feel close to Wolff's definition of the *vis essentialis* (since it is similar to his own description of the formative drive).— Beside Blumenbach's dissertation, between 1777 and 1779, Kant also intensively studied Johann Nicolas Tetens' *Philosophische Versuche über die menschliche Natur* (1776/77), which outline the debate on embryology between the advocates of preformation and epigenesis, including Wolff's account of the *vis essentialis*. However, both sources convey only Wolff's conception of organic powers but not of his conception of part and whole in organized matter (which Wolff himself considered to be of great importance). Two letters by Johann Georg Hamann (1777 and 1779 in 1957, 337 and 1959, 81) to Johann Gottfried Herder from October 15, 1777 and May 17, 1779 testify to Kant's Tetens studies.

2 In this paper, I argue on the basis of Wolff's Latin dissertation, *Theoria generationis* (1759), and the extended German version of the dissertation *Theorie von der Generation*, published in 1764. In the years after 1766, Wolff also published the writing *De formatione intestinorum* in two volumes of the Proceedings of the Academy of the Sciences at Petersburg. His final work on embryology was the essay *Von der eigenthümlichen und wesentlichen Kraft* (1789). All English translations of Wolff's Latin and German writings in this paper are mine.

body" and thereby triggers the "formation" of the whole (ibid., 37). The initiating power of all processes of generation in organic bodies is the so-called essential power (*vis essentialis*). This force is the "first principle of generation" in nature ("[p]rimum [...] generationis principium"; Wolff 1759 [1999], §233) and is considered to be "that specific power which in vegetable bodies initiates all features that cause us to ascribe life to organic beings" (Wolff 1764, 160). This determination is important because it explicitly entails a reference to the "life" of organisms. It is therefore one of the most vitalistic functional definitions of the essential power. Its presence in Wolff's account could strengthen the consensus among recent researchers that Wolff—with his conception of the specific power in organisms—intends to make a turn to a vitalistic position (see Huneman 2007 and Dupont 2007). Thus let us consider Wolff's description of the essential power in closer detail.

The essential power is essential because "a plant" would not continue to "be a plant" without this force (Wolff 1764, 160). It is a "*sufficient principle for the generation of both plants and animals*" (Wolff 1759 [1999], §242). It effects a "precisely determined distribution of the fluids" (Wolff 1764, 163), "*accumulating the fluids from the surrounding earth, coercing them to enter the roots, distributing them through the plant, partly saving them at different places, partly excreting them again*". Whereas the "ingestion", "distribution", and "evaporation" of "fluids" serve as an impetus to plant growth (Wolff 1759 [1999], §1), the "*diminution of the quantity*" of the nutritive fluids inhibits it (ibid., §95).

Variation in the nutritive fluids caused by the essential power leads to the formation of the substance of a plant. The essential power causes variation in the absorption (ibid., §§1, 3), and attraction (ibid., §§2, 4), distribution (ibid., §§1, 5, 7, 22–3.), penetration (ibid., §§7, 22, 60), and transition (ibid., §§5, 7, 22), repletion (ibid., §81), expansion, augmentation (ibid., §§4, 21–2, 25), deposition (ibid., §§22–3), and finally the excretion and exhalation of nutritive fluids (ibid., §§1–2, 26–7). Reflection on these different effects leads to the conclusion that the essential force, although described as a principle of vegetable life, is the embodiment of physical determinations; it is the cause of all the different mechanical motions of a plant.

Wolff also discusses a faculty of "solidification", which inhibits growth through a kind of coagulation and cohesion of the vegetable substance (ibid., §§242–3). Roe (1979) and Dupont (2007) take the faculty of solidification to be a second principle that is distinct from the essential power. So Roe (1979, 5–6) says that in his dissertation "Wolff proposed a model for development in plants and animals based on two factors: the ability of plant and animal fluids to solidify, and a force, which he named the *vis essentialis* (essential force)". Similarly Dupont (2007, 40) claims vegetable or animal "development" to be "based

on two factors: the essential force and the tendency of plant and animal fluids to solidify" (see also Duchesneau 2006, 173, 177).

However, it is not clear whether Wolff does indeed distinguish the faculty of solidification from the essential power: in some passages consolidification and deposition seem to belong to the effects of the essential power (Wolff 1759 [1999], §187; see also §§22–3, 26–8, 61). Furthermore, he says that "*the essential force together with the faculty of solidification*" is "one sufficient principle *both of the development of plants and animals*" (ibid., §242, my italics). However, in other passages Wolff argues for a functional distinction between both faculties and designates them as two principles whose interplay effects the "order of all parts of a plant and their specific composition" (ibid., §93). Regardless of which position one takes in this dispute, it is of *systematic* importance that the faculty of solidification, like the essential power, plays a role in a physical-mechanical process.

The formation of a plant begins from a specific vegetation point. It is located at the end of the caulis or the stem. From this point, the development of the leaves, blossoms, and fruits proceeds by emission and excretion. It is an initial area that continuously generates vegetable meristem. The kind of structure that is produced depends on the amount of nutritive fluid that reaches the vegetation point (ibid., §§43–4). Since Wolff assumes that generation is similar in plants and animals (see Wolff 1764, 164–5, 203), he argues that animals must have something like the vegetation point found in plants. In animals it is located in the embryonic disk and the surrounding area of the umbilicalis. It is at this point that arteries, veins, and the heart first arise from the unstructured matter of the yolk (Wolff 1759 [1999], §§173–81). Just as in plants, in animals, the "*essential power*" determines the transport of "*nourishing parts*" from the yolk to the evolving living being and from the egg to the embryo (ibid., §§168–9). Wolff claims that "*forwarding the materials from the fetus*" can be "*caused only by the same essential power*" that causes their "*separation*" (ibid., §187).

As we have seen, Wolff defines (ibid., §§187, 233) the essential power by reference to a multiplicity of functions and effects. Thus, it seems all the more astonishing that in several passages of the text he claims that he is unable (and unwilling) to describe the essential power more precisely (ibid., §4)—a statement which seems founded in scepticism concerning the sufficiency of the conceptual means chosen to describe the nature of this force. Whereas he outlines the basic function of the essential power as a vitalistic one (it is the principle of life in plants and animals), the conception of the force that generates this life remains

mechanical.[3] Therefore Wolff's account contains an internal discrepancy, which might have been the reason for Wolff's discontent.

1.2 Wolff's Conception of the Formation of Organic Matter

In the third part of his Latin dissertation and also in the German publication *Theorie von der Generation*, Wolff describes the formation of organic substance or matter using a specific part-whole relation. The most important feature of this relation is that the whole arises from the composition of the parts. It always occurs later than the parts. A researcher of nature "who is not able to talk about the structure of the parts and the composition of the body, and who cannot indicate the principles for the parts and their composition, and demonstrate how the parts and the composition are determined by these principles cannot explain generation either" (Wolff 1764, 13).

Wolff claims that the "formation" of an organic body occurs "little by little by the addition of matter or by the congregation of parts" (Wolff 1759 [1999], §235). This is so because "without the composition of the parts", the "transfer of nutritive substances" that is fundamental for the formation of an organism cannot proceed (ibid., §238). Wolff gives two reasons for his claim that the parts of an organism form a whole: first, "*the parts cannot exist alone without each other*"; second, all of the individual parts "*receive some of their nourishment*" from other parts of the body (ibid., §236). The degree of "*organization de-*

3 Breidbach (1999, xxii–iii, my translations) interprets Wolff as offering an entirely mechanical account, especially in the *Theoria generationis*. He claims that the "basic power postulated by Wolff" is "understood as a mechanism" that cannot be interpreted "in a vitalistic manner". The "shape of an organism" not only with regard to its "function" but also "with regard to its generation is mechanical". It is the "result of a mechanism" and the "product of a process that can be explained in an entirely naturalistic fashion". But Breidbach's interpretation misses Wolff's determination of the *vis essentialis* as a principle of life which is not mechanistic even though Wolff's terminology remains mechanical. Duchesneau also emphasizes the mechanical nature of Wolff's *vis essentialis*, but he more cautiously reconstructs the intricate structures of this mechanism which at some points seem to transcend its mechanical nature: the *vis essentialis* is a "material force", that "selects among the material elements for the sake of organic structuring, but this "for the sake of" is only a metaphorical formula, and the discriminating function of this force should be compared with "chemical affinities" and with mechanical phaenomena dependent on attraction/repulsion" (Duchesneau 2006, 172). The *vis essentialis* "seems to foreshadow the notion of a *vital principle*. But, looking more closely, it appears that those bodies on which vegetation acts are inorganic in their ingredients; and the end products of this process are devices of a complex mechanical type on which the function of the resulting organism depend" (ibid., 177).

pends on the amount of the composed parts" dedicated to its nourishment if the "*common source of nourishment for all parts remains the same*". The organization "*dwindles if the amount of sources of the nourishment increases*", and organization "*completely disappears if the body is dissolved into inorganic parts*" (ibid., §237).

In the *Theoria generationis* (1759) Wolff distinguishes three types of parts that are formed by the entering fluids: separate, distinct, and imaginary parts. Separate parts are formed "*by the excretion from that part of the stem which they rest on*"; distinct parts are formed "*by the sedimentation from that part of the stem by which they are enwrapped*"; and imaginary parts are formed "*neither by excretion nor by sedimentation but rather by the mere extension of the substance in which they occur*" (ibid., §239).

The organization of an organism follows a composition of the parts of the whole which is yet inorganic, and which becomes organized afterwards. The preliminary production of an inorganic body occurs according to the internal dependency of the parts. The ontologically superior part is generated first. Only once all of the parts necessary to the structure of the organism have been formed is the body considered organized and organic. Only once all of the inferior parts —which remain inorganic until their production is complete—are structured into their respective wholes do they become organized and organic. For Wolff, the organic whole is never prior to the parts, and the organization, as a structuring principle, never precedes the structure.

In the *Theorie von der Generation* (1764), Wolff modifies his description of the three kinds of part. The first class consists of simple and ultimate parts, out of which all other parts are composed. The second class consists in composition of simple and ultimate parts that cannot exist independently, and that themselves are parts of other parts. And the third class of parts consists of compositions of simple and ultimate parts from the first class and of compositions of parts from the first and the second class (Wolff 1764, 145–6). As in the *Theoria generationis* (1759), Wolff describes the relationship between the essential power and the formation of an organism from its parts as a process of *inorganic* production preceding a process of the *organization* of matter. He tells us that it could be considered as a "general law of the formation of natural bodies" that "every organic body or part of an organic body" is first produced "without any organic structure" and only afterwards "is rendered organic" (Wolff 1764, 163). However, it is also difficult in *Theorie von der Generation* to pinpoint the transition from inorganic to organic based on Wolff's account.

First, a preliminary production merely produces the outer outline of the parts of the whole organism. The fluids penetrate the young, still inorganic parts (which lack all vessels) and are distributed equally through the young

part. Locations growing up equally necessarily receive the same amount of nourishing fluids; however, locations that expand faster and stronger, necessarily receive a greater amount of nourishing fluids. This first step of inorganic production generates all inorganic parts (ibid.), followed by a second process of inner organization. This further step consists in a differentiation and consolidation of structures and results in the actual vitalization and organization of the parts: the nourishing fluids distributed by the essential power now produce the vessels and vesicles.

Just as the vitalizing effects of the essential power (the grounding of organic life) are to be produced by mechanical causes (by powers of penetration, attraction, expansion, excretion), Wolff claims that the generation of organic matter is to proceed in a mechanical fashion first by an aggregation and composition of parts that form an inorganic whole and afterwards by an internal structuring that adds as much complexity as necessary for the body to be an organic being.

2 Epigenetic Elements in Immanuel Kant's Account of Organized Beings: Formative Power and the Formation of Organized Materials

The precise formulation 'formative power [bildende(n) Kraft]' appears in fourteen passages within the whole Kantian œuvre.[4] Two of those passages—*CPJ* V 374.21–6 in §65 and *CPJ* V 423.12–424.6 in §81—belong to Kant's published writings; though only the passage *CPJ* V 374.21–6 in §65 refers to Kant's own account. All other appearances occur in lectures, notes, reflections, and fragments—texts which Kant himself did not authorize for publication. The term 'formative power' is a rare term. Nevertheless, placed at the center of §65, the formative power might be an indispensable part of Kant's account of biological causation.

4 There are, of course, more passages in which Kant discusses epigenetic conceptions of powers under varying names, for instance a "capacity for [...] formation [Bildungsvermögen]" (*CPJ* V 371.25) in §64 of the *CPJ*, and a "generative power [Zeugungskraft, zeugende Kraft]" in his two early writings on races (*Races* II 435.1–436.8, *Human Race* VIII 98.11–99.12). In §81 of the *CPJ*, he mentions Blumenbach's "*formative drive* [Bildungstrieb]" (*CPJ* V 424.34) in a review of epigenetic positions. Furthermore in §58 he talks about a chemical version of "formation [Bildung]" (*CPJ* V 348.11, 21, 25; 349.1; 350.1). The limitation but also the value of the following investigation is its concentration on those selected passages where Kant precisely uses the term 'formative power'.

Reading all fourteen passages results in a surprisingly clear picture of two different treatments of the term 'formative power' in Kant's writings. The earlier meaning appears in eight passages and belongs to *epistemology*. All passages stem from the 1770s. In this early (pre-critical) view, Kant treats formative power as a source of the spontaneous production of mental representations in the human (seven passages) and in the animal's mind (one passage). The term 'formative power' designates a productive force of the consciousness to spontaneously generate representations on both the sensual and the conceptual level. In its most elaborate version, Kant distinguishes six kinds of spontaneously generated *sensual* representations: "re-formations [Abbildungen]", "post-formations [Nachbildungen]", and "pre-formations [Vorbildungen]", "in-formations [Einbildungen]", "anti-formations [Gegenbildungen]", and "ex-formations [Ausbildungen]" (*Lect. Met.* L_1 XXVIII/1 235.24 – 237.28). In addition, he identifies two kinds of spontaneously generated *conceptual* representations: concepts (categories) and laws of the understanding.

The later meaning of the term 'formative power' appears in six passages, one of them stems from the early 1780s, five from the 1790s onwards until Kant's latest notes. All six passages belong to the field of *biology*; however, their particular contents and backgrounds are so diverse that they cannot be used to interpret each other. Thus, for the purposes of the current investigation, I only consider the allegedly well-known passage in §65 of the *CPJ*, since this is the most pertinent source for our understanding of Kant's notion of a formative power.[5] In this passage, Kant treats the formative power as a natural force that is responsible not for creating or generating organized matter, but for establishing and sustaining the organized teleological *order* or *form* of organized beings.[6]

5 For more detailed discussions see my paper "Kant on Formative Power" (2012).

6 Here is a list of these passages:

Lect. Met. L_1		
(1) XXVIII/1 230 – 240	mid 1770s	epistemology
(2) XXVIII/1 276	mid 1770s	epistemology
Notes and Fragments on metaphysics		
(3) XVII 736, refl. 4811	phase τ 1775 – 6?, μ 1770 – 1?	epistemology
Notes and Fragments on anthropology		
(4) XV/1 95, refl. 251	phase ν^1 1771?, ρ^1 1773 – 5?, φ^1 1776 – 8, χ^1 1778 – 9	epistemology
(5) XV/1 127, refl. 321	phase λ 1769 – 70?, ξ 1772?	epistemology
(6) XV/1 383, refl. 872	phase υ 1776 – 8	epistemology
(7) XV/2 699, refl. 1484	phase σ 1775 – 7	epistemology
Lect. Moral Phil. Mrong.		
(8) XXVII/2.2 1498	mid 1770s	epistemology
Notes and Fragments on metaphysics		

The crucial passage in §65 consists of only one intricate sentence:

> **[a]** An organized being is thus not a mere machine, for that has only a *motive* power, **[b]** while the organized being possesses in itself a *formative* power, **[c]** and indeed one that it communicates to the matter, which does not have it (**[d]** it organizes the latter): **[e]** thus it has a self-propagating formative power, which cannot be explained through the capacity for movement alone (that is, mechanism). [Ein organisirtes Wesen ist also nicht bloß Maschine: denn die hat lediglich *bewegende* Kraft; sondern es besitzt in sich *bildende* Kraft und zwar eine solche, die es den Materien mittheilt, welche sie nicht haben (sie organisirt): also eine sich fortpflanzende bildende Kraft, welche durch das Bewegungsvermögen allein (den Mechanism) nicht erklärt werden kann] (*CPJ* V 374.21–6).

The sentence contains the following five claims: a) the formative power distinguishes organized beings from machines with which they share motive powers; b) the formative power belongs to the organized being in itself; c) the formative power is communicated by the (organized) being to materials, materials do not have formative power; d) when communicated to materials the formative power organizes a being; e) the formative power is a self-propagating formative power.

What do these claims mean? a) An organized being is partly identical with a machine, namely insofar as it possesses motive power. But it differs from a machine insofar as it possesses a formative power that cannot be identified with the capacity of motion alone. The formative power can involve but cannot be reduced to the mechanisms of motion. b) The formative power is an *intrinsic* power in the organized being. It does not externally cause the organized being (as for instance the formative power of an artisan that produces the artificial object). The formative power is a natural capacity of and is effective in the organized being.

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(1) XVIII 574, refl. 6302	phase ψ^2 1783–4	biology
CPJ		
(2) §65, V 374	1790	biology
(3) §81, V 423–4	1790	biology
Lect. Met. K_2		
(4) XXVIII/2.1 761	early 1790s	biology
OP		
(5) XXI 475	1786–98	biology
(6) XXI 630	1798–9	biology

The dating of the passages follows the editors of the "Academy Edition" and the editors of "The Cambridge Edition of the Works of Immanuel Kant". The reflections on metaphysics and anthropology are dated by Adickes, see the editorial remarks in *Notes and Fragments* XIV xxv–liv. For dates of the lectures on metaphysics, see the editorial remarks by Ameriks and Naragon in the "Cambridge Edition" of the *Lectures on Metaphysics* (1997, xxii).

Section c) is a difficult, ambiguous part of the sentence, which also has bearing on the different meanings of section d). The "Cambridge Edition" translations of c) and d) fail to convey an important aspect of the German text. The original Kantian text says in c) and d) that an organized being has a formative power "und zwar eine solche, die es den Materien mittheilt, welche sie nicht haben". Using 'den Materien' in c), and correspondingly 'welche', and 'haben' in d), Kant indicates plural, i.e., he does not suggest that the formative power acts upon matter, but upon several materials. The "Cambridge Edition" translators write: "the matter, which does not have it". Using 'matter' in c), and correspondingly 'does' in d), they—at first glance—indicate a singular, although 'matter', as the word 'Materie' in German, does not exclusively designate a singular.

One possible reading of Kant's claim that an organized being communicates formative power to materials, which do not have formative power is: cα) The organized being communicates the formative power to materials (reading "den Materien" as 'allen Materien'), none of which have formative power. This non-restrictive reading suggests that in an organized being the formative power acts upon all kinds of matter, and that no kind of matter itself has formative power. The consequence of this reading is that the formative power is itself not material, for otherwise it would be part of matter. The formative power then is an immaterial power. In addition, an organized being that contains formative power "in itself" cannot be an entirely material being, for at least its formative power is an immaterial element "in" the organized being. In line with this reading, White (1997, 134) stresses that the formative power "is in some essential sense distinguishable from the matter" it determines.

cβ) Emphasizing "*den* Materien" in the sense of 'only those', an alternative reading is that the organized being communicates the formative power only to those kinds of materials that do not have it. In this restrictive reading it is possible to interpret the formative power itself as part of matter. It could be a material power that occupies some parts of matter (organized materials), whereas it is communicated to all other raw matter (unorganized materials) that do not have formative power and that will be formed by the formative power. The distinction between cα) and cβ) is that the formative power in cα) is immaterial whereas in cβ) it is material. The ambiguity of the passage allows both readings. Frigo (2009, 13, 15) describing "matter as formative power [Materie als Bildungskraft]" and "matter as formative drive [Materie als Bildungstrieb]" seems to hold cβ).

Look's (2006, 372) proposal, in contrast, provides indirect support for cα). He argues that precisely since Blumenbach identifies the formative power as a part of matter, Kant thought that he had to depart from Blumenbach. Kant criticized Blumenbach for determining the formative drive as "a feature of *all* matter". Furthermore, a defender of cα) could stress that Kant's text suggests at several pla-

ces that the formative power as the cause of the purposive form of nature is analogous to the human will and the "practical faculty of reason" (*CPJ* V 375.24–5) as the cause of the purposive form of our human actions. The human will and its faculty of reason is an immaterial power for Kant. However, the analogy between the formative power and the human will does not imply that Kant ascribes reason to nature, since, in the Kantian sense, nature does not have practical reason. Thus, some of Müller-Sievers' (2000, 61) remarks go too far in saying that the "formative drive" is "the expression of a will for self-organization in nature". But even if the formative power is not identical with practical reason, it can be an immaterial power. I am inclined to say that cα) has more support in the text.

d) The formative power acts upon matter and thereby organizes the materials. In d) Kant describes the effect of the formative power: it organizes matter. The meaning of 'organization' is explained in a brief footnote where Kant says that an organized being is a "whole" in which each part is "not merely a means, but at the same time also an end, and, insofar as it contributes to the possibility of the whole, its position and function should also be determined by the idea of the whole" (*CPJ* V 375.34–7). In an organized being, whole and part stand in specific relations to each other. For a body,

> therefore, which is to be judged as a natural end in itself and in accordance with its internal possibility, it is required that its parts reciprocally produce each other, *as far as both their form and their combination is concerned*, and thus produce a whole out of their own causality, the concept of which, conversely, is in turn the cause [...] of it in accordance with a principle; consequently the *connection* of *efficient causes* could at the same time be judged as an *effect through final causes* (*CPJ* V 373.26–34, first two italics are mine).

It is at this point that Kant's view on the formative power meets his view on the relation between part and whole in an organism. Like the formative power that involves but cannot be reduced to moving power, the composition of the organized being that results from the formative power involves but cannot be reduced to a mechanical composition of the being. Organization consists in at least four different types of causal processes between whole and part: 1) Parts of type A mechanically cause parts of type B. Or more precisely: the materials of parts of type A in an organized being have an effect on the materials of other parts based on mechanical laws and motive powers. 2) Material parts cause the composition of the whole as an aggregate of all parts based on mechanical laws and moving powers. 3) The purpose of a part of type A teleologically causes parts of type B. The purposive form or function of one part has a teleological effect on other parts based on the formative power: parts B serve to support the purpose of a part A. Parts exist "*for the sake of the other*[]" parts (*CPJ* V 373.35). And 4),

the purpose of the organized whole teleologically causes the parts. The purpose of the organized whole has a teleological effect on all parts, since all parts are thought to stand in supportive relations to the purpose of the whole. This support is caused by the formative power, which directs the mechanical motions of a being towards the purpose of the being. The former two part-whole relations are mechanical, the latter two are teleological.

The most astonishing claim is e): the formative power is "a *self*-propagating formative power [eine *sich* fortpflanzende bildende Kraft]" (my italics). Kant does not say 'a propagating power [eine fortpflanzende Kraft]'; i. e., he does not claim that the formative power causes the process of the impregnation and generation of organized beings, at least not on a material level. Instead, he says "a *self*-propagating formative power [eine *sich* fortpflanzende bildende Kraft]" (my italics). The word "self" might be read in two ways:

eα) In German 'to propagate [sich fortpflanzen]' is used as a metaphor to say that something spreads out or extends itself. If we say that a wave, caused by a tsunami, spreads out in the ocean and along the coast, we could say: 'Die Welle pflanzt sich im Meer und an der Küste fort'. The domino effect of an economic crisis in one country, which causes a crisis in the neighboring countries, would be another example for 'sich fortpflanzen'. For we could say: 'Die Krise pflanzt sich in den benachbarten Ländern fort'. This meaning does not necessarily describe a new generation of something, but only an extension of something (a form or order or even disorder) in something else, without the new generation of this something else. The 'formative power' in this sense would be an immaterial power that is transferred to and spread out in something else: namely matter, without generating matter. It only generates a new form of matter—its organization. The cited sentence would say that in the organized being an immaterial formative power is transferred to and spread out in matter, which does not have a formative power originally. It thereby generates a new organization in this matter. It self-organizes matter.

eβ) In German 'to propagate [sich fortpflanzen]' is used literally with regard to plants, animals, and humans. However, Kant claims the self-propagating capacity not with regard to plants, animals, and humans but with regard to a power. In this sense, the "self-propagating formative power [eine sich fortpflanzende bildende Kraft]" can have a self-reflexive meaning, namely 'a formative power that propagates itself [eine sich selbst fortpflanzende bildende Kraft]'. The formative power would then be a power that generates and/or preserves *itself*. How can we make sense of such a claim without making it sound mystical? A possible self-reflexive reading would be to say that a formative power is a self-explanatory and self-evident basic power. In his writing *Teleological Principles*,

written two years before the *CPJ* in 1788, Kant describes such a basic power as follows:

> [A] basic power that is effectuated through an organization has to be thought as a cause effective according to *ends*, and this in such a manner that these ends have to be presupposed for the possibility of the effect. But we know such powers, *in terms of their ground of determination* only in *ourselves*, namely in our understanding and will [...]. In us understanding and will are basic powers, of which the latter, insofar as it is determined by the former, is a faculty to produce something *according to an idea* which is called an end (*Teleological Principles* VIII 180.18 – 181.14).

The formative power then would be a final and fundamental purpose (or end) setting force of nature, which cannot lead back to another principle. Equivalent to the human understanding and will as inner capacities (causes), it brings about an end as its effect and generates order among the means to achieve this end. Given d) and e), it is likely that the formative power itself is not a power of generation. Although Kant calls this power 'fortpflanzend' it does not necessarily function as seminal fluid. The immaterial, natural formative power is a basic, ordering and *form*[7] giving principle which is directed towards an end or purpose, and spreads out its organizing and ordering capacity in matter. But it does not necessarily bring matter into existence.

3 A Response to the Kant-Wolff-Debate in the Literature

Now I am in the position to respond to contemporary scholars who argue that Wolff's account seems to be an important predecessor of Kant's theory of the organism. Dupont (2007, 37– 8), for instance, writes: "even though it is to Blumenbach and not to Wolff that Kant refers [...] in the third *Critique*, Wolff's embryological works do represent a condition of realizability of the Kantian project for the biology". Similarly, Huneman (2007, 75) argues: "the Wolffian embryology, exposed in the *Theorie von der Generation* (1764) [...] enabled Kant to resolve the philosophical problem of natural generation, and subsequently to determine what is proper to the explanation of living processes".

7 The majority of passages throughout the second half of the third *Critique* support a reading according to which the formative power is responsible for the form of the being; see for instance *CPJ* V 369.33 – 370.15, 373.4 – 34, 377.1 – 23, 378.12 – 379.9, 407.13 – 409.22, 410.16 – 411.29.

Huneman's claim is based on a comparison of the conception of epigenetic powers, but not on the part-whole composition of organisms in Wolff and Kant. He interprets Wolff's conception of an essential power as a precursor of Kant's notion of a formative power, serving the epistemological function of guaranteeing the systematicity of an immanent, natural order of the organic. For Wolff, he claims, two events that causally and temporally follow each other do not belong to the same series because they presuppose the same, initially tiny, invisible, and later more and more visible *form* as preformism argued. Rather, these two events belong to the same series because they presuppose the continuity of the same *force* (ibid., 83–4). The essential power serves as a reason for the causal connection between unstructured matter and structured parts whose form and shape do not obviously follow from the unstructured matter.

According to Huneman (ibid., 78), Wolff's theory of epigenesis anticipates the solution of the "generation dilemma", i.e., "to provide any intelligible account of generative mechanisms". For generation is a process that occurs in discontinuous phases. It is precisely this discontinuity of generation that requires a "*principle of continuity*" (ibid.), as a guarantee that it is the same generation that constantly occurs. The essential power brings continuity and temporal order into the discontinuity of generation: it "*sets* the discontinuous phases seen by the observer *into series* and *order*" (ibid., 84). Therefore, it cannot be explained by mathematical or mechanical powers; which means it cannot be a Newtonian force that causes regular effects in correspondence to mathematical laws.

First, there is a general argument against Huneman's emphasis on Wolff's importance for Kant, since the transition from *form* to the unity of *force* as a justifying reason for the generation of an organism is not merely part of Wolff's account, but a general feature of all epigenetic accounts. Therefore the presence of this transition in Wolff tells us nothing specific about Wolff's role in the genesis of Kant's ideas. Second, Huneman's thought is plausible only if one follows his exegesis claiming Wolff transcended the mechanistic way of thinking (ibid., 82–3). But, as demonstrated above, in his *Theoria generationis* and the *Theorie von der Generation*, Wolff characterizes the essential power as an aggregation of mechanical determinations. Moreover, he argues explicitly that "all appearances occurring in the world" can be "produced and originated by *physical* causes" alone (Wolff 1764, 51, 57, my italics). Wolff's model of generation and growth in which "nutrition provides the key for analyzing generative processes" (Duchesneau 2006, 174) is to the greatest possible extent based on mathematical and mechanical considerations, where the amount of nourishing fluids is proportionate to the degree of growth and development—even though in some passages Wolff transcends mechanical descriptions of the essential force. Wolff's position is not able to resolve the "generation dilemma" of a mechanical account. Kant's

notion of a formative power, however, is part of a finalistic account of causality, which includes but cannot be reduced to mechanical powers of motion.

Whereas the systematic proximity between Wolff and Kant regarding their conceptions of epigenetic powers is questionable, it is important that Wolff, before Kant, uses a part-whole model to explain the generation of an organism, and in this way, anticipates one of the most central ideas in Kant's theory of biology. However, Wolff's and Kant's positions are also opposed to each other on this front. Kant does not divide the process of production into an inorganic and an organic phase. For Kant production is *always* an organizing formation of the parts, for it occurs with regard to the whole. Furthermore, according to Kant, the organized whole or part is not only caused by a mechanical aggregation of materials, but by the purpose of the organized whole and also by the more specific purposes of parts that are causally prior to the materials and mechanisms of parts.

In contrast, on Wolff's account the materials and mechanisms of the parts precede the whole. The organic whole is the final result of an inorganic organization followed by an organic formation of all parts. Even in passages that seem to suggest that a superior whole is structured prior to the parts—for instance if first of all the outer shape of a blossom is produced without any internal organization—it is not true that the organic whole, the blossom, precedes its parts. Based on the systematic distinction between an inorganic production and an organic formation, Wolff claims that the superior whole is formed inorganically and never precedes its parts as an organic but only as an inorganic whole.

On the other hand, the appearance of a part-whole model in Wolff's account before Kant's emphasis of the whole-part relation as an essential feature of organized beings increases the systematic importance of Wolff's view with regard to Kant and relativizes the dominance of the Blumenbach-Kant-debate as *the* central historical target in the literature, since Blumenbach misses one of the most central concerns in Kant's account of biology: the part-whole relation as a significant feature of organized beings.[8]

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