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AVICENNA X. MEDICINE AND BIOLOGY
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x. Medicine and Biology

Introduction: Avicenna between Aristotle and Galen. At the time of Avicenna natural philosophy and medicine overlapped, sharing a large area of the field that today we call biology. But they were two distinct traditions, in the important sense that each had its own literature and leading authorities, primarily Aristotle (Aresṭātālīs) for philosophy and Hippocrates (Boqrāṭ) and Galen (Jālīnūs) for medicine.

Galen, whose dominance of medicine was nearly complete, had differed sharply with Aristotle on some questions, the most central of which was whether the powers that control animal life have one single source (the heart, as Aristotle believed) or three distinct sources (the brain, heart, and liver, as Galen argued). He also forcefully challenged Aristotle's views on the male and female roles in sexual generation. These differences fueled a fierce dispute between the followers of Aristotle (the natural philosophers) and the followers of Galen (the physicians) for centuries.

Nowhere in medieval thought was the contest between Galen and Aristotle as dramatic as in the works of Avicenna, where the two great traditions intersected. Avicenna wrote the medieval textbook of Galenic medicine the

Qānūn (the *Canon*), as well as the central medieval statement of Aristotelian biology (the *Ḥayawān*, the biological section of the *Šefāʾ*). In both works he confronted the problem of the Aristotelian-Galenic division, and settling the contest between the two titanic authorities became the cardinal interest of his life-work in medicine and biology (Table 3).

Already in book 1 of the *Canon* (composed before 405/1015, when he was thirty-five years old), Avicenna had taken Aristotle's side in the theoretical controversies, with the ironical result that this most influential Galenic document of the Middle Ages was written by someone openly committed to the Aristotelian point of view. This apparent irony only deepens when we realize that the *Ḥayawān*, arguably Avicenna's most explicitly Aristotelian work, harbored a massive amount of purely Galenic material. In fact, Avicenna's synthesis depended on accepting the new (post-Aristotle) Galenic evidence in anatomy and physiology, and equally on interpreting it so as to fit Aristotelian theory.

The Canon. Galen (and Hippocrates as presented by Galen) had generally dominated Islamic medicine from its beginnings. Galen's positive ideas about anatomy, physiology, disease, and treatment of disease have the pride of place in the *Canon*, as they do in all of Islamic medicine.

The *Canon* has been accurately described as a "monumental unity," and "the clear and ordered "summa" of all the medical knowledge of Ibn Sīnā's time" (A.-M. Goichon, "Ibn Sina," *EI*^{2} III, p. 942). In this, Avicenna did not break new ground. As a magisterial exposition of Galenic medicine the *Canon* is not unique, nor was it the first in Arabic. Islamic medicine had developed for two centuries before Avicenna: Ḥonayn b. Esḥāq (fl. 192-260/808-73) and his associates had firmly established its sources and Arabic terminology, and ʿAlī b. Sahl Rabbān Ṭabarī, Moḥammad b. Zakarīyāʾ Rāzī, and ʿAlī b. ʿAbbās Majūsī (q.v.) had all published systematic and sophisticated medical works. Majūsī's *Kāmel al-ṣenāʿa al-ṭebbīya*, in particular, rivals the *Canon* in size as well as in the clarity and authority of its exposition of Galenic medicine.

The *Canon* is organized into five books. Book 1 (the *Kollīyāt*) covers the basic principles of medicine, and is in four parts. Part 1 discusses the constitution of the body (What is it made of? The four elements: earth, water, air, and fire, and the four humors: blood, phlegm, yellow bile, and black bile, whose mixture determines the temperament of every individual); the anatomy of uniform parts (the bones, muscles, nerves, veins, and arteries); and general

physiology (How does the body function?). Part 2 deals with the causes and symptoms of disease. Part 3 is devoted to preventive medicine (*ḥefẓ al-ṣeḥḥa* "the maintenance of health"), principally through disciplined living and diet. Part 4 deals with the treatment of disease, again with emphasis on regimen and diet, and on medicines only when these fail.

Avicenna devoted two of the *Canon's* five books to medicines: Book 2 comprises the Materia Medica, which lists about 800 individual drugs, mostly of vegetable origin (but with many animal and mineral substances); and book 5 (the Formulary), which contains some 650 compounded prescriptions—theriacs, electuaries, potions, syrups, etc.

The diseases of particular organs, starting from the head and moving down to the toes, are systematically discussed in book 3. Book 4 deals with medical conditions that affect the body as a whole (fevers, poisons) or that could happen to any part of it (wounds, fractures). It concludes with a treatise on personal hygiene, emphasizing care of the hair, skin, nails, body odor, and the treatment of overweight or underweight persons.

Medicine and natural philosophy. No doubt the *Canon*'s dominance of later medicine owed much to Avicenna's general influence. Yet it is possible that the *Canon*'s special perspective on Galenic medicine contributed to its popularity among the learned. This perspective can best be appreciated when contrasted with that of Majūsī's *Kāmel al-ṣenāʿa*, its closest rival. Majūsī began his book with a history of medicine from the ancient Greeks to his own day, and justified his work without reference to anything else. In contrast, Avicenna avoided the history of medicine, and instead took extraordinary pains in the *Canon* itself to circumscribe medicine to what he considered to be its proper domain. By defining the place of medicine in the hierarchy of the sciences, something which Majūsī had failed to do, Avicenna increased the appeal of his work as a textbook for teachers of the medieval curriculum.

Since in practice the content of medicine and natural philosophy overlapped, Avicenna wished to delineate clearly their respective areas of competence. He devoted the first chapter of the *Canon* to this task, and repeatedly returned to it afterwards. Medicine for him was indeed an independent science with its own special subject, as the first sentence of the *Canon* makes clear: "Medicine is a science by which we learn about the conditions of the human body in health and in the absence of health, in order to maintain health or to restore it." However, medicine begins with a set of basic concepts (including the

"elements," "humors," "temperaments," and "faculties," i.e., the common vocabulary of Galenic medicine) which it borrows from natural philosophy. The actual investigation of these theoretical concepts falls outside the purview of medicine, belonging instead to natural philosophy. According to Avicenna, the physician could not independently answer such questions as: Do the elements exist? What are the humors? How many faculties are there? He persistently admonishes the physician to leave this task to the natural philosopher. When Galen dealt with such questions, Avicenna writes, he did so "not as a physician, but as someone who wanted to be a philosopher" (*Canon* I, pp. 4, 5, 6, 17, 19, 21, 67, 71, 72).

A certain urgent purpose emerges through Avicenna's repeated admonitions, namely his desire to safeguard natural philosophy, and the authority of its master Aristotle, from the inroads of Galenism. But his emphasis on the difference between the two sciences amounted to little more than a holding action. For the real source of the trouble was that medicine and natural philosophy, though distinct, were nevertheless joined together like Siamese twins by anatomy—the common material on which all medical and biological discussion depended. And since anatomical knowledge was supposed to be based strictly on "experience and dissection" (ibid., I, p. 5), there were no grounds for asking the physician to defer to the philosopher in arguments about anatomical facts. It is this which had given Galen's challenge its cutting edge, for he was the beneficiary of centuries of anatomical discoveries after Aristotle.

The essence of the problem for Avicenna was that Aristotle's anatomy was comparatively primitive, and had enfeebled his whole biological system. Ultimately Avicenna was able to deflect Galen's challenge only by rebuilding the Aristotelian system on the firmer basis of the new anatomy. But what he did in the *Canon* was principally to recognize the problem, his normal practice being (1) to say that a controversy exists (on generation or the heart) between Galen (or the physicians) and Aristotle (or the philosophers), and to state briefly the two positions, and (2) to say either that he will resolve the dispute in his philosophical works (ibid., I, p. 22), or that "serious analysis" will show that Aristotle's view is the correct one (p. 67). It was only in the *Ḥayawān*, much later, that he confronted the problem head on.

The Ḥayawān. The *Ketāb al-ḥayawān* (Book of animals) is the last and largest part of the "Physics" (*Ṭabīʿīyāt*) of the *Šefāʾ*. The *Šefāʾ* itself is highly original in conception, being the first all-inclusive work in philosophical literature, giving

a detailed exposition of all the Greek, primarily Aristotelian sciences. Avicenna's purpose in the *Šefāʾ* was not to write a commentary on Aristotle, but to restate the Aristotelian arguments convincingly. His method is more clearly evident in the *Ḥayawān* than in any other part of the *Šefāʾ*.

The *Ḥayawān* is organized into nineteen books following the scheme of Aristotle's own "Book of animals." This was a translation of the three treatises, *Historia animalium*, *De partibus animalium*, and *De generatione animalium*. The Arabic translation, traditionally ascribed to Ebn al-Beṭrīq, regarded the three treatises as one corpus, in 19 *maqāla*s (books). Books 1-10 represented the *Historia*, books 11-14 the *De partibus*, and books 15-19 the *De generatione*. The *Historia* contained Aristotle's descriptions of some 500 animals and their behavior, mostly raw material that could be augmented without raising any theoretical problems. He took up the difficult problems of the classification of animals and their anatomy in the *De partibus*, and it was here that Galen had seriously encroached on his system. The same situation held for the *De generatione*, the most significant of his biological works. The *Ḥayawān* text treats the Aristotelian biology in three ways: summary, new synthesis, and outright substitution.

a. Summary. Ebn al-Beṭrīq's translation of Aristotle was especially poor. Avicenna's *Ḥayawān* provided a more accessible account of the Aristotelian biology, in the form of clear summaries of (1) the *Historia* (*Ḥayawān*, books 1-8, pp. 1-140, except chapter 2, book 1, pp. 10-19, and chapter 1, book 3, pp. 40-46) and (2) of the *De generatione* (*Ḥayawān*, books 15-19, pp. 384-433). There is little doubt that Avicenna based his summaries on Ebn al-Beṭrīq's translation, to judge from his direct quotations from it (e.g., *Ḥayawān*, p. 398). Three centuries later Ebn Qayyem Jawzīya also quoted directly the same translation (*Meftāḥ*, II, pp. 155-56) which suggests that it was the only available one (published in the various volumes of Brugman and Drossaart Lulofs, Kruk, and Badawī).

b. New synthesis. In the *Ḥayawān* Avicenna was firmly committed to Aristotle's theoretical conclusions, and equally determined to modernize Aristotelian biology. The new material consisted almost entirely of the later anatomy of the Hellenistic physicians which Galen had inherited and elaborated, and Avicenna had already taught in the *Canon*. Joining the fray openly as the loyal champion of Aristotle, he was able to win for Aristotelian theory a new lease on life, but only by accepting a large portion of Galen's positive contribution, his intemperate attacks on him notwithstanding ("Let us

then look at Galen's contradictions, and show that he did and said nothing well, that even when he thought he presented proof, he did not convince; and that he is extremely weak in the principles [of philosophy], even though he is very productive in the branches of medicine." *Ḥayawān*, pp. 146, 155).

In the first part of the *Ḥayawān* (pp. 1-140) Avicenna had essentially followed Aristotle's outline by selecting material from the *Historia* on the behavior of animals and adding similar observations of his own. However, there is early in book 1 a significant departure from this method where chapter 2 (pp. 10-19) consists of non-Aristotelian anatomical material lifted verbatim out of the *Canon* (I, book 1, pp. 19-24). This is a harbinger of the major textual transplant that will occur in later sections of the *Ḥayawān* to be discussed below. Of more immediate interest is chapter 1, book 3 where at last Avicenna deals with the problem of the heart, fulfilling the promise he had made in the *Canon* (e.g., I, p. 22) as well as in *Ketāb al-nafs* (p. 234), the *De anima* of the *Šefāʾ*.

Aristotle believed the heart to be the central location of the soul—the organizing principle of all the functions of the body, including digestion ("concocting" food into blood), sensation, and movement. He made little distinction between the veins and arteries, calling them both by the same term, *phlebes* (blood vessels). Being convinced of the need for a central focus for all sensation, and writing before the discovery of the nervous system, he also assigned that role to the heart. In brief, Aristotelian biology asserted that the heart was the origin, anatomically, of the arteries, veins, and nerves.

The Hellenistic physicians after Aristotle made major advances in anatomy. Praxagoras of Cos (fl. ca. 300 B.C.) distinguished clearly between the arteries and the veins; Herophilus of Chalcedon (fl. ca. 300 B.C.) discovered the nervous system; and Erasistratus (fl. 258 B.C.) gave the blood-making faculty to the liver, not the heart. By Galen's time, scientific opinion saw the brain as the origin of the nerves (and the faculty of sensation), the liver as the origin of the veins (and the faculty of digestion), and the heart as the origin of the arteries only. Galen summed up the arguments forcefully in his *De placitis Hippocratis et Platonis*.

Avicenna, in a typical example of his general method in the *Ḥayawān*, managed to accept the new anatomy and, at the same time, hold firmly to the Aristotelian theory that the heart is the origin of all the body's faculties. He argued that Galen's anatomical facts, where indeed the nerves appear to "grow" from the brain and spinal cord, and the veins from the liver, derived

from dissection of the completely formed animal. Avicenna interpreted Aristotle to mean that the heart is the origin of all the organs and their faculties in embryological development, where it is the first organ to be formed by the soul, and all else is formed later through its agency (*Ḥayawān*, pp. 40-46).

The shift of the argument to embryological development was not entirely tactical on Avicenna's part, for in fact it pointed to his and Aristotle's primary concern in biology, namely the problem of sexual generation and development of the fetus. Aristotle had set about to answer such questions as: What is it that tells the fetus to develop into dog, or human, or horse? How does the fetus know how to develop the organs? How does it know the order of their development and differentiation? In brief, what is the organizing principle? Aristotle found the answer in the soul, whose connection to the heart and to the male semen is the backbone of the Aristotelian-Avicennan biology.

In book 9, while still in the part ostensibly devoted to the *Historia*, Avicenna abruptly departed from Aristotle's model to discuss, with some urgency, "the controversies about semen and the fetus—not according to Aristotle's scheme, but following what we consider more appropriate in our own time" (pp. 144-45). The discussion of sexual generation which followed became the pivotal discussion of the *Ḥayawān* and determined Avicenna's method in the biology as a whole.

The normal location of this discussion would have been in books 15-19 of the *Ḥayawān* (where Avicenna made a masterly abridgment of the *De generatione*, repeating briefly some of the arguments of book 9). Clearly Galen's challenge had forced him to confront the issue early on. The titles of the first three chapters of book 9 give a palpable sense of a drama to this central section of the *Ḥayawān*: (1) "On puberty, semen, menses, and the controversy about them." (2) "On Galen's criticism of Aristotle, and the refutation of that criticism, and the establishment of its fatuousness." (3) "The return to the Aristotelian source, and the proof that women do not really have semen, and that the female matter called semen has no formative faculty, but only a passive faculty . . ."

The Greek thinkers had disagreed radically on the question of parental contribution to sexual reproduction. Hippocrates maintained that both male and female contribute "semen," reasoning that the child's resemblance to both of its parents means that both contribute similar reproductive material to it

(*Hippocratic Writings*, p. 322). Aristotle categorically rejected this theory, and formulated a radical distinction between the male and female contributions, asserting that the female provides only the passive material (menstrual blood) which the male semen, as sole carrier of the soul, forms into the fetus. He maintained that semen was a residue of the blood, which only the male, by virtue of his adequate vital heat, could transform into semen. The female, lacking this ability because she is not "hot" enough, discharges her contribution as menstrual blood (*De generatione*, 728a, 726b, 7306, 738b).

Galen re-affirmed the original Hippocratic idea of equal contribution, and supported it with new evidence. Although he agreed with Aristotle that semen was a residue of the blood, he insisted that women as well as men could produce it. According to him, both male and female semina contributed equally to the "form" as well as to the "matter" of the fetus. His new evidence was the discovery (probably first made by Herophilus of Chalcedon) of the ovaries which he called "female testicles." Aristotle had had no notion of these organs and had also denied that the male testicles contributed to the actual production of semen. Galen re-affirmed the direct relevance of the testicles to reproduction and was able to point to their existence in both sexes (*De semine* 1.5 (ed. Kuhn, vol. IV), pp. 527ff.).

By Avicenna's time the discovery of the ovaries had long been incorporated into the body of scientific knowledge. His first statement of the problem made clear the degree to which Aristotelians were on the defensive, and the extent to which Galenism had come to define the basic issues of generation (*Ḥayawān*, pp. 145-46). In what was a critical departure in Aristotelian biology, Avicenna's response was to accept the existence of the ovaries and the argument that it is the female semen, and not menstrual blood, which represents the basic female contribution to reproduction (ibid., pp. 145, 161, 388-90). But in what sense, then, can we still speak of Avicenna's biology as Aristotelian? What remained of the original Aristotle? Nearly everything that mattered. Avicenna applied to the female semen Aristotle's central hypothesis, giving it exactly the same role that Aristotle had assigned to the menstrual blood: "Clearly the seed of women is fit to be matter, but not fit to be the principle of movement. The seed of men is the principle of movement" (ibid., p. 399).

There were purists among the Aristotelians after Avicenna, for example Ebn Rošd, who held fast to the letter of Aristotle ("As to the "testicles" which Galen claims women have, it is possible that they play no role in generation—if the

"semen" they produce has no role in generation. This is not strange when you consider that breasts in the female are organs of generation, but do not have such a function in the male. . . . If the female semen could do what the male can, a female should be able to generate by herself, and there would be no need for the male." Ebn Rošd, *Kollīyāt*, p. 30). However, most medieval Aristotelians, East and West, attest to the success of Avicenna's solution, for they elected to view their biology through him (Sarton, *Introduction* II, 1, p. 63), even though the original Aristotle was available to them in both Arabic and Latin. Avicenna's version was much less vulnerable to Galenic attack than the original.

c. Substitution. Fitting the ovaries into Aristotle's anatomy was the cardinal example of Avicenna's treatment, but—as we have already noted—the first anatomical discussion in the *Ḥayawān* came directly from the *Canon*. Similarly, the chapter on the development of the embryo (book 9, chap. 5, pp. 172-78), and the anatomy of the penis and the uterus (book 15, chap. 1, pp. 387, 388-89, 390) were also taken verbatim from the *Canon*.

The attempt to update Aristotle's data is especially blatant in books 11-14 of the *Ḥayawān*, the sections which parallel Aristotle's *De partibus animalium* (pp. 188-383). Here there took place a wholesale substitution: Most of the original Aristotelian text was simply discarded and replaced by Galenic material lifted out in bulk from the *Canon*. The substituted text included all the anatomy of uniform parts from book 1 of the *Canon* (I, pp. 6-66) and nine sections on the anatomy of the organs from book 3 (II, pp. 2-5, 108-110, 208-10, 261-62, 283-86, 349-50, 418-21, 555-56, and 557-62).

Over seventy-five percent of the text of books 11-14 (150/195 pages) and fully forty percent of the text of the whole *Ḥayawān* (170/433 pages) came from the *Canon*. The transplanted material—aside from its critical implications for the establishment of Avicenna's texts—radically changed the original balance of Aristotle's biology. In Bekker's edition of the Greek text of the three treatises, the *De partibus* occupies only twenty-one percent of the pages; in the Cairo edition of the *Ḥayawān*, books 11-14 (representing the *De partibus*) fill forty-five percent of the pages. In the process of updating Aristotle, the space devoted to anatomy was more than doubled.

The *Ḥayawān* changed the emphasis of Aristotle's biology in another important way. Aristotle, although emphasizing man, considered the whole animal kingdom as his subject. The anatomy transplanted from the *Canon* was

exclusively human anatomy, tending to narrow the focus of biology from the living creation as a whole to man. This was the clearest effect on natural philosophy of Avicenna the physician.

d. Composition of the *Ḥayawān*. The substitution of the new anatomy for the old carried out—with vengeance—Avicenna's evident design to modernize Aristotle. Yet the size and extraordinary crudeness of this textual transplant are startling, and raise a question about the extent of Avicenna's direct responsibility for it.

The text of the *Ḥayawān* is uneven. Books 1-10 and 15-19 (representing the *Historia* and the *De generatione*) are clearly more finished than books 11-14. Their borrowings from the *Canon* are limited (a total of twenty pages) and well integrated either into genuine summaries of Aristotle (books 1-8 and 15-19), or into a new synthesis (books 9-10). In contrast, the transplanted text of books 12-14 (book 11 poses a special problem to be discussed below) was merely adjusted to the *Ḥayawān*'s different arrangement of subjects, as Table 31 shows.

There is a revealing record of the checkered fortunes of the *Šefāʾ* in general and the *Ḥayawān* in particular. According to Abū ʿObayd Jūzjānī, Avicenna's companion and biographer, the *Šefāʾ* took seventeen years to write, with many interruptions, and with the *Ḥayawān* always left to the end. Avicenna worked on the *Šefāʾ* during three separate periods. The first was in 406/1015: "I asked him to comment on the works of Aristotle . . . and so he began with the "Physics" of a work he called the *Šefāʾ*." However, he made little progress and dropped the project for six years. The second period was in 412/1021, when he "finished all of the "Physics" and "Metaphysics," with the exception of the book on Animals." Lastly, during his years in Isfahan after 415/1024, "he finished the *Šefāʾ*, except for the two books on the Plants and the Animals, which he wrote on the way in the year that ʿAlāʾ-al-dawla attacked Sābūr Ḵᵛāst (most probably 423/1032). He also wrote the *Najāt* en route." (Gohlman, *Life*, pp. 54-67).

Was it true that Avicenna wrote the *Najāt* and the *Ḥayawān* together on the same trip? Curiously the *Najāt*, which he composed by simply selecting material from all parts of the *Šefāʾ*, has preserved no memory of the *Ḥayawān*. It would be easier to understand why the *Najāt* omitted the biology if we were to assume that when he composed it, Avicenna was not working on the *Ḥayawān* and considered it unfinished.

Did Avicenna ever finish the *Ḥayawān*? Here the case of book 11 is the most telling. It exists, if this is the right word, as one paragraph of less than six lines. The nature of this paragraph is not entirely a mystery. In 1021, the second time he began working on the *Šefāʾ*, Avicenna first produced an outline of "the main topics" of the whole work. (When Jūzjānī later said, in his introduction to the *Šefāʾ*, that Avicenna finished the book when he was forty years old—Avicenna was born in 370/980—he could have only been referring to this completed outline.) As it now stands, book 11 represents literally the "main topic" from Avicenna's original outline of 412/1021, and nothing more. The subject of book 11 is of critical importance. In the original *De partibus* it contained Aristotle's theoretical justification for his system of classification and anatomy, and it attracted lengthy commentaries by Ebn Bajja (Avempace) and Ebn Rošd. It is tempting to suggest that when Avicenna and Jūzjānī took the road to Sābār Ḵᵛāst in 1032, books 11 to 14 of the *Ḥayawān* were still unwritten. Ultimately, books 12, 13, and 14 were "finished" by raiding the *Canon*. But there was no such convenient source for book 11 of the *Ḥayawān*, since Avicenna had not dealt with the subject anywhere else in his writings. Neither Avicenna on the road, nor Jūzjānī after him, ever finished it.

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