

INTRODUCTION

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Writing physiology

In the history of early modern medicine, physiology – now understood as the theory of the normal functioning of living organisms – remains the poor relation.

The papers presented here are intended to help scholars in a range of disciplines to consider why it is so difficult to provide a history of physiology; how far is this due to changing notions of what physiology is, and how far does it depend on the methods by which physiology comes to its conclusions? There has been no general history of physiology for the last forty years and, in contrast to anatomy, the topic has received very little attention at all from historians in that period. Within philosophy, the situation is rather different; the work of Dennis Des Chene, particularly his *Physiologia. Natural Philosophy in Late Aristotelian and Cartesian Philosophy* (Cornell University Press, 1996) has been welcomed by philosophers but has had surprisingly little impact outside that field. In this book, and in his subsequent monograph *Life's Form. Late Aristotelian Conceptions of the Soul* (2000), Des Chene locates Descartes within his Aristotelian background, exploring the emergence of modern ideas of 'science' from medieval philosophy. The standard modern histories of physiology include Thomas Hall's work, originally published in 1969 and subsequently reissued as *History of Physiology 200 BC–AD 1900* in 1975, and the 1953 book in German by Karl Rothschuh, published in English translation in 1973.¹ Hall set out what he regarded as the 'classic questions' of physiology, from the Greeks onwards: these concerned 'motion, generation, nutrition' and 'the life-matter problem, of the nature of life and of its seat in the body'.² In his Introduction to the English translation of Rothschuh, Leonard G. Wilson stated that 'Physiology, as a subject of inquiry has a long and remarkably

¹ Hall T., *History of Physiology 200 BC to AD 1900* (Chicago: 1975); Rothschuh K., *History of Physiology*, tr. Risse G. (Huntington, NY: 1973).

² Hall, *History of Physiology* 7.

continuous history beginning with studies and speculations of the Greeks in the fifth century BC.³

This image of continuity has been challenged by the work of Andrew Cunningham, whose papers published in 2002 and 2003 respectively, cited by a number of contributors to this volume, are among the very few modern studies of the relationship between anatomy and physiology in the Early Modern period. Cunningham emphasised how physiology used reason rather than experiment, and that it remained very close to philosophy, so that 'When explanations in natural philosophy changed, so explanation in physiology also changed'.⁴ While the word 'physiology' is thus found in texts written before the nineteenth century, there is a wide range of concepts working underneath the same name.

In contrast to the neglect of the unified and functioning body of 'physiology', the history of 'anatomy' – traditionally seen as concerned with structure, rather than function – has been the subject of considerable recent study. Trends in medical history towards 'the body in parts' approach have privileged anatomy; literally, the cutting-up or 'division' of the body. They have done this by concentrating on a single body part – heart, head, foot – and tracing its representation and interpretation across time.⁵ Anatomy has been important in recent histories of early modern medicine partly because of its place in education; for example, Katy Park's *Secrets of Women* (2006) traced the rise of human dissection from its emergence in the thirteenth century to its establishment in the curriculum of European universities in the mid-sixteenth century, and showed how the quest to understand women's

³ Rothsschuh, *History of Physiology* xi. On the claims for continuity, see further Cunningham A., "The Pen and the Sword: Recovering the Disciplinary Identity of Physiology and Anatomy before 1800 I: Old Physiology – The Pen", *Studies in History and Philosophy of Science Part C. Studies in History and Philosophy of Biological and Biomedical Sciences* 33 (2002) 636.

⁴ Cunningham, "Old Physiology – The Pen" 641. The companion article is "The Pen and the Sword: Recovering the Disciplinary Identity of Physiology and Anatomy before 1800 II: Old Anatomy – The Sword", *Studies in History and Philosophy of Science Part C. Studies in History and Philosophy of Biological and Biomedical Sciences* 34 (2003) 51–76.

⁵ King H., "Inside and Outside, Cavities and Containers: the Organs of Generation in Seventeenth-century English Medicine" in Baker P. – Land-van Wesenbeeck K. van 't (eds.), *Medicine and Space. Body, Surroundings, and Borders in Antiquity and the Middle Ages* (Leiden: 2011) 37–60. See for example Hillman D. – Mazzi C. (eds.), *The Body in Parts. Fantasies of Corporeality in Early Modern Europe* (London-New York: 1997); Porter J. (ed.), *Constructions of the Classical Body* (Ann Arbor, MI: 1999); Egmond F. – Zwijnenberg R. (eds.), *Bodily Extremities. Preoccupations with the Human Body in Early Modern European Culture* (Aldershot: 2003). See also Cunningham, "Old Anatomy – The Sword" 57 'anatomists were, in general, more concerned with the parts than with the whole body, which was the subject-matter of the old physiologist'.

interior ‘secrets’ informed this anatomical turn to medicine.⁶ The division of the body was, she has shown, an important part of early modern cultural practices even before the rise of dissection for educational purposes; parts of the dead, saintly body could be buried separately, and preserved independently as relics.⁷ Furthermore, the demonstrations in the anatomy theatres of sixteenth-century Europe were less about anatomical training and more about moral education, with the audiences including civic dignitaries and interested men of learning.⁸

What Cunningham characterises as ‘old physiology’ – in order to distinguish it from the ‘experimental physiology’ of the nineteenth century – emerged as a ‘sub-discipline of the experimental discipline of anatomy’ in the eighteenth century, and was seen as a speculative activity in which the scientist took the facts of anatomy as the basis of his speculations.⁹ In the eighteenth century, physiology was close to physics, since it depended on notions of the nature of matter and of motion. Albrecht von Haller recognised that it was necessary to become an expert anatomist before becoming a physiologist and described physiology as ‘animated anatomy’.¹⁰ William Hunter wrote in his *Two Introductory Lectures [...] to his Last Course of Anatomical Lectures* that ‘every good Anatomist, who has a cool head, and keeps a guard over his imagination, knows, that many of the received hypotheses in Physiology, are build on very loose foundations, and liable to weighty objections; or, demonstrably repugnant to what we already know of the structure of our body’.¹¹

But what of the period before the eighteenth century, on which this collection of essays focuses? What was physiology, before it became the speculative wing of anatomy? Tilly Tansey’s chapter on ‘The physiological tradition’ in Bynum and Porter’s *Companion Encyclopedia of the History of*

⁶ Park K., *Secrets of Women. Gender, Generation and the Origins of Human Dissection* (Brooklyn, NY: 2006); Cunningham, “Old Anatomy – The Sword” 52.

⁷ See Cunningham A., *The Anatomical Renaissance. The Revival of the Anatomy Projects of the Ancients* (Aldershot: 1997); Santing C., *The Heart of the Matter. Signification and Iconic Reification of Human Remains at the Papal Court, ca. 1450–1600* (forthcoming).

⁸ Huisman T., *The Finger of God. Anatomical Practice in 17th-century Leiden* (Leiden: 2009).

⁹ Cunningham A., *The Anatomist Anatomis’d. An Experimental Discipline in Enlightenment Europe* (Aldershot: 2010) 156–157.

¹⁰ Cunningham, *The Anatomist Anatomis’d* 93 and 157. On von Haller, see further Cunningham, “Old Physiology – The Pen” 650–657.

¹¹ Hunter William, *Two Introductory Lectures, Delivered by Dr William Hunter, to his Last Course of Anatomical Lectures* (London, printed by order of the Trustees, for J. Johnson: 1784) 93–94; cited in Cunningham, *The Anatomist Anatomis’d* 138–139.

Medicine (1993) contained only two pages on ‘the Renaissance’, one of them being devoted to William Harvey.¹² One of the roles of the present volume is to try to flesh out the period before Harvey. Anatomy claimed as its founder the great hero of classical medicine, the second-century AD writer Galen whose ideas, systematised into ‘Galenism’, dominated medicine into the Early Modern period. Galen himself had not been able to perform systematic human dissection, but his work on animals led him to stress the importance of understanding the structure in order to comprehend the function. Thus those sixteenth-century writers who argued that the true study of the physician or surgeon should be the ‘book’ of the human body itself could still call on Galen for support; if only he had been allowed by the conventions of his day to perform dissection, he would have done exactly as they were now able to do. Hence Cunningham, memorably, described the great Renaissance anatomist Andreas Vesalius as ‘simply Galen restored to life’.¹³

At the peak of the practice of ‘anatomy’ in early modern Europe there was also a move towards seeing medicine itself as unduly ‘divided’ by changes in its professional and intellectual structure between the ancient world and the Renaissance. In the *Preface* to *De corporis humani fabrica* (1543) Vesalius produced a polemic against the perceived inadequacies of the medicine of his own day. In this text on the fragmentation of the body, the great evil is another sort of ‘fragmentation’: ‘that evil fragmentation of the healing art’. ‘So much did the ancient art of medicine decline many years ago from its former glory’: Vesalius regards the lost ideal as being the Alexandrian medicine of the third century BC, which he saw as bringing together control of diet, drugs and surgery in a single person, in contrast to the medicine of his own day when nurses supervise diet, apothecaries drugs, and barbers all manual operations. In Vesalius himself – according to Vesalius – the three spheres had been reunited; this supposed ideal of classical Greek medicine had been realised afresh. Was physiology part of the role of this ideal, holistic, physician?

But, as Vivian Nutton shows in the essay which opens this collection, while Galen wrote a great deal about anatomy, he was less enthusiastic about the role of ‘physiologising’ in medicine. Lending another dimension to the point that the modern division between anatomy and physiology is itself a historical construct, for Galen, the term physiology extended well beyond

¹² Tansey E.M., “The Physiological Tradition” in Walker Bynum C. – Porter R. (eds.), *Companion Encyclopedia of the History of Medicine* (London: 1993), vol. 1. On Harvey as ‘no physiologist but an anatomist’, see Cunningham, “Old Anatomy – The Sword” 55.

¹³ Cunningham, *Anatomical Renaissance* 115.

later concepts of the normal functioning of an organism and even included far more than those areas which we would label the life sciences and medicine. Deriving from the Greek *phusiologia*, in the ancient world physiology formed part of what is better translated as ‘the enquiry into nature’ rather than as ‘natural history’, and represented a search for a better understanding of the power of nature and of what is ‘natural’ and ‘contrary to nature’. In medicine, Galen believed, these types of speculation should hold only a minor place.

In its original meaning, then, *phusiologia* was the entire tree, rather than only one branch. As a predecessor of Galen wrote, ‘The physiological is that which treats of the investigation, *theôria*, into the power of nature that organises and regulates us’.¹⁴ As for the modern sense of ‘physiology’, which is commonly traced back to Jean Fernel, this concept can be traced back to the fifth century AD; furthermore, Fernel too included anatomy under the heading of physiology.¹⁵ Nutton argues that Fernel used the term ‘physiology’ in order to emphasise his Greek credentials, and that it was only in the second half of the nineteenth century that physiology came to be seen as separate from anatomy.

The discourse of medical paternity sometimes makes Fernel ‘the Father of Physiology’, but – in comparison with anatomy – the situation is again less clear. While Herophilus is labelled ‘the Father of Anatomy’ – Vesalius sometimes rivals him, but as ‘Father of Modern Anatomy’ – who holds the corresponding role for physiology? Sometimes it is Herophilus’s fellow physician Erasistratus, but this in fact imposes on to these two men a later division, projecting back distinctions that were not made in their period, the third century BC. Other contenders for ‘the Father of Physiology’ include Herman Boerhaave, William Harvey, and the nineteenth-century William Sharpey or Claude Bernard, for whom – reversing the priority order of the previous century – ‘Anatomy is indeed only the first step in physiology’.¹⁶

The movement of fluids

It has become a commonplace that the pre-modern body was ‘a body of fluids’ rather than a ‘body of organs’, but study of these fluids has thus

¹⁴ Galenus, *Definitiones medicae* 11 (19.351 K.); see below, V. Nutton 29 in this volume.

¹⁵ On Fernel, see Cunningham, “Old Physiology – The Pen” 641–648.

¹⁶ Cunningham, “Old Physiology – The Pen” 639.

far tended to concentrate on the humours.¹⁷ The colloquium as originally conceived aimed to expand the boundaries and to include studies of non-humoral fluids such as sweat, semen, urine and tears, as well as more individual concepts such as the medieval theories of two types of female seed (discussed here by Karine van 't Land), Boerhaave's 'nervous juice' or Sabuco's *chilo*, studied in Marlen Bidwell-Steiner's contribution to this volume.

Specifically, when Manfred Horstmanshoff and Helen King began to draft the original Call for Papers, Horstmanshoff was beginning a project on tears, focusing in particular on the French physician Pierre Petit (Petrus Petitus, 1617–1687). Pliny the Elder had claimed the capacity to shed tears as something that defined human beings against other animals, stating that 'Man alone Nature deposits naked on the naked ground at the time of his birth, immediately to wail and cry' (*Natural History* 7.2).¹⁸ Horstmanshoff noted that the classically-rooted work of Petit, *De lacrymis libri tres* (1661), was published in the same year as the Danish anatomist, geologist, mathematician, theologian, and craftsman Niels Stensen (Nicolaus Stenonius) defended at the University of Leiden his thesis on the glands of the human face.¹⁹ While the thesis did not discuss the lachrymal glands, in December of the same year Stensen published *De glandulis oculorum novisque earundem vasis observationes anatomicae, quibus veri lacrymarum fontes deteguntur*. It was then printed again, with the 1661 dating, within a more accessible book: *Observationes anatomicae* (1662). Horstmanshoff was struck by the synchronicity of the 1661 events. The same year saw a thoroughly 'classical' discussion of questions such as how tears are produced and 'Whether the substance of tears is already in the body before weeping, or comes into existence by weeping itself', structured in Aristotelian terms, drawing on Greek and Latin sources as well as

¹⁷ Cunningham, *The Anatomist Anatomis'd* 158 cites Winslow's 1733 comment that 'The history of the fluid parts [...] properly belongs to what is called Physiology or the Animal Oeconomy'.

¹⁸ '<Natura> hominem tantum nudum et in nuda humo natali die abicit ad vagitus statim et ploratum'.

¹⁹ Stensen's thesis: *Disputatio anatomica de glandulis oris, et nuper observatis inde prodeuntibus vasis prima*, Leiden, Johannes Elzevir: 1661. *De glandulis oculorum novisque earundem vasis observationes anatomicae, quibus veri lacrymarum fontes deteguntur* is printed from 79 in his *Observationes anatomicae*, Leiden, Jacobus Chouët: 1662. There he says: 'Ex hisce glandulis, earumque vasis, qui palpebras inter oculique globum observatur, humor procedens, per lacrymalia puncta in nares defluit', 'The fluid flowing from these glands and their vessels, observable between the eyelids and the eyeball, flows down through the punctum lacrimalis into the nose'.

the Bible and the Church fathers (all seen by Petit as making up a single, living tradition) and using the concepts of *spiritus* and humours: but also a 'modern' analysis, based on observation of animal dissection, coming to the conclusion that the function of tears is simply to irrigate the eyes.²⁰ The role of tears forms part of a wider discussion on the role of the emotions, and how far this changed in the Enlightenment,²¹ but the synchronicity of Petit and Stensen also illustrates well how arguments based on analogy, and arguments derived from observation and experimentation, were both being made in 1661. However, at this period, 'experiment' could simply mean 'experience'.²²

Structure and function, movement and stability

How does physiology fit into the ideals of seeing for oneself, and of a unified medical science? Whereas structure can be discovered by dissection, function cannot easily be seen in the same way;²³ Galen used his observations from dissection as the basis for his theories of physiology but, as Véronique Boudon-Millot points out in her chapter in this collection, he was trying to account for 'a reality that is, by its very nature, unobservable'.²⁴ His theories of vision, specifically, relied on the invisible *pneuma*, which he believed was so thin and light that it escaped even before the dissection commenced. Boudon-Millot thus extends to the ancient world Cunningham's point that physiology could be seen as the speculative narrative based on the structures shown by anatomical investigations, but adds the further idea that invisible substances could be used as the basis of the speculation.²⁵

But it is important to acknowledge that even structure is not 'given' to experience; while some bodily structures, such as a bone or an organ, may appear to be self-evident entities, even here interpretation is needed. For

²⁰ *Existimo itaque lacrymas nihil esse, nisi humorem, qui oculo irrigando destinatus est* (92–93).

²¹ See Page Bayne S., *Tears and Weeping. An Aspect of Emotional Climate Reflected in Seventeenth-Century French Literature* (Tübingen-Paris: 1981) and Lange M.E., *Telling Tears in the English Renaissance* (Leiden-New York-Cologne: 1996).

²² Cunningham, "Old Anatomy – The Sword" 60.

²³ Cunningham, *The Anatomist Anatomis'd* 156.

²⁴ See the contribution of V. Boudon-Millot 559 in this volume.

²⁵ Cunningham, "Old Anatomy – The Sword"; see also Cunningham, *The Anatomist Anatomis'd*.

example, early modern treatises often regarded the vagina not as a different organ, but as part of the womb. In early modern medical Latin, the word *vagina* could mean what we call 'the womb', with what we call the vagina being regarded as 'the neck of the womb'.²⁶ In *European Sexualities, 1400–1800* Katherine Crawford notes that 'Female parts were not distinct enough to merit separate names'.²⁷ This is rather overstating the situation; while the late medieval infertility treatises studied by Amy Lindgren show 'blurry or even nonexistent' boundaries between the womb, vulva and female testes, writers in this period who focused on anatomy did separate out the 'neck' of the womb as a separate structure.²⁸ By the early seventeenth century, works such as Bauhin's *Theatrum anatomicum* (1605) included the *fundus*, the *os*, the *cervix* and the various parts of the *pudendum externum*, among them the clitoris and labia. Because early seventeenth-century medical writers accepted Galen's view that women as well as men produce seed, they organised their discussions of the female generative parts on the model of the male body, first describing the vessels that produce, store and evacuate this seed, before moving to the organ of evacuation: the penis or the womb.²⁹ The perception of structure could thus derive from beliefs about function. Sometimes function led to a belief in a part of the body that we no longer accept. In this collection, Michael Stolberg draws our attention to a previously-unstudied aspect of the early modern body, a space 'between the flesh and the skin', which appears to result from a greater interest in sweat as a means of excreting unhealthy substances. Valeria Gavrylenko goes back to the Homeric poems to ask when 'skin' became a body part, and argues that, while the terms for animal skin, or hide, could be applied to humans in poetic language, the Homeric heroic body is a 'body without skin' in which surface and depth are united, and the whole flesh can 'melt' under the impact of emotion. Even where we agree on the bodily part, our view of it may be very different; for example, Michael McVaugh offers a sense of how our 'kidney' differs from that of Mondino.

²⁶ See for example Hobby E. (ed.), *Jane Sharp. The Midwives Book, or, the Whole Art of Midwifry Discovered* (New York-Oxford: 1999) xxxi.

²⁷ Crawford K., *European Sexualities, 1400–1800* (New York: 2007) 106–108.

²⁸ Lindgren A., *The Wandering Womb and the Peripheral Penis. Gender and the Fertile Body in Late Medieval Infertility Treatises* (PhD thesis, University of California, Davis: 2005) 103; 92–93.

²⁹ E.g. Bauhin, *Theatrum anatomicum* 214; *ibidem Institutiones anatomicae* 78–80 on the woman's 'vasa spermatica, testes, vasa deferentia seu ejaculatoria'; 80–86 on the womb.

The characterisation of anatomy as static, physiology as concerned with motion, also merits historical study. Sabine Kalff looks at seventeenth-century arguments, that motion was the way to preserve the health of both bodies and states, proposed by writers outside the area of medicine. Tomas Macsotay's paper also looks outside medical views of health and disease to examine how eighteenth-century artists interacted with medicine in their own explorations of the body. He discusses how artistic education at the Paris Royal Academy was criticised for relying on the anatomical model or the posed body, with Diderot proposing the observation of real people moving about as they performed everyday tasks. Diderot admired ancient Greek sculptors, while at the same time taking ideas from Montpellier vitalism.

Analogy and metaphor

In pre-modern medicine, represented for example by Petit, the dominant model of thinking about the function of the body was an analogical one; rather than discussing causality, analogies were drawn between bodily systems, with other aspects of the natural world, and with emerging technologies. The woodcut we have chosen as our cover image is a striking example of analogical thinking. In the third part of his encyclopaedia Ma'aseh Tobiiyyah (*Work of Tobias*), published in Venice in 1708, Tobias Cohn illustrated the human body as a house (fol. 107 recto).³⁰ One of the first Jews to study medicine in a German university, Frankfurt-am-Oder, Cohn moved to Padua because, as a Jew, he could not graduate at Frankfurt. He then worked in Poland and as a doctor to five successive sultans in Adrianople and then Constantinople. The house of the body divides body space so that, for example, the head is the roof, the spleen the cellar, and the legs the foundations. The functions of the body are seen according to a thermodynamic model that uses comparisons with the apparatus of distillation. Allan has shown how this eclectic representation picks up analogies used by William Harvey and John Donne; the illustration both summarises and transmits the Galenic tradition, and incorporates the

³⁰ Allan N., "Illustrations from the Wellcome Institute Library: A Jewish Physician in the Seventeenth Century", *Medical History* 28 (1984) 324–328; 324 n. 1 discusses the date of this work. On Cohn see <http://www.jewishencyclopedia.com/view.jsp?artid=656&letter=C&search=cohn> accessed 8 January 2011.

newest discoveries.³¹ As heat is represented as the motor, the ideas of Descartes and the thermodynamic model of the body are also incorporated.³²

We have already noted that, while anatomical structures can be discovered by dissection, function can less readily be seen. A further important point follows from this; because physiology cannot base its knowledge on visible structures, it needs to use analogies in a different way. Instead of linking two visible phenomena, physiological analogies have to conceptualise what cannot be seen by the eye. However, anatomical analogies may then lead to assumptions about physiology. In this collection, Elizabeth Craik examines the Hippocratic treatise *On Glands*, which proposed that 'glandular parts belong to an integrated system'. Based on knowledge of comparative anatomy gained in sacrifice and cooking, these glands are said to be 'sponge-like' or 'fat-like' in appearance from a very early date. However, while their appearance was well-known, their function was less easy to discover. *On Glands* itself played little part in early modern discussions, perhaps because it favoured flux theory over humoralism. Furthermore, as physiology studies processes rather than structures, for physiology even the term 'structure' is misleading, resting as it does on the claim of an isomeric structural analogy between visible and invisible parts of bodies. Different types of metaphors are needed in physiology, in particular those borrowed from art and meteorology, as the contributions of Tomas Macsotay and Barbara Orland demonstrate here.³³ Sabine Kalff concentrates on the ways in which views of dynamic motion in physiology interacted with the utopian views of Tommaso Campanella and Francis Bacon, examining in particular the image of the body as a battlefield, with fever, for example, being seen not as a sign of disorder, but as part of the process of healing.

Aristotle described how analogy can connect what is not fully understood with what is known. An example would be his own comment that the formation of the embryo is like the process of turning milk into cheese, discussed here by Karine van 't Land. However, the analogy is capable of more than one use. When Avicenna repeated this analogy, he departed from it in that he considered that the active principle – the rennet, or male sperm – itself became part of the final product. Liba Taub's chapter

³¹ Allan, "A Jewish Physician in the Seventeenth Century" 327. We thank Ana Resende for bringing this illustration to our attention.

³² I owe this point to Claus Zittel.

³³ See further on this point Zittel C., *Theatrum philosophicum. Descartes und die Rolle ästhetischer Formen in der Wissenschaft* (Berlin: 2009).

discusses the difference between analogy and metaphor, arguing that, while ‘analogies point to resemblances [...] metaphors may include novelty as an important feature’.³⁴ As Daniel Schäfer argues, when discussing the image of ageing as a fading flame, analogies to natural or cultural processes regularly served as starting points for medical thinking, or as confirmations of medical conceptions. In the frontispiece to Francis Bacon’s *The Historie of Life and Death* (London, Humphrey Mosley: 1638), a work which Schäfer discusses, scenes of life and death surround the author’s portrait. This metaphor for ageing immediately draws the reader’s attention to the obvious analogies between nature and culture which, for Bacon, become scientific analogies, made possible by the imagination.³⁵ This kind of *scientiae analogia*³⁶ was not thought to be a law or even a natural structure, but rather was used as a heuristic tool in the search for experimental knowledge.³⁷ [Fig. 1]

Schäfer shows both continuity and change in the Early Modern period, when analogies drawn from iatrochemistry (such as fermentation) and iatromechanics (the body as a machine wearing out) came into play. Tamás Demeter’s chapter includes discussion of Hume’s question as to whether the mind is more like a wind instrument, or a string instrument; imagery and practice were closely connected, with Prins’s chapter on Ficino looking not only at ‘the music of the pulse’, but also at the use of music to change the pulse. Kalff shows how Campanella represented the pulse as a drum, summoning the spirits to battle against a fever. The theme of the senses is found in many papers in this collection, with hearing and voice also considered by Wells, and sight by Boudon-Millot and Vanagt.

By the Early Modern period, ancient explanations of physiological phenomena thus existed alongside newly emerging methods of explanation based on the study of nature. Jacomien Prins, however, draws our attention to alternative constructions even of ‘nature’; when Marsilio Ficino talks about it, ‘the “nature” of which [he] speaks is not our observed

³⁴ See the contribution of L. Taub 42 in this volume.

³⁵ See for example Jardine L., “*Experientia literata* or *Novum Organum*? The Dilemma of Bacon’s Scientific Method”, in Sessions W.A. (ed.), *Francis Bacon’s Legacy of Texts* (New York: 1990) 47–68; Eamon W., *Science and the Secrets of Nature* (Princeton, NJ: 1994).

³⁶ *Temporis partus masculis*, in Bacon Francis, *The Works of Francis Bacon, Baron of Verulam, Viscount St. Alban, and Lord High Chancellor of England*, eds. Spedding J. – Ellis R.L. – Heath D.D., 14 vols. (London: 1858–1874), vol. III, 538.

³⁷ See Bacon Francis, *Novum Organum*, vol. II, nr. 42, in Bacon Francis, *The Works of Francis Bacon, Baron of Verulam, Viscount St. Albans, and Lord High Chancellor of England*, eds. Spedding J. – Ellis R.L. – Heath D.D., 14 vols. (London: 1858–1874), vol. I, 316.



Fig. 1. English of Francis Bacon, *The Historie of Life and Death* (London, Humphrey Mosley: 1638); five panels with scenes representing life and death surround the title in the centre. In the top panel, there are animals, trees and figures in a landscape. At the left of this panel is a crowned woman with a wand and the inscription 'Art can slay Natures decay'. To the right, Time holds a book and a scythe. The inscription here is: 'Let time Looke on this booke'. To the left of the title an elderly couple with walking sticks is represented, and to the right mourners amidst dead livestock, as birds fall from the sky. The bottom section has a portrait of Francis Bacon at the centre; to the left, a medallion showing dead animals, with the inscription 'To death all', at the right side another depicting tombs and bones, with the inscription 'At last fall'. Engraving. © Trustees of the British Museum.

nature, but the supernatural nature of the intelligible harmonic realm'. The analogical movement operated in both directions; in meteorology, geology, cosmology, and political and economic theory, analogies and metaphors derived from physiology could be used. This was not simply an early modern phenomenon; Liba Taub's chapter looks at the use of physiological analogies in ancient meteorology, an area that would today be seen as 'geology', and shows how the imagery of digestion, in particular, was applied to other areas of the ancient 'enquiry into nature' such as the cause of earthquakes. She reminds us of Piet Schrijvers' comments on Lucretius, noting that the use of physiological analogies, by referring to the familiarity of the human body, can make otherwise daunting natural phenomena less terrifying. 'What', Taub asks, 'is more familiar to us than our own bodies, and the processes they undergo?'³⁸

In the frontispiece to a 1664 publication by Lewenheimb (Philipp Jakob Sachs von Lewenheimb, 1627–1672),³⁹ we find a rare example of a pictorial representation of such analogies between meteorology and physiology. [Fig. 2]

The comparison between the veins of the earth and of the body had been used to explain weather since Aristotle (Arist. *Mete.* 32a); it was still firmly established in the scientific communities of the seventeenth century,⁴⁰ and can be found even in Harvey and Descartes. In his *Principia* Descartes went so far as to compare explicitly the circulation of the blood discovered by Harvey, and the weather cycle.⁴¹ The French edition of the *Principia* includes further interesting additions: 'De façon que le cours de l'eau en cette Terre imite celui du sang dans le corps des animaux, où il

³⁸ Schrijvers P., "Seeing the Invisible: A Study of Lucretius' Use of Analogy in *De rerum natura*", in Gale M. (ed.), *Oxford Readings in Classical Studies. Lucretius* (Oxford: 2007) 255–288; see the contribution of L. Taub 58 in this volume.

³⁹ For Lewenheimb see Margulis L. – Sagan D., *Dazzle Gradually. Reflections on the Nature of Nature* (White River Junction, VT: 2007) 157–158.

⁴⁰ Cf. Perrig A. "Leonardo: die Anatomie der Erde", *Jahrbuch der Hamburger Kunstsammlungen* 25 (1980) 51–80. Thanks to Claus Zittel for this example and for the bibliography discussing it.

⁴¹ 'Atque ita, ut animalium sanguis in eorum venis et arteriis, sic aqua in terrae venis et in fluviis circulariter fluit', Descartes, *Principia*, vol. IV § 6, Adam C. – Tannery P. (eds.), *Œuvres de Descartes* (Paris: 1897–1913), vol. VIII, 244). Cf. Harvey, *De motu cordis* ch. 8; Gregory A., "Harvey, Aristotle and the Weather Cycle", *Studies in History and Philosophy of Biological and Biomedical Sciences* 32 (2001) 153–168; Pulkkinen J., "The Role of Metaphors in William Harvey's Thought", in Zittel C. – Engel G. – Nanni R. (eds.), *Philosophies of Technology. Francis Bacon and his Contemporaries* (Leiden-Boston: 2008) 253–286.



Fig. 2. Frontispiece to Philippi Jacobi Sachs a Lewenheimb, *Phil. et Med. D. et Collegii Naturae-Curiosorum Collegae Oceanus Macro-Microcosmicus seu Dissertatio Epistolica De Analogo Motu Aquarum ex et ad Oceanum, Sanguinis ex et ad Cor. / ad [...] Dn. Thomam Bartholinum, Medicum et Anatomicum Incomparabilem Professorem Regium Honorarium, et Decanum Fac. in Regia Hafnensi Perpetuum* (Wroclaw, Fellgiebel: 1664).

fait un cercle en coulant *sans cesse fort promptement de leurs veines en leurs arteres, et de leurs arteres en leurs veines*'.⁴²

Change, continuity and authority

A major theme of this collection is that what appears to be 'new' in early modern writing may not in fact be new at all, but may derive from the ancient texts with which writers in early modern Europe were often very familiar. Many ideals of Greek medicine were inherited by Renaissance and early modern writers. Claims are still made for the 'Greek miracle'; for the origin of rationality in medicine, the retreat from superstition and magic, and the emergence of the belief that natural causes lie behind disease, and that natural substances can cure it. This can of course be overstated; the Hippocratic writers of the classical Greek period rarely attack religion, for example, and where they do, they attack individual wandering healers but not the religion of the city-state. In Greek medicine, there is always debate; there are claims to knowledge in which it is important where that knowledge came from. Contrary to the standard legend of the historiography of science, which locates only in the Early Modern period the shift from the 'book' of the classical authority to first-hand observation by the individual, such claims are often based on one's own eyes – 'I myself have seen', as in *Nature of the Child*¹³ where the writer claims to have seen a very early conception – or in the appeal to the individual case history, to the patient, as in the seven books of the Hippocratic *Epidemics*. This raises questions about the validity of experience, and the relevance of the individual case. Rina Knoeff's paper for this collection shows how Boerhaave was doing 'armchair medicine', based 'on conceptual reasoning; it was a medical system which had little to do with the discussion and treatment of individual cases'. In this sense, early modern physiology was a long way from the idealisation of observation and the individual case of Hippocratic Greece. Even the concept of 'empirical research' was very different in the Early Modern period, a point addressed by Marlen Bidwell-Steiner. Rainer Brömer reminds us of the conflicts in the Islamic world between those who followed the Greek philosophers and those who argued from 'scripture and prophetic traditions'.

⁴² Descartes, *Principes*, in *Œuvres de Descartes*, vol. IX, 237.

After the Middle Ages, Aristotle continued to dominate the field of scientific writing, and perhaps most famously has been seen as contributing to Harvey's work by suggesting that the circle is the most perfect shape, but many other ancient texts continued to hold appeal for Renaissance and early modern scientists; for example, Lucretius' *De rerum natura*, discussed here by Fabio Tutrone, who focuses on Lucretius' views on the nature of 'matter' and his role in the acceptance of atomistic theories in sixteenth- and seventeenth-century physiology; or Hippocrates, regarded by Boerhaave as compatible with Harvey. Stoic and Epicurean philosophy also had a lasting influence on images of the body, as Bidwell-Steiner argues when looking at sixteenth-century Italian and Spanish writers. In his *True Intellectual System of the Universe* (1678), Ralph Cudworth presented the great thinkers of the past and the present as forming a continuous thread of insight, offering answers to the same questions, but using terminology that had often obscured the concordance between them. As Diana Stanciu shows here, his concept of 'plastic nature' drew on sources including Plato, Aristotle, Plotinus, the Stoics, Galen, Harvey, Paracelsus and van Helmont. Cudworth presented plastic nature as an immaterial and immanent force in both nature and living things, thus offering a challenge to a mechanistic physiology in the style of Descartes. Tracing the reception of Ibn al-Nafis and his supposed 'discovery' of the pulmonary transit, Rainer Brömer reminds us that links existed not only across time, but also across space, in this case between opposite ends of the Mediterranean, and across the Muslim world.

Furthermore, where technological change may lead us to expect that ancient ideas would be challenged, this was not necessarily the case. Sometimes analogies could be adapted to fit a new situation. Tamás Demeter concentrates on the eighteenth century, after Newton, and challenges the view according to which Hume drew from mechanical models, arguing instead that he was closer to vitalist physiology. Hume, Demeter argues, applied the 'language of natural phenomena to the moral domain'.

In the seventeenth century, the new technology of microscopy confirmed the established view that the skin was porous, and shifted the focus from the substance to the spaces in between, but Mienieke te Hennepe shows here how the ancient image of a fisherman's net, taken from Plato's *Timaeus*, continued to be used. The intellectual approach to the skin altered, but – despite some evidence of patients experiencing their bodies differently because of the new knowledge – not the practical expression of this knowledge in medical treatment. Microscopic viewing of the skin was followed by an increased interest in the physiology of sweat. Michael Stolberg

also examines changes in the understanding of skin in this period, including the argument that visible sweat was produced by specific tiny glands, with 'insensible transpiration' occurring through tiny pores. Above all, he emphasises the enormous range of types of sweat that can be found in early modern medical writing.

Spirits and blood

Across the papers collected here, two aspects of physiology recur in many different guises: spirits and blood. The first is alien to us, and invisible, while the second is all too familiar to our experience, but we may be surprised at the range of variations in each that can be explored.

Julius Rocca, for example, focuses on the role of 'spirits' in the body. He looks at Galen's 'natural *pneuma*', showing how valuable it is in thinking about the body precisely because it is 'indeterminate, invisible, and, above all, malleable'.⁴³ He traces its origins and also its fortunes in Galenism, in both late antique and Arabic medicine, showing how, as an analogical model, it survived especially in non-experimental physiological systems. Brömer examines the role of 'spirit', and the substance from which it is made, in Ibn al-Nafis, arguing that it is the theological basis of the argument, rather than any anatomical study of the body, that leads Ibn al-Nafis to argue against a permeable septum in the heart. Sergius Koderá argues for the role of the technology of distillation in transforming the role of 'spirits' in the fifteenth to seventeenth centuries; 'spirits' provided a model by which physiological phenomena such as digestion could be explained, accounted for human ageing, and provided explanations for health and disease that differed from those offered by the humoral system. Koderá contrasts the Neoplatonic Ficino, who used the imagery of distillation but did not appear to have been involved with the practical use of the still, with the Paracelsian Duchesne, who used the knowledge he had gained from observation in his personal experience of distilling liquors. Koderá shows how the art of distillation could apply to both the macrocosm and the microcosm; in the work of Bacon, the body is a still, and cooling all of the body except the stomach is necessary to keep the 'spirits' in check and prolong life. In another version, proposed by Bernardino Telesio, 'spirits' also feature in the papers of Tutrone, Kalff and Bidwell-Steiner, while the

⁴³ See the contribution of J. Rocca 634 in this volume.

role of *pneuma* in vision is discussed by Boudon-Millot. Vanagt's paper on the development of the *camera obscura* illustrates the challenges to 'spirits' in accounts of the process of seeing, and the use of physiological experiments to cut through the apparent impasse between the differing views concerning sight in the ancient authorities; in 1632, looking at the camera obscura from a medical point of view, Plempius urged his readers to dissect for themselves the eye of a freshly-butchered ox.

Several papers address different aspects of blood, one of the canonical four humours, but important far beyond the others in conceptions of the body. Their authors note not only that there were thought to be different kinds of blood, as Catrien Santing shows for Andrea Cesalpino in particular, but also that fluids can be understood as being composed of other fluids – thus, blood includes water and serum – with ideas about one fluid influencing those about another. The word serum, as Stolberg reminds us, comes from the Latin for 'whey', the liquid by-product of cheesemaking. The skin is thus represented as a sieve. McVaugh looks at early discussions of whether the kidney is a strainer, separating liquid from solid, or a sieve, removing smaller solid particles and not the larger; for Galen, sometimes it is one, but sometimes the other. McVaugh argues that 'Galen appears to think mechanically up to the point where he has to conclude that mechanical explanation will no longer work, at which point he turns to attraction as an explanatory principle'.

Barbara Orland discusses the use of analogy in thinking about the unseen parts of the body, taking as her focus the analogy between blood and milk, derived from Aristotle. The analogy worked both ways: milk could be seen as 'white blood' while blood could be seen as 'slightly coloured' milk. The model survived to the nineteenth century, but it is important to understand how it was adjusted in order to survive in different contexts. Indeed, how far was this an 'analogy', and how far did it indicate that the two fluids were seen as different forms of a single fluid? Using Cornelis Bontekoe's *Life, Health, Illness and Death* (1684), Orland counters Laqueur's claims for the 'fungibility' of fluids,⁴⁴ instead insisting that blood and milk were seen as different substances, while Bidwell-Steiner shows how, a century earlier, Oliva Sabuco had challenged the idea that sperm and milk were formed from blood.

⁴⁴ Laqueur T., *Making Sex. Body and Gender from the Greeks to Freud* (Cambridge, MA: 1990).

This interest in the transformation of fluids and the degree to which they are separate is common to many papers here. Marion Wells draws our attention to Webster's *Duchess of Malfi*, where Bosola says of his unexpected tears, 'These tears, I am very certain, never grew | In my mother's milk'. A similar interest can be found in Jacomien Prins's comments on the Italian Renaissance philosopher Marsilio Ficino, for whom phlegm comes out through sweat and tears while, in the harmonious body, the blood should contain an ideal balance of the other humours. Michael McVaugh links the question of analogy to that of the relationships between bodily fluids; Berengario da Carpi uses a complex analogy in which sweat, milk and urine come together, so that urine is 'sweated out like milk from the breast'. Michael Stolberg notes how, in Galen, sweat and urine were formed from the same matter, and both contained bile, while inadequate loss of one of the two fluids could be compensated by a greater evacuation of the other.

In order to explore how the analogy between blood and milk was used in medical practice, Orland looks at the fields of generation, where the supposed 'sympathy' between womb and breasts was regarded as a possible source of disease, and nutrition, particularly of the foetus. Orland investigates in particular how the analogy survived when a humoral model was replaced in the seventeenth century by the mechanical 'hydraulic body', and when the amniotic fluid came to be seen not as waste material, but as a form of milk. She concludes that blood came to be seen as 'red milk', while 'milk' was set in a new relation to 'white chyle'. Interestingly, she argues, the idea of blood circulation served only to strengthen the old assumptions about materials moving within the body.

Blood in the female body is also discussed by Baert, Sidgwick and Kusters, who examine the representation in the late antique and early medieval world of the Biblical figure of the 'woman with the issue of blood', healed by touching the hem of Christ's garment. The story was used to articulate concerns about menstruation and purity, with the Haemorrhoida being enlisted on both sides of the debate. While visual arts shied away from showing her bleeding, they suggested this with strategically-placed wells or fountains. Meanwhile the materials of magical healing – gems, amulets and spells – used her as a figure of power, not only because of the power she draws from Christ, but also because of her own faith in believing in his healing potential. Catrien Santing emphasises the close connections between Christian and medical approaches to blood in the sixteenth century. The subject of one of her two case studies, Levinus Lemnius, praised the man dominated by the humour of blood, but embedded his Galenic

views within a firmly Christian framework. The other, Andrea Cesalpino, linked the four blood vessels of the heart to the four rivers of Paradise.

In medieval and early modern medical writing, menstrual blood was seen both as 'filthy' and as laudable since, although it was regularly expelled, it also acted as nourishment for the foetus. Wells invites us to consider the pregnant body as a location in which the foetal mind is affected by the mental state of its mother. Karine van 't Land looks at the connections between generation and nutrition; in both processes, creating respectively a new being, and new tissue, blood was thought to play a central role. She charts the complex variations on the fluids blood and semen, starting from the point that 'According to the medieval medical tradition, sperm and menstrual blood left their traces in the body during the whole course of life'. Some parts – those that were hard and white, like the bones – were thought to derive from semen, others from blood. But this was by no means the end of the story. Both sexes produced two different types of 'sperm', while the term *menstruum* could in medieval literature include 'female sperm'. Concentrating on four medieval commentaries on Avicenna, van 't Land shows how tissue formed from different fluids was thought to behave differently during a person's life, with parts formed from blood having a greater capacity to regenerate than those formed from sperm; this, then, concerned far more than generation. Bidwell-Steiner introduces us to a very different model of the female body, proposed by a woman; the seventeenth-century Oliva Sabuco, whose maternal metaphors were part of a materialist model of the body in which menstrual blood nourished the single fluid which, for her, replaced the three Galenic spirits.

Conclusion

While the papers collected here show the different possible meanings of 'physiology' and help us to see that ideas about the function of the body are historically specific and culturally determined, what wider lessons for the history of medicine and of the body can be taken from these studies? The most important may simply be to bear in mind the links between different genres of writing. For example, Lewenheimb and Lohenstein shared a publisher, and this could facilitate the exchange of physiological metaphors and concepts between medicine and literature, a topic covered here by the papers of Wells and Kalff. In Lohenstein's plays, for instance in his *Agrippina* (1665), the temperaments of the characters are explained by

using the physiological concepts of the time; the hearts of Agrippina and Nero are sometimes soft or hard, cold or hot.⁴⁵

Several papers challenge the periodisation of the history of the body and our tendency to set up milestones. For example, as we have seen, Nutton argues against the 'traditional ascription to Jean Fernel of the creation of physiology as a specific area of medicine' while McVaugh takes issue with those who wish to identify Mondino, Vesalius or Malpighi as discoverers of the modern kidney: 'changes were already occurring in the perception of that organ well before Malpighi wrote, indeed before Harvey's proclamation of the circulation in 1628'.⁴⁶ The collection as a whole also challenges the category of 'Early Modern', as it illustrates the continuities between the Ancient and the Modern world, and includes several papers that examine the Enlightenment. Tomas Macsotay, for example, looks at medical knowledge in eighteenth-century philosophers, focusing on the relationship between medicine and artistic production, in particular how images of suffering were read, while Tamás Demeter looks at Hume's relationship both to mechanism and to vitalism. Rainer Brömer further challenges our need to create a story of discovery, in this case of 'the circulation of the blood', showing that 'when Ibn al-Nafis, Servet, İtaki, al-'Atţār, and finally the twentieth-century historians of medicine talk about the structure and function of the cardio-pulmonary system, they are not speaking of the same "thing"'.⁴⁷

Many contributors also interrogate the concept of 'humoral' medicine. Wells, for example, uses Webster's *Duchess of Malfi* to investigate how valid a humoral model was for interpreting mental symptoms in the seventeenth century, and asks whether the passions caused humoral imbalance, or humoral imbalance generated the passions, a question also addressed by Santing. Stahnisch argues that, by the end of the eighteenth century, conditions formerly linked to the humours were coming to be more closely tied to specific bodily organs. Several essays introduce very different ways of modelling the body, such as Telesio's view that

⁴⁵ Cf. Brancaforte C., "Liebesmetaphorik in Lohensteins Agrippina im Lichte wissenschaftlicher Debatten des 17. Jahrhunderts", *Daphnis* 12 (1983) 305–320; Rahn T., "Affektpathologische Aspekte und therapeutische Handlungszytate in Lohensteins 'Agrippina'" in Benzenhöfer U. – Kühmann W. (eds.), *Heilkunde und Krankheitserfahrung in der Frühen Neuzeit. Studien am Grenzrain von Literaturgeschichte und Medizingeschichte* (Tübingen: 1992) 201–227 and Rahn T., "Anmerkungen zur Physiologie der Liebesblicke in Lohensteins 'Agrippina'", *Simpliciana* 14 (1992) 163–176. I owe these references to Claus Zittel.

⁴⁶ See 105 in this volume.

⁴⁷ See 359–360 in this volume.

conflict between the Sun and Earth was responsible for all things (Bidwell-Steiner), or Campanella's presentation of hot and cold as the adversarial forces, their rivalry having a creative effect (Kalf).

One aspect that we would like to have addressed in more detail is that of the patient's experience of the body. Frank Stahnisch addresses the theme of tears through the experiences of a famous patient, Johann Gottfried von Herder. He argues that Herder's experiences not only of suffering from repeated infections due to a blocked tear duct, but also of unsuccessful surgical treatment, led him to examine the place of tears in the human condition, first through medical training and then through philosophy and theology. As a result, Herder went beyond Haller's theories of 'irritability' and looked forward to a future 'physiologist of both the soul and the body of man' (*Ein Physiologe der Seele und des Koerpers des Menschen*).⁴⁸ The place of the soul, and of consciousness, in the body is another area which we would like to have developed; for example, Brömer discusses the corporeality of the soul in Islamic medicine, and Stanciu looks at Cudworth's metaphor of the 'sleeping musician', whose musical skill is still within him, even when he is not himself conscious of it.

Nevertheless, we hope that the individual papers presented here, as well as this collection as a whole, will present a challenge to existing master narratives of 'continuity' and 'progress', by showing the many variations across time and space in early modern Europe, broadly conceived. We would like to see this book as the start of a process of greater dialogue not only between those working in different periods, but also different academic disciplines. The relative ranking of physiology and anatomy has shifted over time, with physiology being seen as the prior field of knowledge; as the speculative side of anatomy; and as a sub-discipline of anatomy. But only if we talk to each other, and share our knowledge, will we be able to understand what physiology meant in the past.

⁴⁸ Herder J.G. von, *Zum Sinn des Gefuehls* (1800) in Pross, "Herder – Werke", vol. II, 244.

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