Galen's Teleology and Functional Explanation

GALEN'S TELEOLOGY AND FUNCTIONAL EXPLANATION

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1. Introduction

The importance of functional analysis in contemporary biology and social science is widely recognized. By *functional analysis* I mean an approach in which the parts of a complex system are studied in order to determine their contribution to the continued existence or operation of the system as a whole. Thus we may say that the *function* of the heart in an organism is to circulate the blood, and in doing so we identify the contribution of the heart to the organism's continued existence.[1] When we cite the function of an organ such as the heart to explain its presence or its distinctive structure we are giving a functional explanation, and such an explanation will involve teleological language. Why does the heart have four chambers and a set of precisely fitting valves? *In order to* fulfill its function of circulating the blood. The status of such functional explanations is a major concern in contemporary philosophy of science, in which key issues include the precise understanding of terms such as 'function', the possibility of reformulating functional explanations in non-teleological language, and the question whether the prevalence of functional explanations in biology and the social sciences reflects inherent differences between those disciplines and the physical sciences. The question 'what functions explain' is a matter of ongoing debate.[2]

Whatever position one takes on these foundational issues, there seem to be at least two major reasons why functional analysis is important in the study of living things. (1) First, organisms have capacities for self-maintenance and reproduction, and these capacities imply a certain plasticity of behavior. That is, whatever the changes in the environment, a living organism will behave in ways that promote its own survival and reproduction. Since

the organism consistently engages in these activities despite changes in the environment, it is natural to take the activities as basic *explananda* and to inquire into the roles of the various parts in promoting them. (2) Moreover, living things are organic wholes whose parts interact with one another in complex ways; organisms are not systems of independently functioning parts. As Nagel put it, the parts of the organism are 'internally related'; they 'mutually influence one another, and their behavior regulates and is regulated by the activities of the organism as a whole'.[3] For these reasons, among others, functional explanations are prevalent in contemporary biology. Such explanations, of course, do not imply any reference to animate agents; to say that the heart is structured in a certain way in order to circulate the blood is not to say that an intelligent agent *designed* it for this purpose, *intended* it to do so, or *makes* it circulate the blood.

The aim of this paper is to argue that Galen adopted a functional approach to the study of living organisms and that he did so for reasons similar to those that have just been described. Galen's method in works such as *On the Use of the Parts* (*De usu partium, UP*) and *On the Natural Faculties* (*De naturalibus facultatibus, Nat. fac.*)[4] reflects a keen awareness of the complexity of the ways in which the parts of the body work together to promote activities such as self-maintenance and reproduction. The basic idea that governs his approach in *UP* is that the existence, structure, and attributes of all the parts must be explained by reference to their functions in promoting the activities of the whole organism; this means that functions have an ineliminable role in the explanation of the parts.

In *UP* and other works, Galen describes the construction of the human body as the result of the effort of a supremely intelligent and powerful divine Craftsman or Demiurge, who exerts foresight or providence (*pronoia*) on behalf of living things. Galen also frequently attributes the construction of the body to a personified nature or *physis*, which is said to be 'craftsmanlike' (*technikē*), i.e. capable of art or craft (*technē*). Galen was obviously committed to the view that the structure of the body is a result of intelligent

design. To argue that Galen's Demiurge is only a device of exposition would be going too far, and that is not my claim. Nevertheless Galen's descriptions of the ways in which the Demiurge devised the structure of the human body reflect a highly sophisticated, functional analysis of the organism, and there are good reasons to adopt such an approach that are independent of belief in a divine artificer. Sections 2-5 below describe the background and main features of Galen's functional approach; I return to the question of the relationship between functions and design in section 6.

2. Aristotle

Although the Hippocratic writings of the fifth and fourth centuries BC are rich in descriptions of the human body and its parts, the first thinker to apply functional analysis consistently to the study of living things is Aristotle.[5] I therefore begin with a brief account of his methodology, based largely on the *De anima* (*An.*) and *De partibus animalium* (*PA*).[6] For Aristotle, what distinguishes the living from the lifeless is the possession of soul, viewed as the source of a set of 'powers' or 'faculties' (*dynameis*) to engage in activities such as nutrition, reproduction, appetite, perception, locomotion, and thought (*An.* 413a20-b13, 414a29-32). The most basic faculty of the soul is that of self-nutrition and reproduction; it is common to all living things, and so also serves to distinguish the living from the lifeless (*An.* 412a13-15, 415a23-b3, 415b26-8, 416b17-20). All other faculties of the soul, such as perception, locomotion, and thought, presuppose the capacity for nutrition (i.e. self-maintenance) and reproduction (*An.* 415a1-13). In identifying self-maintenance and reproduction as the distinctive activities of living things, Aristotle focuses on the tendency of organisms to respond to the environment in ways that promote their own survival. The growth of plants is not explained by reference to the natural tendencies of fire to move upward and earth downward; rather, plants grow in a way that is directed at maintaining their existence, and it is because of this that they count as alive (*An.* 413a25-

31; cf. 415b28-416a9). Since survival and reproduction are the most fundamental activities of living things, we must take them as the starting point of explanation and investigate the ways in which the organism is able to perform them.

The same issues are approached from a slightly different angle in the opening chapters of the *De partibus animalium* (*PA* 1.1-1.5). A major theme in this work is the idea that the parts of an organism can only be understood with reference to the whole; in other words, the whole organism is prior to its parts in the order of explanation. The processes that go on during embryonic development make up a complex, interrelated progression whose order is only intelligible from the point of view of the resulting organism, just as in the case of housebuilding, the steps in the process make sense only in reference to the finished house. Explanations of development must therefore begin with a specification of the form (*eidos*) or definition (*logos*) of the finished product or organism (*PA* 1.1, 640a33-b4). In *PA* 1.5 Aristotle explains the implications of this kind of approach for the study of the parts of the fully-developed organism:

> Since every instrument [*organon*] is for the sake of something [ἕνεκά του], each of the parts of the body is for the sake of something, and since that for the sake of which they exist is some activity [πρᾶξις], it is clear that also the whole body is constituted for the sake of some complex activity [πράξεώς τινος ἕνεκα πολυμεροῦς]. For the sawing does not come about for the sake of the saw, but the saw for the sake of sawing, because sawing is a use [χρῆσις]. Hence also the body is in a certain way for the sake of the soul, and the parts for the sake of the functions [*erga*] for which each of them is naturally constituted [πρὸς ἃ πέφυκεν ἕκαστον]. First, then, we must state the activities [πράξεις] common to all, then those which belong to a genus and a species. (*PA* 1.5, 645b14-22)

Just as the saw exists 'for the sake of' sawing, so the body exists 'for the sake' of the soul and its characteristic activities. The basic idea is the adaptation of structure to function. The saw is constructed in such a way as to make it good for sawing, just as any tool or instrument is made to perform its function well; similarly, the parts of the body, and the body as a whole, are constructed in such a way as to perform the activities (πράξεις) of the soul. All the parts contribute to the achievement of a particular set of activities which make up an intelligible pattern, the characteristic life of the organism; in this sense, they exist 'for the sake of' these activities. Once again the method is clear: we must begin with an enumeration of the organism's activities, then go on to consider the parts that enable it to perform them.

Aristotle consistently describes the parts of the organism as 'instruments' or organs (*organa*) distinguished by their 'works' or 'functions' (*erga*), i.e. the contributions they make to the organism's characteristic activities. What makes the eye an eye is its capacity to see, just as an axe is defined by its capacity to chop; an eye without the capacity to see is an eye only in name (*An.* 412b9-22).[7] In many cases, the function (*ergon*) of a part will be its contribution to the organism's self-maintenance or reproduction. Some organs, however, are present in order to make life better, not just to make it possible. Thus the kidney, for example, exists to improve the functioning of the bladder, and the senses other than touch are present 'not for the sake of being, but for well-being'.[8] In every case, however, the functions are understood as contributions to the organism's characteristic activities. And, crucially, the analysis stops there: Aristotle does not conceive of organisms or their parts as having functions in some larger order or system.[9]

A final important aspect of Aristotle's conception of the organism is the notion of functional organization, the ways in which the parts work together to promote the activities of the whole. In the *De motu animalium* (703a29-b2) he compares the organism to a well-

governed city in which each part performs its allotted function (*ergon*). But it is not as though the function of each of the parts can be specified independently of the others. The organism is a system in which the parts interact with one another to produce results that are beneficial for the whole. Respiration, for example, occurs when the lungs expand due to the increase in innate heat caused by the process of nutrition. But the function of respiration is to cool the innate heat, and thus to enable the organism's continued self-maintenance and nutrition (*De respiratione* 474a25-b24 and 480a16-b20). In this way the functions of the organs of respiration (the lungs) and of the innate heat (the heart) are interdependent.

Four interconnected features of Aristotle's approach have emerged from this brief survey: (1) the fundamental importance of self-maintenance and reproduction; (2) the explanatory priority of the whole organism to its parts; (3) the emphasis on the functions of the parts, understood as their contributions to the organism's activities; (4) the notion of functional organization and the interdependence of the various organs. Let us now turn to Galen and see how these features are reflected in his approach.

3. An Aristotelian approach

Like Aristotle, Galen identifies self-maintenance and reproduction as the fundamental activities of living things. In *Nat. fac.* Galen conceives of the organism's *physis* or 'nature' as an entity responsible for managing (διοικεῖν) activities which do not involve cognition or voluntary motion, such as growth and nutrition; cognition and voluntary motion, by contrast, are assigned to the soul (*psychē*) rather than nature. Plants have a nature but not a soul, reflecting the status of self-maintenance and reproduction as marking off the living from the lifeless (*Nat. fac.* 1.1, 101.1-15 H, 2.1-2 K).[10] The investigation of *physis* begins from an enumeration of its characteristic 'works' (*erga*) and 'activities' (*energeiai*); to each activity there corresponds a particular faculty (*dynamis*) as its cause (*aitia*). Galen explains

that 'works' (*erga*) refers primarily to products, such as flesh, blood, and bone, while 'activities' refers to processes or, more specifically, 'active changes' (δραστικαὶ κινήσεις). The scope of *ergon* is wider than *energeia*, since all activites (e.g. digestion or blood-production) can be considered products, but not all products (e.g. flesh, blood, bone) are activities (*Nat. fac.* 1.2, 105.13-106.3 H, 2.6-7 K; 1.4, 107.20-24 H, 2.10 K). The most fundamental activities of *physis* are those that make possible the organism's continued existence and promote its development: generation (γένεσις), growth (αὔξησις), and nutrition (θρέψις). Galen emphasizes both the interdependence of these activities and their contribution to the organism's self-maintenance. The faculty of generation is responsible for the formation of the organism in the womb, that of growth for its development to full size once born, and that of nutrition for its continued existence. Generation is 'compounded' (σύνθετος) from alteration (ἀλλοίωσις) and shaping (διάπλασις) (*Nat. fac.* 1.5, 107.24-108.20 H, 2.10-11 K). The faculties of growth and nutrition are present in the embryo, but only as 'handmaids' (ὑπηρέτιδες) to the generative faculty; from the time of birth until the organism reaches its full size, the faculty of growth is dominant, while alteration and nutrition are its 'handmaids' (*Nat. fac.* 1.7, 112.6-15 H, 2.16 K).

Once the various activities and their interrelationships have been analyzed, Galen turns to an examination of the organs that perform them. Nutrition, defined as 'assimilation of that which nourishes to that which is nourished' (ὁμοίωσις τοῦ τρέφοντος τῷ τρεφομένῳ), requires organs which alter food so that it can be assimilated, others which dispose of the inevitable residues formed during this process, and still others which convey the nutriment through the body; a large number of organs will be needed to perform these activities, and the investigation should begin from those those are most closely related to the end (*telos*) to be achieved, i.e. nutrition (*Nat. fac.* 1.10, 117.17-118.2 H, 2.23-4 K; 1.11, 118.7-8 H, 2.24 K). In this way the investigation of the principal activities of *physis* leads directly to the investigation of the parts of the body and their activities.

Just as *Nat. fac.* takes off from the *De anima,* so the *De usu partium* picks up from the *De partibus animalium.*[11] After a brief introductory paragraph setting out the notion of a part as that which is neither totally distinct from nor entirely fused with its surroundings, Galen continues with a statement that is of fundamental significance for understanding his method throughout the work:

> The use [*chreia*] of all of them [sc. the parts] is for the soul. For the body is its instrument [*organon*], and for this reason, the parts of animals differ greatly from one another, because their souls also differ. For some are brave and others timid; some are wild and others tame; and some are, so to speak, political and craftsmanlike [πολιτικά τε καὶ δημιουργικά], whereas others are, as it were, asocial. But for all of them, the body is suited to the character [ἤθεα] and faculties [*dynameis*] of the soul. (*UP* 1.2, 1.1.13-2.2 H, 3.2 K)

Like Aristotle, Galen identifies the body as the 'instrument' (*organon*) of the soul, the tool that enables it to carry out its characteristic activities. The body and its parts are for the sake of the soul, in the sense that they are adapted to the performance of the organism's activities. If one is to understand why an organism has the parts it does, it is necessary to have knowledge of its characteristic activities, as expressed in the 'character and faculties' of its soul. Galen elaborates by considering the appropriateness of various creatures' bodies to their souls: the lion is strong and fearless and has teeth and claws to match, while the timid deer has a body that is sleek but also defenseless (*UP* 1.2, 1.2.2-11 H, 3.2-3 K). Human beings, though they lack defensive organs, make up for this by the possession of hands; with these they construct tools to compensate for their natural inferiority to animals in qualities such as speed and strength (*UP* 1.2, 1.2.11-3.24 H, 3.3-5 K). Galen goes on to praise Aristotle for rejecting Anaxagoras' suggestion that human beings are intelligent

because they possess hands; rather, they possess hands because they are intelligent (*UP* 1.3, 1.4.2-5 H, 3.5 K; cf. Arist. *PA* 687a7-23). In all of this the underlying idea, as in Aristotle, is the explanatory priority of the whole organism to its parts. The organism's activities are not explained by reference to its parts; rather, the parts are explained by reference to the total pattern of the organism's activities, as expressed in the character and faculties of its soul.

Like Aristotle, Galen conceives of all the parts as existing for the sake of three primary ends: life, a better life, and reproduction.[12] Furthermore the Galenic body, as well as being the 'instrument' of the soul, is also a collection of instruments or organs (*organa*) which are distinguished from one another by their activities (*energeiai*). What makes an organ an organ, as opposed to just a 'part' (*morion*), is its ability to perform an activity. Thus the eye is both an organ and a part, since it is a functional system that produces a single activity, sight; on the other hand the retina and the cornea are parts (both of the eye and, secondarily, of the face) but not organs.[13] Galen indicates his indebtedness to Aristotle for his functional conception of the organs, and is if anything more strict than Aristotle in insisting that organs must be identified in purely functional terms. He often remarks in *UP* that organs should be named according to their activities rather than their visible structure or form, and criticizes Aristotle for failing to do so.[14]

As an example of Galen's functional approach we may consider his discussion of the human hand in *De usu partium* 1.8-10. These chapters set out what Galen describes as a general method for determining the 'use' (*chreia*) of any part — a problem which, he says, had led to extensive disagreement among doctors and philosophers alike (*UP* 1.8, 1.12.13-19 H, 3.17 K). Galen takes his start from a cryptic remark found in the Hippocratic text *On Nutriment* (*Alim.*), a work which is now generally considered to reflect Stoic influence, but which for Galen was a key source of genuine Hippocratic doctrine:

> Taken as a whole, all in sympathy, but taken severally, the parts in each part for its work [*ergon*].[15] (*UP* 1.8, 1.12.24-5 H, 3.17 K = Hp. *Alim.* 23, 9.106 Littré)

Galen offers a typically creative exegesis of this remark, which he says 'is rather obscure for most people because it is written in the archaic style and with his [sc. Hippocrates'] customary conciseness':

> All the parts of the body are in sympathy with one another, that is to say, all cooperate [ὁμολογεῖ] in producing one work [*ergon*]. The large parts, main divisions of the whole animal, such as the hands, feet, eyes, and tongue, came to be for the sake of the activities [*energeiai*] of the animal as a whole and all cooperate in performing them [πρὸς ταύτας ... ὁμολογεῖ]. But the smaller parts, the components of the parts I have mentioned, have reference to the work [*ergon*] of the whole organ. The eye, for example, is the instrument of sight, composed of many parts which all cooperate [ὁμολογοῦντα] in one work [*ergon*], vision; it has some parts by means of which we see, others without which sight would be impossible, others for the sake of better vision, and still others to protect all these. This, moreover, is also true of all the other parts. (*UP* 1.8, 1.13.7-20 H, 2.18-19 K)

As Galen has it, 'Hippocrates' is remarking on the way which the parts of the body work together or 'cooperate' (ὁμολογεῖν) to produce the characteristic activities (*energeiai*) of the organism.[16] First there are the larger parts such as the hand or eyes, which have come to be for the sake of the activities (*energeiai*) of the body as a whole, and cooperate (ὁμολογεῖ) with one another in bringing them about. But each individual organ such as the eye is also composed of many component parts, and these also cooperate (ὁμολογεῖ) towards producing the work (*ergon*) of the entire organ: the eye has some parts 'through which' (δι' ὧν) we see, others for the sake of seeing better, others as necessary conditions

of seeing, and still others for protection. Knowledge of the activities (*energeiai*) of the various organs (*organa*) is thus essential for understanding the uses (*chreiai*) of the parts, their beneficial contributions to the organism's activities. In the case of the hand, Galen claims, it is evident that its work (*ergon*) is grasping; but earlier thinkers have failed to understand the way in which all its parts have been constructed with a view towards performing this activity (*UP* 1.8, 1.13.22-14.2 H, 3.19 K). In the case of many other organs the *ergon* is not at all clear, and this explains many of the errors that have been made concerning the uses (*chreiai*) of the parts (*UP* 1.8, 1.14.9-13 H, 3.19-20 K). In sum, when studying the uses of the parts, activity or *energeia* is 'the starting point [ἀρχή] of investigation and the criterion [κριτήριον] of what is discovered' (*UP* 1.10, 1.20.2-4 H, 3.27 K).

There is much more to be said about the distinction between 'use' (*chreia*) and 'activity' (*energeia*), and I will return to this in the next section. But it should now be clear that the coordinated activity of the various organs was a major factor that motivated Galen's functional approach to the body. The organs all work together to enable the organism to perform its characteristic activities, just as the parts of each organ work together to enable it to function normally. As in Aristotle, more is involved than just a high level of structural organization. The major organs and bodily systems not only work together towards the maintenance of the whole; they also depend on one another and influence one another's behavior. In *On the Formation of the Embryo* Galen claims that while the parts can perform their activities (*energeiai*) independently of one another, they depend on 'assistance' (ἐπικουρία) from one another for their continued operation; this is because the substance of the parts is constantly changing in both quantity and quality (*De foetuum formatione* 5, 88.13-21 Nickel, 4.684 K). He goes on to describe the interdependence of the three most important organs of the body, the brain, heart, and liver:

> Now the heart (which some believe to be solely responsible for managing [διοικεῖν] the animal) when deprived of breathing ceases its motion, and with it the whole animal dies. It is deprived of breathing not just in cases of strangulation or when the path for inhalation is shut off due to inflammation of the parts around the larynx, but also when the nerves that move the chest are damaged (whether by cutting, crushing, or ligation), the spinal cord being the source of all these nerves, and the brain in turn of it. So just as the brain is useful [χρήσιμος] to the heart in order for the latter to sustain itself [εἰς τὴν διαμονήν] — it moves the chest through the nerves, and it is by expansion of the chest that inhalation takes place and by contraction, exhalation — in the same way, the heart provides a use [*chreia*] to the brain and the liver to both of these, as has been shown in the accounts of these matters. But it is not only these three principal organs [ἀρχαί] that are helped by one another; this is characteristic of all the other parts as well. For the present, let a single reminder suffice of all the other individual points that were made in *On the Use of the Parts.* (*De foetuum formatione* 5, 88.25-90.7 Nickel, 4.685 K)

The activity of the heart depends on the brain, but the heart also serves the brain as the source of the arteries, which maintain the innate heat and nourish the psychic pneuma. The liver serves both heart and brain, but it is also dependent on them for its continued activity.[17] The analysis of major bodily systems thus involves a kind of feedback in which each both sustains and is sustained by the others. Evidently Galen considers this kind of functional interdependence to be one of the essential points of the *De usu partium.*[18]

4. Use and activity

One way in which Galen goes beyond anything found in Aristotle's biological works is in developing a systematic distinction between the notions of 'use' (*chreia*) and 'activity' (*energeia*).[19] At the beginning of the last book of the *De usu partium,* Galen offers his most explicit characterization of this distinction:

> Now the activity [*energeia*] of a part differs from its use [*chreia*], as I have said before, because activity is active change and use is the same as what is commonly called utility [εὐχρηστία]. I have said that activity is *active* change because many changes occur passively [κατὰ πάθος], and indeed they are called 'passive' [παθητικαί] — all those which occur in things when other things change them. (*UP* 17.1, 2.437.8-15 H, 4.346-7 K)

The idea of *energeia* as a specifically active (δραστικός) change or motion (*kinēsis*) is one that can be paralleled in other Galenic works, where we also find the contrast with 'passive' (παθητική) change arising from an external source; it is clear in these passages that *kinēsis* covers both change of quality and change of place or local motion. Thus when food becomes blood this is a passive change of the food but an active change of the veins; similarly when the muscles move the limbs, the motion of the muscles is active and that of the limbs passive.[20] Galen's extensive deployment of *energeia* and its correlate *dynamis* obviously reflects the pervasive influence of Aristotle on Greek medical and biological thought, though the extent to which his use of these concepts is genuinely Aristotelian is not immediately clear.[21]

The remark that *chreia* is equivalent to 'what is commonly called utility (εὐχρηστία)' is the closest Galen comes to defining the term in *UP*. LSJ gives a wide range of meanings, including 'need', 'want', 'use', 'advantage', and 'service', and examples of all these senses can be found in the hundreds of instances of *chreia* in *UP.*[22] Despite this variation,

however, the basic idea expressed by *chreia* in a large number of passages is that of a beneficial contribution to the organism's characteristic activities, especially self-maintenance and reproduction. The importance of a part is judged by its *chreia*, its beneficial contribution to the organism's life:

> This can be decided in both cases by the use [*chreia*]. But since there are three kinds of use — either for life itself [εἰς αὐτὸ τὸ ζῆν], or for living well [εἰς τὸ καλῶς ζῆν], or for preserving the race [εἰς τὴν τοῦ γένους φυλακήν] ... (*UP* 6.7, 1.318.8-11 H, 3.435 K)

Again we have the Aristotelian tripartite schema: all the parts contribute to life, reproduction, or the improvement of life.[23] Insofar as *chreia* refers primarily to the beneficial contribution of the parts rather than to their 'suitability' or 'fitness' to make such contributions, the translation 'use' is preferable to 'utility' or 'usefulness'.[24]

Understood in this way, *chreia* is clearly distinct from *energeia* understood as 'active change'. Galen writes of the *chreiai* of *energeiai,* where what is in question is the contribution of the active motion or change in question to the organism's life. For example, the *energeia* of the arteries is their active, pulsating motion, caused by the 'pulsative faculty' (σφυγμικὴ δύναμις) transmitted by the heart through the arterial coats; but the *chreia* of this activity is the preservation of the vital heat and nourishing of the psychic pneuma.[25] Where a part does have an activity of its own, its principal contribution to the organism's life will be made through that activity. An example of this is the elephant's trunk: Galen says he thought it was useless and superfluous until he saw the elephant performing many useful actions with it; in this case 'the use of the part is bound up with the usefulness of the activity'.[26] Nevertheless, the concepts of *chreia* and *energeia* remain

distinct. The *chreia* of some parts consists in providing security or the necessary conditions for activities, or in making it possible for them to be performed better.[27]

The distinction between use and activity is also reflected on the methodological level. The investigation of *energeiai* involves the attempt to discern the specific causes of motions or changes in the parts, e.g. whether the pulsation of the arteries is caused by a faculty (*dynamis*) transmitted by the heart through the arterial coats or by the heart acting as a pump.[28] Since Galen holds that a part's activity depends on the character of the substance from which it is made (i.e. the particular blend of hot, cold, wet, and dry), the investigation of activities will also involve a study of the material substance of the parts.[29] The study of the *chreia* of a bodily process or part, on the other hand, involves a general consideration of its role in the overall economy of the organism. In particular, it requires the systematic examination of the contribution of all the part's attributes (including substance, shape, and arrangement in relation to other parts) to the life of the organism as a whole.[30]

In many passages, the *chreia* of a part is closely associated with the purpose for which it was constructed:

> Now nature in providing for their [sc. the fingernails'] safety made them moderately hard, so as not to detract in any way from the use for which they have come to be [τὴν χρείαν, ἧς ἕνεκα γεγόνεσαν], and also to keep them from being easily harmed. (*UP* 1.11, 1.21.6-10 H, 3.29 K)

> If the leg were completely without movable joints it could not be extended or flexed, and so would lose all the use for which it has come to be [τὴν χρείαν, ἧς ἕνεκα γέγονεν]. (*UP* 3.14, 1.185.4-7 H, 3.252 K)

> Since the whole arm was constructed for many, varied movements, it needed to have the head of the humerus rounded ... and to have a concavity associated with it that was not very deep and did not end in large rims. For if the joint of the humerus were enclosed in a shallow concavity but still restrained all around by large rims, it could not be rotated easily in every direction, though this rather than safety was its use [*chreia*], since it was for the sake of this [τούτου γὰρ ἕνεκα] that the whole arm was created. (*UP* 13.12, 2.276.1-12 H, 4.129-30 K)

In contexts such as these, to specify the *chreia* of a part is to state the reason why it is present in the organism; the terminology [οὗ ἕνεκα, 'for the sake of which'] obviously recalls the Aristotelian final cause. The connection between *chreia* and purpose is reinforced by an association between *chreia* and *skopos* ('aim', 'goal'). *Chreia* is the 'primary aim' (πρῶτος σκοπός) of the construction of all the parts; the most important 'cause' (*aitia*) to consider in explaining an organ is 'the aim of its activity' (σκοπὸς τῆς ἐνεργείας).[31] In passages where *chreia* refers to the reason why a part is present in the organism or the purpose for which it came to be, it retains the connotation of 'need': to state the reason why a part is present is also to say why it is needed. Galen sometimes uses the phrase ἀναγκαία χρεία ('necessary use') to refer to this sort of essential contribution to the organism's life. For example, the fibula 'provides a use [*chreia*] to the animal: the primary and necessary one is twofold, but there is a third use for good measure' (*UP* 3.13, 1.180.20-22 H, 3.246 K).[32]

As this remark suggests, however, parts may have uses that are not necessary or essential for the organism's life. Galen frequently distinguishes between the *chreia* 'for the sake of which' (ἧς ἕνεκα) a part has been created and its other beneficial contributions to the organism's activities:

> It was, then, for the sake of these activities [ἕνεκα μὲν δὴ τούτων] that the convexities at the ends of the ulna and radius came to be; but nature also makes use of them to secure another advantage [χρῆται δ' αὐταῖς καὶ πρὸς ἄλλο τι χρηστόν], just as she is accustomed frequently to make something that has come to be on account of one thing serve other uses as well [τῷ δι' ἕτερόν τι γεγονότι συγχρῆσθαι καὶ πρὸς ἄλλα]. For she located the heads of the tendons moving the fingers in the concavity between these eminences, thus establishing as if with a wall or tower a safe refuge for the tendons. (*UP* 2.11, 1.97.19-98.2 H, 3.133 K)

The purpose 'for the sake of which' (ἕνεκα) the convexities were made (the mobility of the hand) is clearly distinct from the ancillary or spinoff benefit that it confers (protection of the tendons). These spinoff benefits are also *chreiai*, and they are in fact one of the most important indications of nature's craftsmanship:

> For the greatest evidence of a resourceful craftsman, as has been said many times before, lies in using what has come to be for the sake of one thing also for other uses [τὸ συγχρῆσθαι τοῖς ἑτέρου τινὸς ἕνεκα γεγονόσι καὶ πρὸς ἄλλας χρείας], instead of seeking to make a special part for each use. (*UP* 9.5, 2.17.18-22 H, 3.706 K)

> How, then, would this too not be among the most wondrous works of nature, namely that she is eager to craft each of the organs that has come to be for the sake of some use to the animal [ἕνεκά τινος χρείας τῷ ζώῳ] straightaway also for some other benefit [πρὸς ἄλλο τι ... ὠφέλιμον]? (*UP* 7.22, 1.439.20-3 H, 3.605 K)

In contexts where Galen emphasizes the distinction between 'primary' or 'necessary' *chreiai* and such spinoff benefits, *chreia* is more general than purpose; it refers to any contribution that a part makes to the organism's activities.

One way in which Galen attempts to articulate the complex functional organization of the human body is by stressing the interdependence of uses and activities. For example, the *chreia* of a part of the hand will be its contribution to the *energeia* of the hand, grasping; but this activity also has many uses (*chreiai*) for the life of the organism as a whole. A more complex example comes in *UP* 6.9 (322.13-323.17 H, 3.441-3 K). Here Galen argues that the hearts of animals with a lung always have the right ventricle, while those of lungless animals lack the right ventricle. The right ventricle exists for the sake of (ἕνεκα) the lung (i.e. its service to the lung is its *chreia*), while the lung itself is an organ of respiration and voice (i.e. its *energeiai,* which have further *chreiai* for the organism as a whole). Criticizing Aristotle's view that the number of chambers of the heart is correlated with the size of the organism, Galen writes:

> Nature pays no attention to the large or small size of the body when she varies the form of the organs; on the contrary, her aim [*skopos*] in construction is difference of activity [*energeia*], and she measures the activities themselves in turn by their principal use [τῇ πρώτῃ χρείᾳ]. Thus there is produced a wonderful series [στοῖχος] of activities and uses succeeding one another, as I have demonstrated in what I have already said and as my present discourse will show no less clearly to those who will study it with some degree of care. (*UP* 6.9, 1.323.9-17 H, 3.442-3 K)

Elsewhere Galen writes that the 'association' or 'partnership' (κοινωνία) of *chreiai* and *energeiai* makes an important contribution to the organism's life (*UP* 8.7, 1.475.20-8 H, 3.655-6 K).

The interdependence of *chreiai* and *energeiai* is also reflected on the methodological level. It is a recurrent theme in *UP* that the study of *chreiai* presupposes a knowledge of *energeiai,* which itself is sometimes said to be based on the results of dissection.[33] Galen

often remarks that it is not his purpose in *UP* to investigate *energeiai;* rather, for the knowledge of these one should use the results established in other works such as *Nat. fac.* or *PHP* as 'foundations' (ὑποθέσεις).[34] On the other hand, he sometimes suggests that knowledge of *chreiai* can confirm an account of *energeiai* where the latter is unclear or disputed.[35] It is possible to grasp the usefulness of some part to the organism as a whole without grasping the nature of its activity, just as an activity can be grasped independently of its contribution to the overall economy of the organism. Accounts of *chreiai* and *energeiai* thus confirm one another, leading to a more complex methodological situation than some of Galen's explicit remarks might suggest.[36] Where the *chreia* of a part or process is known, it can help to determine the nature of the *energeiai* invoved; where an *energeia* is known, it can be used to find *chreiai.* Again, activities are both 'the starting point of investigation and the criterion of what is discovered' (*UP* 1.10, 1.20.2-4 H, 3.27 K).

The sequence of *chreiai* and *energeiai* revealed by the study of the parts must explain their role in promoting the primary activities of the organism. This is relatively straightforward in some cases: the parts of the hand are useful because they promote the activity of the hand, which has many uses for the animal in attempting to survive in a changing environment. In the case of bodily processes such as respiration and the pulse, however, the sequence tends towards circularity: the uses of these activities consist partly of contributions to their own continued performance. Thus the pulse is the *energeia* of the arteries, and is caused by the pulsative faculty transmitted by the heart; the existence of this faculty depends on the constitution of the flesh of the heart, which is the seat of the innate heat. The primary *chreia* of the pulse, Galen says, is maintenance of the innate heat. But the innate heat itself also has many uses, including nutrition and digestion, and these activities contribute to preserving the distinctive mixtures of the various organs (including the heart) so that they can continue to exercise their faculties. Thus the primary use of the

activity of the arteries is to create the conditions necessary for its continued performance by maintaining the innate heat, and the uses of the innate heat include the activities that help to sustain it. Such circularity is in no way vicious; it is, rather, just what we should expect from a sophisticated attempt to explain the feedback inherent in a self-maintaining system such as the human body.[37]

5. Functions

I now want to consider the extent to which Galen's concepts of *chreia* and *energeia* capture the notion of function as it is used in contemporary biology and philosophy of science. At first sight it is perhaps natural to think that *energeia* corresponds to function, for the idea of function seems closely linked to activity: an account of a thing's function is, very crudely, an account of something that it *does*.[38] But the function of a part of a complex system need not be an activity: it is reasonable to say that the function of the windows in a house is to let in light, but this is not an activity.[39] In fact it is *chreia* that corresponds more closely than *energeia* to the modern notion of function, as can be seen from two consderations in particular. (1) Giving an account of a part's *chreia* involves specifying its beneficial contribution to the organism's activities, chief among them life, reproduction, or a better life. Specifying the *chreia* of a part thus carries an implicit reference to the good or benefit of the organism as a whole. The notion that function ascriptions imply a reference to the organism's good, and in particular its survival and reproduction, is fundamental to many modern discussions of biological function. One modern attempt to set out a conception of biological function that is especially close to Galen's notion of *chreia* is that of John Canfield.[40] For Canfield, to give a functional analysis of a structure, part, or feature of an organism is to state what the item in question 'does' that is 'useful' to the organism (where 'does' need not imply activity but includes verbs such as 'store' or 'prevent', and 'useful' is glossed as 'contributing to survival and reproduction'). Canfield notes further

that the class of items for which functions should be specified includes processes such as the heartbeat or the secretion of bile, and also that functions can be understood as contributing not only to the organism as a whole but also to 'subsystems' such as the homeostasis of blood sugar.[41] All this is entirely in the spirit of Galen: compare the notion that the use of the pulse (which is itself the activity of the arteries) is the maintenance of the innate heat.[42] (2) The second point concerns the kinds of questions that an account of *chreia* is meant to answer. An account of the *chreia* of a part explains its contribution to the organism's activities; it answers the question: 'What is this part good for?' But in giving the *chreia* of a part Galen may also be explaining why it is present in the organism or why it has the particular set of attributes that it does; it is these questions, in fact, that seem to be Galen's primary concern throughout *UP*. The important point is that the scope of functional explanation in modern philosophy of science covers both sorts of questions: both 'What is this part good for?' and 'Why is this part here?' To say that the function of the liver is to secrete bile is to specify the liver's contribution to the animal's survival, but it may also be part of an explanation of the presence of livers in animals (e.g. because the presence of an organ to secrete bile was favored by natural selection).[43] For these reasons, Galen's accounts of *chreia* can reasonably be viewed as functional explanations.

To be sure, Galen's use of *chreia* is broader than some contemporary conceptions of function in at least two respects. First there is the issue of the kinds of activities to which *chreiai* are viewed as contributing: these include more than just survival and reproduction, for Galen says that *chreia* can be understood as a contribution to living well (τὸ καλῶς ζῆν). In this he follows both Plato and Aristotle.[44] Second, there is the more problematic question of whether utility alone is an adequate criterion for the identification of functions. Much of the recent literature is based on the idea that functions must be distinguished from accidental benefits. The importance of the distinction between function and accident has been urged especially by Wright, who remarks: 'Something can do something useful purely

by accident, but it cannot have, as its function, something it does only by accident.'[45] Since for Galen *chreia* can refer to any beneficial contribution to the organism's life, it would seem that he lacks the means for distinguishing genuine functions from accidental benefits.

In fact, however, the situation is both more complicated and more interesting. As we have seen, Galen's concept of *chreia* is richly differentiated, and he frequently distinguishes between 'spinoff' benefits and the 'primary *chreia*' for which a part was created. Building on this distinction, one might develop a view on which the functions of the parts would be limited to their primary *chreiai*, as reflected in the need for the Demiurge or nature to bring them into existence in the first place. But it is also possible to take Galen's wide-ranging application of the concept of *chreia* to support the idea that *any* contribution a part makes to the organism's activities may be considered one of its functions. It is not at all clear that the distinction between functions and accidental benefits is as fundamental as some modern authors have taken it to be. If functions are understood as contributions to the welfare of the organism as a whole, there is no obvious reason to rule out *any* such contribution from counting as a genuine function.[46]

However this may be, it should be clear that Galen's use of the concept of *chreia* shares a good deal of common ground with modern discussions of biological function, as it does with Aristotelian functional analysis. The basic reason for this is that for Galen, ascriptions of *chreia* are always referred back to the organism's good, understood as survival, reproduction, or a better life. Galen may be a lot more generous than Aristotle in ascribing functions to the parts and their attributes (see next section), but it can hardly be said that his ascriptions are arbitrary or piecemeal. Rather, they flow from a sophisticated analysis of the organism's activities and the various ways in which the parts contribute to their performance.

6. From functions to design

So far I have emphasized the close similarities between Galen's and Aristotle's functional approach to the study of living things. But there are of course major differences as well, and it is important to take note of them. First of all, Galen's argument in *UP* is not only that the parts of the body are adapted to the performance of the organism's activities, but also that they are so well adapted to carrying out those activities that no better construction is possible. At the beginning of *UP* 1.5, immediately after his introductory discussion of the human hand, Galen goes on to give the first of many statements of this fundamental thesis:

> Come now, let us investigate this very important part of man's body, examining it to determine not simply whether it is useful or whether it is suitable for an intelligent animal, but whether it is in every respect so constructed that it would not have been better had it come into being differently. (*UP* 1.5, 1.6.18-22 H, 3.9 K)

Galen's attempts to discern purpose in the structure and arrangement of the parts of the body are nothing less than an effort to demonstrate this sweeping claim. Now while Aristotle is certainly concerned to show that the parts of a human being are 'useful' and 'suitable for an intelligent animal', it is no part of his project to argue that the parts are so well constructed that they could not be any better. For Aristotle, the goal is just to show that a certain feature or structure makes some contribution to the organism's activities, especially survival or reproduction; for Galen this is only the beginning. This explains the abundance of counterfactual argument in *UP:* Galen often argues that if a certain part were any larger or smaller, or placed differently in any way, the activities of the organism would somehow be impaired.[47] Such arguments play no role in Aristotle's accounts of living things. In general Galen's teleology is comprehensive in a way that Aristotle's is not. He is committed to finding a use for virtually every part of the body, and every attribute;

Aristotle, by contrast, is more willing to acknowledge that some parts are present for no purpose.[48]

Thus Galen, as well as adopting a functional approach to the study of the parts, also argued for the claim that the human body displays optimal construction. As Galen sees it, this is largely a matter of the best possible adaptation of structure to function. But it is important to see that an argument for optimal construction is independent of a concern with functional explanation *as such*. As the example of Aristotle shows, one can adopt a functional approach to the study of the parts without arguing for their optimal construction. And one might also argue that the parts are structured as well as they could possibly be without grounding this in a notion of functional organization. Galen's concern to argue for optimal construction thus reflects different commitments than those which motivate his functional approach.

In fact, this concern is connected with a feature of Galen's thought that is Platonic rather than Aristotelian: the notion that a divine Craftsman or Demiurge is ultimately responsible for the order discernible in the world as a whole and living things in particular. That the human body is constructed 'as well as it could possibly be' is for Galen a major piece of evidence for the existence of the Demiurge. In the last book of *De usu partium,* Galen discusses the purpose of studying the uses of the parts. This study has several uses for the doctor, including diagnosis and prognosis (*UP* 17.2, 2.449.20-450.26 H, 4.363-4 K). But the main reason to pursue it is for what it reveals about the beneficent intelligence that is responsible for the design of the human being:

> Thus, when anyone looking at the facts with an open mind sees that in such a slime of fleshes and juices there is yet an indwelling intelligence and sees too the structure of any animal whatsoever — for they all give indication [ἔνδειξις] of a wise craftsman — he will understand the superiority of the intelligence in the heavens. Then a work on the

> use of the parts, which at first seemed to him a thing of scant importance, will be truly established as the starting point [ἀρχή] of a precise theology [θεολογίας ἀκριβοῦς], which is a thing far greater and far more honorable than all of medicine. Hence such a work is useful not only for the doctor, but much more so for the philosopher who is eager to gain an understanding of the whole of nature. (*UP* 17.1, 2.447.16-448.3 H, 4.360-1 K)

The crucial step in the argument is the move from optimal construction to the existence of the Demiurge — a classic example of 'inference to the best explanation', which is strictly speaking no inference at all. Galen views the situation as a choice between two exhaustive alternatives: *either* the marvelous construction of living things is due to the random collision of elementary particles, *or else* it is the result of divine intelligence (*UP* 17.1, 2.440.3-41.10 H, 4.350-51 K). Given this choice, Galen opts for the latter alternative as the best explanation. It is not my intention to evaluate the plausibility of this move here; I want only to point out that it too is independent of a functional approach to the study of the parts. Just as one can argue for optimal construction on grounds other than functional organization, so too the move from optimal construction to design does not itself imply a concern with functional explanation. This suggests that it was not the assumption of design that motivated Galen's functional approach, but rather the Aristotelian notion of the organism as a unified whole manifesting a coherent pattern of activities such as self-maintenance and reproduction.

Now it is true that, for Galen, functional considerations do enter into the arguments for the optimal construction of the body and the existence of the Demiurge. They do so via the notion of craftsmanship (*technē*). The human body, Galen claims, displays a superlative degree of craftsmanship; hence it must be the work of a divine Craftsman, even if we cannot perceive his existence directly.[49] Galen's notion of craftsmanship involves a number

of features, including symmetry (συμμετρία), equality (ἰσότης), proportion (ἀναλογία), and beauty, but the most important feature is the adaptation of structure to function.[50] Just as the craftsman constructs all the parts of a complex artifact with a view to the uses they must serve in the whole, so all the parts of the human body are constructed to perform their functions in the whole organism. The perfect adaptation of the parts of an artifact to their uses is a reliable indication of craftsmanship, and this holds no less of the human body than of an artifact such as a ship or a couch. Of those who fail to recognize the craftsmanship manifest in living things, Galen writes:

> They completely forget the judgment that all men naturally make about the arts [*technai*], and they forget the very great similarity between our construction and the arts; and yet they see many men working with materials who are not called shoemakers of builders or molders unless it is evident that every object they fashion has been made for some useful purpose [χρησίμου ἕνεκά τινος], since there is no other mark of an art besides the use [*chreia*] of each part of the product it fashions. (*PHP* 9.8, 2.590.30-592.1 De Lacy, 5.784 K)

Thus, grasping the supposedly perfect adaptation of structure to function in the body reveals that it is the product of craftsmanship, which in turn reveals the existence of the Demiurge.

However, even though Galen believes that the complex functional organization of living things could never have arisen without divine intelligence, it does not follow that the uses of the parts can only be understood with reference to the Demiurge's intentions. This is because Galen, like Aristotle, holds that organisms have internal rather than external teleology: that is, the end subserved by the parts of an organism is the continued existence of the organism as a whole, rather than any purpose external to it. The teleology of

artifacts, by contrast, is external: an artifact is created by an intelligent agent to serve some purpose that lies outside the artifact itself.[51] Now it is certainly possible to conceive of organisms as having external teleology in this sense. The Stoics, for example, argued that living things are part of a hierarchy in which each kind of organism serves a purpose external to it that is established by God: the purpose of grass is to be eaten by sheep, just as that of sheep is to be eaten by man.[52] On such a view, the functions of the parts of an organism are determined by their contributions to the purpose of the organism as a whole: as Chrysippus put it, the pig has a soul to keep it fresh for the slaughterhouse.[53] But Galen does not think that organisms have purposes external to themselves, and his version of the argument from design makes no appeal to such considerations.[54] In arguing that living things display craftsmanship, Galen does not appeal to the idea that an artifact *as a whole* has a use; instead what he emphasizes is that all the parts are optimally useful *with respect to* the whole.[55] While the functions of the parts of an externally teleological system depend on the purpose for which the system has been designed, the functions of the parts of an internally teleological system can be understood independently of the intentions of its designer — if there is one. The parts have functions, understood as contributions to the system's continued existence, whether or not the system was designed by an intelligent agent.[56] In this way, even though Galen thinks that living organisms are so complex that they could never have arisen without intelligent design, the *chreiai* of their parts can be understood independently of any reference to the Demiurge's intentions.

Moreover it is not the case that the parts are useful just *because* the Demiurge created them or gave them a certain structure; rather, the Demiurge creates the parts and structures them as he does because such an arrangement is maximally beneficial to the organism. It is *chreia* that determines the Demiurge's intentions, not the other way around.[57] The Demiurge simply reasons like any good craftsman would; if we are able and apply ourselves to the study of the parts, we can reconstruct his reasoning. The uses of the

parts of course *correspond* to the Demiurge's intentions, but that is just because he is supremely intelligent and therefore able to grasp what sort of construction would be most useful to an organism of a certain kind. And because he is supremely powerful (though not omnipotent), he is largely able to realize this construction.[58] In an important sense, then, Galen's functional explanations are independent of the thesis of design. What they tell us is *why* the Demiurge structured the parts in a certain way. That the Demiurge *intended* to act as he did is indeed fortunate; it tells us something about him and about how the body came to be structured as it is. But in itself it is irrelevant to the fact that the parts structured in this way are useful; *that* is because of their beneficial contributions to the organism as a whole.[59]

It would no doubt be overly simplistic to suppose that Galen adopted the thesis of design purely on the basis of his investigation of the correspondence between structure and function in the organism. Galen obviously had many reasons for his commitment to the existence of a Platonic Demiurge, some of them religious or theological, others connected with his own education and the intellectual prestige of Plato in the philosophical tradition.[60] The assumption that the body is the result of providential design must have functioned as a heuristic principle legitimating the search for uses of the parts even where others had seen none: once it is accepted that the design of the human body is the result of the activity of a Demiurge who is supremely good, powerful, and intelligent, there is every reason to suppose that he will have left no part without a use insofar as this is possible.[61] As a guide to anatomical investigation such a principle is undeniably fruitful, even if it did sometimes lead to excesses. Nevertheless the fact remains that Galen's explicit argument in *UP* and *PHP* 9 is *from* optimal construction, understood as consummate craftsmanship, *to* the existence of the Demiurge. Craftsmanship is chiefly a matter of the adaptation of structure to function, and so the starting point of the whole argument is a grasp of the complex functional organization of living things. As I have tried to show, Galen had good reasons to adopt this

as a starting point for his biological investigations — reasons which were independent of some of the bolder and more sweeping conclusions he attempted to draw from them.

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Notes

I would like to express my thanks to Peter McLaughlin, Francesca Schironi, David Sedley and Gisela Striker for their very helpful comments on earlier versions of this paper, which was completed under the ideal working conditions provided by the Institute for Advanced Study, Princeton.

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[1] C. Hempel, *Aspects of Scientific Explanation* (New York, 1965), 304-5: 'The kind of phenomenon that a functional analysis is invoked to explain is typically some recurrent activity or some behavior pattern in an individual or a group, such as a physiological mechanism, a neurotic trait, a culture pattern, or a social institution. And the principal objective of the analysis is to exhibit the contribution which the behavior pattern makes to the preservation or the development of the individual or the group in which it occurs. Thus, functional analysis seeks to understand a behavior pattern or a sociocultural institution by determining the role it plays in keeping the system in working order or maintaining it as a going concern.' For E. Nagel, functions are analyzed in terms of the contributions of parts of a system to the maintenance of its global properties or modes of behavior, and the function-bearer is viewed as supporting the 'characteristic activities' of the system (*The Structure of Science: Problems in the Logic of Scientific Explanation* [*Structure*] [New York, 1961], 403, 409, 421-2).

[2] Nagel (*Structure*, ch. 12) argues for the possibility of reducing teleological to non-teleological explanations, while recognizing the importance of functional explanation as a mode of investigation in the biological sciences. See also Hempel (*Aspects of Scientific Explanation*, 297-330); J. Canfield, 'Teleological Explanation in Biology', *British Journal for the Philosophy of Science,* 14:56 (1964), 285-95; F. J. Ayala, 'Teleological Explanations

in Evolutionary Biology', *Philosophy of Science,* 37:1 (1970), 1-15; L. Wright, 'Functions', *Philosophical Review,* 82:2 (1973), 139-68; and for a full review of the contemporary literature and all the major issues P. McLaughlin, *What Functions Explain: Functional Explanation and Self-Reproducing Systems* [*What Functions Explain*] (Cambridge, 2001).

[3] Nagel, *Structure*, 401.

[4] For *UP* and *Nat. fac.* I use the Greek text of G. Helmreich (*Galeni De usu partium Libri XVII,* 2 vols. [Leipzig, 1907-9]; *Claudii Galeni Pergameni scripta minora,* vol. 3 [Leipzig, 1893]), with reference to volume, page and line of his edition (H) followed by the reference to volume and page in the edition of C. G. Kühn (*Claudii Galeni Opera Omnia,* 20 vols. in 22 [Leipzig, 1821-33; repr. Hildesheim, 1965]). For all other Galenic works I give the volume and page reference to Kühn (K) along with references to more recent editions where available. Translations are my own unless otherwise indicated, but I have drawn extensively on the excellent translation of M. T. May (*Galen: On the Usefulness of the Parts of the Body* [*Usefulness*], 2 vols. [Cornell, 1968]).

[5] In general the Hippocratics conceive of the parts of the body in structural rather than functional terms: they are 'forms' or 'conformations' (σχήματα, Hp. *VM* 22) rather than 'organs' or 'instruments' (*organa*). For the general point see J. Jouanna, *Hippocrates* (Baltimore, 1999), 310-11; see also B. Gundert, 'Parts and Their Roles in Hippocratic Medicine', *Isis,* 83:3 (1992), 453-65. The sole Hippocratic treatise that can be said to adopt a consistently functional approach is *On the Heart* (*De corde*), but this feature is generally regarded as a sign of its Hellenistic date; see I. M. Lonie, 'The Paradoxical Text *On the Heart*', *Medical History,* 17 (1973), 1-15 and 136-53 at 4-5, 143-7. Cf. esp. *De corde* 8,

9.84-6 Littré on the auricles as 'instruments' (*organa*) with which nature captures the air, like the bellows in a blacksmith's furnace.

[6] On Aristotle's functional approach see M. Nussbaum, *Aristotle's De Motu Animalium* [*De Motu*] (Princeton, 1978), 76-85 and M. R. Johnson, *Aristotle on Teleology* (Oxford, 2005), 159-78.

[7] Even the parts of plants are organs, albeit very simple ones: the leaf protects the pericarp, and the roots attract nutriment like a mouth (*An.* 412b1-4). Cf. *An.* 416a4-6: 'the head in animals is analogous to the roots in plants, if we are to identify and distinguish organs (*organa*) by their functions (*erga*)'.

[8] *An.* 435b17-25, esp. 435b20-21 (οὐ τοῦ εἶναι ἕνεκα ἀλλὰ τοῦ εὖ). Cf. *PA* 640a33-b1 and 670b23-7: the kidneys are present 'for the sake of what is good and fine' (τοῦ εὖ καὶ καλῶς ἕνεκεν), i.e. 'so that the bladder might perform its function (*ergon*) better'. On this category of parts see Johnson, *Aristotle on Teleology*, 188-9 and 197-8. Cf. also Plato, *Timaeus* 75 D 5-E 5 on the dual role of the mouth and tongue as both serving a necessary purpose and contributing to the best life.

[9] I take this to be a consequence of the fact that for Aristotle, the final cause must be an end of whatever it is meant to explain: the cause 'for the sake of which' is always referred to the nature (*physis*) or essence (*ousia*) of the individual thing in question (cf. *Phys.* 198b8-9). This is not to deny that the various natural kinds may be so ordered as to benefit one another by the fulfillment of their individual ends (cf. *Metaph.* Λ 10), or that the lower creatures may be instrumentally useful to man (cf. *Pol.* 1256b10-22). The point is just that

the good that is relevant to the final cause is the good of the organism as specified in its definition or *logos*, not the good of anything outside it. See Nussbaum, *De Motu,* 95-7 and Johnson, *Aristotle on Teleology* for a comprehensive and (I think) convincing defense of this interpretation. For the contrary view see D. Sedley, 'Is Aristotle's Teleology Anthropocentric', *Phronesis,* 36 (1991), 179-96.

[10] In dividing up the activities of soul and nature in this way Galen follows Stoic usage.

[11] Cf. P. Moraux, 'Galen and Aristotle's *De partibus animalium*', in A. Gotthelf (ed.), *Aristotle on Nature and Living Things: Philosophical and Historical Studies Presented to David M. Balme on His Seventieth Birthday* (Pittsburgh, 1985), 327-44.

[12] *UP* 14.1, 2.284.20-285.1 H, 4.142 K: 'Nature had three principal aims [*skopoi*] in constructing the parts of the animal; for she crafted them either for the sake of life [ἕνεκα τοῦ ζῆν] (the brain, heart, and liver), or for a better life [τοῦ βέλτιον ζῆν] (the eyes, ears, and nostrils), or for the continuance of the race [τῆς τοῦ γένους διαδοχῆς] (the pudenda, testes, and uteri).'

[13] *De methodo medendi* 1.6, 10.47 K: 'I call an organ [*organon*] a part of the animal that is productive of a complete activity [*energeia*], as the eye is of vision, the tongue of speech, and the legs of walking; so too arteries, veins and nerves are both organs [*organa*] and parts [*moria*] of animals.'

[14] For recognition of the Aristotelian background see *De placitis Hippocratis et Platonis* (*PHP*) 1.8, 1.92.23-94.15 De Lacy, 5.202-3 K. Cf. *UP* 8.4, 1.454.8-11 H, 3.627 K,

criticizing Aristotle for being deceived by 'names which are established not from the very essence [οὐσία] of the thing, but from some accidental characteristics [ἀπό τινων συμβεβηκότων]'.

[15] κατὰ μὲν οὐλομελίην πάντα συμπαθέα, κατὰ μέρος δὲ τὰ ἐν ἑκάστῳ μέρει μέρεα πρὸς τὸ ἔργον. However, this differs slightly from the standard modern text of *On Nutriment* (R. Joly, *Hippocrate, tome VI pt. 2* [Paris, 1972], 143): Σύρροια μία, σύμπνοια μία, συμπαθέα πάντα· κατὰ μὲν οὐλομελίην πάντα, κατὰ μέρος δὲ τὰ ἐν ἑκάστῳ μέρει μέρεα πρὸς τὸ ἔργον. This might be rendered: 'Conflux one, conspiration one, all things in sympathy; all the parts as forming a whole, and severally the parts in each part, with reference to the work' (so W. H. S. Jones, *Hippocrates 1* [Cambridge, MA, 1923], 351). Galen was fond of the aphorism and refers to it on a number of occasions as expressing the essence of Hippocrates' teaching about the body; see *Nat. fac.* 1.12, 122.6-10 H, 2.29 K; 1.13, 129.7-9 H, 2.39 K; 3.13, 238.4-7 H, 2.189 K; 3.13, 243.10-13 H, 2.196 K; *De causis pulsuum* 2.12, 9.88 K; *De tremore* 6, 7.616 K; and *De methodo medendi* 1.2, 10.16 K (where the doctrine is ascribed to both Aristotle and the Stoics as well as Hippocrates). For the Stoic influence on *Alim.* see H. Diller, 'Eine Stoisch-pneumatische Schrift im Corpus Hippocraticum', *Sudhoffs Archiv,* 29 (1936), 178-95, repr. in G. Baader and H. Grensemann (eds.), *Hans Diller: Kleine Schriften zur Antiken Medizin* (Berlin, 1973), 17-30.

[16] I follow May in translating ὁμολογεῖν as 'cooperate' (rather than, say, 'agree') since I take Galen's point to be not just that the parts 'agree' or 'accord' with one another (i.e. that they fit together well, making compatible but distinct contributions to the organism's activities), but also that they actively work together to promote the organism's activities.

The ideas of active assistance and interdependence between the parts are suggested by the references to 'sympathy' (συμπάθεια), 'conspiration' (σύμπνοια), and 'conflux' (σύρροια) in the Hippocratic passage that Galen is expounding here.

[17] For the heart as the source of the arteries and their role in maintaining the vital heat and nourishing the psychic pneuma see *UP* 1.16, 1.32.23-33.10 H, 3.45-6 K. For the dependence of the liver on the brain and heart see *UP* 4.13, 1.227.4-23 H, 3.309-10 K: arteries from the heart arrive at the liver in order to preserve the due measure of heat in it, and a nerve is inserted into its outer tunic to prevent it from being completely without sensation. For ἐπικουρία cf. *De propriis placitis* 10, with the new text of V. Boudon-Millot and A. Pietrobelli, 'Galien ressuscité: *édition princeps* du texte grec du *De propriis placitis*' ['Galien ressuscité'], *Revue des Études Grecques,* 118 (2005), 168-213, at 181.26-182.15.

[18] The discussion of R. Siegel, *Galen on Psychology, Pschopathology, and Function and Diseases of the Nervous System: An Analysis of His Observations and Experiments* (Basel, 1973), 31-53 has the merit of drawing attention to Galen's conception of functional integration or interdependence, though his translations and analyses are often unreliable.

[19] On Galen's use/activity distinction see D. Furley and J. S. Wilkie, *Galen on Respiration and the Arteries* [*Galen on Respiration*] (Princeton, 1984), 58-69; R. J. Hankinson, 'Galen Explains the Elephant', in M. Matthen and B. Linsky (eds.), *Philosophy and Biology* (Calgary, 1988), 135-57.

[20] *Nat. fac.* 1.2, 105.13-23 H, 2.6-7 K. Cf. *De methodo medendi* 1.6, 10.45-6 K; 2.3, 10.87 K; and *PHP* 6.1, 2.360.22-3 De Lacy, 5.506 K: 'Now activity is active change, and I mean by "active" a change arising from the thing itself, while "affection" is change in one thing that arises from another' (ἡ μὲν οὖν ἐνέργεια κίνησίς ἐστι δραστική, δραστικὴν δ' ὀνομάζω τὴν ἐξ ἑαυτοῦ, τὸ δὲ πάθος ἐν ἑτέρῳ κίνησίς ἐστιν ἐξ ἑτέρου). Galen goes on to say that the active and passive changes are often the same process, but viewed in two different ways; e.g. the separation of a cut object is an activity of the cutter but an affection of what is cut. But then he adds that according to another usage *energeia* is change 'according to nature' (κατὰ φύσιν) and πάθος change 'contrary to nature' (παρὰ φύσιν), and that when the terms are used in this sense it does not matter whether the source of the change is internal or external (2.360.23-362.9 De Lacy, 5.506-7 K).

[21] The term 'active' (δραστικός) is not found in Aristotle, and its use by Galen probably reflects Stoic influence. Moreover, while Aristotle recognizes a close association between *energeia* and *kinēsis*, he also draws important distinctions between the two concepts (see esp. *Metaph.* 1048 b18-35).

[22] A TLG search for the various forms of *chreia* in *UP* yields some 467 instances.

[23] See also *UP* 6.7, 1.318.15-19 H, 3.436 K (those parts of the heart are most important [κύριον] whose *chreiai* preserve the life of the whole organism) and *UP* 8.6, 1.471.14-16 H, 3.650 K: the pores of the nostrils have two *chreiai,* one of which is necessary for life itself (the discharge of residues from the brain), the other for a better life (the transmission of odors to the organ of smell).

[24] *Pace* May (*Usefulness,* vol. 1, 9), who takes the basic meaning to be 'the suitability or fitness of a part for performing its action'. The translation 'use' is in keeping with the traditional Latin title, *De usu partium;* cf. also the titles περὶ χρείας ἀναπνοῆς (*De usu respirationis*) and περὶ χρείας σφυγμῶν (*De usu pulsuum*). In Harvey's usage, the terms *usus* and *actio* correspond to Galen's *chreia* and *energeia*; see Furley and Wilkie, *Galen on Respiration*, 61.

[25] *UP* 1.16, 1.32.23-33.10 H, 3.45-6 K; cf. *De usu pulsuum* 3, 5.160-1 K. See also *UP* 6.4, 1.308.15-18 H, 3.422 K: 'Where the use of the activity [ἡ τῆς ἐνεργείας ... χρεία] of each of two organs is of equal importance [ὁμότιμος], as for the eyes and ears and hands and feet, nature has made the ones on the right exactly equal to those on the left.'

[26] συναφθείσης τῷ τῆς ἐνεργείας χρησίμῳ τῆς χρείας τοῦ μορίου: *UP* 17.1, 2.438.19-20 H, 4.348 K. Cf. *UP* 11.16, 2.167.15-17 H, 3.918 K: 'when the activity [*energeia*] of this muscle has been discovered, its use [*chreia*] is also immediately clear'.

[27] *UP* 6.4, 1.307.25-308.1 H, 3.421 K: 'Indeed, the use [*chreia*] of the respiratory organs would rightly come about through movement [διὰ τῆς κινήσεως], while that of organs of support would come about through rest [δι' ἡσυχίας]'. *UP* 7.12, 1.407.7-14 H, 3.559-60 K: 'Now when parts act, their use [*chreia*] straightaway becomes evident at the same time, and anyone who is explaining use [*chreia*] need only mention their activity [*energeia*]. But for those parts which perform no activity manifestly useful to the animal as a whole (for this is how you should always understand use) but which subserve parts that do act, I must give in this treatise an explanation in greater detail; for this is its special purpose.'

[28] For Galen's discussion of this question see *PHP* 6.7, 2.404.38-406.24 De Lacy, 5.560-2 K; *An in arteriis natura sanguis contineatur* 8, 4.733-4 K.

[29] For the dependence of *energeiai* on the substance of the organs see e.g. *Nat. fac.* 1.3, 106.4-6 H, 2.7 K.

[30] See *UP* 1.9, 1.19.9-24 H, 3.26-7 K and *UP* 4.13, 1.220.19-25 H, 3.300 K on the need to study not just the distinctive substance of the parts but also their placement, number, size, contexture (πλοκή), shaping (διάπλασις), connection (ξύμφυσις), and interrelationships (τῆς πρὸς ἄλληλα κοινωνίας ἁπάσης).

[31] *UP* 11.13, 2.153.19-26 H, 3.899 K; 6.12, 1.338.20-22 H, 3.464 K. Cf. also *UP* 6.4, 1.308.18-27 H, 3.422 K; 5.9, 1.276.26-277.4 H, 3.378 K.

[32] See also *De anatomicis administrationibus* 7.1, 2.590 K: 'All these things nature made in the first instance [κατὰ πρῶτον λόγον], some of them for the sake of necessary uses [ἀναγκαίων ἕνεκα χρειῶν], for life itself, but others for uses that are indeed beneficial to living things, but not necessary to them'.

[33] E.g. *UP* 2.7, 1.86.1-4 H, 3.117 K; 2.16, 1.114.6-12 H, 3.155 K; 6.12, 1.337.22-338.1 H, 3.463 K; 7.4, 1.379.23-380.1 H, 3.522-3 K; 7.12, 1.407.4-7 H, 3.559 K.

[34] E.g. *UP* 4.13, 1.226.7-15 H, 3.308 K; 4.17, 1.241.19-242.1 H, 3.329 K; 8.4, 1.453.11-18 H, 3.625-6 K; 8.11, 1.484.15-23 H, 3.667-8 K.

[35] E.g. *UP* 5.5, 1.266.24-267.4 H, 3.364 K; 7.5, 1.382.15-18 H, 3.526 K; 7.8, 1.391.24-25 H, 3.539 K.

[36] Cf. *UP* 7.5, 1.383.25-384.3 H, 3.528 K: 'But now, since I have shown that all the true statements I have made about uses [*chreiai*] in this exposition and about activities [*energeiai*] in earlier ones are consistent and corroborate one another [πάντ' ἀλλήλοις ὁμολογεῖ τε καὶ μαρτυρεῖ τἀληθῆ], let us proceed to discuss the remaining parts of the lung'.

[37] The circularity is noted by Wilkie (*Galen on Respiration,* 66-7), but he does not connect it with the need to account for the organism as a self-maintaining system. For the role of the innate heat in causing nutrition and digestion see *Nat. fac.* 2.4, 165.23-166.12 H, 2.89-90 K. Galen sometimes identifies it as the cause of the motion of the arteries, as at *PHP* 8.7, 2.524.10-13 De Lacy, 5.702 K. At *De causis pulsuum* 1.2, 9.4-5 K, however, he refuses to state whether the cause of the pulse is the innate heat, the peculiar blend of qualities in the heart, or a number of other possibilities; he is willing only to assert the existence of a faculty (*dynamis*) that causes the pulse. For the self-maintaining character of the innate heat see *De tremore* 6, 7.616 K, where it is identified with nature and soul: 'And nature and soul are nothing other than this, so that if you think of it as an self-moving, ever-moving substance (οὐσίαν αὐτοκίνητόν τε καὶ ἀεικίνητον), you will not be in error'.

[38] May thinks that *energeia* is closer to 'function' than *chreia* (*Usefulness,* vol. 1, 9). M. Beckner ('Function and Teleology', *Journal of the History of Biology,* 2 [1969], 151-64) restricts functions to activities.

[39] The example is taken from Wright, 'Functions' (above, n.2), 139; cf. ibid., 152 (objecting to Beckner): 'It is not at all clear that functions — even natural functions — have to be activities at all ... Making seconds easier to read is an example, but there are many others: preventing skids in wet weather, keeping your pants up, or propping open my office door. All of these things are legitimate functions (of tire treads, belts, and doorstops, respectively); none are activities in any recognizable sense.'

[40] Canfield, 'Teleological Explanation in Biology' (above, n. 2).

[41] Canfield, 'Teleological Explanation in Biology', 287 n. 1.

[42] R. Sorabji ('Function', *Philosophical Quarterly*, 14:57, [1964], 289-302) identifies contribution to a good as an essential attribute of functions in living organisms and social systems. Various authors (e.g. Wright) have attacked the view that a contribution to the organism's good is essential to function ascriptions; but see McLaughlin, *What Functions Explain*, for a defense of the view that function ascriptions, if they are to be genuinely explanatory, demand an (Aristotelian) metaphysical commitment to the existence of the organism as the beneficiary of a good.

[43] Wright is a leading proponent of the view that function ascriptions explain the presence of the function-bearer in biological systems, via the mechanism of natural selection. Thus, the function of the liver is what the liver does in a organism that also explains (via natural selection) why livers are there: 'If an organ has been naturally differentially selected-for by virtue of something it does, we can say that the reason the organ is there is that it does that something' ('Functions', 159). On his view, we can say that Y is the function of a part X if and only if X does Y and X is there *because* it does Y. For the alternative view that what

functions explain is not the presence of the function-bearer but rather its role in a complex system see esp. R. Cummins, 'Functional Analysis', *Journal of Philosophy,* 72 (1975), 741-65.

[44] As Sorabji has noted ('Function', 293-5), both Plato and Aristotle recognize the distinction between activities essential for the preservation of life and those that make it possible to live well (cf. n. 8 above). He makes a good case for regarding contributions to the latter kind of activities as 'luxury functions'.

[45] Wright, 'Functions', 147, objecting to the view of Canfield mentioned above.

[46] Wright, who has emphasized the importance of the function/accident distinction, also rejects the notion that functions can be understood as contributions to the organism's welfare.

[47] As R. J. Hankinson notes ('Galen and the Best of All Possible Worlds', *Classical Quarterly*, NS 39:1 [1989], 206-27 at 220-1), such arguments are open to objection in that they presuppose that all the parts other than the one in question are fixed, so that only variation in that particular part needs to be considered when evaluating whether it is structured as well as it could possibly be. But this ignores the possibility that a radically different structural plan might enable the organism to perform its activities better.

[48] The spleen is a case in point (*PA* 670a30-1); cf. also the remarks on bile at *PA* 677a11-19. Such parts or constituents, Aristotle thinks, follow necessarily from the presence of parts that *do* have a purpose; cf. Johnson, *Aristotle on Teleology,* 197. It is sometimes said

that Galen refuses to acknowledge the existence of *any* parts of this kind in the body (e.g. Hankinson, 'Galen and the Best of All Possible Worlds', 214). See however *UP* 5.3 on the jejunum or νῆστις, which provides no *chreia* to the organism but 'follows by necessity on parts which have come to be for a purpose [ἐξ ἀνάγκης ἕπεσθαι τοῖς ἕνεκά του γεγονόσιν]', 1.254.6-7 H, 3.346 K); cf. also *UP* 5.16, 1.297.21-24 H, 3.406 K (the obliquity of the neck of the bladder follows of necessity on purposive structures) and UP 11.14, 2.160.20-161.1 H, 3.908-9 K (hair in the armpits is due not to the providence [*pronoia*] of the Demiurge, but rather to the nature of the fluids there). Galen says that such features are simply not his concern in *UP*: 'For in these commentaries I am explaining not the necessary consequences of things that have come to be for a purpose [τῶν ἐξ ἀνάγκης ἑπομένων τοῖς ἕνεκά του γεγονόσιν], but those things that have been crafted by nature in the first instance [τῶν κατὰ πρῶτον λόγον ὑπὸ τῆς φύσεως δεδημιουργημένων]' (5.3, 1.257.4-8 H, 3.350-1 K). None of this is to deny, of course, that Galen is much more systematic and comprehensive than Aristotle in his search for uses of the parts.

[49] The claim that the human body displays skilled craftsmanship is a constant refrain throughout *UP;* Galen elaborates on it at length in *UP* 17.1 (2.441.10-446.7 H, 4.351-8 K). In *PHP* 9.8 Galen presents the inference from the craftsmanship of the body to the existence of the Demiurge as a paradigm example of inductive reasoning (2.590-6 De Lacy, 5.782-91 K). At *PHP* 9.8, 2.596.5-20 De Lacy, 5.789-91 K Galen argues that to doubt the existence of the Demiurge simply because he cannot be perceived directly would be as absurd as doubting that an artifact such as a bed or couch was made by a craftsman just because he has never been seen.

[50] For these features of the craftsmanship of the body see esp. *UP* 17.1, 441.10-446.7 H, 4.351-58 K and *PHP* 9.8, 2.592.22-596.4 De Lacy, 5.786-89 K. For beauty as the adaptation of structure to function see *UP* 1.9, 1.17.20-18.5 H, 3.24-5 K: 'And so, if you are seeking to discover the proper form for the eye or nose, you will find it by correlating their structure [κατασκευή] and activities [*energeiai*]. In fact, this is your standard, measure, and criterion of proper form and true beauty [κάλλος], since true beauty is nothing but excellence of structure, and in obedience to Hippocrates you will judge that excellence from activities [*energeiai*], not from whiteness, softness, or other such qualities, which are indications of a beauty meretricious and false, not natural and true.'

[51] For the distinction between external and internal teleology see Ayala, 'Teleological Explanations in Evolutionary Biology' (above, n. 2), esp. 13: 'A feature of a system will be teleological in the sense of internal teleology if the feature has utility for the system in which it exists and if such utility explains the presence of the feature in the systems. Utility in living organisms is defined in terms of survival or reproduction. A structure or process of an organism is teleological if it contributes to the reproductive efficiency of the organism itself, and if such contribution accounts for the existence of the structure or process. Man-made tools or mechanisms are teleological with external teleology if they have utility, i.e., if they have been designed to serve a specified purpose, which therefore explains their existence and properties.' What Galen offers in the case of organisms is an internal teleology that is the result of design.

[52] Cf. Cicero *De natura deorum* 2.37 (*SVF* 2.1153, Long and Sedley 54H; tr. Long and Sedley): 'As Chrysippus cleverly put it, just as the shield-cover was made for the sake of the shield and the sheath for the sake of the sword, so too with the exception of the world

everything else was made for the sake of other things: for example, the crops and fruits which the earth brings forth were made for the sake of animals, and the animals which it brings forth were made for the sake of men (the horse for transport, the ox for ploughing, the dog for hunting and guarding).'

[53] See Porphyry *De abstinentia* 3.20.1 (*SVF* 2.1152, Long and Sedley 54P; tr. Long and Sedley): 'It was certainly a persuasive idea of Chrysippus' that the gods made us for our own and each other's sakes, and animals for our sake: horses to help us in war, dogs in hunting, and leopards, bears and lions to give us practice in courage. As for the pig, that most appetizing of delicacies, it was created for no other purpose than slaughter, and god, in furnishing our cuisine, mixed soul in with its flesh like salt.'

[54] Cf. *De semine* 1.15, 132.16-19 De Lacy, 4.581 K, discussing the tension of strings on a musical instrument (tr. De Lacy): 'But let us not suppose that because their tension is useful [χρήσιμος] to performers, this state is natural [κατὰ φύσιν] for the cords. The natural state [τὸ κατὰ φύσιν] of each thing that exists is not measured by usefulness to us [ταῖς ἡμετέραις χρείαις]; for by that reckoning even the death of animals slaughtered for food will be natural [κατὰ φύσιν], as they are about to become useful to us.'

[55] The only passage I have found where Galen seems to appeal to the *chreia* of an artifact as a whole is *UP* 17.1, 2.438.2-7 H, 4.347 K, which reads as follows in May's translation (slightly modified): 'there is no part which we desire for its own sake, and a part deprived of its activity would be so superfluous that we should cut it off rather than wish to keep it. Indeed, if there were any such part in the body of an animal, *we would not say that the whole had any certain use* [οὐκ ἂν ἁπάντων ἐλέγομεν εἶναί τινα χρείαν]. But since neither man nor any other animal has such a part, we say that nature is skillful.' But the

italicized sentence could better be translated 'we would not say that all the parts had a use', and there is in any case some uncertainty about the reading ἁπάντων (the alternatives include both αὐτοῦ and ἀπ' αὐτοῦ according to Helmreich's apparatus).

[56] Cf. McLaughlin, *What Functions Explain*, 142-50.

[57] See esp. *De constitutione artis medicae ad Patrophilum* 58.34-60.6 Fortuna, 1.231 K: 'Just as the person who wishes to know precisely what sort of thing a house that has already come to be is attains knowledge of it from analysis and decomposition, in the same way we too will come to know the body of a human being from dissection. Now god and nature recognize the parts in advance, like the one who originally constructed the house, since use furnishes them with the model [τῆς χρείας αὐτοῖς τὸ παράδειγμα γεννώσης], but we [recognize the parts] like one who investigates the house that has already come to be. And yet for us too, if we do not make our knowledge as similar as possible to god, it will be impossible to recognize whether all [the parts] have come to be on account of some use [*chreia*], or some of them in vain.'

[58] Galen's Demiurge is limited by the nature of the matter he has to work with; in this sense he is fundamentally distinct from the Judeo-Christian God, who could 'make a horse or a cow out of ashes' (*UP* 11.14, 2.158.23-26 H, 3.906 K).

[59] Of course it is presumably the Demiurge who conceives of the various kinds of living things, so in this sense the uses of all the parts do ultimately depend on his intentions. But once the forms of living organisms have been established (i.e. by specifying the 'character and faculties' of their souls) the plan of construction follows immediately. The point is that even though Galen thinks that organisms, like artifacts, are the result of intelligent design,

the teleology of the organism does not depend on the intentions of its designer in the same way as the teleology of an artifact. In the case of artifacts, the functions of the parts are dependent on the purpose for which the artifact was designed. In the case of organisms, which are their own ends, the functions of the parts depend solely on their contributions to the whole; the designer is invoked only because matter would never come to possess an appropriate level of structural organization if left to its own accord.

[60] In *De propriis placitis* 2, Galen says that the existence of the gods can be inferred from their 'works' (*erga*), which include: the 'construction' (κατασκευή) of living things; omens, portents, and dreams; cures (Galen refers to an occasion on which he was cured by Asclepius); and help at sea (Galen claims personal experience of the providence [*pronoia*] and power [*dynamis*] of the Dioscuri). See the recently rediscovered Greek text as presented in V. Boudon-Millot and A. Pietrobelli, 'Galien ressuscité'.

[61] On the heuristic role of teleology in Galen see Hankinson, 'Galen and the Best of All Possible Worlds', 223-7.