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# 'Fibre Body': The Concept of Fibre in Eighteenth-century Medicine, c.1700–40

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**Abstract:** This paper attempts a comprehensive account of 'fibre medicine' elaborated by iatromechanists from c. 1700 to c. 1740. Fibre medicine, a medical theory informed by the notion of the fibre, has been neglected by medical historians despite the pivotal role played by the fibre in animal economy. Referring to a wide range of medical fields such as anatomy, physiology, pathology, therapeutics and life sciences, this paper elucidates the ways that the fibre serves as an indispensable concept for iatromechanists to establish their medical theories. This paper also highlights the metaphorical dimension of the fibre as an integral part of fibre medicine. In re-evaluating the concept of the fibre, this paper seeks to redress the neuro-centric view of eighteenth-century medicine, and attempts to locate the fibre body amidst the fundamental shift from humoralism to solidism.

**Keywords:** Fibre, Nerves, Tone and Elasticity, Stamina, Iatromechanism, Solidism

## Introduction

Medical historians have not paid due attention to the crucial place of fibre in eighteenth-century medical theory.[1] Discourse on the concept of fibre played a pivotal role in an emerging vision of the secular (modern) body in eighteenth-century medicine. The present article deals with this important aspect of British medical theory in the anatomy, physiology, pathology, therapeutics and biology of the first half of the eighteenth century.[2]

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[1] See, however, Alexander Berg, 'Die Lehre von der Faser als Form- und Funktionselement des Organismus', *Virchows Archiv für Physiologische Anatomie und Physiologie und für klinische Medizin*, 309 (1942), 333–460, for a long overview of fibre from antiquity to the modern era; and most recently Tobias Cheung, 'Omnis Fibra Ex Fibra: Fibre Oeconomies in Bonnet's and Diderot's Models of Organic Order', *Early Science and Medicine*, 15 (2010), 66–104, the first section of which presents an overview and a brief prehistory of fibre up to the mid-eighteenth century, but misses the important phase of iatromechanism.

[2] A preliminary remark should be made on the range covered by this essay: the materials I consulted are mainly in English and by British authors. An important exception is Boerhaave, whose writings deeply influenced British authors and were also widely plagiarised by them. Thus in the present paper the terms 'fibre medicine' and 'fibre theory' by and large designate British fibre medicine and fibre theory. Nevertheless, I presume that it is a

I shall show that the implications of fibre in eighteenth-century medicine are significantly broader than one might assume. In anatomy, the fibre as the minimal building unit became the key to the inner mysteries of the body. In physiology and pathology, fibre, with its innate property of elasticity, played an indispensable role in understanding how health was maintained or disturbed. In biology (ie. life sciences), fibre was deemed to be the most appropriate concept to explain animal growth within the preformationist framework, a dominant paradigm in Enlightenment embryology. Moreover, the concept of fibre was employed to determine individual constitutions and differences in gender and social rank. In short, fibre and 'fibre theory' (ie. the theoretical articulation of fibres) occupied a critical place in eighteenth-century medicine, particularly in theoretical medical discourse. Eighteenth-century medical discourse from c. 1700 to c. 1740 is pervaded with fibre-related terms and descriptions such as 'membranes', 'web', 'stamina', 'weaving', 'vibrating', 'folding', 'tone' and 'tension', rather than 'nerves' and the 'nervous system'. These and similar fibre-related words constitute the terminology of the 'Fibre Body'. The prevalence of this vocabulary bears witness to a concerted effort of medical theorists to transform the older medical theory of the 'humoral' and fluid body into a theory of solidism.

Nevertheless, this theory of solids has been misinterpreted as referring solely to the nervous system, with the result that 'nerves', rather than 'fibre' has been privileged as the key term for eighteenth-century medical discourse in general.[3] This neurocentric interpretation of eighteenth-century medicine, starting with Willis in the mid-seventeenth century and continuing through Cheyne in the early eighteenth to Cullen in the second half of that century, obscures the importance of fibres. It is only towards the end of the eighteenth century that the brain and nervous system took primacy and departed from the underpinnings of general fibre theory. Rather than provide a sweeping generalisation about eighteenth-century medicine, this article will attempt a comprehensive re-evaluation of fibre and the fibre theory in the first half of the eighteenth century.[4]

Unlike the neuro-anatomical revolution in the preceding century, the eighteenth-century 'fibre body' has been largely ignored. Current historiography on eighteenth-century medicine rarely touches upon the significant roles played by fibres. These physical

pan-European phenomenon – for besides Baglivi and Boerhaave, both mentioned in this paper, other important figures subscribed to and contributed to fibre theory, eg. Albrecht von Haller, Charles Bonnet (who developed the theory of fibre-psychology), Denis Diderot, Emanuel Swedenborg (who penned a book-length study of fibre) and Tiphaigne de la Roche (who exploited fibre theory in his utopian fiction).

[3] The most influential proponent of the neurocentric view of Enlightenment medicine is G.S. Rousseau; see his series of essays on the nerves: 'Discourse of the nerve', in Frederick Amrine (ed.), *Literature and Science as Modes of Expression* (Boston: Kluwer Academic Publisher, 1989), 29–60; *idem*, 'Towards a semiotics of the nerves: the social history of language in a new key', in Peter Burke and Roy Porter (eds), *Language, Self and Society: A Social History of Language* (London: Polity, 1991), 213–75; these and other essays are now conveniently collected in his *Nervous Acts: Essays on Literature, Culture and Sensibility* (London: Palgrave, 2004). See also a recent collection on eighteenth-century neuroscience, Harry Whitaker, C.U.M. Smith and Stanley Finger (eds), *Brain, Mind and Medicine: Essays in Eighteenth Century Neuroscience* (New York: Springer, 2007). On the centrality of the nervous system in eighteenth-century medicine, especially from the 1740s onward, see among others Christopher Lawrence, 'The nervous system and society in the Scottish enlightenment', in Barry Barnes and Steven Shapin (eds), *Natural Order: Historical Studies of Scientific Culture* (London: Sage Publications, 1979), 19–40.

[4] My project on fibre and the fibre body in eighteenth-century medicine, in a sense, counterbalances the disproportionate weight given to the nerves. Some of my essays on fibre have been published; see 'The Elasticity of the Animal Fibre: Movement and Life in Enlightenment Medicine', *History of Science*, 44, 4 (2006), 435–68; and 'Enlightening the Fibre-Woven Body: William Blake and Eighteenth-Century Fibre Medicine', *Literature and Medicine*, 25, 1 (2006), 72–92.

components of the body have been considered by medical historians only in terms of their connection with the Hallerian sensibility and irritability, which are respectively ascribed to nervous and muscular fibres.[5] The association of fibre with Haller's doctrine of cellular tissue, which was increasingly reinforced as the century developed, has obscured our historical account of fibre and fibre theory, which was clearly articulated well before Haller's systematic adaptation. The rediscovery and reinvestigation of fibre and the fibre theory of the first half of the eighteenth century will therefore contribute to a more authentic account of early eighteenth-century medicine. My research shows that the period of 'iatromechanism' (a medical doctrine based on mechanical laws derived from such fields as geometry, mathematics and hydraulics[6]) is not an infertile era in the history of medicine,[7] but witnessed a very energetic pursuit of the formation and elaboration of 'fibre medicine'. As such, 'fibre medicine' is probably a more appropriate designation for eighteenth-century medical science.

Historiographically speaking, the development of eighteenth-century medicine has been described as a gradual progress from the mechanical view of the body (supported by iatromechanists such as Herman Boerhaave, the most influential medical authority of the first half-century) to the vitalistic conceptualisation of the body (informed by accumulated knowledge about the nervous system since about the mid-eighteenth century).[8] Accordingly, the medical theory of the eighteenth century has been described as a progressive development from mechanism to vitalism. In the iatromechanistic view, the body, imagined as a hydraulic machine, is composed of pipes, with fluids perpetually circulating through these pipes. The vitalistic view, on the other hand, sees the body as primarily a nervous and sensible organism that is regulated by the brain and the nervous system. Fibre and fibre theory does not appear to fit anywhere within these views. This article and the following one 'The Presence of Fibre in Eighteenth-Century Medicine, c.1740–c.1800' (in preparation), which will be concerned with the vitalistic phase, propose that fibre, far from being one of the categories or subsets of the vascular or nervous system, underlies both mechanical and vitalistic understandings of the body and resultant theories. Focusing on the iatromechanical era, the heyday of fibre and fibre theory, this paper will comprehensively describe the fibre-related discourse of eighteenth-century medical theory.

## Fibre Anatomy and the Fibre-Woven Body

The fibre theory, narrowly understood as the theory that assumes that the whole body is composed only of fibres, was first formulated in the anatomical field in the late seventeenth century.[9] From the mid-seventeenth century, natural philosophers and plant and animal anatomists explored the micro-structure of body parts through the microscope. They eventually proposed that fibres were the minimum building unit of bodily components and

[5] See, for instance, Roy Porter, 'The eighteenth century', in Lawrence I. Conrad *et al.*, *The Western Medical Tradition: 800BC–AD 1800* (Cambridge: Cambridge University Press, 1995), ch. 7, 393–4.

[6] Lester S. King, *The Philosophy of Medicine: The Early Eighteenth Century* (Cambridge, MA: Harvard University Press, 1978), ch. 5.

[7] This inveterate view was first articulated in William Le Fanu, 'The Lost Half-Century in English Medicine, 1700–1750', *Bulletin of the History of Medicine*, 46, 4 (1972), 319–48.

[8] See Theodore M. Brown, 'From Mechanism to Vitalism in Eighteenth-Century English Physiology', *Journal of the History of Biology*, 7, 2 (1974), 179–216.

[9] I elaborate on this in my 'Visualizing the fibre-woven body: Nehemiah Grew's plant anatomy and the emergence of the fibre body', in Matthew Landers and Brian Muñoz (eds), *Anatomy and the Organization of Knowledge, 1500–1850* (London: Pickering and Chatto, 2012), ch. 8.

perceived the body as entirely interwoven of elementary fibres. This new understanding of the body was first articulated and visualised in *The Anatomy of Plants* (1682) by Nehemiah Grew, a prominent English plant anatomist. By the end of the seventeenth century, this idea was introduced to the field of human anatomy. On the continent, Friedrich Hoffman, a professor at the University of Halle, set forth a doctrine of solid pathology in his medical textbook *Fundamenta Medicinae* (1695). His doctrine posited fibres as the fundamental building unit of the body, suggesting that 'fibres are the basic threads and filaments of all the parts'; he saw the body as being skilfully woven of these threads.[10]

One sign of the transition of fibres into human anatomy in England can be seen in a medical text by Bernard Connor, a renowned Irish-born physician. In 1697, Connor published in Latin a controversial book on miracles, which claims to provide medical proof for miraculous cures.[11] Because of this scandalous assertion, his book stirred the minds of clerics and medical practitioners alike. In the present context, Connor's book is important in that he presented a rudimentary idea of fibre anatomy. Seeing the body as composed of two kinds of fine threads (ie. 'vessels and vascular filaments'), Connor perceived the structure of the human body in a similar way to that of the later Enlightenment medical practitioners.[12] The 'vessels' refer to the veins, arteries, nerves and lymph ducts, which, according to most medical writers of that time, compose the entire body. Nevertheless, Connor argues that the countless 'vascular filaments' also participate in the composition of the body by comprising bones, cartilages, ligaments, membranes, tendons, muscles and glands. These filaments are laid over one another and form 'little plates of filaments', which swell up in length and breadth through the action of the blood, finally forming the 'splendid structure of the human body'.[13] Identifying solids as thread-like substances, Connor also thought, in much the same way as the later iatromechanists, that bodily health consists of the interaction of solids and fluids.[14] Because Connor died in 1698, soon after this publication, his research was unfortunately not extended.

In the year of Connor's death, the idea of fibre anatomy found clear expression in James Keill's small textbook on human anatomy. Keill, a Newtonian physiologist and anatomist, for the first time in the history of English anatomical textbooks departed from the traditional division of the human body, and consequently from the common position taken by most authors of anatomical textbooks, of dividing the human anatomy into similar and dissimilar parts and contained and containing parts, or of describing which parts belong to which side of the body. Keill pronounced such a fastidious definition and division of components unnecessary and of no great use for students, since the fact that 'All the Parts are made up of Fibres' was a sufficient basis for the anatomical knowledge

[10] Friedrich Hoffman, *Fundamenta Medicinae*, introduced and translated by Lester S. King (London: Macdonald, 1971), 13–14; 16. On Hoffman's solid pathology, see Ian M. Lonie, 'Hippocrates the Iatromechanist', *Medical History*, 25, 2 (1981), 113–50.

[11] Bernard Connor, *Evangelium Medici: seu Medicina Mystica* (London, 1697); I used an Amsterdam edition of 1699. On Connor, see Liam Chambers, 'Medicine and miracles in the late seventeenth century: Bernard Connor's *Evangelium Medici* (1697)', in James Kelly and Fiona Clark (eds), *Ireland and Medicine in the Seventeenth and Eighteenth Centuries* (Farnham: Ashgate, 2010), 53–72.

[12] *Ibid.*, 10.

[13] *op. cit.* (note 11), 10; see also 16, and *idem*, 'A new plan of an animal oeconomy' in an appendix to *The History of Poland* (London, 1698), Vol.1, 293; 'the solid Parts [are] all made of Vascular Fibres'.

[14] Connor, *Evangelium Medici*, *op. cit.* (note 11), 17. Connor, however, sticks to humoral pathology, without acknowledging the vital role of the solids in diseases on which the later fibre-solidists placed critical importance ('The solid Parts of the Body have no Motion…of their own'…; 'all…Diseases have their first Seat in the Blood'; p. 298).

of the body. After defining the three kinds of fibres from which all body parts are formed, Keill offered a final criticism of the traditional division of the body:

> Now the several Parts of the Body are formed by the various textures and different Combination of some or more of these Fibres; and therefore tho' commonly the Bones, Nerves, Ligaments, Cartilages, Veins and Arteries are reckoned Similar Parts, that is Parts made up of one sort of Fibres, yet all of them have either more or less of different sorts of Fibres, and may be called Dissimilar Parts, as well as the Lungs or Stomach.[15]

The seemingly similar parts are actually composed of different kinds of fibres, which reveals the composite texture (structure) of the body parts; hence, Keill's statement that there are 'No Similar Parts' in the body.[16] Keill later modified this view. He withdrew the above statement from the fifth edition and added a new phrase to the passage that defined the three kinds of fibres, 'And most of them, when examined with a Microscope, appear to be composed of still smaller Fibres'.[17] Although Keill's version of 'fibre anatomy' was rather unelaborated, his innovative rendition of fibre theory in human anatomy was widely shared by other anatomists, as Keill's book became a standard textbook.[18] The enduring idea of fibre anatomy can be seen in Quincy's equally popular *Medicinal Dictionary*, published almost a century after Keill's book; notwithstanding the announced 'improvements' made by the latest authors, it still listed the same description of the body as composed of fibres.[19] Many medical practitioners of diverse theoretical backgrounds embraced the idea of fibre anatomy, whether or not they were more inclined to the mechanical philosophy, Newtonian physics or a quasi-vitalistic natural philosophy.

The complete version of fibre anatomy as developed in the first half of the eighteenth century can be described as follows: the simplest fibres (ie. the smallest unit of the solid body that is unable to be dissolved by any force), when united, forms other tangible fibres that are applied to each other in a parallel direction. These tangible fibres constitute the smallest membranes, which in turn, if bound together, form the smallest vessels. From the smallest vessels, united in a longitudinal direction, arise the membranes of a second degree with their characteristic thickness and strength, which again are bound together to create vessels of the second degree. This cyclic process from the fibres/vessels to the membranes and again to the vessels continues up to the largest 'vessels' (ie. the viscera), which are composed of all the fibres, vessels and membranes found in the human body. Therefore, through various textures and different combinations of fibres, the membranes and the vessels successively constitute the substantial parts of the body.[20] Cheyne, an

15 James Keill, *The Anatomy of the Humane Body Abridged; or, a Short and Full View of all the Parts of the Body* (London, 1698), 2.

16 *Ibid*., 2.

17 Keill, *op. cit.* (note 15), 5th edn (London, 1714), 2.

18 Herman Boerhaave, *A Method of Studying Physick*, trans. Mr Samber (London, 1719), 149; E. Chambers, *Cyclopaedia* (London, 1728), s.v. 'Fibre'; George Cheyne, *The English Malady* (1733) rpt., ed. with an introduction by Roy Porter (London: Routledge, 1991), 61; Robert James, *A Medicinal Dictionary* (London, 1745), s.v. 'Fibra' (this entry covers more than twenty pages, comprising a small treatise on fibre theory in a Boerhaaverian vein; pages are unnumbered, the subsequent pagination in brackets is mine); M.N., B.A. *Anatomy Epitomized and Illustrated* (London, 1737), 4; Peter Paxton, *A Directory Physico-Medical, Composed for the Use and Benefit of all such as Design to Study and Practice the Art of Physick* (London, 1707), 4.

19 John Quincy, *Lexicon Physico-Medicum; or a New Medicinal Dictionary*, 10th edn with new improvements from the latest authors (London, 1782), s.v. 'Fibres'.

20 James, *op. cit.* (note 18), s.v. 'Fibra', [13–4]; Boerhaave, *op. cit.* (note 18), 141–2, 147–9, 150–1, 164–6; Gerald van Swieten, *The Commentaries upon the Aphorisms of Dr Herman Boerhaave*, 2nd edn (London, 1771), Vol. 1, 98–101.

intriguing natural philosopher who subscribed to the fibre-membrane theory, depicted fibre anatomy using an illuminating descriptive tincture that was typical of the era:

All the solids of the Body... resolve themselves... into such [least] *Fibres* at last. They are probably platted and twisted together... or make the larger sensible *Fibres*: And these again are either united in Bundles to form the *Muscles, Tendons, Ligaments*, &c. or woven into a fine *Web*, like cloth, to make the *Membranes*, the coats of the Vessels, &c.[21]

Therefore, what is the fibre that makes up all the solid animal bodies? First, the nature of the fibres was that of threads or filaments, and fibres were often characterised as long, slender, white threads in the form of filaments.[22] The thread-like nature of fibre was of particular concern to the anatomists as they depicted the body as entirely interwoven of thread-like fibres (see below in this section). It must be stressed that the most minute fibre or vessel was nothing but a hypothetical entity that was not visible even with the help of various types of instruments. The nature of the smallest fibre was interpreted by analogy with the larger sensible vessels that were visible and which by close inspection were found to be composed of numerous further minute fibres, which in turn were made up of even more minute fibres. This process seemed to continue indefinitely to an ultimate limit that could only be speculated. This limit was generally called the 'least fibre', although it was sometimes called the least 'vessel',[23] and sometimes, confusingly, the 'nerve'.[24] Anatomists were perplexed by the smallness of the fibres, the extremely large number of which posed the sheer impossibility of counting them. Keill, for instance, argued that the fibres of a muscle, which were nine times smaller than a strand of hair, were each made up of a hundred smaller fibres. He then stated that 'each of these must have had Nerves, Veins and Arteries', and each of them are made up of a hundred more fibres, then still more fibres, etc.[25] Boerhaave too mused on the minuteness of the least vessels and calculated that one hundred million of them might be contained in one grain of sand.[26]

The classification of the different kinds of compound (sensible/visible) fibres was no less confused than the nature of the simplest (invisible) fibres. Some anatomists divided fibres into three classes according to the degree of softness and flexibility, that is, from the

[21] Cheyne, *op. cit.* (note 18), 62. Cheyne is one of the most important medical men who subscribed to fibre theory; he published a Latin treatise on fibre, *De natura fibrae* (1725), in which he elaborates the fibre-solid pathology of chronic diseases (ie. nervous diseases), anticipating his later popular work *The English Malady*. A similar rendition of the above quotation is to be seen in the Latin book, pp. 1–2. On Cheyne, see Anita Guerrini, *Obesity and Depression in the Enlightenment: The Life and Times of George Cheyne* (Norman: University of Oklahoma Press, 2000).

[22] Chambers, *op. cit.* (note 18), s.v. 'Fibre'; Daniel Le Clerc and Jon Jacob Magnet, *Bibliotheca Anatomica, Medica, Chirurgica, &c.* (London, 1711–14), Vol. 2, 394.

[23] Edward Barry, *A Treatise on a Consumption of the Lungs* (London, 1722), 78–9; Boerhaave, *op. cit.* (note 18), 152, 164.

[24] This view was generally attributed to Boerhaave; Flemyng called it 'Boerhaave's doctrine' (Malcolm Flemyng, *The Nature of Nervous Fluid, or Animal Spirits Demonstrated*, London, 1751), xiii. Confusingly, Boerhaave himself elsewhere discussed the simplest fibres as the basic unit; Boerhaave, *op. cit.* (note 18), 146; Swieten, *op. cit.* (note 20), 38–9; G.A. Lindeboom, 'Boerhaave's Concept of Basic Structure of the Body', *Clio Medica*, 5, 3 (1970), 203–8. Boerhaave's use of the term 'nerves' seems to refer to the ultimate vessels, the functional (nutritional) units, whereas the basic structural unit he called 'the least fibres'; see L.J. Rather, 'Some Relations Between Eighteen-Century Fibre Theory and Nineteenth-Century Cell Theory', *Clio Medica*, 4, 3 (1969), 191–202.

[25] James Keill, *An Account of Animal Secretion, the Quantity of Blood in the Humane Body, and Muscular Motion* (London, 1708), 130.

[26] Boerhaave, *op. cit.* (note 18), 149.

softest to the hardest.[27] Other anatomists classified fibres according to their functions, as either motive or sensitive, which could probably be traced back to the animistic definition of fibre by the English physician and physiologist Francis Glisson.[28] Whatever the division of the fibres, fibre in general is much the same in its original formation; therefore, the different states and properties of the specific parts, or the whole formation of the individual body, largely derive from the various textures and combinations of the different kinds of fibres.[29] By extension, the different physiological and pathological states of the physical temperaments of individuals are partly determined by the anatomical warp and weft of the fibre-woven body. (See the section on physiology and pathology, and that on constitutions later.)

Even more significant than the idea of the body being entirely fibrous is the use of metaphor to describe fibre anatomy. Detailed research into the micro-structure of the inner parts of the body inspired anatomists to employ a variety of metaphors for fibres derived from weaving, textiles and embroidery, to articulate what they saw.[30] As the eighteenth-century theorists inherited the concept of fibre anatomy from the anatomists and natural philosophers of the preceding century, so they described the body, from top to bottom and from the smallest to the largest parts, using metaphorical terminology drawn from the seventeenth-century concept of fibre anatomy. Descriptions of fibre anatomy were accompanied by references to weaving practices ('interwove', 'weave' and 'knit') and products such as 'cloth' and 'embroidery'. Fibres, identified with threads or filaments, became the appropriate material for knitting and weaving the body.

More than any other body part, the membranes or coats received scrupulous attention, because of their natural similarity with cloth. Cheyne compared the process of weaving the fibre-threads into membranes to that of clothmaking, stating that the fibres were 'woven into a fine *Web*, like Cloth, to make the *Membranes*'.[31] Cheyne elsewhere described the innermost coat of the stomach as 'Carpet-like'.[32] Even for Boerhaave, who usually preferred the mechanical-hydraulic metaphor to the fibre-woven one, the membrane appeared to be 'a kind of sheet where the filaments or threads are closely interwoven (as in Linen)'.[33] The membranes were not only interwoven of fibres; they were also stitched together by blood vessels (themselves ultimately composed of fibres). Observing the spectacular texture of membranes interwoven with perplexing inter-and-cross connectedness between and within the vessels, the anatomists sometimes employed picturesque rhetoric. Quincy's description of the blood vessels in the membranes is typical: 'the innumerable Divisions, Windings, and Turnings, serpentine Progressions, and frequent Inoculations, not only of Veins and Arteries together, but also of Veins with

[27] Keill, *op. cit.* (note 15), 2; M.N., *op. cit.* (note 18), 2–3; John Quincy, *Physico-Medicum: or, a New Physical Dictionary* (London, 1719), s.v. 'Fibre'. A similar way of dividing the fibres according to the degree of flexibility can be seen in their four-part classification as fleshy, nervous, tendinous or osseous (bony); see Chambers, *op. cit.* (note 18), s.v. 'Fibre'; George Cheyne, *An Essay on Gout* (London, 1720), 78.

[28] See Stephen Blancard, *A Physical Dictionary* (London, 1684), s.v. 'Fibrae'; Chambers, *op. cit.* (note 18), s.v. 'Fibre'; Thomas Gibson, *The Anatomy of Humane Bodies Epitomized*, 6th edn (London, 1703), v; Nicholas Robinson, *A New Theory of Physick and Diseases, Founded on the Principles of the Newtonian Philosophy* (London, 1725), 46–7; cf. Baglivi's classification of the fibres, see E. Basthlom, *The History of Muscle Physiology: From Natural Philosophers to Albrecht von Haller* (Copenhagen: Ejnar Munksgaard, 1950), 181.

[29] Cheyne, *op. cit.* (note 18), 64.

[30] On this point see my 'Visualizing Fibre', *op. cit.* (note 9).

[31] Cheyne, *op. cit.* (note 18), 62.

[32] George Cheyne, *Philosophical Principles of Natural Religion* (London, 1705), 225.

[33] Boerhaave, *op. cit.* (note 18), 163.

Veins, and Arteries with Arteries', adding, in testimony of the metaphoric tradition, a stock figure from the rhetoric of textiles: '[all of them] make a most agreeable Embroidery and delicate Net-work'.[34] Thus, in their discourse on fibre anatomy, the medical practitioners, astonished by the 'wonderful texture' of the human body, closely compared it to a complex textile.[35]

The anatomical discourse of the fibre-woven body as a textile or cloth had important consequences. First, it endorses the principle of continuity of the body, which plays a vital role in fibre physiology and pathology. If the fibres successively enter into the composition of all the solids of the body (from fibres to membranes to vessels and viscera), the body as a whole can be imagined as materially continuous from beginning to end ('animal Bodies... are in a manner framed of one continued Maze of innumerable Canals, in which Fluids are incessantly circulating'[36]). This physical continuity would ensure the physiological function of the fibre vessels, that is, the perpetual circulation of the fluids. The second consequence of the anatomical discourse of the fibre-woven body is related to a cultural interest in the delicate body. To understand this connection, we need to consider the concept of the 'solid', and how it is conceived in the discourse on fibre anatomy. The solids need not be as hard and strong as the bones or the tendons, the hardness and strength of which are made possible only by the gradual hardening of extremely soft fibres. In other words, the solids are solid not because their material properties imply hardness, but because they are 'continuous and continent parts of the body'; they are defined as such in opposition to the fluids, which are contained in the solids.[37] Fibre-anatomists conceived the solid body not so much as a physically dense matter but as a delicate, fragile and flexible entity interwoven of unimaginably slender threads and extremely tenuous membranes. Bone, the hardest part of the body, was a critical issue in the discourse on its delicate texture. Nesbitt, for instance, dismissed as 'a vulgar error' the hitherto prevailing notion that bones are originally formed from the cartilaginous matter;[38] instead, he insisted that the cartilaginous substance was 'fibrous', and therefore that the bones are originally formed from the 'bony' fibres ('bony' in the sense that they are the constituent part of the bones).[39] Alexander Monro *primus*, a specialist on the micro-anatomy of bones, also discussed the ossification process. He described the bones as being composed of a large number of 'Plates', 'made up of Fibres or Strings', and 'united by smaller irregularly disposed Fibrils', which being interwoven with the former plates (the larger fibres) made

[34] Qunicy, *op. cit.* (note 19), s.v. 'Membrane'; see also Benjamin Martin, *The Philosophical Grammar; Being a View of the Present State of Experimented Physiology, or Natural Philosophy* (London, 1735), 272, which reads the same expression; Stephen Hales, *Statical Essays: Containing Haemastaticks* (1733), rpt., with an introduction by Andre Cournand (New York: Hafner, 1964), n.p., ('an inimitable Embroidery of Blood-Vessels'). During this period fibre theory provided no general account of the membrane *per se*; membranes were studied and treated only as a constituent of specific parts, eg. the pleura for the thorax or the meninges for the brain; see James Douglas, *Myographiae Comparatae Specimen: or, a Comparative Description of All the Muscles in a Man, and in a Quadruped*, a new edition with additions (Dublin, 1755), xi; Keill, *op. cit.* (note 15), 19. There were several kinds of coats, usually divided into three as muscular, nervous and vascular; see Anon, *Physical Essays on the Parts of the Human Body and Animal Oeconomy* (London, 1734), 57; Barry, *op. cit.* (note 23), 47–8; James Drake, *Anthropologia Nova; or, a New System of Anatomy* (London, 1707), Vol.1 , 58–61, 67ff; Jeremiah Wainewright, *A Mechanical Account of the Non-Natural* (London, 1707), 3ff.

[35] Hales, *Ibid.*, n.p.

[36] Hales, *op. cit.* (note 34), n.p, intro, no. 3.

[37] Chambers, *op. cit.* (note 18), s.v. 'Solids'.

[38] Robert Nesbitt, *Human Osteogeny Explained in Two Lectures* (London, 1736), 2–4.

[39] *Ibid.*, 8–12; see also M.N., *op. cit.* (note 18), 5–7.

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'a reticular Work'.[40] While the bones are solid substances, the bony structure is here represented as a textile cloth, similar to other fibrous, textile-like parts. Monro refuted the concept that bones do not have a fibrous texture by arguing that, however solid and compact the bones may appear, they were once soft membranes, 'nay a mere Gelly'. To support this, he referred to repeated observations of a developing embryo, which attest to a gradual hardening of a once-tender substance.[41]

The discovery that the bones, the hardest part of the human body, were originally a jelly-like soft substance provided evidence for the anatomists' concept of the solid body as tender and delicate. If even the hardest matter was once fibrous, there should be no difficulty in believing that the other solid parts were also tender and delicate. Thus, the notion of the 'solid' body as interwoven by innumerable minute threads like an intricate embroidery contributed to a cultural understanding of the delicate and tender body, a body very receptive to external stimuli, a body that loomed large in the burgeoning culture of sensibility and the commercialised 'fashionable' society of the eighteenth century.[42] To acknowledge a plausible connection between the fibre-woven body in fibre anatomy and the cultural formation of the delicate (later called 'nervous') body would force us to rethink the putative 'medical' origin of the culture of sensibility, which is customarily attributed to the Willisian revolution of brain anatomy and the exploration of the nervous system by its eighteenth-century successors. Although this point cannot be further pursued here, the discourse on fibre theory, fibre anatomy and the fibre-woven body in early eighteenth-century medicine is intimately related to the emergent cultural concern of the sensible body, which precedes the rise of the discourse on the nervous system in medical theory from the 1740s onward.

## Fibre Physiology, Pathology and Therapeutics

The concept of the delicate structure of the fibre-woven body became important for people such as women, children or fashionable people whose constitutions were supposedly endowed with fine sensibility. This type of fragile temperament was increasingly confounded with disease characteristics such as 'hypo' or hysteria, the causes of which were sought in the pathological state of fibres that are too lax and flabby. However, the tendency to describe the fibre-woven body as diseased should be counterbalanced by conceptions of the physiologically 'normal' body. This section will discuss the interrelated arguments on the respective role of fibres in circular physiology, solid pathology and therapeutics, in order to posit the legitimate place of fibre in each field.

### *Physiology and Elasticity*

Early eighteenth-century medical practitioners, who saw the body as a hydraulic machine, commonly assumed that life depends on the uninterrupted circulation of fluids through innumerable winding, 'hollow' vessels. The doctrine of obstruction suggests that physiological dysfunction is caused by blockage of these minute vessels by bodily fluids causes.[43]

[40] Alexander Monro, *primus*, *The Anatomy of the Humane Bones* (Edinburgh, 1726), 9.
[41] *Ibid*., 34–5.
[42] See G.J. Barker-Benfield, *The Culture of Sensibility: Sex and Society in Eighteenth-Century Britain* (Chicago: University of Chicago Press, 1992).
[43] See my 'Elasticity' paper for further elaboration of this section; *op. cit.* (note 4).

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The fragile solids, however, are always subject to wear and tear. The solids are perpetually wasted and impaired by the force of circulating fluids that furnish nutritious matter. As such, circulation must constantly supply the proper animal juices to nourish and repair the solids. It then becomes important to ask how the blood, the universal fluid from which all the other fluids or humours are derived,[44] circulates through the vessels. It cannot be from a force innate to the fluids themselves, since they are not endowed with a 'self-moving Principle'.[45] The blood is moved by the impulse of the 'muscular' heart, the vital engine of the hydraulic machine. However, the force of the heart seemed to be too weak to convey the fluids through every nook and passage of the minutest extremities.[46] Full circulation must be aided by an impulsive force of the vessels and membranes (the solids) themselves, as well as the heart. Since the heart functions through the muscular mechanism of fibres, that is, as instruments of motion, the solid vessels themselves, by means of the complicated mechanism and texture of their muscular fibres, can also propel the fluids. It is not in the fluids, therefore, but in the solids as a whole, the amalgamation of innumerable vessels, that we will find the chief spring of force.

Morgan's description of the ubiquitous presence of muscular fibre illustrates this: the muscular elastic fibres were 'every where twin'd and interwoven with the Blood-Vessels, not only in the Muscles strictly so call'd, but also in the Glands, the muscular Coats, and universally wherever any Blood-Vessels [were] to be found'.[47] The sum of forces exerted upon the blood is explained by the elastic fibres taken together, with the force of the heart accounting for only a part. We now need to question how the fibres move the fluids. This can be explained by the innate 'elasticity' of the animal fibres. Many medical theorists maintained that the vital motions of the animal economy (with circulation seen as an epitome) were not possible without this inherent property of elasticity in the fibres. Browne Langrish, for instance, went so far as to say that without this property of the fibres, 'Life could not subsist but a few Hours, or perhaps minutes'.[48] Similarly, Cheyne insisted on the axiomatic function of the elastic fibres by suggesting that 'in this *Elasticity* alone, the Force, Power and Pleasure of Life, and of the *animal Functions*, consists'.[49] In a word, 'the whole Business of the Animal Life' is derived from the elasticity of the animal fibres.[50]

What is elasticity, then, and by what mechanism do the elastic fibres enable the fluids to move? First, elasticity is an innate property residing in all fibres, by which they restore themselves to their former state if they become stretched, the degree of which varies according to the nature and state of the specific parts.[51] All the fibres in the living body were assumed to be in a state of 'Violence' or 'Distraction' as the fibres were unnaturally

[44] John Arbuthnot, *An Essay concerning the Nature of Aliments* (London, 1733), 74; Keill, *op. cit.* (note 25), 107–8; Robinson, *op. cit.* (note 28), 15; Thomas Short, *A Discourse Concerning the Causes and Effects of Corpulency* (London, 1727), 51.

[45] Robinson, *op. cit.* (note 28), 23.

[46] Thomas Morgan, *Philosophical Principle of Medicine* (London, 1725), 138–9.

[47] *Ibid.*, 139.

[48] Browne Langrish, *A New Essay on Muscular Motion* (London, 1733), 49.

[49] Cheyne, *An Essay on Regimen* (London, 1740), xii; also see viii; Arbuthnot, *op. cit.* (note 44), 156; Cheyne, *op. cit.* (note 21), 3.

[50] Cheyne, *op. cit.* (note 27), 80; also see Chambers, *op. cit.* (note 18), s.v. 'Fibre'; Langrish, *The Modern Theory and Practice of Physic*, 2nd edn (London, 1738), 52–4; Quincy, *op. cit.* (note 19), s.v. 'Fibre'.

[51] Cheyne, *op. cit.* (note 32), 224–5; Langrish, *op. cit.* (note 50), 58; Nicolas Robinson, *A New System of the Spleen, Vapours, and Hypochondriack Melancholy* (London, 1729), 16.

drawn out to a greater length by the violent stretching force of the fluids.[52] The proper action of the fluids in distending and stretching the vascular parts should be counteracted by the equally natural and continual exertion ('Conatus'[53]) of the solid elastic fibres that resist the action of the fluids and restore the former state.[54] By this mutually dependent and cyclic movement, distension of fluids and contraction of elastic fibres, all motions and functions of the animal body are maintained. The living body's state of health or derangement depends on this precarious equilibrium between solids and fluids; that is, on the elasticity, or faculty of restitution, of the former and on the influent force of the latter against the solids.[55] If animal fibres lacked 'Elasticity', 'Tone' or 'Tension' (the terms were used interchangeably) to impel the fluids, the body would fall into some kind of disorder.[56] In the framework of circulatory physiology, life depended on the circulation of the blood; ultimately, however, this meant that life relied on the elasticity of the fibres.[57] This important aspect of fibres applies equally to two other fields: solid pathology and fibre-based therapeutics.

## *Pathology*

When the long-standing doctrine of humoralism, attributing all disease to imbalance of the four humours, was gradually superseded by the new doctrine of solidism at the turn of the eighteenth century, medical theorists in search of the origins of diseases began to focus on the solids, particularly the fibres. Thanks to Baglivi, an Italian iatromechanist and the founder of solid pathology, the importance of solids in treating disease was recognised by the medical theorists of the early eighteenth century.[58] As some medical writers came to appreciate the power of the solids, the latter were no longer regarded as passive matter but as the active mover of the fluids.[59] In the earlier stage of development of solid pathology in Britain, Bartholomew Beale resorted to Baglivi's doctrine of the solid, lamenting that it had been neglected for many years[60] and insisting that the solids were the main, and sometimes, the sole cause of many diseases.[61] The disorders of human bodies are, according to Beale, falsely attributed to vitiated fluids.[62] The humours or animal juices did not become morbid by themselves, since the qualities of bodily fluids are mainly a consequence of the elastic forces of the solid fibres.[63] After Baglivi, Herman Boerhaave systematised fibre-solid pathology in his extraordinarily popular textbook *Boerhaave's*

[52] James, *op. cit.* (note 18), s.v. 'Fibra'[3]; Quincy, *op. cit.* (note 19), s.v. 'Fibre'; Robinson, *op. cit.* (note 28), 17.

[53] Morgan, *op. cit.* (note 46), 126.

[54] Morgan, *op. cit.* (note 46), 127.

[55] Arbuthnot, *op. cit.* (note 44), 148–9; Edward Strother, *An Essay on Sickness and Health* (London, 1725), 260.

[56] Arbuthnot,*op. cit.* (note 44), 148; J. Browne, *Institutions in Physick, Collected from the Writings of the Most Eminent Physicians* (London, 1714), xviii; James, *op. cit.* (note 18), s.v. 'Fibra'[17]; John Quincy, *Medico-Physical Essays* (London, 1720), 45; Robinson, *op. cit.* (note 28), 49–50.

[57] Browne, *ibid.*, xviii.

[58] See Thomas Apperley, *Observations in Physick, both Rational and Practical* (London, 1731), 15.

[59] Browne, *op. cit.* (note 56), xix; Morgan, *The Mechanical Practice of Physick* (London, 1735), 145; 'in all animal Motion, the original active Force is intrinsically in the Solids, and the Fluids only act as they are acted upon'.

[60] Bartholomew Beale, *An Essay Attempting a More Certain and Satisfactory Discovery Both of the True Causes of all Diseases* (London, 1706), 57.

[61] *Ibid.*, 54. See also Cheyne, *op. cit.* (note 21), 82, where he summarised his tenet of solid pathology, saying that every disease is a disease of the solids rather than of the humours.

[62] *Ibid.*, 57; Beale, *op. cit.* (note 60).

[63] *Ibid.*, 57; James, *op. cit.* (note 18), s.v. 'Fibra'[14]; Quincy, *op. cit.* (note 56), 30–1, 44.

*Aphorisms*, later lengthily supplemented by van Swieten's commentaries. Boerhaave begins by discussing 'the most simple solid fibre', and explains the diseases classified into those that proceed from 'a weak and lax Fibre' and those from 'a stiff and elastic Fibre'; then, he discusses the diseases of 'the least and larger Vessels', which proceed from the same causes as those of the least fibre, before turning to the defects of the humours, which are only secondary.[64] The focal point of solid pathology should be sought in the fibres and their state of elasticity.

There is an important point to make here regarding fibre-solid pathology. The 'one disease theory' of fibre pathology can be seen in two contexts: one concerns the principle of continuity discussed above; the other is related to a nosological aspect of solid pathology. As argued in the section on fibre anatomy, the body is imagined as successively woven out of elementary fibres, from the strands of hair and the nerves, to the vessels and viscera. The fibre-woven body is bundled together by these same fibre-threads in such a way that every part is continuous with every other part; one series of vessels is continuous with another higher series of vessels. The corollary of this reasoning (ie. the principle of continuity) is that the dictum deduced from the simplest fibres is equally applicable to the larger fibres or vessels, so that if one wants to seek the explanation of the diseases of the small or large vessels, one has only to look for the diseases of the most minute vessels.[65] In this view, the morbid state of the smallest fibre would designate a similar morbid state in all the other fibres, due to their continuity. For example, John Arbuthnot integrates the disease theory based on fibre anatomy with the principle of continuity: 'of those [smallest] Fibres, [are constituted] the Vessels, of those Vessels the *Viscera* or Organs of the Body; therefore the Weakness and Laxity of the Fibres, Vessels, Viscera, and all Parts of the Body, may be considered as one Disease',[66] though he admits that disease is not always 'universal' (that is, there is a weakness or a strength of some parts which appear to be absent in other parts).

Another aspect of the 'one disease theory' is that it implies a homogeneous view of diseases that reduces the source of disorders to one continuously linked pathological state of the fibres, that is, loss of tone or elasticity, caused by their being either too relaxed and weak, or too rigid and tense.[67] Interestingly, medical practitioners were less interested in the considerable rigidity of the animal fibres as a specific cause of diseases, than in their laxity. Theoretically speaking, both states 'above or beneath the Balance of Nature', as suggested by Robinson,[68] occasioned diseases, but cases are more often ascribed to a too relaxed than a too rigid state. In fact, there seems to be a deep-seated assumption that the too-rigid state is not essentially pathological, but rather a kind of deviant or excessive consequence of a process that would otherwise be beneficial; in other words, that excessive rigidity of animal fibres is caused by a therapeutic activity which, had it not been excessive for the weakened fibres, would have benefited them. Thus, moderate exercise would strengthen the solids, but excessive exercise would dry up the fibres and render them rigid.[69] Moreover, an over-strained motion first tightens the fibres (ie. puts them in a state of tension), but the tightened fibres afterwards recoil and become more

64 Herman Boerhaave, *Boerhaave's Aphorisms concerning the Knowledge and Cure of Diseases* (London, 1715), 5–16; and Drake, *op. cit.* (note 34), 450–1; Robinson, *op. cit.* (note 28), 86.

65 James, *op. cit.* (note 18), s.v. 'Fibra'[13].

66 Arbuthnot, *op. cit.* (note 44), 149.

67 Langrish, *op. cit.* (note 50), 2.

68 Robinson, *op. cit.* (note 28), 81.

69 James, *op. cit.* (note 18), s.v. 'Fibra'[11].

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relaxed.[70] In this sense, the second dimension of the 'one disease theory' of fibre pathology is further abstracted, leading to a one specific causation of diseases – weakness of fibres. As James acclaims, 'there is no fault in the whole Body, except only a Weakness of the Fibres, which is considered abstractly as a Disease, independent of all others'.[71]

## *Therapeutics*

Therapeutic activities largely focused on the loosened fibres, in order to restore their lost tone or 'Springiness'. Besides blood-letting and medicinal drugs,[72] fibre-based therapeutics was practised within the perspective of the traditional six non-naturals – air, bodily motion, food and drink, excretion and retention, passions, sleep and waking. In diet, a stimulating substance such as 'acrid' matter would increase the oscillating motion of the solid-fibres,[73] and a mineral 'Diuretick' water would restore the lost tone of the weakened fibres through the water's astringent quality.[74] However, a caution should be raised against the excessive ingestion of 'modish' dishes with high salt and spices, which would render the fibres dry, 'crispy' (ie. crinkly) and tense, and deprive the fibres of tension.[75] Interest was also focused on air: it was believed that the state of the atmosphere has a great influence on the fibres, since we constantly absorb air through every pore of the body.[76] Thus, cold and dry air was thought to brace and stiffen the fibres, not only by condensing, but also by 'congealing the Moisture' that relaxes the fibres. Cold air produces strength and activity[77] by giving 'great Energy to the Fibres',[78] whilst moisture or moist air would render the fibres more lax and flaccid, diminishing their elasticity and retarding circulation, so that the animal juices would become slimy and eventually stagnate.[79] The idea that cold air braces the fibres exalts cold and dryness over heat and moisture, which duly led the British to appreciate their northern climate for its beneficially dry, cold and bracing effect on lax fibres.[80] Passions should also be given due attention for, if excessive, they would contract and tighten the fibres into springs of violent convulsion.[81]

[70] John Quincy, *Medicina Statica: Being the Aphorisms of Sanctorius, Translated into English, with Large Explanations*, 4th edn (London, 1728), 426.

[71] James, *op. cit.* (note 18), s.v. 'Fibra' [5].

[72] On bleeding, see Langrish, *op. cit.* (note 50), 115; on drugs, George Cheyne, *An Essay of Health and Long Life* (London, 1724), 215–16; James, *op. cit.* (note 18), s.v. 'Fibra'[8–9].

[73] Arbuthnot, *op. cit.* (note 44), 136, 115.

[74] Richard Blackmore, *A Treatise of the Spleen and Vapours; or, Hypochondriacal and Hysterical Affections* (London, 1725), 79.

[75] Langrish, *op. cit.* (note 50), 30.

[76] Langrish, *op. cit.* (note 50), 3–5; he argued that little change of air had a great influence on Tubes.

[77] John Arbuthnot, *An Essay Concerning the Effects of Air on Human Bodies* (London, 1733), 56.

[78] Clifton Wintringham, *The Works of the late Clifton Wintringham, Physician at York* (London, 1752), Vol. 1, 29; see also Cheyne, *op. cit.* (note 72), 31; Langrish, *op. cit.* (note 50), 6–9, 11; Archibald Pitcairn, *The Works of Dr Archibald Pitcairn* (London, 1715), 117.

[79] Arbuthnot, *op. cit.* (note 77), 61–12; James, *op. cit.* (note 18), s.v. 'Fibra'[4]; Short, *op. cit.* (note 44), 10–2; Wintringham, *ibid.*, 22–5.

[80] Cheyne, *op. cit.* (note 72), 31; John Tennent, *Physical Enquiries*, 2nd edn (London, 1749), 1–2.

[81] Cheyne, *op. cit.* (note 72), 158; Morgan, *op. cit.* (note 46), 374; Short, *op. cit.* (note 44), 24, 73. Intense study and excessive sex ('Venery') were thought to be similar in the sense that they exhaust the animal spirits; they deprive the fibres of the nervous juice to the point of wearing out and debilitating the tone of the fibres. The immoderate passions – sex and study – were of an exceptional category; the fibres were believed to be stretched and tightened if those activities exceeded the standard set by nature, although the resultant state of the fibres after immoderate coitus was all the more relaxed and flabby. Short, *op. cit.* (note 44), 25, 46–7; also Langrish, *op. cit.* (note 50), 39; Quincy, *op. cit.* (note 72), 426.

Among the non-naturals, however, exercise seemed to receive the most assiduous attention; more precisely, vibratory, oscillatory motions such as gentle shock, shaking, minute vibrations and pulsations brought on by exercise (or any other means), rather than exercise *per se*, were assumed to be the most critical ingredients of cure and prevention.[82] Thus, moderate exercise would give a 'gentle Shock to all our Fibres', increasing their contractile power,[83] and motions such as riding and walking, by shaking the whole frame, would bestow it with firmness.[84] The curative virtues of shaking the fibre-machine were astonishingly revealing, for, by being shaken, the vibrations of the solids are quickened, and the body becomes relatively lighter, with the ligaments and the muscles cleared of their 'Excrements'; moreover, superfluous particles are 'dislodged and shook off' by exercise, while animal spirits or juices are rendered finer.[85] This vibrating virtue was even more surprisingly effective; it could prevent not only 'contagious' ulcer,[86] but plague or 'Epidemical Distempers',[87] both of which were caused by invisible worms or 'Animalcules' ('imperceptible Insects') floating in the air.[88] We constantly ingest the seeds of diseases from the air or from food and drink.[89] These seeds could bring distempers unless a 'perpetual Pulsation' imperceptible to our eyes could beneficially shake off these insects before they secure a place in our bodies.[90] Whatever increased the vibratory motion of the solids could be therapeutic – bleeding, vomiting and everything that acts as a stimulus, such as riding, 'gestations', friction and even music.[91] Even the symptoms of certain diseases may be therapeutic agents, as when a fit of gout or a spasm of a nervous disorder is said to remove other complaints by 'concussion' and brisk motion.[92]

It was crucial for therapy to support and improve the continuous vibrating motion of the solids, which was ultimately identifiable with, and variously expressed as, 'tone', 'tension' or 'elasticity'. The living body must 'move' in a particular way to maintain health. As demonstrated previously, life depends upon the perpetual circulation of the blood to the minute vessels; however, 'circulation' is merely the tonic motion of the solid-fibres. It was the contractile ('tonic') power of the fibres that propelled the resisting fluids further, the sum of which comprised notion of 'circulation'. In this sense, circulation includes the extension of the pulsative motion (alternative motion of systole and diastole) of the vessels as well as the heart. To sustain the circulation of the fluids, the animal machine or the living body must 'move' everywhere, that is, incessantly shake, vibrate, undulate and pulsate ('every living Part of a human Body has a perpetual Pulsation').[93] Therefore, the living motion in the body that is necessary to life is not the circular movement of blood; this motion of life more properly refers to the 'vibration' that is manifested in the tonic or elastic motion of the animal fibres. Here, the definition of 'Tonic' given by Quincy is

[82] More on this see my 'Elasticity', *op. cit.* (note 4).
[83] Short, *op. cit.* (note 44), 246.
[84] Quincy, *op. cit.* (note 72), 426; also 324.
[85] Quincy, *op. cit.* (note 56), 43.
[86] Barry, *op. cit.* (note 23), 274.
[87] Apperley, *op. cit.* (note 58), 87.
[88] Apperley, *op. cit.* (note 58), 85.
[89] Apperley, *op. cit.* (note 58), 85–6.
[90] Apperley, *op. cit.* (note 58), 90–1; also Barry, *op. cit.* (note 23), 274–5 on ulcer.
[91] Cheyne, *op. cit.* (note 72), 94–5; James, *op. cit.* (note 18), s.v. 'Fibra'[5, 7]; Quincy, *op. cit.* (note 56), 45–6; Quincy, *op. cit.* (note 72), 332; Swieten, *op. cit.* (note 20), 67–9.
[92] Quincy, *op. cit.* (note 72), 421; also see Cheyne, *op. cit.* (note 72), 132.
[93] Barry, *op. cit.* (note 23), 274; also Langrish, *op. cit.* (note 50), 60, 61; Quincy, *op. cit.* (note 56), 40.

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heuristic, for he applies the term to 'that tremulous Motion or Vibration of the Nerves and Fibres, in a human body'.[94]

If we return to fibre anatomy and remember that the whole body is composed of innumerable thread-like fibres, the foremost importance of the fibres' functional movement, 'vibration', or 'tone', as discussed in this section, becomes more cogent and understandable, for the solids could freely vibrate even more inasmuch as they are all made up of thread-like fibres that easily yield to undulation. The felicitous co-ordination of the anatomical (structural) and functional (vibration, elastic tone) aspects of the fibre-threads might well be exemplified by the 'mechanical' effect of music on the body. The least stroke imaginable upon the 'Contexture of Animal Threads' must move the component of the fibres in all their parts through the 'Undulation of the Air' that is made by a musical instrument, which gives the animal threads a corresponding 'Concussion', depending on the degree of tension.[95] Here, the body is imagined as a kind of musical instrument that sensibly resonates with other musical instruments that occasion the (musical) impulse. It is no accident that the term 'tone' that is customarily employed within the realm of music is appropriated as the designation of fibres' vibratory motion. Neither is it fortuitous that the body is analogised as a specific kind of musical instrument, as a string instrument with tense 'elastic' chords similar to a harpsichord or an organ.[96] For David Stephenson, an ardent 'mechanical' medical theorist, the human body, consisting of the elastic fibre-solids, is comparable to 'a most finish'd exquisite string'd musical Instrument' that is extremely susceptible to the least impressions from the outside, such as the 'smallest Sound or Motion of the Air' which causes the whole animal frame to 'vibrate inwards and outwards'.[97] Endowed with 'the most exquisite Sensation', this elastic, vibratory body, 'a most prefect musical Instrument' accounts for the phenomenon of sympathy or antipathy because it is affected by a vibratory motion throughout the fibre body.[98] As with fibre anatomy, it is difficult to dismiss the cultural overtones implied by the fibres' functional aspect (vibratory motion), for vibration or involuntary motion is also the palpable sign of sensibility in the larger sphere of a polite society. As much as the fibre-woven body prefigures the formation of the delicate body, the fibres' vibratory motion pre-moulds the formation of a sympathised, sensible body, something that is usually ascribed to the rise of a nervous sensibility under the dominance of the nervous system. The latter phenomenon actually proceeds from the crystallisation of the fibre theory and the fibre 'elastic' body.

[94] Quincy, *op. cit.* (note 19), s.v. 'Fibre'; he also indicated that a variety of expressions employed by mechanical writers such as 'distraction, contraction, vibration, undulation, tonick motion, concussion, relaxation, corrugation, and elasticity of the solids' were nothing but the different ways of expressing the 'various Modifications and Dispositions' of the animal fibres. See also Cheyne, *Fibrae*, where Cheyne puts a more emphasis on the role of 'undulation or vibration' of the fibre-solids than in his later works, *op. cit.* (note 21), especially 8–9.

[95] Quincy, *op. cit.* (note 56), 46.

[96] See, for instance, Cheyne, *op. cit.* (note 18), 4–5. Also see Blackmore's remarks on palsy in terms of the musical metaphor; if the muscular fibres have lost their natural elasticity and become too flaccid and feeble, they cannot return by themselves to recover their regular disposition, just like the 'Strings of musical Instruments' which have lost their tension, and if this happens, palsy must follow; *Spleen*, *op. cit.* (note 72), 179.

[97] David Stephenson, *Medicine Made to Agree with the Institutions of Nature; or a New Mechanical Practice of Physick* (London, 1744), 54.

[98] *Ibid.*, 57.

## Fibre Biology: Fibre as Stamina

The concept of fibre in eighteenth century medicine was extended into the mysterious realm of the life sciences. Especially in investigations on the origin and development of the embryo, and on the processes of man's growth and decline, the concept of fibre was used for a more cogent clarification of the otherwise unfathomable phenomenon of life. In this section, the important place that fibre occupied in the life sciences of the era will be discussed.

From the latter part of the seventeenth century, the 'mechanical' theory of embryonic development loomed large – the doctrine of the pre-existence of the germ, according to which all generations were seen as a mere growth (extension) of the germs (or animalcules) that were encased in the first parents (Adam or Eve) at the beginning of the world. The astonishing demonstration by the Dutch naturalist Jan Swammerdam in 1669 showing how a butterfly goes through successive stages in its life cycle in such a manner that one stage is enclosed within another (egg, larva, pupa, adult) contributed greatly to the formulation of the pre-existence theory. Swammerdam carefully observed the deceptively abrupt metamorphosis of the butterfly as an orderly, progressive development from egg to butterfly. His analysis revealed the seemingly 'radical' alterations of the structure's appearance as the continuation of an already structurally formed organisation. Exploiting Swammerdam's observation, Nicolas Malebranche, a Cartesian philosopher and priest, suggested the idea of the encasement of germs, saying that the first female contained all the subsequent germs that were prearranged and preordained to hatch from the inside of all the females descended from her. Fanciful as it sounds today, the doctrine of pre-existence, with the idea of encasement, was the most cogent and consistent theory for the mechanical philosophers, for it matched the mechanical view of the world, behind which God, as both Creator and Architect, presided. Moreover, it 'mechanically' endorsed the theological concept of original sin. Theologically acceptable and theoretically persuasive, the preformation doctrine of encasement was widely disseminated by 1700 and firmly established in the medical field.[99]

How does fibre theory relate to the preformation doctrine? In order to understand this relation, we should pursue the interlocking ideas of fibres, solids, 'animalcules' and 'stamina'. Fibre anatomy demonstrated that the solids of the body are entirely fibrous, but what were the fibrous solids in their original state, and how did they grow or develop? The majority of the medical writers of the era resorted to the idea of 'stamina' as a way to consider the beginning of life. Assuming that original parts existed in the seed (or embryo) from the beginning,[100] the idea of stamina was set as the biological basis from which all the solids took their departure.

The medical theorists argued that stamina are organised from the start, not as a formless fluid body but as a complete organisation of solids. According to them, the essential solid parts must be distinguished from the accidental parts later added to the original stamina by means of nutrition: everything essential to the animal was deemed to be 'stamina',

[99] Charles W. Bodemer, 'Regeneration and the decline of preformationism in eighteenth century embryology', *Bulletin of the History of Medicine*, 38, 1 (1964), 20–31; Virginia P. Dawson, *Nature's Enigma: The Problem of the Polyp in the Letters of Bonnet, Trembley and Réaumur* (Philadelphia: American Philosophical Society, 1987), 42–5; Jacques Roger, *The Life Sciences in Eighteenth Century French Thought*, in Keith R. Benson (ed.), Robert Ellrich (trans.) (Stanford: Stanford University Press, 1997), ch. 6.
[100] Chamber, *op. cit.* (note 18), s.v. 'Stamina'.

while the rest was added by the nutritious fluids.[101] This is consonant with the metaphoric usage of the Latin word *stamina* (plural of stamen), which in classical Latin means 'warp threads', ie. the supporting threads stretched on a loom, under and over which the weft threads are woven to produce a textile. This metaphoric usage of stamina is already seen in discussions of generation in Jean Fernel's *Physiologia* (1567) and Andreas Laurentius's *Historia Anatomica* (1602).[102]

The original stamina almost concurred with the solids, the quantity of which was surprisingly small.[103] The process of incredibly minute stamina growing into mature solids was imagined as their enlargement by the impelling force of the nutritious fluids. This image presupposes that stamina form vessels. Within these vessels, the contained fluids circulate to distribute nutrition for growth. Therefore, the stamina are sometimes identified with the 'Animalcules' in the semen, the hypothetical organised bio-substance[104] in which all the vessels of the body are originally contained.[105] The number of the vessels comprised by the stamina or animalcule is inconceivable; it actually exceeds the vessels of the adult body, for in the process of growth, the great number of soft, tender vessels compound together and become more compact and solid, forming sensible vessels, cartilages or bones.[106] As incalculable as the number of vessels in the stamina or the animalcule, equally inconceivable is the weight of the stamina: some calculated that three thousand million vessels in the stamina were not equal in weight to a grain of sand,[107] while Wintringham, drawing on Leuwenhoeck and Keill's mathematical calculation of the animalcule, computed the weight of the stamina at 1/9240812993491060244207375200th part of a grain![108]

The question here is how one can imagine that such minute stamina comprise all the vessels or how one can make sense of the idea that the originally vascular (vessel-textured) stamina grow into an animal body.[109] The observation and knowledge of how the adult body of an insect was enclosed in the larva or the pupa provided the medical writers with the clue to the mystery of the stamina. Here, Swammerdam's observation and drawings of the 'nymph' (pupa) of a fly offered illumination by revealing the figure of an animal having all the preformed features of an adult, features that await expansion.[110] The drawings compellingly displayed the unfolding image of the parts: layer after layer, folding after folding, plait after plait, the curling, curving and folding parts were laid on top of each

[101] Chamber, *op. cit.* (note 18), s.v. 'Stamina'; Clifton Wintringham, *An Enquiry into the Exility of the Vessels in a Human Body* (London, 1743), 9–10.

[102] Cf. Walter Pagel, *William Harvey's Biological Ideas: Selected Aspects and Historical Background* (New York: Hafner, 1967), 239.

[103] Chamber, *op.cit.* (note 18), s.v. 'Stamina'; also N. Bailey, *An Universal Etymological English Dictionary* (London, 1730), s.v. 'Stamina'.

[104] Keill, *op. cit.* (note 25), 127–8.

[105] Boerhaave, *op. cit.* (note 18), 155. Sometimes, the stamina were said to be contained in the animalcule; Wintringham, *op. cit.* (note 101), 2–3.

[106] Arbuthnot, *op. cit.* (note 44), 43.

[107] M.N., *op. cit.* (note 18), 93; Martin, *op. cit.* (note 34), 298.

[108] Wintringham, *op. cit.* (note 101), 18–19. Cheyne, an ardent supporter of the encasement doctrine, claimed that the infinite number of animalcules should exist 'in the bigness of a pin's head'; Cheyne, *Remarks on Two Late Pamphlets Written by Dr Oliphant, against Dr Pitcairn's Dissertations* (London, 1702), 43–4.

[109] One aspect of Needham's criticism of preformationism was on precisely this point, that is, the disproportion between 'the great Expansion of the Web and minuteness of the animalcule'; Turbervill Needham, *Observations upon the Generation, Composition, and Decomposition of Animal and Vegetable Substances* (London, 1749), 6.

[110] Clara Pinto-Correia, *The Ovary of Eve: Egg and Sperm and Preformation* (Chicago: University of Chicago Press, 1997), 31, Figure 5 from Swammerdam's *The Book of Nature*.

other, awaiting future expansion. In this sense, the doctrine of preformation was not only about the idea of pre-existing germs that explained subsequent generations; it was also about the informative and powerful image of un/en-folding with regard to growth and development. Hence, drawing on the image of an insect's transformation, the medical theorists could argue that the stamina or animalcules were enfolding by themselves the series of layers of the folded parts, which would stretch and expand, as clearly expressed in Cheyne's remark:

> [T]he Solid Parts of these *Animalculs* [sic] are as it were folded and wrap'd up in *Plaits*, and these Folding are wrap'd together by surrounding Membranes, which in process of Time are rent and torn, by the encreas'd Force of the Fluid and Augmentation of the Solid Parts; As is commonly observ'd in the Transformation of all Insects.[111]

This image of the unfolding of stamina was precisely what growth meant: 'Growth is nothing, but the unfolding of the original *Membranes* and *Fibres*'.[112] Here, the fibres and membranes were evoked, not only because the solids were originally fibrous, but also because the fibres and the membranes agreed with the un/en-folding image through a metaphorical association, and structural affinity, with a pliable textile that enjoyed the elastic property of extending, condensing and contracting. The stamina constituted the fibres, always already plural, because they were formed simultaneously. Hence, by definition, the fibres, the solids, the stamina and the animalcule all equated with each other; 'Fibres' were the 'stamen, or matter of the animal',[113] and the 'Stamina' were the 'Solids of a human body'.[114] Moreover, the equation of stamina with fibres was supplemented by the etymological meaning of stamina, '*warp threads*',[115] sometimes also described as 'Lines' or 'Lineaments'.[116] The metaphorical and visual dimensions of the preformation theory in embryology were at one with the metaphorical, structural and functional aspects of fibres in fibre theory (their minuteness and slenderness, their quasi-infinity of number, their natural affinity with threads and the innate elasticity that makes them capable of expansion and contraction). In this sense, fibre anatomy, fibre physiology and fibre biology mutually refer to and reinforce each other, and this efficacious interconnectedness is the real strength that constitutes the alluring consistency of fibre theory.

## Fibre Constitution

As the discourse on fibre took an increasingly ascendant place in the medical theory of the early eighteenth century, a radical shift occurred in understanding, perceiving and in some case even experiencing the body. The long-enduring humoral theory, on which the knowledge of physical and moral temperaments rested, was gradually superseded by a fibre-based understanding of the temperaments (at least in the theoretical system of medicine, for the older physiological belief about humours persisted in the popular mind). According to the old humoral system, the proportion in the mixture of four humours (phlegm, black bile, yellow bile, blood), each with its own quality (cold and wet, cold and dry, hot and dry, hot and wet, respectively), determines the preponderant temperament

[111] Cheyne, *op. cit.* (note 108), 44; also Cheyne, *op. cit.* (note 72), 203–4; *idem*, *op. cit.* (note 32), 232.

[112] Cheyne, *op. cit.* (note 27), 79; also *idem*, *op. cit.* (note 72), 203–4; James, *op. cit.* (note 18), s.v. 'Fibra' [23].

[113] Chambers, *op. cit.* (note 18), s.v. 'Fibre'.

[114] Bailey, *op. cit.* (note 102), s.v. 'Stamina'.

[115] Chambers, *op. cit.* (note 18), s.v. 'Solids'; also see OED, ie. Oxford English Dictionary, s.v. 'Stamina'.

[116] Daniel Turner, *De Morbis Cutaneis, A Treatise of Diseases Incident to the Skin*, 2nd edn (London, 1723), 169; also Cheyne, *op. cit.* (note 49), 174; Needham, *op. cit.* (note 109), 8.

of the individual: phlegmatic – dull temperament, melancholic – gloomy temperament, bilious – choleric (quarrelsome) temperament and sanguine – balanced and cheerful temperament.[117] However, after iatromechanical philosophy reinforced the primacy of blood among the four humours and transferred the properties of the other humours to blood itself, and the physiology of circulation discredited humoral physiology, diversity of temperament needed to be founded on something other than the humours. Fibre could now serve this purpose.

Although the fundamental tenets of humoralism were largely discarded by the new fibre-based solidism, the fluids still played an important, though not critical, role in the knowledge of temperaments, the difference of which was thought to lie in the various motions of the blood ('different Constitutions [are] no other than various Motions of the Blood'[118]). The motions of the blood varied first by the different size and quantity of the 'moving Fibres', and more importantly by the fibres' 'Pulse and Tone', which determined their strength and vigour.[119] Thus, endowed with the vigour to move the blood and thereby alter its qualities, the elasticity or tone of the fibres was seen as crucial in determining the different qualities of constitutions.

Robinson provides an interesting case for the new classification system of temperaments that re-aligns the traditional four types of constitutions according to the degree of elasticity of the fibres. First, the 'biliose' constitution, also known as the bilious or choleric, arises from the highest degree of elasticity in the solids, inclining the individuals of this temperament to gratify their passions; naturally their intellectual faculties are lively, vivacious and 'abounding with the sublime Wit', and genius resides in this constitution. Second, the sanguine constitution is derived from the less elastic impulse of the heart and arteries, at least less elastic than the 'biliose'; the sanguine's solid way of thinking is apt for the discoveries of experimental knowledge. Third, the fibres of the 'phlegmatick' constitution have less elasticity, whereby all impulses are weaker, and the motions and secretions slower; because of this reduced elasticity, the phlegmatic's intellect is not appropriate for a quick apprehension of objects offered to the senses, but they can retain most of what they perceive so as to improve upon inventions first discovered by others. The melancholy temperament, the last temperament, is only 'phlegmatick' to a greater degree.[120]

Fibre-based constitutions were polarised – people had either very elastic or very weak fibres – although a variety of intermediate degrees was admitted.[121] People with very elastic fibres are generally lean and dry; they have strong, hard muscles and clean, firm bodies; they are naturally impatient, prone to action,[122] and subject to inflammatory diseases. Sometimes, they are called 'hot constitutions' since they have stronger fibres than others.[123] People with weak and lax fibres, on the contrary, have thin hair, are small, have soft, loose muscles, a fair skin and since their extremities, because of their 'cold constitutions', are often cold, they are prone to catch cold on the slightest occasion; they

[117] See Mary Lindemann, *Medicine and Society in Early Modern Europe* (Cambridge: Cambridge University Press, 1999), 12–13.
[118] Short, *op. cit.* (note 44), 63.
[119] Browne, *op. cit.* (note 56), xxii; Robinson, *op. cit.* (note 51), 17–18; but see Arbuthnot, *op. cit.* (note 44), 146, on an alternative view of the fluids affecting temperaments.
[120] Robinson, *op. cit.* (note 51), 19–22.
[121] Cheyne, *op. cit.* (note 72), 82–4.
[122] Short, *op. cit.* (note 44), 55.
[123] James, *op. cit.* (note 18), s.v. 'Fibra'[10].

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are frequently lazy, indolent and dull, and subject to chronic diseases.[124] Sometimes, the traditional discourse on the polarity between robust people who live in the country and the luxurious and indolent men of the city was superimposed on the theory of fibre-based constitutions: robust country people tended to have strong fibres while lazy, weak, city people had flabby fibres.[125] However, tense, over-strained fibres could become rigid, too stiff and eventually un-elastic or 'callous'. In people endowed with such fibres, the advantages of firm health might be offset by the disadvantages of lesser mental and sensory capacities, as Cheyne included in this category, '*Ideots*, *Peasants*, and *Mechanicks*'.[126]

Implicit in the system of fibre-based constitutions was the belief that social distinctions among particular types of intellect was physically embedded in the tone and texture of the fibres. Contemplating the immense variety of human mental capacities, Robinson[127] reasoned that since the souls of all people must be equal, the difference between the idiot and the genius must be sought in the body, that is, the fibres.[128] All the 'sublime Flights and extatick Visions' the genius enjoyed were owing to the 'due Modulation of the Solids', the 'happy Structure of the Fibres' – the arteries very springy, the blood easily moveable, the secretion of the animal spirits naturally large and the nervous system adjusted to the highest pitch its natural standard would admit. All this ensured such strong impulses of the ideas on the sensorium as to sufficiently produce an elegant turn of thought and a quickness of memory.[129] Natural stupidity, on the other hand, came from 'an over Laxness in the Fibres of the Brain' which produced the very opposite effect.[130] For Blackmore, the alleged intellectual backwardness of Africans, as well as the variety of monstrous and irregular minds in general, was the result of Nature's error, ie. the 'improper Length, Size or Situation of a Fibre'.[131]

As a robust man with tense fibres would be stigmatised as obtuse, so in the delicate man of finer fibre, a variety of nervous distempers such as 'hypo', spleen or hysteria, would be ambiguously counterpoised to his superior mental capacities.[132] Indeed, this was the age of 'English Malady', an epithet that signalled, paradoxically, the superior rank of the nation and of certain individuals; for being afflicted by certain diseases was believed to be rather desirable so long as the disorder was of a less serious degree.[133] In the course of the eighteenth century, the medico-cultural myth of nervous sensibility – that a person is more delicate if they have finer nerves – intensified with the full-grown culture of sensibility, especially from mid-century on.[134] It should be noted, however, that at this point, in the first half of the century, especially before the 1740s, the nervous system was not the sole physical factor underlying the privileges of the higher orders; rather, it was only a part of the larger system of the fibre-solids. What was essentially important in determining social

[124] Short, *op. cit.* (note 44), 56; also James, *op. cit.* (note 18), s.v. 'Fibra' [10].
[125] James, *op. cit.* (note 18), s.v. 'Fibra' [10].
[126] Cheyne, *op. cit.* (note 72), 160.
[127] Robinson, *op. cit.* (note 51), 30ff.
[128] Robinson, *op. cit.* (note 51), 34.
[129] Robinson, *op. cit.* (note 51), 56–7.
[130] Robinson, *op. cit.* (note 51), 65, 73.
[131] Blackmore, *op. cit.* (note 72), 263–4. Cf. Cheyne, *op. cit.* (note 72), 82–4; he mentioned two kinds of human races – those that govern and those that are governed.
[132] Cheyne, *op. cit.* (note 18); *idem*, *op. cit.* (note 72), 82.
[133] Cheyne, *op. cit.* (note 18); Blackmore, *op. cit.* (note 72), 90.
[134] See on this point Barker-Benfield, *op. cit.* (note 42); and Rousseau, *op. cit.* (note 3).

and cultural distinctions was not the nerves and their sensibility, but the fibres and their elasticity.

Although the notion of stamina predisposes us to regard the fibre-solids as innate and unchangeable throughout life,[135] the notion of tone or elasticity implies that fibres are highly malleable under the influence of the non-naturals.[136] The malleability of the fibre-based constitution is clearly seen in northern people of firmer habits and 'superior Elasticity of the *Muscular Fibres*', who underwent considerable constitutional change in a southern climate. Tennent suggested that fibres of the northern people, the 'superior' elasticity of which is largely due to the cold atmosphere, became lax and weak when exposed to the heat and humidity of the south. (Note the implied assumption of the superiority of cold northern people and the inferiority of hot southern people.) In a hot and humid climate, the particles of the blood combine, whereby the blood acquires a greater degree of viscidity and eventually stagnates; it is for this reason that northern people are so susceptible to a mortal fever upon their arrival in the West Indies.[137] It is of great interest to see how the concept of the plasticity of fibre-constitutions resonated with cultural concerns regarding the malleability of man. The discourse on the fibre-based constitution is one of the general points that differentiates the first half of the century (epitomised by the solids in general and the fibre in particular, with its innate property of elasticity) from the second half (exemplified by the nervous system in general and the brain or the nerves in particular, with the innate power of sensibility). Towards the end of the century, the diversity of humankind and the differences within specific groups of people (eg. social rank, class or gender) would be founded in biological and anatomical differences, signs of which were embodied in the nervous system and other systems of the body. The relatively malleable system of fibre-solids of the earlier eighteenth century gave way to the more innately codified system of the nerves and the brain, which eventually led to the establishment of a 'nervous' foundation for the racial sciences of the nineteenth century.[138] By the beginning of the Victorian era, the fluid-and-flux constitution, as formulated by traditional humoralism, had been completely replaced by the scientific classification of constitutional 'types'. Yet in the eighteenth century, especially in its earlier half, the idea of fibre-based constitutions, through their innate elasticity flexibly interacting with the environment (roughly equivalent to the six non-naturals), was sustained, fluctuating between the sheer fluidity of humours of the older era, and the rigid and crude codification underlying some of the more sinister elements of the coming era.

## Concluding Remarks

By scrutinising the prominence of the discourse on fibres in the medical theory of the first half of the eighteenth century, this article has attempted to redress the medical historians' fallacious tendency to see eighteenth-century medical theory in terms of either mechanism

[135] Cf. Robinson, *op. cit.* (note 51), 15.

[136] Short, *op. cit.* (note 44), 63–4.

[137] Tennent, *op. cit.* (note 80), 1–4. Tennent cautions that 'tho' a person leaves England in the most healthful State, the Constitution must undergo a Change, that threatens to terminate in a stagnation of the Blood, perhaps a total Stagnation, which is *Death*, and indeed is too often the Case' (3).

[138] See H. F. Augstein (ed.), *Race: The Origin of an Idea, 1760–1850* (Bristol: Thoemmes Press, 1996); Nancy Stepan, *The Idea of Race in Science: Great Britain, 1800–1960* (London: Macmillan, 1982). Charles White, a disciple of John Hunter, in his *An Account of the Regular Gradation in Man, and in Different Animals and Vegetables* (London, 1799), appropriated Camper's theory of facial angle to the racial hierarchy of human race (134 and passim).

(the hydraulic machine composed of pipes and the fluids running through them) or vitalism (the sensitive organism composed of the brain and the nerves). The concept and metaphor of fibres were frequently invoked and became a reference point to explain anatomical structure, physiological functions, pathological processes, therapeutic practices, biological phenomena and constitutional differences. Arguably, the medical practitioners of the era needed the concept of fibres, rather than that of vessels, muscles or nerves, since fibres comfortably met the demands of the various interlocking areas of medicine. In anatomy, the idea of fibre was most appropriate for conceiving the body as wholly woven from a thread-like substance; in physiology, pathology and therapeutics, medical theory was made plausible by the idea of the tone or elasticity of fibres capable of incessant vibration; in biology, the image of fibre-membranes identifiable with stamina was in harmony with the preformationist explanation of the mysterious process of 'un/en-folding'; and lastly, the malleability of fibre was in full conformity with the equally malleable idea of constitutions interacting with the environment. It should be emphasised that metaphors such as weaving, elastic vibrating and un/en-folding, rather than the mere nature or properties of the fibres *per se*, played a significant role in conceptualising the fibre theory of each field, all the more so when the metaphor mediated between fibre theory and the socio-cultural realm. In this sense, the metaphorical dimension of fibre was an integral part of fibre theory, not an obstacle to objectivity. Paradoxically, it may have been fortunate for the fibre theorists that the ultimate fibre was never found, since therefore they could only imagine what it would be like; and it was this hypothetical and imaginary substance that fueled the imagination, sustaining fibre theory and its many layers of metaphoric density. If the cell of the nineteenth century became the 'ultimate fact' that the medical scientists required,[139] the fibre of the eighteenth century was a kind of 'necessary fiction' for medical practitioners of the earlier era.

From a broader perspective of the history of medicine, the fibre medicine of the eighteenth century may be posited as the transitional phase from ancient humoralism to modern solidism. The conceptual framework of humoral theory was gradually discarded during the first half of the eighteenth century, with the result that ideas of health and disease, life and death, no longer rested on the balance of the four humours but on the grades of 'tone' or 'tension' of the solid parts of the body. However, what part of the solids was relevant for life and health? Solids were not co-terminous with the nervous system, as the later vitalistic medical theorists claimed, but they were primarily fibres and those parts made of fibres (membranes, vessels, muscles, bones, as well as nerves). Fibre theory arguably occupied the central place in the very foundation of the modern theory of solidism.

This aspect of the relevance of fibre to solidism is more understandable if we relate it to the emergence of the modern (secular) body. As the historiography of the eighteenth century reveals, that century witnessed, in various fields, substantial transformations that laid the groundwork for what we call 'modernity'.[140] Recent studies on the history of the body and sexuality also point to the eighteenth century as a key period in determining how modernity would understand and experience the body. Historians of the body, particularly of sexuality, and the scholars of related fields (gender studies, family history or literary

[139] See L.S. Jacyna, 'The Romantic Programme and the Reception of Cell Theory in Britain', *Journal of the History of Biology*, 17, 1 (1984), 13–48.

[140] See Roy Porter, *The Creation of the Modern World: The Untold Story of the British Enlightenment* (New York: Norton, 2000); Miles Ogborn, *Spaces of Modernity: London's Geographies 1680–1780* (London: Guilford Press, 1998).

studies) have claimed that the earlier pre-modern body underwent a significant change during the eighteenth century.[141] The pre-modern body, once conceived as divinely given and hence understood in cosmological terms, and often perceived according to criteria more socially than biologically determined (eg. gender), became at once precariously and happily modern and secular in the eighteenth century – happily in the sense of the liberation of the mind and the body from longstanding authoritative religious teachings (an aspect exemplified in the pursuit of happiness and the hedonistic enjoyment of bodily pleasure), and precariously in the sense of the scientific underpinnings and the correlated 'moral' discipline imposed on the body as alternatives to those traditional religious teachings. The 'Fibre Body', derived from, and enlightened by, fibre medicine, was deeply involved in this process of transformation. With the change in the way the body was understood and experienced, from the fluid (humoral) to the solid, medical theorists exploited the solid-fibre instead of the fluid-humours as the physical basis for the reformulation of the body in its modern, secular guise; more precisely, they had little choice but to do so. For the body could not, in the first place, be treated in strictly anatomical, physiological or natural terms (ie. as the physical and solid body liberated from the domination of humours and thus from the traditional socio-cosmological underpinnings of humoral theory) without the material presence of the solid-fibres as a frame of reference to designate the new way in which the body was to be understood, perceived, or marked in the realms of sex, gender, race, ethnicity or class. The radical shift from humoralism to solidism, hitherto relatively neglected by medico-cultural historians, is more indispensable for the understanding of the emergence of the modern body than one might assume. The fibre body reigns amidst this shift.

[141] See Helen Deutsch and Felicity Nussbaum (eds), '*Defects*'*: Engendering the Modern Body* (Ann Arbor: University of Michigan Press, 2000); Anthony Fletcher, *Gender, Sex and Subordination in England 1500–1800* (New Haven: Yale University Press, 1995); Thomas Laqueur, *Making Sex: Body and Gender from the Greeks to Freud* (Cambridge, MA: Harvard University Press, 1990); Londa Schiebinger, *The Mind Has No Sex?: Women in the Origins of Modern Science* (Cambridge, MA: Harvard University Press, 1989).