

covered with a lining of bronze plates. Of the two chief methods of working bronze, gold, and silver, it is probable that the hammer process was first practised, at least for statues, among the Greeks, who themselves attributed the invention of the art of hollow casting to Theodorus and Rhœcus, both Samian sculptors, about the middle of the 6th century B.C. Pausanias specially mentions that one of the oldest statues he had ever seen was a large figure of Zeus in Sparta, made of hammered bronze plates riveted together. With increased skill in large castings, and the discovery of the use of cores, by which the fluid bronze was poured into a mere skin-like cavity, hammered or repoussé work (Greek, *sphyrelata*) was only used for small objects where lightness was desirable, or for the precious metals in order to avoid large expenditure of metal. The colossal statues of ivory and gold by Phidias were the most notable examples of this use of gold, especially his statue of Athena in the Parthenon, and the one of Zeus at Olympia. The nude parts, such as face and hands, were of ivory, while the armour and drapery were of beaten gold. The comparatively small weight of gold used by Phidias is very remarkable when the great size of the statues is considered.

A graphic representation of the workshop of a Greek sculptor in bronze is given on a fictile vase now in the Berlin Museum (see Gerhard's *Trinkschalen*, plates xii., xiii.). One man is raking out the fire in a high furnace, while another behind is blowing the bellows. Two others are smoothing the surface of a statue with scraping tools, formed like a strigil. A fourth is beating the arm of an unfinished figure, the head of which lies at the workman's feet. Perhaps the most important of early Greek works in cast bronze, both from its size and great historical interest, is the bronze pillar (now in the Hippodrome at Constantinople) which was erected to commemorate the victory of the allied Greek states over the Persians at Plataea in 479 B.C. (see Newton's *Travels in the Levant*). It is in the form of three serpents twisted together, and before the heads were broken off was at least 20 feet high. It is cast hollow, all in one piece, and has the names of the allied states engraved on the lower part of the coils. Its size and the beauty of its surface show great technical skill in the founder's art. On it once stood the gold tripod dedicated to Apollo as a tenth of the spoils. It is described both by Herodotus and Pausanias.

Marble was comparatively but little used by the earlier Greek sculptors, and even Myron, a rather older man than Phidias, seems to have executed nearly all his most important statues in metal.

Additional richness was given to Greek bronze-work by gold or silver inlay on lips, eyes, and borders of the dress; one remarkable statuette in the British Museum has eyes inlaid with diamonds, and fret-work inlay in silver on the border of the chiton.

The mirrors of the Greeks are among the most important specimens of their artistic metal-work. These are bronze disks, one side polished to serve as a reflector, and the back ornamented with engraved outline drawings, often of great beauty (see Gerhard, *Etruskische Spiegel*, 1843-67).

The Greek workman, in fact, was incapable of making an ugly thing. Whatever the metal or whatever the object formed, whether armour, personal ornaments, or domestic vessels, the form was always specially adapted to its use, the ornament natural and graceful, so that the commonest water-jar was a delight alike to him who made it and those who used it.

In metal-work, as in other arts, the Romans were pupils and imitators of the Greeks. Owing to the growth of that spirit of luxury which in time caused the extinction of the Roman empire, a considerable demand arose for magni-

ficent articles of gold and silver plate. The finest specimens of these that still exist are the very beautiful set of silver plate found buried near Hildesheim in 1869, now in the Berlin Museum. They consist of drinking vessels, bowls, vases, ladles, and other objects of silver, parcel-gilt, and exquisitely decorated with figures in relief, both cast and repoussé. There are electrotypes of these in the South Kensington Museum.

When the seat of the empire was changed from Rome to Byzantium, the latter city became the chief centre for the production of artistic metal-work. From Byzantium the special skill in this art was transmitted in the 9th and 10th centuries to the Rhenish provinces of Germany and to Italy, and thence to the whole of Western Europe; in this way the 18th-century smith who wrought the Hampton Court iron gates was the heir to the mechanical skill of the ancient metal-workers of Phœnicia and Greece.

In that period of extreme degradation into which all the higher arts fell after the destruction of the Roman empire, though true feeling for beauty and knowledge of the subtleties of the human form remained for centuries almost dormant, yet at Byzantium at least there still survived great technical skill and power in the production of all sorts of metal-work. In the age of Justinian (first half of the 6th century) the great church of St Sophia at Constantinople was adorned with an almost incredible amount of wealth and splendour in the form of screens, altars, candlesticks, and other ecclesiastical furniture made of massive gold and silver.

Metal-Work in Italy.—It was therefore to Byzantium that Italy turned for metal-workers, and especially for goldsmiths, when, in the 6th to the 8th centuries, the basilica of St Peter's in Rome was enriched with masses of gold and silver for decorations and fittings, the gifts of many donors from Belisarius to Leo III., the mere catalogue of which reads like a tale from the *Arabian Nights*. The gorgeous Pala d'Oro, still in St Mark's at Venice, a gold retable covered with delicate reliefs and enriched with enamels and jewels, was the work of Byzantine artists during the 11th century. This work was in progress for more than a hundred years, and was set in its place in 1106 A.D., though still unfinished (see Bellomo, *Pala d'Oro di S. Marco*, 1847).

It was, however, especially for the production of bronze doors for churches, ornamented with panels of cast work in high relief, that Italy obtained the services of Byzantine workmen (see Garrucci, *Arte Cristiana*, 1872-82). One artist named Staurachios produced many works of this class, some of which still exist, such as the bronze doors of the cathedral at Amalfi, dated 1066 A.D. Probably by the same artist, though his name was spelled differently, were the bronze doors of San Paolo fuori le Mura, Rome, careful drawings of which exist, though the originals were destroyed in the fire of 1824. Other important examples exist at Ravello (1197), Salerno (1099), Amalfi (1062), Atrani (1087); and doors at Monreale in Sicily and at Trani, signed by an artist named Barisanos (end of the 12th century); the reliefs on these last are remarkable for expression and dignity, in spite of their early rudeness of modelling and ignorance of the human figure.

Most of these works in bronze were enriched with fine lines inlaid in silver, and in some cases with a kind of niello or enamel. The technical skill of these Byzantine metal-workers was soon acquired by native Italian artists, who produced many important works in bronze similar in style and execution to those of the Byzantine Greeks. Such, for example, are the bronze doors of San Zenone at Verona (unlike the others, of repoussé not cast work); those of the Duomo of Pisa, cast in 1180 by Bonannus, and of the

Duomo of Trôia, the last made in the beginning of the 12th century by Oderisius of Benevento. Another artist named Roger of Amalfi worked in the same way; and in the year 1219 the brothers Hubertus and Petrus of Piacenza cast the bronze door for one of the side chapels in San Giovanni in Laterano. One of the most important early specimens of metal-work is the gold and silver altar of Sant' Ambrogio in Milan. In character of work and design it resembles the Venice Pala d'Oro, but is still earlier in date, being a gift to the church from Archbishop Angilbert II. in 835 A.D. (see Du Sommerard, and D'Agincourt, *Moyen Âge*). It is signed WOLVINIVS MAGISTER PHABER; nothing is known of the artist, but he probably belonged to the semi-Byzantine school of the Rhine provinces; according to Dr Rock he was an Anglo-Saxon goldsmith. It is a very sumptuous work, the front of the altar being entirely of gold, with repoussé reliefs and cloisonnée enamels; the back and ends are of silver, with gold ornaments. On the front are figures of Christ and the twelve apostles; the ends and back have reliefs illustrating the life of St Ambrose.

The most important existing work of art in metal of the 13th century is the great candelabrum now in Milan cathedral. It is of gilt bronze, more than 14 feet high; it has seven branches for candles, and its upright stem is supported on four winged dragons. For delicate and spirited execution, together with refined gracefulness of design, it is unsurpassed by any similar work of art. Every one of the numerous little figures with which it is adorned is worthy of study for the beauty and expression of the face, and the dignified arrangement of the drapery (see fig. 3).

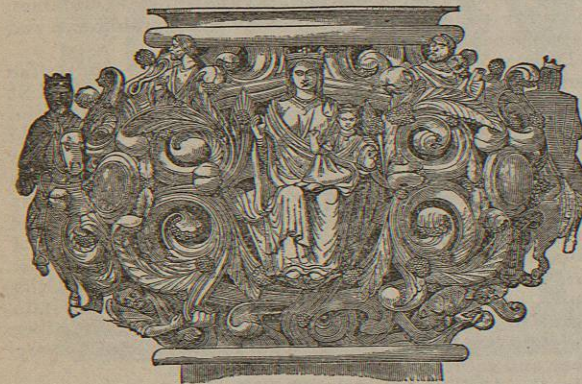


FIG. 3.—Boss from the Milanese Candelabrum.

The semi-conventional open scroll-work of branches and fruit which wind around and frame each figure or group is devised with the most perfect taste and richness of fancy, while each minute part of this great piece of metal-work is finished with all the care that could have been bestowed on the smallest article of gold jewellery. Though something in the grotesque dragons of the base recalls the Byzantine school, yet the beauty of the figures and the keen feeling for graceful curves and folds in the drapery point to a native Italian as being the artist who produced this wonderful work of art. There is a cast in the South Kensington Museum.

During the 13th and 14th centuries in Italy the widespread influence of Niccolò Pisano and his school encouraged the sculptor to use marble rather than bronze for his work. At this period wrought iron came into general use in the form of screens for chapels and tombs, and grills for windows. These are mostly of great beauty, and show remarkable skill in the use of the hammer, as well as power

in adapting the design to the requirements of the material. Among the finest examples of this sort of work are the screens round the tombs of the Scala family at Verona, 1350-75,—a sort of net-work of light cusped quatrefoils, each filled up with a small ladder (*scala*) in allusion to the name of the family. The most elaborate specimen of this wrought work is the screen to the Rinuccini chapel in Santa Croce, Florence, of 1371, in which moulded pillars and window-like tracery have been wrought and modelled by the hammer with extraordinary skill (see Wyatt, *Metal-Work of Middle Ages*). Of about the same date are the almost equally magnificent screens in Sta Trinita, Florence, and at Siena across the chapel in the Palazzo Pubblico. The main part of most of these screens is filled in with quatre-foils, and at the top is an open frieze formed of plate iron pierced, repoussé, and enriched with engraving.

In the 14th century great quantities of objects for ecclesiastical use were produced in Italy, some on a large scale, and mostly the works of the best artists of the time.



FIG. 4.—Silver Repoussé Reliefs from the Pistoia Retable.

The silver altar of the Florence baptistery is one of the chief of these; it was begun in the first half of the 14th century, and not completed till after 1477 (see *Gaz. des Beaux Arts*, Jan. 1883). A whole series of the greatest artists in metal laboured on it in succession, among whom were Orcagna, Ghiberti, Verrocchio, Ant. Pollajuolo, and many others. It has elaborate reliefs in repoussé work, cast canopies, and minute statuettes, with the further enrichment of translucent coloured enamels. The silver altar and retable of Pistoia cathedral (see fig. 4), and the great shrine at Orvieto, are works of the same class, and of equal importance.

Whole volumes might be devoted to the magnificent works in bronze produced by the Florentine artists of this century, works such as the baptistery gates by Ghiberti, and the statues of Verrocchio, Donatello, and many others, but these come rather under the head of sculpture.

Some very magnificent bronze screens were produced at this time, especially that in Prato cathedral by Simone, brother of Donatello, in 1444-61, and the screen and bronze ornaments of the tomb of Piero and Giovanni dei Medici in San Lorenzo, Florence, by Verrocchio, in 1472.

At the latter part of the 15th century and the beginning of the 16th the Pollajuoli, Ricci, and other artists devoted much labour and artistic skill to the production of candlesticks and smaller objects of bronze, such as door-knockers, many of which are works of the greatest beauty. The candlesticks in the Certosa near Pavia, and in the cathedrals of Venice and Padua, are the finest examples of these.

Niccolò Grossi, who worked in wrought iron under the patronage of Lorenzo dei Medici, produced some wonderful specimens of metal-work, such as the candlesticks, lanterns, and rings fixed at intervals round the outside of the great palaces (see fig. 5). The Strozzi palace in Florence and



FIG. 5.—Wrought Iron Candle-Pricket; late 15th-century. Florentine work.

the Palazzo del Magnifico at Siena have fine specimens of these,—the former of wrought iron, the latter in cast bronze.

At Venice fine work in metal, such as salvers and vases, was being produced, of almost Oriental design, and in some cases the work of resident Arab artificers. In the 16th century Benvenuto Cellini was supreme for skill in the production of enamelled jewellery, plate, and even larger works of sculpture (see Plon's *Ben. Cellini*, 1882), and John of Bologna in the latter part of the same century inherited to some extent the skill and artistic power of the great 15th-century artists. Since that time Italy, like other countries, has produced little metal-work of real value.

Spain.—From a very early period the metal-workers of Spain have been distinguished for their skill, especially in the use of the precious metals. A very remarkable set of specimens of goldsmith's work of the 7th century are the eleven votive crowns, two crosses, and other objects found

in 1858 at Guarrazar, and now preserved at Madrid and in Paris in the Cluny Museum (see Du Sommerard, *Musée de Cluny*, 1852). Magnificent works in silver, such as shrines, altar crosses, and church vessels of all kinds, were produced in Spain from the 14th to the 16th century,—especially a number of sumptuous tabernacles (*custodia*) for the host, magnificent examples of which still exist in the cathedrals of Toledo and Seville. The bronze and wrought iron screens—*rejas*, mostly of the 15th and 16th centuries—to be found in almost every important church in Spain are very fine examples of metal-work. They generally have moulded rails or ballusters, and rich friezes of pierced and repoussé work, the whole being often thickly plated with silver. The common use of metal for pulpits is a peculiarity of Spain; they are sometimes of bronze, as the pairs in Burgos and Toledo cathedrals, or in wrought iron, like those at Zamora and in the church of San Gil, Burgos. The great candelabrum or *tenebrarium* in Seville cathedral is the finest specimen of 16th-century metal-work in Spain; it was mainly the work of Bart. Morel in 1562. It is of cast bronze enriched with delicate scroll-work foliage, and with numbers of well-modelled statuettes, the general effect being very rich and graceful. Especially in the art of metal-work Spain was much influenced in the 15th and 16th centuries by both Italy and Germany, so that numberless Spanish objects produced at that time owe little or nothing to native designers. At an earlier period Arab and Moorish influence is no less apparent.

England.—In Saxon times the English metal-workers, especially of the precious metals, possessed great skill, and appear to have produced shrines, altar-frontals, retables, and other ecclesiastical furniture of considerable size and magnificence.

Dunstan, archbishop of Canterbury (925-988), like Bernward, bishop of Hildesheim a few years later, and St Eloi of France three centuries earlier, was himself a skilful worker in all kinds of metal. The description of the gold and silver retable given to the high altar of Ely by Abbot Theodwin in the 11th century, shows it to have been a large and elaborate piece of work decorated with many reliefs and figures in the round. In 1241 Henry III. gave the order for the great gold shrine to contain the bones of Edward the Confessor (see W. Burges in *Gleanings from Westminster*). It was the work of members of the Otho family, among whom the goldsmith's and coiner's crafts appear to have been long hereditary. Countless other important works in the precious metals adorned every abbey and cathedral church in the kingdom.

In the 13th century the English workers in wrought iron were especially skilful. The grill over the tomb of Queen Eleanor at Westminster, by Thomas de Leghton, made about 1294, is a remarkable example of skill in welding and modelling with the hammer (see fig. 6).

The rich and graceful iron hinges, made often for small and out-of-the-way country churches, are a large and important class in the list of English wrought iron-work. Those on the refectory door of Merton College, Oxford, are a beautiful and well-preserved example dating from the 14th century.

More mechanical in execution, though still very rich in effect, is that sort of iron tracery work produced by cutting out patterns in plate, and superimposing one plate over the other, so as to give richness of effect by the shadows produced by these varying planes. The screen by Henry V.'s tomb at Westminster is a good early specimen of this kind of work.

The screen to Bishop West's chapel at Ely, and that round Edward IV.'s tomb at Windsor, both made towards the end of the 15th century are the most magnificent

English examples of wrought iron, in which every art and feat of skill known to the smith has been brought into play to give variety and richness to the work.

Much wrought-iron work of great beauty was produced at the beginning of the 18th century, especially under the superintendence of Sir Christopher Wren (see Ebbetts, *Iron Work of 17th and 18th Centuries*, 1880). Large flowing leaves of acanthus and other plants were beaten out with wonderful spirit and beauty of curve. The gates from Hampton Court are the finest examples of this class of work (see fig. 7).

From an early period bronze and latten (a variety of brass) were much used in England for the smaller objects both of ecclesiastical and domestic use, but except for tombs and lecterns were but little used on a large scale till the 16th century. The full-length recumbent effigies of Henry III. and Queen Eleanor at Westminster, cast in bronze by the "cire perdue" process, and thickly gilt, are equal, if not superior, in artistic beauty to any sculptor's work of the same period (end of the 13th century) that was produced in Italy or elsewhere. These effigies are the work

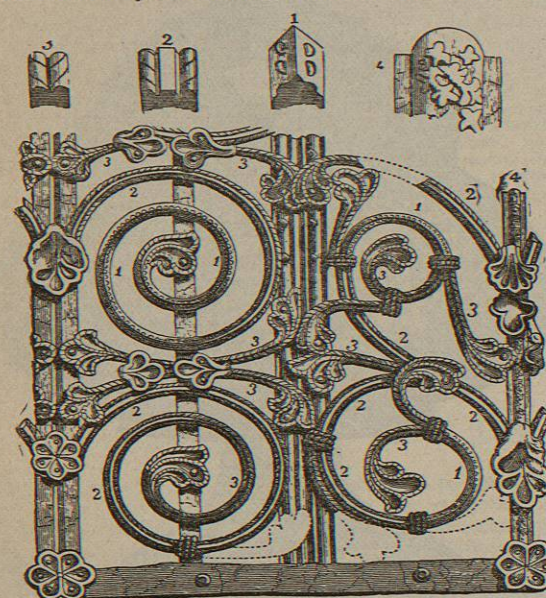


FIG. 6.—Part of the "Eleanor Grill."

of an Englishman named William Torel (see *Westminster Gleanings*). The gates to Henry VII.'s chapel, and the screen round his tomb at Westminster (see fig. 8), are very elaborate and beautiful examples of "latten" work, showing the greatest technical skill in the founder's art. In latten also were produced the numerous monumental brasses of which about two thousand still exist in England. Though a few were made in the 13th century, yet it was not till the 14th that they came into general use. They are made of cast plates of brass, with the design worked upon them with the chisel and graver. All those, however, to be seen in English churches are not of native work—great quantities of them being Flemish imports (see Cotman, Waller, and Boutell on Monumental Brasses).

In addition to its chief use as a roof covering, lead was sometimes used in England for making fonts, generally tub-shaped, with figures cast in relief. Many examples exist: e.g., at Tidenham, Gloucestershire; Warborough and Dorchester, Oxon; Chirton, Wilts; and other places.

Germany.—Unlike England, Germany in the 10th and 11th centuries produced large and elaborate works in cast bronze, especially doors for churches, much resembling the contemporary doors made in Italy under Byzantine influence. Bernward, bishop of Hildesheim, 992-1022, was especially skilled in this work, and was much influenced in design by a visit to Rome in the suite of Otho III. The bronze column with winding reliefs now at Hildesheim was the result of his study of Trajan's column, and the bronze door which he made for his own cathedral shows classical influence, especially in the composition of the drapery of the figures in the panels.

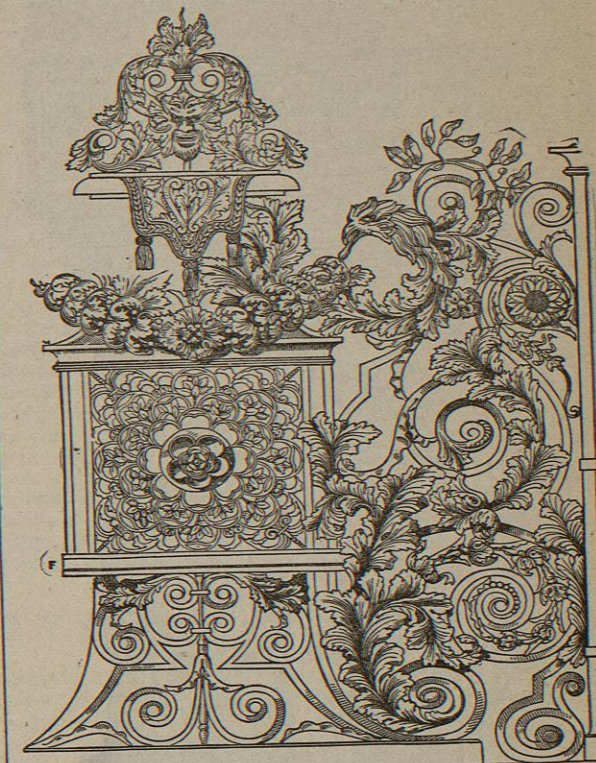


FIG. 7.—Part of one of the Hampton Court Gates.

The bronze doors of Augsburg (1047-72) are similar in style. The bronze tomb of Rudolph of Swabia in Mersburg cathedral (1080) is another fine work of the same school. The production of works in gold and silver was also carried on vigorously in Germany. The shrine of the three kings at Cologne is the finest surviving example.

At a later time Augsburg and Nuremberg were the chief centres for the production of artistic works in the various metals. Herman Vischer, in the 15th century, and his son and grandsons were very remarkable as bronze founders. The font at Wittenberg, decorated with reliefs of the apostles, was the work of the elder Vischer, while Peter and his son produced, among other important works, the shrine of St Sebald at Nuremberg, a work of great finish and of astonishing richness of fancy in its design (see Doebner, *Christliches Kunstblatt*, 1866, Nos. 10-12). The tomb of Maximilian I., and the statues round it, at Innsbruck, begun in 1521, are perhaps the most meritorious German work of this class in the 16th century, and show considerable Italian influence.

In wrought iron the German smiths, especially during the 15th century, greatly excelled. Almost peculiar to Germany is the use of wrought iron for grave-crosses and sepulchral monuments, of which the Nuremberg and other cemeteries contain fine examples. Many elaborate well-canopies were made in wrought iron, and gave full play to



FIG. 8.—Part of Henry VII.'s Bronze Screen.

the fancy and invention of the smith. The celebrated 15th-century example over the well at Antwerp, attributed to Quintin Massys, is the finest of these.

France.—From the time of the Romans the city of Limoges has been celebrated for all sorts of metal-work, and especially for brass enriched with enamel. In the 13th and 14th centuries many life-size sepulchral effigies were made of beaten copper or bronze, and ornamented by various-coloured "champlevé" enamels. The beauty of these effigies led to their being imported into England;

most are now destroyed, but a fine specimen still exists at Westminster on the tomb of William de Valence (1296). In ornamental iron-work for doors the French smiths were pre-eminent for the richness of design and skilful treatment of their metal. No examples probably surpass those on the west doors of Notre Dame in Paris—now unhappily much falsified by restoration. The crockets and finials on the fleches of Amiens and Rheims are beautiful specimens of a highly ornamental treatment of cast lead, for which France was especially celebrated. In most respects, however, the development of the various kinds of metal-working went through much the same stages as in England.

Persia and Damascus.—The metal-workers of the East, especially in brass and steel, were renowned for their skill



FIG. 9.—Brass Vase, pierced and gilt; 17th century Persian work.

even in the time of Theophilus, the monkish writer on the subject in the 13th century. But it was during the reign of Shah Abbas I. (d. 1628) that the greatest amount of skill both in design and execution was reached by the Persian workmen. Delicate pierced vessels of gilt brass, enriched by tooling and inlay of gold and silver, were among the chief specialties of the Persians (see fig. 9).

A process called by Europeans "damascening" (from Damascus, the chief seat of the export) was used to produce very delicate and rich surface ornament. A pattern was incised with a graver in iron or steel, and then gold wire was beaten into the sunk lines, the whole surface being then smoothed and polished. In the time of Cellini this process was copied in Italy, and largely used, especially for the decoration of weapons and armour. The repoussé process both for brass and silver was much used by Oriental workers, and even now fine works of this class are produced in the East, old designs still being adhered to.

Recent Metal-Work.—In modern Europe generally the arts of metal-working both as regards design and technical skill are not in a flourishing condition. The great bronze lions of the Nelson monument in London are a sad example of the present low state of the founder's art. Coarse sand-casting in England now takes the place of the delicate "cire perdue" process.

Some attempts have lately been made in Germany to revive the art of good wrought-iron work. The Prussian gates, bought at a high price for the South Kensington Museum, are large and pretentious, but unfortunately are only of value as a warning to show what wrought iron ought not to be. Some English recent specimens of hammered work are more hopeful, and show that one or two smiths are working in the right direction.

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METAMORPHOSIS. This term has been employed in several distinct senses in biology. During the early part of the century it was constantly used to include the current morphological conceptions, as, for instance, of the parts of a flower as modified or "metamorphosed" leaves, or of the segments of a skull as modified vertebrae. It is still frequently employed to denote that progressive change from the general to the special undergone by all developing tissues and organs (see BIOLOGY, EMBRYOLOGY), but in this sense is conveniently superseded by the term "differentiation." In the process of animal development, two types are broadly distinguishable,—a fetal type, in which development takes place wholly or in greater part either within the egg or within the body of the parent, and a larval type, in which the young are born in a condition more or less differing from that of the adult, while the adult stage again is reached in one of two ways, either by a process of gradual change, or by a succession of more or less rapid and striking transformations, to which the term metamorphosis is now usually restricted. Metamorphosis is generally regarded as having been brought about by the action of natural selection, partly in curtailing and reducing the phases of development (an obvious advantage in economy of both structural and functional change), and partly also in favouring the acquirement of such secondary characters as are advantageous in the struggle for existence. Freshwater and terrestrial animals develop without metamorphosis much more frequently than marine members of the same group, a circumstance which has been variously explained. For details of metamorphoses see the articles on the various groups of animals; see also Balfour's *Comparative Embryology*, 1880-81.

METAPHYSIC

THE term metaphysic, originally intended to mark the place of a particular treatise in the collection of Aristotle's works, has, mainly owing to a misunderstanding, survived several other titles,—such as "First Philosophy," "Ontology," and "Theology," which Aristotle himself used or suggested. Neo-Platonic mystics interpreted it as signifying that which is not merely "after" but "beyond" physics, and found in it a fit designation for a science which, as they held, could not be attained except by one who had turned his back upon the natural world. And writers of a different tendency in a later time gladly accepted it as a convenient nickname for theories which they regarded as having no basis in experience, in the same spirit in which the great German minister Stein used the analogous title of "metapolitics" for airy and unpractical schemes of social reform. A brief indication of the contents of Aristotle's treatise may enable us to give a general definition of the science which was first distinctly constituted by it, and to determine in what sense the subjects which that science has to consider are beyond nature and experience.

For Aristotle, metaphysic is the science which has to do with Being as such, Being in general, as distinguished from the special sciences which deal with special forms of being. There are certain questions which, in Aristotle's view, we have a right to ask in regard to everything that

presents itself as real. We may ask what is its ideal nature or definition, and what are the conditions of its realization; we may ask by what or whom it was produced, and for what end; we may ask, in other words, for the formal and the material, for the efficient and the final causes of everything that is. These different questions point to different elements in our notion of Being, elements which may be considered in their general relations apart from any particular case of their union. These, therefore, the first philosophy must investigate. But, further, this science of being cannot be entirely separated from the science of knowing, but must determine at least its most general principles. For the science that deals with what is most universal in being is, for that very reason, dealing with the objects which are most nearly akin to the intelligence. These, indeed, are not the objects which are first presented to our minds; we begin with the particular, not the universal, with a *πρῶτον ἡμῖν* which is not *πρῶτον φύσει*; but science reaches its true form only when the order of thought is made one with the order of nature, and the particular is known through the universal. Yet this conversion or revolution of the intellectual point of view is not to be regarded as an absolute change from error to truth: for Aristotle holds that *nilhil est in intellectu quod non prius in sensu*, in the meaning that in sense perception there is already the working of that discriminative intelli-