VIII

AFTER BICHAT

Less than thirty-one years old at the time of his death, Bichat had managed to acquire a unique position within the Paris school and in the French medical world in general. He was remembered by many students with great affection and his reputation as an anatomist and physiologist was enormous. His work left a mark on clinical teaching and practice that would persist for decades. The members of the Paris hospitals and clinical school quickly absorbed his ideas on the living body, making the *Anatomie descriptive* a textbook for their students. His influence on colleagues and successors lingered particularly in pathological anatomy, which he had begun to teach only shortly before his death, basing it upon his tissue theory. Taking their direction from Bichat, members of the Paris school would add much to the field for the next forty or so years. Among those who admitted their indebtedness to Bichat were René-Théophile-Hyacinthe Laënnec, an anatomist who had worshipped Bichat as a student; P. J. Roux, the disciple and friend who finished the *Anatomie descriptive* and who reputedly kept Bichat's alcohol-preserved head at his side for forty-three years; François-Joseph-Victor Broussais, the inventor of "physiological medicine" and leader of Paris medicine after 1816; Guillaume Dupuytren, the head of clinical studies at the Paris school and a great surgeon; Gaspard-Laurent Bayle, a member of the "pathological-anatomical" school, as well as many others.[1]

Furthermore, Bichat's arguments on behalf of the separation of physiology from the physico-chemical sciences seems to have entrenched itself. Claude Bernard (1813–78) reported, for example, that the Paris medical school was still imbued with the "doctrinal errors" of vitalism nearly forty years after Bichat's death. He remembered being reprimanded early in his career by a Professor Gerdy at the Société Philomathique for questioning the assumption that living nature is infinitely variable and hence fundamentally different from the world of physics.[2] Bernard eschewed many of the notions of the vitalists and especially that about the capriciousness of the organism. One can safely infer, nevertheless, that Bichat's arguments on that subject worried him for decades. Indeed, his most famous work, the *Introduction to the study of experimental medicine* published in 1865, was the result of many years of wrestling with Bichat's ghost concerning the nature of medical science and the methodology appropriate to it.

The challenge to Bichat's assumptions started before that, however, with Bernard's mentor François Magendie (1783–1855) who, in the 1820s, published annotated editions of the *Traité des membranes* and the *Recherches physiologiques sur la vie et la*

[1] The central role of Bichat's anatomical and physiological teaching in post-revolutionary France is assumed by two authors who deal specifically with medical and clinical teaching in the period. All the persons mentioned here are discussed in the context in Erwin H. Ackerknecht, *Medicine at the Paris Hospital, 1794–1848*, Baltimore, Md., Johns Hopkins University Press, 1967; and Michel Foucault, *The birth of the clinic*, trans. by A. M. Sheridan, London, Tavistock, 1973.

[2] Claude Bernard, *Lectures on the phenomena of life common to animals and plants*, trans. by Hebbel E. Hoff, Roger Guillemin, and Lucienne Guillemin, Springfield, Ill., Charles C Thomas, 1974, p. 41.

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mort which, he remarked, were already classics.[3] Magendie praised Bichat's observational spirit, his experimental genius, and his lucid manner of presenting the facts. Meanwhile, however, he regretted the uncritical acceptance of many of Bichat's hypotheses and wanted to warn students against them. In the fourth edition of *La vie et la mort*, for example, he thundered against the notion of the two lives, and objected to the image of the "animal as a plant clothed in external garb of the organs of relation" on the grounds that it tended to isolate parts and functions which work together to achieve particular results. For example, Bichat would have it that the muscular apparatus of the animal life passes a lump of food from the mouth to the oesophagus while that of the organic life moves it through the remainder of the gastrointestinal tract. As early as 1809, Magendie set out his lifelong theoretical position in *Quelques idées générales sur les phénomènes particuliers aux corps vivants*, in which he criticized vital principles, properties, powers, and forces.[4] He particularly objected to Bichat's vital forces, which were unequally distributed and even, in some cases, limited to particular parts of the body. His point was that if it is a vital property, it ought to be general, characterizing life everywhere. He argued that all living phenomena can be explained by two organic characteristics – *nutrition*, which is a process of decomposition and recomposition; and *action*, which is particular to each group of organs such as contraction is to muscles. In effect, Magendie was criticizing the very explanatory framework in which his predecessors, and especially Bichat, had long laboured.

As his objections to the two lives illustrate, Magendie achieved a new focus for physiology, addressing himself not to the properties and functions of organs or of tissues, but to integrated bodily *functions*. For Bichat, the unit of physiology was the anatomical element. But Magendie started not, for example, with the lung and its tissues but with respiration, which was achieved with many organs besides just the lungs. Accordingly, sensibility and contractility ceased to be causal entities as they were for Bichat and other vitalists and were reduced to mere effects.[5]

One need only go to Magendie's *Précis élémentaire de physiologie* of 1825, however, to get the sense that Bichat's ghost still hovered. Having years before dismissed sensible organic contractility and other vital forces as gratuitous, he asserted yet again that they are the "deplorable illusions of modern physiologists" who believe that "in forging a word like *vital principle* or *vital force*, they have done something analogous to discovering universal gravity".[6] He was writing in the present tense of the verbs. Georges Cuvier, the great naturalist, would voice similar objections to the ill-defined and gratuitous vital principles and forces.[7] One cannot help but think

[3] François Magendie, in Xavier Bichat's, *Recherches physiologiques sur la vie et la mort*, 4th ed., Paris, Gabon Libraire, 1822, esp. pp. v–vii, 4–5, 6–7, 15, 19.

[4] François Magendie, 'Some general ideas on the phenomena peculiar to living bodies', in William Randall Albury, 'Experiment and explanation in the physiology of Bichat and Magendie', *Stud. Hist. Biol.*, 1977, **1**: 107–115.

[5] Ibid.

[6] François Magendie, *Précis élémentaire de physiologie*, Paris, Méquignon-Marvis, 1825, 2nd ed., 2 vol., esp. 'Preface', pp. v–xii, and 'Notions préliminaires', pp. 1–32.

[7] See Georges Cuvier, 'Histoire de la classe des sciences mathématiques et physiques', *Mem. Inst. nat. Sci. Arts: Sci. Math. phys.*, 1806, **7**: 1–79. A translation of pp. 76–79 is found in Albury, op. cit., note 4 above, pp. 105–106. See also Georges Cuvier, 'De Barthez, de Médicus, de Desèze, de Cabanis, de Darwin et de leurs ouvrages', *Histoire des sciences naturelles*, 5 vols., Paris, Fortin, 1843, vol. 4, pp. 27–46.

that the words of such men concerning the nature of physiological explanation must have carried considerable authority. In the final analysis, however, this was really a quibble over classifications and over the ontological status of certain natural causes that had been identified to account for phenomena.

Bernard would take on the more fundamental questions having to do with Bichat's notion of two natural sciences. Bernard's recollection, in 1878, of Professor Gerdy's reproof some forty years before, has to do with just that point. The *Introduction to the study of experimental medicine* represented a high point in his career. Recognized as an important document in Bernard's own time, it remains a classic. It contains the arguments that clinch the case on behalf of one set of laws governing all of nature, such that physiology is grounded in physico-chemical principles. He denied absolutely any great metaphysical or epistemological gulf such as that which Bichat alleged separates the science of life from that of non-life.

Conceding that the behaviour of the living organism is, by all appearances, unpredictable, Bernard warned that all is not what it appears to be. The point is not, he argued, that there are two separate categories of sciences but rather two separate environments. Hence Bernard's famous notion of the internal environment (*milieu intérieur*) of the body, which coexists with the external environment outside the body. It is at once a simple and elegant answer to the conundrum with which the vitalists had challenged the mechanists and the reductionists since the seventeenth century. And it is still taught in physiology courses. Bernard wrote about the internal environment as follows:

> If we limit outselves to the survey of the total phenomena visible from without [a living body], we may falsely believe that a force in living bodies violates the physico-chemical laws of the general cosmic environment, just as an untaught man might believe that some special force in a machine, rising in the air or running along the ground, violated the laws of gravitation. Now a living organism is nothing but a wonderful machine endowed with the most marvellous properties and set going by means of the most complex and delicate mechanism .... In experimentation on inorganic bodies, we need to take account of only one environment, the external cosmic environment, while in the higher living animals, at least two environments must be considered, the external or extra-organic environment and the internal or intra-organic environment .... The great difficulties that we must meet in experimentally determining vital phenomena and in applying suitable means to altering them are caused by the complexity involved in the existence of an internal organic environment .... The circulating liquids, the bloodserum and the intra-organic fluids all constitute the internal environment.[8]

Bernard wanted to be rid of vitalism in physiology because he believed it to be a conceptual barrier to experimentation. From the middle of the eighteenth century, the Montpellier school had maintained that observation is the sole reliable source of data about living creatures, a view disseminated by the *Encyclopédie*. As we have seen, however, Bichat performed many experiments. Nevertheless, Bernard insisted that it was Magendie who established experimentation in medicine when he attacked Bichat's vitalism.[9] Now the organism can be subjected to experiment, according to Bernard, because the biological sciences, like the physical ones, are deterministic. This

[8] Claude Bernard, *The introduction to the study of experimental medicine*, trans. by Henry Copley Greene, New York, Schuman, 1949, pp. 63–64.

[9] Discussed by Albury, op. cit., note 4 above. This was also the claim in J. M. D. Olmsted and E. Harris Olmsted, *Claude Bernard and the experimental method in medicine*, Toronto, Abelard-Schuman, 1952, p. 23, where one reads that Magendie was "the pioneer who brought physiology in France back to the experimental method in which it had been established by Harvey in England".

assures that there is a regularity and hence a predictability in nature. Given the same conditions, the same phenomena will always be observed. Living phenomena appear more variable than physical ones only because there are more variables in the internal environment. Without determinism, biology is not a science:

> Absolute determinism exists indeed in every vital phenomenon; hence biological science exists also . . . . We must therefore have recourse to analytic study of the successive phenomena of life, and make use of the same experimental method which physicists and chemists employ in analysing the phenomena of inorganic bodies. The difficulties which result from the complexity of the phenomena of living bodies arise solely in applying experimentation; for fundamentally the object and principles of the method are always the same.[10]

Finally, the exorcism seems to have been accomplished.

Interestingly enough, neither Magendie nor Bernard nor many others denied the existence of a supra-physical force to account for the apparently purposeful activities of the living body. Two centuries earlier, observation of the development of an embryo had confirmed William Harvey's vitalistic assumptions at the very time when other men were taking his circulatory theory to be supportive of iatromechanism. While protesting that the embryonic changes are in accordance with the "physico-chemical conditions proper to vital phenomena", Bernard permitted himself to speculate about the existence of a "developing organic force", the "guiding idea of the vital evolution", and a "creative vital force".[11] Life, it would seem, is still greater than the sum of its parts, causing the most committed determinist to bow before its complexity and mystery. On the other hand, neither Magendie nor Bernard treated this force or idea as a hypothesis to be tested. Nor did they speculate about its essential nature.

It is perhaps worth remarking that between 1800 and 1865 the amount of light which physics and chemistry could shed on physiological questions had increased enormously, making it easier for Bernard to affirm his arguments. In 1800, Lavoisier's experiments demonstrating the quantitative analogy between respiration and combustion were the single notable application of chemistry and physics to physiology. That demonstration had not been enough, however, to deflect Bichat from his conviction that there is no correspondence between the organic and inorganic realms of nature. Whereas Lavoisier had argued that control of bodily temperature occurs in the lungs, Bichat came nearer the truth by locating it in the capillaries, alleging that the various organs and parts separate caloric from food and air by means of their insensible organic contractility. Bichat took the fact that most animals maintain a temperature different from their surroundings as an affirmation that living and inert nature are separate realms. It was left to Justus von Liebig, a vitalist, to account for animal heat in an entirely satisfactory manner and thus to solve one of the most fundamental and long-standing mysteries surrounding life. By means of painstaking analytical work recorded in his *Animal chemistry* of 1840, he showed that heat is produced by the oxidation or combustion of food.

By the mid-nineteenth century, vital forces were no longer part of the commonplace

[10] For Bernard's views on determinism in physiology, see op. cit., note 2 above, pp. 16–45. The relationship of the notions of Bernard, Bichat, and others to the problems associated with respiration and animal heat is discussed by June Goodfield, *The growth of scientific physiology*, London, Hutchinson, 1960, pp. 135–364. Paul Bert gives Bernard credit for introducing determinism into biology in the 'Introduction' to op. cit., note 8 above, pp. xiii–xix.

[11] Goodfield, op. cit., note 10 above, p. 161.

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language of physiology, having given way to physico-chemical images adapted to the organic world. It was not a question of mechanist arguments disproving vitalist ones. It was, rather, that such vitalist convictions as remained had less and less effect upon the experiments or observations of the physicians. In the eighteenth century, the language of animism and especially vitalism addressed the life of the organism itself. Claiming for themselves the mantle of Newtonianism and sound scientific method generally, the vitalists concerned themselves specifically with those features of organisms which distinguish them from non-living matter. They remarked that what had to be addressed was not so much that our glands filter humours like sieves, or that the heart is a pump, or that the vessels are tubes of moving liquid, but that all the parts are acting in response to needs and want, conscious and unconscious, which act to achieve some integrated goal. The living individual is greater than the sum of its parts. Because they addressed the sensation and the motion belonging to the living body, animists and vitalists helped create the science of physiology. In the eighteenth century, its images were necessarily vitalistic because their formulators wanted to have the measure of that which makes life unique. Their iatromechanist predecessors resorted to mechanical images because they yearned for the certitude that they perceived to belong to physics and mechanics.[12]

While it is true, as students and even scientists are apt to affirm, that the nineteenth century reverted to mechanistic explanations of living phenomena, it was not because they finally shook off the last vestiges of a simpler age. Rather, it was because, possessing its own language thanks to the labour of the vitalists, physiology was finally able to adapt a rapidly developing physics and chemistry to its purposes. It was grounded in experiment and in physico-chemical assumptions, as Magendie and Bernard were convinced it must be, but the techniques are special. It was biophysics and biochemistry. The lessons of the Montpellier vitalists, and especially of Bichat, had not been lost after all.

It is occasionally pointed out that the mechanist-vitalist debate surfaces still. While that is true, it has nothing to do with empirical work or with its interpretation. It is rather a transcendental question having to do with whether one believes that an individual, a species, or all of living nature is merely an evolutionary accident, the ultimate product of some chance cosmic collision, or whether some goal or purpose lies behind it all. The scientist in his laboratory does not frame his questions in response to vitalist or mechanist convictions, for they are matters of faith or inclination and not testable hypotheses. Therefore, all scientists have been mechanists in their laboratories for at least the last one and a half centuries.

The tissue theory, as introduced into anatomy in the late eighteenth century, also gave way to advances in physics and chemistry. The product of the method of "analysis" as expounded by Condillac, and flourishing briefly because of a growing interest in pathology, it was superseded by cellular theory. The tissue was displaced in its role as the ultimate unit of life by the cell. Partly, of course, it was because advances in microscopy in the 1830s made identification of cells possible. But it is also true that as sensibility and irritability were demoted from physiological causes into

[12] This is the point basic to François Duchesneau, *La physiologie des lumières: empiricisme, modèles et théories*, The Hague, Nijhoff, 1982.

mere effects, the units which bore them in the former instance were also diminished in status in the body. People still speak of tissues and Bichat's description of their qualities and distribution remains good and thorough anatomy. Nevertheless, tissues are themselves but compounds of living units.

As is usually the case with origins, it is difficult to say just when and where the cellular theory originated. The English botanist Robert Brown observed in 1832 that there are pockets or cells in plants and that every cell contains a nucleus. In 1838, a paper entitled 'Beiträge zur Phytogenesis', appeared in *Müllers Archiv*. It was by Matthias Schleiden, a botanist in Johannes Müller's famous Berlin laboratory, and it described the plant as a community of cells and each individual cell as the "foundation of the vegetable world". Schleiden described Brown's nucleus as a "cytoblast" or kind of regenerative centre of the cell.

In the same laboratory, the zoologist Theodore Schwann undertook to look for cells in all living tissues, thereby expanding Schleiden's work into a general theory about the basis and origin of living phenomena. The credit for clearly defining the cell's character as an independent living unit properly belongs to still another of Müller's students, Rudolf Virchow. His *Cellularpathologie* of 1858 discusses the cell as the basic unit of disease, much as Pinel and Bichat had discussed the membranes and tissues as the seat of illness. Virchow also established the crucial point that all cells spring from pre-existing cells and thus life perpetuates itself. The concept of the cell as a structural unit common to all forms of life was one of those grand unifying notions that was immediately successful because it took account of great complexity with an efficiency of basic explanation.

Until recently, Bichat has tended to be a somewhat confusing and even vague figure in medical history. On the one hand, there has been a conviction that his work is important, as much as anything because his successors, especially in France, had flattered it and responded to it with enthusiasm. In spite of his very short working life, his approach to anatomy and physiology mightily influenced a school of pathology and left its mark on the regenerated post-revolutionary medical institutions of France. His viewpoints and accomplishments, however, had to do with nineteenth-century developments only indirectly. As we have seen, for persons like Magendie and Bernard, his work was a place from which to commence the development of contrary viewpoints. His insights, therefore, enjoyed only a transitory applicability, giving way quickly to new observations and conceptions. What makes his work worth studying for our purposes is that it is so elegant and thorough an integration of the major themes that run through the eighteenth century. Bichat inherited his vitalistic convictions from a long line of investigators who took issue with the simplistic iatromechanism of the early eighteenth century. Flawed though they were shown to be subsequently, his arguments positing variable living phenomena against predictable physico-chemical ones summarized a position to which many assented. Their ontological status aside, the five vital properties very successfully described living behaviour, at least for a time. Armed with his sensationalist methodology, Bichat achieved a remarkably unified and coherent system. Subsequent advances came about partly because Bichat's critics of the nineteenth century were forced to address his persuasive challenges to mechanism and determinism.