

In 1879 he married Rau von Holzhausen; they had four children. After 1871 Ochsenius settled in Marburg, where he was a private scientist and promoter of potash mining near Hannover. He began to publish reports on the observations made during his twenty years abroad. In 1884 the University of Marburg awarded him an honorary doctorate.

Ochsenius is best known for his book *Die Bildung der Steinsalzlager und ihrer Mutterlaugensalze* (1877). This work was outstanding for the great amount of direct observations reported, for the accuracy with which the depositional sequence of salt formation was presented, and for the vigor with which a relatively new idea on the origin of salt deposits was presented (Bischof had offered some preliminary ideas pointing in this direction in the second edition of his *Lehrbuch der chemischen und physikalischen Geologie* [1863–1871]). This new idea, the “bar theory” to explain thick deposits of salt, gypsum, and other evaporites, assumes lagoons separated by bars from the ocean proper. As water is lost by evaporation, evaporites precipitate in the lagoon and additional seawater is fed into the lagoon from the open ocean. With increasing evaporation, the salinity in the almost closed basin increases to the point where gypsum, rock salt, and other evaporites are deposited. The best examples, in Ochsenius’ opinion, are the basins of Kara-Bogaz-Gol and Adzhi Darya on the eastern rim of the Caspian Sea. The Stassfurt sequence of the German Zechstein also appeared to confirm his theory. The physicochemical results of van’t Hoff’s work were welcomed by Ochsenius as confirmations of his observations in nature.

The bar theory was opposed by Johannes Walther, whose “desert theory” proposed a formation of salt basins as closed evaporation basins. Both theories were confirmed by observation of present-day processes, but the bar theory was preferred by more geoscientists. Ochsenius published his last revision of this theory in 1906, the year of his death.

Ochsenius contributed other models and theories to the earth sciences, but none was as successful as his bar theory. Of his theory on petroleum formation only the close association of petroleum and salt provinces has remained confirmed. Equally well confirmed was his theory on partial uplift zones of continents, which was based on numerous observations on the Pacific coast of South America. On the other hand, his theory on coal formation was based on a too restricted observation and, consequently, today applies only to local, special modes of origin. He had tried to apply his bar theory to coal genesis in an attempt to explain the facies change coal / sandstone or coal / claystone in soft-water basins.

Ochsenius’ contributions to science are based on an enormous wealth of keenly remembered and recorded observations and on his independent, undogmatic approach. If a theory appeared to be confirmed by observations, he was not afraid to stand alone in its defense.

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OCKENFUSS, LORENZ. See **Oken, Lorenz.**

OCKHAM, WILLIAM OF (*b.* Ockham, near London, England, *ca.* 1285; *d.* Munich, Germany, 1349), *philosophy, theology, political theory.*

Traditionally regarded as the initiator of the movement called nominalism, which dominated the universities of northern Europe in the fourteenth and fifteenth centuries and played a significant role in shaping the directions of modern thought, William of Ockham ranks, with Thomas Aquinas and Duns Scotus, as one of the three most influential Scholastic philosophers. Of his early life nothing is known; but it is supposed that he was born in the village of Ockham, Surrey, between 1280 and 1290 and that he became a Franciscan friar at an early age. He entered Oxford around 1310 as a student of theology and completed his formal requirements for the degree by lecturing on Peter Lombard’s *Sentences* in the years 1318–1319, thereby becoming a *baccalaureus formatus*, or *inceptor*. During the next four years, while awaiting the teaching license which would have

made him a *magister actu regens*, or doctor of theology, Ockham took part in quodlibetal disputations, revised his lectures on the first book of the *Sentences* for public circulation, and wrote some philosophical and theological treatises.

In this period his teachings, recognized for their power and originality, became a center of controversy and aroused opposition from partisans of Duns Scotus, whose doctrines Ockham criticized, as well as from most of the Dominican masters and some of the secular teachers. In 1323 one of the latter, John Lutterell, went to the papal court at Avignon to press charges of heretical teaching against Ockham, who was summoned to Avignon to answer these accusations early in 1324. Because his academic career was cut short by these events, so that he never received his license to teach, he came to be known as "the venerable inceptor"—that is, candidate who never received the doctoral degree he had earned.

At Avignon, Ockham stayed at the Franciscan convent while awaiting the outcome of the process against him; and during this period he probably wrote several of his theological and philosophical works. A commission of six theologians was appointed by Pope John XXII to examine the charges against his teaching; and although this commission drew up two lists of suspect doctrines, no action appears to have been taken on the charges. Meanwhile Ockham became actively involved in the dispute then raging between Michael of Cesena, general of the Franciscan order, and Pope John XXII over the question of evangelical poverty; and he gave his support to Cesena.

When, in May 1328, it became apparent that the pope was about to issue an official condemnation of their position, Cesena, Ockham, and two other Franciscan leaders fled by night from Avignon and sought the protection of the German emperor, Louis of Bavaria. Louis, whose claim to the imperial crown was contested by Pope John, welcomed the support of Ockham in his cause, as well as that of Marsilius of Padua. The pope, enraged by this defection, excommunicated Ockham and his companions, not for heretical doctrines but for disobedience to his authority. During the ensuing years Ockham remained at Munich and devoted his energies to writing a series of treatises and polemical works directed against John XXII, some of which contained carefully argued discussions of the powers and functions of the papal office, the church, and the imperial or civil authority. When Louis of Bavaria died in 1347, the contest with the Avignon papacy became a lost cause; and there is some evidence that Ockham sought to reconcile himself with the Franciscan faction that had remained loyal to the pope. It is thought that he died in 1349, a

victim of the Black Plague, and that he was buried in the Franciscan church at Munich.

Ockham's writings, as preserved, fall into three main groups: philosophical, theological, and political. The philosophical works include commentaries and sets of questions on Aristotle's *Physics* and commentaries on Porphyry's *Predicables* and Aristotle's *Categoriae*, *De interpretatione*, and *De sophisticis elenchis*. Ockham wrote an independent work on logic, entitled *Summa logicae*, that gave full expression to his own philosophy of language and logical doctrines. An incomplete treatise, published under the title *Philosophia naturalis*, dealt with the concepts of motion, place, and time in an original and independent manner. Of his theological writings the most important is the set of questions on book I of the *Sentences*, edited by Ockham for publication and therefore known as his *ordinatio*, along with the questions on the other three books, which are in the form of *reportata* (stenographic versions of the lectures as actually delivered). The *Quodlibeta septem*, containing 172 questions on theological and philosophical topics divided among seven quodlibetal disputations, are of great value as an expression of Ockham's distinctive philosophical positions.

Of logical as well as theological interest are the treatise *De praedestinatione et de praescientia dei et de futuris contingentibus* and the work known as *De sacramento altaris*, which seems to consist of two distinct treatises and which is devoted chiefly to arguing that the doctrine of transubstantiation does not require the assumption that quantity is an entity distinct from substances or qualities. One other theological work, the authenticity of which has been questioned, is the *Centiloquium theologicum*, consisting of 100 conclusions directed mainly to showing that doctrines of natural theology cannot be proved by evident reason or experience.

The third group of Ockham's writings is made up of the polemical and political works written in his Munich period. Many of these are of interest only in connection with the historical events of the time; but some of them contain important discussions of moral, legal, and political concepts and issues developed in connection with the controversies over the powers of pope and emperor, of church and state. Such are the lengthy *Dialogus inter magistrum et discipulum de imperatorum et pontificum potestate*, the *Octo quaestiones super potestate et dignitate papali*, and the shorter but eloquent *Tractatus de imperatorum et pontificum potestate*, written in 1347. Modern critical editions of the political works are well under way; but editions of the philosophical and theological writings are very much needed, since the

early printed editions are both rare and not fully reliable, while some important works (those on Aristotle's *Physics*) have never been printed at all.

Ockham was a thinker of profound originality, independence, and critical power. Although he had scarcely any acknowledged disciples, and did not found a school in the sense of having followers committed to defense of his teachings (as did Thomas Aquinas and Duns Scotus), the actual influence exerted by Ockham's thought, in his own time and into the seventeenth century, was of a significance and breadth that may well have surpassed that of Aquinas or Scotus. This influence is clearly discernible in the empiricist doctrines of Locke and Hume, in the controversies concerning faith and merit associated with the Reformation, and in the political theories that found expression in the Conciliar Movement and in seventeenth-century constitutional liberalism. Although some historians have portrayed Ockham as an innovator who revolted against the traditional values and standards of medieval Christendom, it is nearer the truth to say that he was very much a product of the medieval culture and educational system, who sought to resolve problems that were generated by that culture and that had reached critical dimensions in his own time.

The condemnations of strict Aristotelianism that took place in 1277 were symptomatic of a crisis in the Scholastic effort to harmonize Greek metaphysics with the Christian creed; while the conflict between Philip the Fair and Boniface VIII, followed by the controversy between Louis of Bavaria and John XXII, brought to the surface issues concerning the sources of political and ecclesiastical authority that were becoming acute with the decline of the feudal system. It was to save the values threatened by these conflicts, rather than to destroy them, that Ockham subjected the prevailing Scholastic positions to criticism, and sought more adequate and powerful principles of analysis. His chief contributions to philosophy, lying in the areas of philosophy of language, metaphysics, and theory of knowledge, were the direct result of his effort, as a theologian, to meet the twofold commitment to reason and experience, on the one hand, and to the articles of the faith, on the other.

This dual commitment to faith and reason finds expression in two maxims that are constantly invoked in Ockham's writings. The first is that God can bring about anything whose accomplishment does not involve a contradiction. Although this principle is accepted on the basis of the Christian creed, it is equivalent to the philosophical principle that whatever is not self-contradictory is possible, so that what is actually the case cannot be established on a priori

grounds but must be ascertained by experience. The second maxim, known as Ockham's Razor because of his frequent use of it, is the methodological principle of economy in explanation, frequently expressed in the formula "What can be accounted for by fewer assumptions is explained in vain by more." Ockham often expressed it, however, in this longer form: "Nothing is to be assumed as evident, unless it is known per se, or is evident by experience, or is proved by the authority of Scripture" (*Sentences* I, d. 30, qu. 1).

These maxims are equivalent in force and constitute the unifying principle of Ockham's doctrine, whether viewed in its theological or philosophical aspect. They determine a view of the universe as radically contingent in its being, a theory of knowledge that is thoroughly empiricist, and a rejection of all realist doctrines of common natures and necessary relations in things—all of which constitute what is called Ockham's nominalism. They also eliminate every form of determinism in Ockham's metaphysics and psychology, by associating the principle of divine omnipotence with that of divine liberty and freedom of choice and by making the liberty of the human will basic to moral and legal theory.

A first consequence of these principles is the elimination of various metaphysical "distinctions" that played a dominant role in late thirteenth-century Scholasticism and that derived in large measure from the interpretation of Aristotle made by the Islamic philosopher Ibn Sīnā. The real distinction between essence and existence, held to be a doctrine of St. Thomas Aquinas, supposed that in an existing thing its essence or nature, although not separable from its existence, is nevertheless really distinct from it. Ockham argued that if essence and existence are distinct realities, then it is not self-contradictory for one to exist without the other; but since it is self-contradictory to suppose that an essence exists without existence, it follows that there cannot be a real distinction between the two. By a similar argument it is shown that there cannot be a real distinction between individuals and their natures, as the theory of common natures existing in individuals supposes.

Ockham directed his main critique against the Scotist theory that the common nature differs from the individuating principle by a formal distinction that is less than a real distinction but more than a distinction of reason. To show that this involves a contradiction, Ockham argued as follows: Let the common nature be indicated by the letter *a* and the individuating difference by the letter *b*. Then, according to Duns Scotus, *a* is formally distinct from *b*. But Scotus must concede that *a* is not formally distinct from *a*. Yet,

Ockham argued, wherever contradictory predicates are verified of two things, those two things must be really distinct. Hence *b* and *a* cannot be really identical if they are formally distinct, as Scotus claimed; and by the same argument it can be shown that if they are really identical, they cannot be formally distinct.

The notion of a common nature in individuals, really or formally distinct from them, is therefore self-contradictory; and it remains that universality is a property of terms, or of concepts expressed by general nouns, and is simply their capacity to be used to signify or denote many individuals. In denying that there is any universality in things, Ockham does not deny that the basis for universal predication of general terms is objectively present in individual things; he only denies that the fact that Socrates and Plato, for example, are similar in that each is a man entails that there is some entity common to both and distinct from each. Ockham's nominalism is not to be construed as a doctrine that denies any foundation in things for the generality of terms, and his theory of human cognition rests squarely on the assumption that direct experience of existing things gives rise to concepts of universal character that directly signify things as they are or can be.

Since whatever exists is individual, Ockham holds that our knowledge of things is based on a direct and immediate awareness of what is present to our senses and intellect, which he calls intuitive cognition. He defines this type of awareness as one which enables us to form an evident judgment of contingent fact—that is, that the object apprehended exists, or that it is qualified in a certain way, or is next to another object, and so forth. Such cognition gives rise only to singular contingent propositions that are evident; hence it does not yield scientific knowledge in Aristotle's sense, in which premises and conclusions must be of universal character. Every intuitive cognition, however, can give rise to an abstractive cognition of the same object, which Ockham defines as the cognition of an object which does not suffice for an evident judgment concerning the existence of the object or concerning a contingent fact about the object. Thus, while I am observing Socrates and hearing him talk, I can judge evidently that Socrates exists and that he is talking; but if I depart from the spot and then form the proposition that Socrates exists, or that he is talking, my statement is not evident and may in fact be false.

But Ockham insists that there is no distinction between intuitive and abstractive cognition with respect to objects cognized, but only with respect to their capacity to yield evident judgments of existence and contingent fact. In the natural course of events, every abstractive cognition presupposes an intuitive

cognition of an object understood by it; but Ockham says that since the cognitions are distinct from each other and from their objects, it is logically possible for God to cause an intuitive cognition of an object which is not present or not presently existing. In such a case, Ockham says, the intuitive cognition will yield a judgment that the object is not present or that it does not exist; for it would be self-contradictory to hold that one can have an evident judgment that an object exists, if it does not exist.

The general propositions which serve as premises of scientific knowledge, in the strict sense, are established by inductive generalization from singular judgments evident by experience. But Ockham holds that such scientific statements, being formed from abstractive cognitions of their objects, cannot have absolute evidence, or necessary truth, as categorical propositions; they must be construed as necessary propositions concerning the possible, or as conditional statements. Except for premises of mathematics, which are known *per se* by the meanings of the terms, the principles of the natural sciences are held by Ockham to be evident by experience but not as necessary in the absolute sense, although they may be said to be necessary in the conditional sense of presupposing the common course of nature without divine interference.

Ockham's empirical theory of knowledge and his nominalist doctrine of the relation of discourse to reality are reinforced by a remarkably original and thoroughgoing use of the *logica moderna* of the arts faculties, with its theory of the supposition of terms, which takes the form of a fully developed philosophy of language. Ockham's *Summa logicae* gives the most complete expression to this semantically oriented logic.

Ockham's treatment of theology is consistent with his treatment of philosophy and natural science, in the sense that absolute evidence for theological propositions cannot be had in this life and only a positive theology based on acceptance of the testimony of Christ and the saints is possible. The order established by God and revealed in the laws of the church, which Ockham ascribes to God's *potentia ordinata*, is freely established by divine choice but is not necessary, since God, by his absolute power, could have ordained a different order. In moral and political philosophy Ockham applies these same criteria of divine freedom and omnipotence to refute the claims of pope and emperor alike to absolute power and dominion over members of the church or citizens of the state. The dignity of man is found in his freedom of choice; and Ockham reiterates that the law of God is a law of liberty, not to be degraded and corrupted into absolutism and coercive tyranny.

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ODDI, RUGGERO (b. Perugia, Italy, 20 July 1864; d. Tunis, Tunisia, 22 March 1913), *medicine*.

The son of Filippo Oddi and Zelinda Pampaglini, Oddi spent four years at the University of Perugia, one at Bologna, and one at Florence, where he graduated in medicine and surgery on 2 July 1889. He remained as an assistant at the Physiology Institute in Florence (directed by L. Luciani) and made a study trip to the Experimental Pharmacological Institute at the University of Strasbourg (directed by Oswald Schmiedeberg), during which he isolated chondroitin sulfate from the amyloid substance. In January 1894 Oddi was appointed head of the Physiology Institute at the University of Genoa, from which he resigned on 1 April 1900 as the result of a complex series of events (reconstructed in 1965 by L. Belloni). This was followed by a short period as physician in the Belgian Congo, during which time his mental condition became more unbalanced, partly as a result of his using narcotics.

Oddi's main contribution is the discovery of the sphincter of the choledochus, made at Perugia as a fourth-year medical student (1886-1887). Intent on studying *in vivo* the action of bile on the digestion, he had the idea of obtaining an uninterrupted flow of bile into the duodenum by removing the reservoir. In a dog that had been cholecystectomized some time before, he was surprised to observe a marked dilatation of the bile ducts, which led him to suppose "that at the outlet of the choledochus into the duodenum there was a special device which allowed the flow of bile only at certain times, preventing it at others, so that the bile, no longer accumulating in the gallbladder, but compelled to create a space in the larger bile ducts, thus caused their enormous dilatation."

A subsequent series of refined morphological researches in various animal species allowed him to demonstrate, both at the outlet of the choledochus and at the outlet of Wirsüng's duct, that there is a special sphincteral device that is largely independent of the muscular layers of the intestine.

Oddi also measured the tone of the sphincter of the choledochus by perfecting an experimental device