

BACON Roger—philosopher, theologian, called *doctor mirabilis*, b. around 1214 in Ilchester, in the county of Sommerset, d. around 1992 in Oxford.

He studied in Oxford under Robert Grosseteste and Adam of Marsh. As a bachelor of the arts around 1235 he went to Paris and then returned from there to Oxford. He was again in Paris from 1245 to 1255, first as a student learning the new Greek and Arab philosophy, and later as a beginning teacher commenting on Aristotle's logical and natural works. There he made the acquaintance of Alexander of Hales, Albert the Great, and Peter of Maricourt. At that time Peter of Maricourt was beginning his innovative studies of nature. He listened to William of Auvergne, Bishop of Paris, who discussed before the university community the *intellectus agens* (active intellect) conceived according to the Augustinian way (*Opus tertium*, c. 32, ed. J. S. Brewer, Lo 1859, 74), and he wrote commentaries on Aristotle's works.

In 1255 Bacon entered the Franciscans. He was probably influenced in this decision by St. Bonaventure. He saw in the Franciscan order a force aiming at the renewal of the Church, the world, and science in keeping with the views proclaimed by Joachim da Fiore.

He returned to Oxford and taught there until a command from the General of the order, the result of a decision regarding the teaching of dangerous doctrines, deprived him of financial support. This deprived him of the means to conduct technical, optical, and chemical experiments. His situation improved during the pontificate of Pope Clement IV (1265–1268), Bacon's protector. The pope released him from all prohibitions and limitations imposed upon him by his superiors in the Franciscan order, and in a letter of June 22, 1265, he asked him to send his work, of which he heard, to Viterbo. Pope Clement IV died in 1268. In 1277 Jerome of Ascoli, the General of the Franciscans, again condemned Bacon's doctrine, and he imprisoned Bacon. Bacon was confined until 1289. After his release he published *Compendium studii theologiae* (1292).

During his first stay in Paris Bacon edited the following commentaries on Aristotle's writings: *Quaestiones supra XI Primae Philosophiae*; *Quaestiones supra libros quattuor Physicorum*; *Quaestiones supra libros octo Physicorum*; a new edition of *Quaestiones supra libros Primae Philosophiae*; *Quaestiones supra librum de causis*; *Quaestiones supra librum de sensu et sensato*; *Summa de sophismatibus et distinctionibus*; *Summa Grammaticae*, *Summulae dialecticae*; *De rebus medicinalibus*, and probably the frequently published *Epistola de secretis operibus naturae* (it was in this work that Bacon wrote of the possibility of building horseless vehicles, ships that moved without sailors, and flying machines). His scientific interests were directed to the secular sciences, linguistics, the mathematical sciences, and the natural sciences, with philosophy, metaphysics, and ethics. He aimed to gather together in one work all the secular sciences, i.e., philosophies ("*scriptum philosophiae principale*", *Opus tertium*, c. 17, 58), but he never completed this plan.

While Bacon was working on the preparatory works for his planned work, Pope Clement IV in 1265 asked Bacon to send him the *Opus*. With this Bacon began a period of feverish activity. From 1266 to the beginning of 1268 he hastily wrote three of his best known works: *Opus maius*, *Opus minus*, and *Opus tertium*. In this he made use of his preparatory works.

While it was first thought that Bacon sent all three works to the pope and that they appeared in the sequence indicated above, today it is generally accepted that the *Opus maius* was

written as the first work and was already complete by 1266. When Bacon received the letter from the pope, he published the *Opus minus* and sent it to the pope. He started to work on the *Opus tertium* afterwards.

The *Opus maius* has seven parts. In the first part Roger Bacon discusses the four causes of human ignorance. In the second part he discusses the relation of philosophy to theology. He devotes the third part to a discussion of the meaning of grammar and the science of language. The fourth part deals with the significance of mathematics for physics and theology. It also contains a calendar, geography, and astrology. In the fifth part optics is discussed, that is, *perspectiva*. In the sixth part there are questions connected with *scientia experimentalis*. The seventh part, which was not completed, is devoted to problems within the scope of *philosophia moralis*. Bridge's edition of the *Opus maius* contains only four parts, while the fragments of the *Opus tertium* (c. 14, 48–52) published by Brewer speaks of six parts. In another fragment of Bacon's *Opus tertium* discovered by P. Duhem the fact that the sixth part was not published is justified, and a latter appended to the *Opus maius* speaks only of five parts.

The *Opus minus* and the *Opus tertium* are in a certain sense a unified whole. We also possess only fragments of these works in Brewer's edition. P. Duhem found and published a new and important fragment of the *Opus tertium*. A. G. Little also found a fragment of this work that partially overlaps the fragment published by Duhem.

Bacon intended to produce an *Opus principale* to send to Clement IV, but before he could do this the pope died (in 1268). The work that is designated as the *Opus maius* is not the same as the *Opus principale*, because in the *Opus maius* (III, ed. J. H. Bridges, 47), it is considered for the first time, and in Bacon's appended letter he writes: *scriptum principale non transmittit*. After the *Opus principale* upon which Bacon work after Clement IV's death, appeared the *Compendium philosophiae (Communia naturalia*, II, pars I, c. I, ed. R. Steele, Ox 1905, 316, n. 4). It was going to have four parts: (1) grammar and logic (*grammatica et logicalia*); (2) mathematics (*partes mathematicae*); (3) the science of nature and the philosophy of nature (*naturalia*); (4) metaphysics and the science of moraliia (*metaphysica cum moralibus*), cf. *Communia naturalia*, I, pars I, d. I, c. I). To the first part of the *Opus principale* belongs the *Compendium studii philosophiae*, written in 1271 or 1272 and published by Brewer. It also included fragments of Greek and Hebrew grammar published by Nolan and Hirsch. Only certain fragments of the second part, which covers mathematics in six books, have been published. The third part contains the science of nature and the philosophy of nature in four books: *De communibus ad omnia naturalia*, *De caelestibus*, *De elementis et mixtis inanimatis*, and *De vegetabilibus et animalibus (Communia naturalia*, I, pars I, d. 1 c). R. Steele published the first two books. The treatise on optics, *De multiplicatione specierum*, published by Bridges (t. II) probably also belongs to the part concerning nature. Bacon sent the treatise on optics in 1268 (separately from the *Opus maius*), or at least he wanted to send it, to the pope (*Opus tertium*, c. 58, ed. J. S. Brewer, 227). The fourth part of Bacon's writings is represented by a fragment published by R. Steele as *Metaphysica de vitiis contractis studio theologiae*. Among Roger Bacon's other writings we should also mention *De speculis comburentibus*. Bacon's last writing was the *Compendium studii theologiae*.

Roger Bacon's scientific work was done in the century between 1250 and 1350. It is said that in another period of the Middle Ages did there appear so many sublime philosophical ideas. Just as Albert the Great and Thomas Aquinas among the Dominicans followed their

own path, so it was among the Franciscans during more or less the same period. Bacon stood beside Bonaventure. The study of nature, which in the first half of the thirteenth century was developed by English philosophers, reached its high point in the works of Roger Bacon. The English school, which was influenced by Platonism, emphasized the importance of mathematics and experience in doing philosophy. Peter of Maricourt should be considered as a precursor of Bacon. Peter of Maricourt studied magnetism and emphasized the importance of experience in metaphysics.

Bacon was opposed to the philosophical and theological ideal of the sciences cultivated in Paris in his support of mathematical and natural knowledge based on experience. By proclaiming *scientia experimentalis*, Roger Bacon may be regarded as a precursor of Francis Bacon (of Verulam), but Roger Bacon differed from Francis Bacon in his opinion of mathematics. Roger Bacon reduced all other sciences to mathematics and so anticipated ideas that became fully accepted in the natural sciences and philosophy only in the seventeenth century. When Bacon identified the *intellectus agens* with God and taught that experience obtained by divine illumination was superior in science, he was thinking within Augustinianism.

Roger Bacon's scientific interests concerned mathematics, natural science, especially physics and optics, as well as linguistics. From this point of view Bacon set forth a strong critique of the theological method that was generally applied at Paris University then. He accused the Parisian scholars (*Studium Parisiense; Opus minus*, 327) of scientific ignorance. He saw the main reason for the shortcomings in the *studium teologii* in their neglect of the scientific and pedagogical value of the mathematical, natural, and linguistic sciences ("*septem peccata studii principalis quod est theologica*", *Opus minus*, 322–359).

Roger Bacon did mathematics and the natural sciences in part on the basis of the works Greek works, Arab works (the treatise *De multiplicatione specierum* was influenced by Alhazen's writings), and Hebrew works, and in part on the basis of his own observations of nature. At the same time he shared with most people of that time an interest in astrology. He laid great emphasis on philology and the knowledge of languages. He thought that these would provide access to the sources of true wisdom. The languages essential for theological and philosophical studies, which he called the languages of the erudite, were Greek, Hebrew, Arabic, and Chaldean (cf., *Opus maius*, pars III, 66 f.).

He had high regard for Aristotle's achievements and called him the *philosophorum doctissimus*. At the same time, he stated that Aristotle also had erred in many points, which freed him from an uncritical acceptance of everything the Philosopher had said. In his commentaries on Aristotle, Bacon relied in particular on Avicenna's remarks, although he was also critical of some of Avicenna's statements. These statements included the idea that the *intellectus agens* (the active intellect) is the highest angel and the highest creator of all things in the world. For Bacon, the *intellectus agens* was none other than the divine Logos of Christian theology, the creative Word of God. For this reason, the *intellectus agens* is not a part of the human soul but is completely separate from the soul and is an essentially different substance. Certainly these expressions call to mind the formulations of al-Farabi and Avicenna. In this connection, it is a mistake to ascribe Averroism to Bacon (or to the Franciscan school in general) (J. B. Hauréau, *Histoire de la philosophie scolastique*, II 2, P 1850, 96; E. Renan, *Averroès et l'averroïsme*, P 1852, 1866³, 259).

Roger Bacon's epistemological views were also influenced by the Augustinian theory of illumination, Aristotelian philosophy, and Arab philosophy. Both the Aristotelian and Augustinian points of view in Bacon's thought were connected with the concept of experience (*experientia*). Bacon states that there are two kinds of experience: one is performed with the help of the external senses (*experientia humana et philosophica*) and the second with the help of internal illumination (*illuminationes interiores*). In Bacon, the experimental method is connected with a pragmatic and utilitarian formulation of truth. Knowledge must be appraised according to the possibility of using it in man's quest for happiness (*beatitudo*), and in this way utilitarianism is ultimately justified ethically and religiously. The benefit of a thing can only be established by way of experience, since experience is the only criterium of the truth. In this statement Bacon sees the foundation for rejecting both authority and demonstration as sources of knowledge. Authority cannot be the source of any knowledge because it does not provide any foundations for recognizing a proposition as true. Rather, authority is one of the sources of errors (*fragilis et indignae auctoritatis exemplum, consuetudinis diuturnitas, vulgi sensus imperiti*). For this reason Bacon clearly rejected the recognized authorities of his time (Alexander of Hales, Albert the Great, and Thomas Aquinas). Bacon criticized Aristotle's logic and said that inductive or deductive argumentation does not concern things but concepts. Bacon recognized logic that starts from experience and is verified on the basis of experience. Knowledge gained by experience is intuition, vision, at the same time sensory and intellectual. Immediacy (the lack of any medium in intuition) is for Bacon an essential element of knowledge. Bacon conceived sensory experience in clearly subjective terms. According to him, our knowledge of an object is modified by the properties of the senses.

The experimental method leads to knowledge of nature and ways to master nature. For Bacon, alchemy, astrology, and magic are the highest degree of natural science. According to Bacon, one of the sources of knowledge is internal experience caused by divine illumination. He conceived of this illumination in three ways: (1) general illumination (*illuminatio lub revelatio generalis*); (2) primitive illumination (*illuminatio primitiva*); (3) special illumination (*illuminatio specialis*). This ultimately belongs to the religious and supernatural order and it is a grace. Bacon also distinguished indirect illumination along with immediate illumination. Indirect illumination refers to truths of the natural order revealed by God and grafted on to the Israelite nation (traditionalism). He contrasts general illumination (*illuminatio generalis*), which is something purely natural, to both forms of revelation. General illumination is necessary for every man and is a freely given light. Its necessity stems from that fact that the human intellect is in potency, and therefore only by the action of someone who exists completely *in actu* can it be set in motion. Man needs this kind of illumination to know spiritual substances. This illumination is similar to the conception of illumination held by those in the Augustinian school where it is commonly called *illuminatio specialis*. It is a special case of *concursus divinus*, distinct from providence and from the action of grace. Since God is here conceived as the *intellectus agens*, here the Augustinian and the Aristotelean ideas are joined in an original way.

There are seven degrees of internal experience. Those who achieve the highest degree arrive at ecstatic knowledge, at rapture. In this way in Roger Bacon mysticism is connected with the doctrine of experience.

Metaphysics contains the principles of all the science. The real philosophical sciences belong to three groups: mathematics, physics, and the science of morality. Grammar and logic constitute merely an accidental part of philosophy (*Opus maius*, pars IV, d. I, c. 2, ed.

Bridges I 99).

Like his teacher R. Grosseteste, whose treatise *De lineis, angulis et figuris* in *Opus maius* (pars IV, d. 2 and 3) is often cited, Bacon regarded mathematics as the foundation of all scientific education. He joins the category of magnitude with the categories of quality, relation, place, and time, because these can be reduced to the category of magnitude. In the same way magnitude plays the role of a medium of knowledge for the category of substance. In this way, logic belongs to mathematics, and Bacon regarded mathematics as the model of knowledge. Only in mathematics is there true demonstration that provides infallible truth and indubitable certainty. At the same time, mathematics is an innate knowledge and precedes all other kinds of knowledge, and furthermore it prepares the mind to learn the other sciences (“*mathematicarum rerum cognitio est quasi nobis innata [...], prima erit inter scientias et praecedens alias, disponens nos ad eas*”, *Opus maius*, pars IV, d. I, c. 3, 103). It follows from this that if in the other sciences we want to achieve certainty beyond all doubt and infallible truth, this must be based on mathematical statements.

The following belong to the group of sciences concerning nature: “*Perspectiva, Astronomia iudiciaria et operativa, Scientia ponderum, Alchymia, Agricultura, Medicina, Scientia experimentalis*” (*Communia naturalia*, pars I, d. I, c. 2, ed. R. Steele, 5 f., n. 2). The science of perspective must be at the beginning because it is the work of the sense of vision and enables us to distinguish things, and all the particular assertions about nature rely on these distinctions. It is followed by *astronomia iudiciaria*, because the first differences of visible things are apparent in the light of the stars. In this astronomy, we study the natural powers of the stars and their influence on the earthly world. The *scientia ponderum* concerns the component elements, because we see in them the differences of mass and lightness. Alchemy is the science of inorganic terrestrial essences and studies all conceivable elementary compositions of earthly things, of which there are 145 (here also is introduced the science of creating gold). *Agricultura* studies terrestrial living essences: plants and animals. Medicine concerns the *animal rationale*, namely man, and primarily his health and sickness, and in this context it studies his construction and generation. *Scientia experimentalis* is the apex of our knowledge of nature and points to the most important practical consequences of this knowledge. It is the “lady” or “mistress” of all the other sciences and they are its “servants” (*Opus maius*, pars VI, c. 12, ed. Bridges, II 221; *Communia naturalia*, I, pars I, d. I, c. 2, ed. Steele, 9). Its task is the empirical verification of the findings of the other sciences (*Opus maius*, pars VI, c. 2, II 172 f.).

Bacon’s appraisal of the natural sciences and experiment remains at the theoretical level. In astronomy he holds a position between Aristotle’s metaphysical theory and Ptolemy’s experimental theory.

Ethics rests upon the metaphysical theory of God’s essence, of God as the creator of the world, and of man’s reward in the life to come (*Opus maius*, pars VIII, II 223 f.). The work dedicated to moral philosophy is divided into six parts. The first part concerns the worship of God. The second part concerns the *bonum commune*. The third part concerns the *bonum privatum*. The fourth and fifth part concern problems connected with the Book of Ecclesiastes. The sixth part was going to deal with *causis ventilandis coram iudice inter partes, ut fiat iustitia*, but Bacon never completed this part. In Bacon’s ethics he wanted to follow the tracks of Aristotle in whose works he even discovered a Christian justification for the philosophy of morality. He follows the example of the ancients when he ascribes to music, to which he attaches poetry, a great influence on people, because music enables the

human spirit to accept divine harmony.

His works are as follows: *Opera quaedam hactenus inedita*, ed. J. S. Brewer (Lo 1859, frg. *Opus tertium*, *Opus minus*, *Compendium philosophiae*, *De secretis operibus artis et naturae et de nullitate magiae*); *Opus maius*, ed. J. H. Bridges (Ox 1897–1900); *Epistola dedicataria*, ed. F. A. Gasquet, *An Unpublished Fragment of a Work of Roger Bacon*, (The English Historical Review 12 (1897), 494–517); P. Duhem, *Un fragment inédit de l'Opus tertium de Rogero Bacon* (Q 1909); A. G. Little, *Part of the Opus tertium of Roger Bacon* (British Society of Franciscan Studies 4, Aberdeen 1912); *Opera hactenus inedita*, ed. R. Steele (started in Oxford in 1905 and continued to 1940), in which were published: *Metaphysica*; *De vitiis contractis in studio theologiae*; *Communia naturalia* (lib 1–2); *De caelestibus*; *Tractatus brevis in Secretum secretorum*; *Compotus* (doubtful authenticity); *Quaestiones supra undecimum Primae philosophiae*; *Quaestiones supra libros quattuor physicorum*; *De retardatione accidentium senectutis* (authorship questioned); *De rebus medicinalibus*; *Quaestiones supra libros Primae philosophiae*; *Quaestiones alterae supra libros Primae philosophiae*; *Quaestiones supra librum de Plantis*; *Metaphysica vetus Aristotelis*; *Quaestiones supra librum de causis*; *Quaestiones supra libros octo Physicorum*; *Quaestiones supra librum de sensu et sensato*; *Summa de sophismatibus et distinctionibus*; *Summa grammaticae*; *Summulae dialectices*; *Compendium studii theologiae*, ed. H. Rashdall (British Society of Franciscan Studies 3, Aberdeen 1911); *The Greek Grammar of Roger Bacon*, ed. E. Nolan, S. Hirsch (C 1902); *Specula mathematica*, *De speculis*, ed. J. Combach (F 1614); *Perspectiva*, ed. J. Combach (F 1614).

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