period a centre of attraction to some of the most earnest spirits of the time. Made a doctor of theology in 1475, he received a professorship at Freiburg in the following year; but his tastes began to incline him more strongly to the vocation of a preacher, while his fervour and eloquence soon led to his receiving numerous invitations to the larger towns. Ultimately he accepted in 1478 a call to the cathedral of Strasburg, where he continued to work with few interruptions until within a short time of his death, which occurred on the 10th of March 1510. The beautiful pulpit erected for him in 1481 in the nave of the cathedral, when the chapel of St Lawrence had proved too small, still bears witness to the popularity he enjoyed as a preacher in the immediate sphere of his labours, and the testimonies of Sebastian Brandt, Beatus Renanus, Reuchlin, Melanchthon, and others who survived him, abundantly show how powerful, how healthy, and how widespread had been the influence of his personal character. His sermons—bold, incisive, abounding in quaint illustrations, nor altogether wanting in instances of what would now be called bad taste—taken down as he spoke them, and circulated (sometimes without his knowledge or consent) by his friends, told perceptibly on the German thought as well as on the German speech of his time.

Among the many volumes published under his name only two appear to have had the benefit of his revision, namely, *Der Seelen Paradies von waren und volkomnen Tugenden*, and that entitled *Das irrig Schaf*. Of the rest, probably the best known is a series of lectures on his friend Seb. Brandt's well-known work the *Navicula* or *Speculum Fatuorum*, of which an edition was published at Strasburg in 1511 under the following title:—*Navicula sive speculum fatuorum præstantissimi sacrarum literarum doctoris Joannis Geiler Keysersbergii concionatoris Argentinensis in sermones juxta turmarum seriem divisa; suis figuris jam signita; atque a Jacobo Othero diligenter collecta. Compendiosa vitæ ejusdem descriptio per Beatum Rhenanum Selestatinum.*

See Von Ammon, *Geyler's Leben, Lehren, und Predigten* (1826); Stöber, *Essai Historique et Littéraire sur la Vie et les Sermons de Geiler* (1834); and C. Schmidt in Herzog's *Real-Encycl.*, iv. 714 (1855).

GEISSLER, Heinrich (1814–79), a distinguished practical physicist, was born at the village of Igelshieb in Saxe-Meiningen, Germany, where he was educated as a glass-blower. After many years spent in travelling from city to city in the exercise of his craft, he settled at Bonn, where he speedily gained a high reputation, not only for his surpassing skill and ingenuity of conception in the fabrication of physical apparatus, but for his comprehensive knowledge, acquired chiefly in later life, of the natural sciences. With Plücker, in 1852, by means of an ingeniously contrived instrument, in which mercury was made to compensate for the expansion of the glass, he ascertained the maximum density of water to be at 3·8° C. He also determined the coefficient of expansion for ice between $-24°$ and $-7°$, and for water freezing at 0°. In 1869, in conjunction with Vogelsang, he proved the existence of liquid carbon dioxide in cavities in quartz and topaz, and later he obtained amorphous from ordinary phosphorus by means of the electric current. He is best known as the inventor of the sealed glass tubes which bear his name, by means of which are exhibited the phenomena accompanying the discharge of electricity through highly rarefied vapours and gases (see Electricity, vol. viii. p. 64). Among other apparatus contrived by him are his vaporimeter, mercury air-pump, balances, normal thermometer, and areometer. From the university of Bonn, on the occasion of its jubilee, he received the honorary degree of doctor of philosophy. He died on the 24th of January 1879, in the sixty-fifth year of his age. See A. W. Hofmann, *Ber. d. deut. chem. Ges.*, 1879, p. 148.

GELA, an ancient city on the south coast of Sicily, on a river of the same name, near the site of the modern Terranuova between Girgenti and Camerina. Founded by a joint colony of Cretans and Rhodians (the latter mainly from the city of Lindus), it soon rose to wealth and power, and by 582 B.C. it was able to become the mother-city of Agrigentum, by which it was however destined before long to be surpassed. The most important among its rulers were the following:—Cleander, who subverted the oligarchy and made himself despot (505–498 B.C.); Hippocrates, his brother, who raised Gela to its highest pitch of eminence (498–491 B.C.); Gelon, who immediately succeeded Hippocrates, and rapidly pursued the same career of aggrandizement till in 485 B.C. he got possession of Syracuse, and gave the first blow to his native city by removing the seat of government to his new conquest; and finally Hiero, the brother of Gelon, who succeeded to the sovereignty in 478 B.C. The decadent Gela was laid waste by Phalaris of Agrigentum, and in the time of Strabo it was nothing more than a heap of ruins. Æschylus died at Gela in 456 B.C.; and it was the birthplace of Apollodorus, a comic poet of note.

GELASIUS, the name of two popes.

Gelasius I. succeeded Felix III. in 492, and confirmed the estrangement between the Eastern and Western Churches by insisting on the removal of the name of Acacius, bishop of Constantinople, from the diptychs. He was also the first decidedly to assert the supremacy of the papal over the imperial power, and the superiority of the pope to the general councils. He is the author of *De duabus in Christo naturis adversus Eutychen et Nestorium.* Five of his letters have also come down to us, and he is most probably the author of *Liber Sacrementorum*, published at Rome in 1680; but the so-called *Decretum Gelasii de libris recipiendis et non recipiendis* is evidently a forgery. Gelasius died in 496, and was canonized, his day being the 18th November.

Gelasius II. (Giovanni da Gaeta) was of noble descent, and was born at Gaeta about 1050. He received his theological education in the abbey of Monte Casino, and afterwards held the office of chancellor under Urban II., and of cardinal-deacon under Pascal II. On the death of Pascal II. he was elected pope by the cardinals, 18th January 1118, and when his person was seized by Cencius Frangipani, a partisan of the emperor Henry V., he was almost immediately set at liberty through the general uprising of the people in his behalf. The sudden appearance of the emperor, however, compelled him to leave Rome for Gaeta, and the imperial party chose an anti-pope, Burdinus, archbishop of Braga, under the name of Gregory VIII. Gelasius, at a council held at Capua, fulminated bulls of excommunication against his ecclesiastical rival and the emperor; and under the protection of the Norman princes he was able to return to Rome, where he stayed for a time in partial concealment, but having barely escaped capture by the Frangipani while celebrating mass in the church of St Praxede, he left the city, and after wandering through various parts of Italy and France died in the abbey of Clugny, January 19, 1119.

GELATIN. When intercellular connective tissue, as met with in skin, tendons, ligaments, and the fasciæ of the muscles, of which it forms the basis, is treated with water, preferably hot, or in presence of dilute acids, for some time, a solution is obtained which in cooling solidifies to a jelly. The dissolved substance bears the name of *Gelatin* or *Glutin*.

The same substance is obtained when the matrix of bones is submitted to similar treatment, after previous removal of the lime salts by means of mineral acids. Again, when unossified cartilage, as for instance the bone-cartilages of the vertebrate fœtus, is treated with water or dilute acids, a solution is obtained which also gelatinizes on cooling. The coagulation in this case, however, is due, not to gelatin, but to a closely allied substance called chondrin. At one

time it was supposed that in each of these three cases the gelatinizing materials obtained were formed by the hydration or by a physical metamorphosis of a different substance pre-existing in the respective tissues, to which the names *collagen*, *ossein*, and *chondrogen* were given respectively—the two former yielding gelatin, and the last chondrin.

Further experiments have made it more probable that gelatin and chondrin do not differ essentially from their parent tissues, analyses of tendons and of gelatin or isinglass (a very fine form of gelatin obtainable from the sturgeon) agreeing within the range of experimental error. At the same time, as Foster observes in the case of chondrin, the fact that its extraction from cartilage requires an amount of boiling with water, much more than would be necessary to dissolve the same amount of dried product, points rather the other way. Most probably the change which occurs is of a purely physical character.

True gelatigenous tissue occurs in all mature vertebrates, with the single exception, according to Hoppe-Seyler, of that in other respects anomalous vertebrate, *Amphioxus lanceolatus*. In the embryo it does not appear till late in fœtal life, chondrin being found instead; and the change which brings gelatin into the place of chondrin is effected, not by a metamorphosis of the latter, but by its removal, and the independent formation of gelatin. The tissue in question was believed to be peculiar to *Vertebrata* until Hoppe-Seyler discovered it in the bodies of *Octopus* and *Sepiola*. By boiling these cephalopods with water he obtained large quantities of gelatin free from chondrin, but in an extension of his experiments to other invertebrates, as cockchafers and *Anodon* and *Unio*, no such tissue could be detected. Gelatin, as such, is not met with in any of the normal fluids of the body, but occurs in the blood in cases of *leukhæmia*.

Various qualities of impure gelatin are prepared on the large scale by boiling up the hides of oxen, skins of calves, and spongy parts of horns; from any of the crude gelatins the pure substance may be obtained by bleaching with sulphurous acid and steeping repeatedly in warm water, when in the state of soft jelly.

Pure gelatin is an amorphous, brittle, nearly transparent substance, faintly yellow, tasteless, and inodorous, neutral to vegetable colours, and unaltered by exposure to dry air. Submitted to analysis it exhibits an elementary composition agreeing closely with that of chondrin, containing in round numbers C 50, H 7, N 18, O + S 24 per cent.; whilst chondrin contains about 3 per cent. less nitrogen and more oxygen.

Nothing is known with any certainty as to its chemical constitution, or of the mode in which it is formed from albuminoids. Besides a similarity in elementary constituents, it exhibits in a general way a connexion with that large and important class of animal substances called *proteids*, being, like them, amorphous, soluble in acids and alkalies, and giving in solution a left-handed rotation of the plane of polarization. Nevertheless, the ordinary well-recognized reactions for proteids are but faintly observed in the case of gelatin, and the only substances which at once and freely precipitate it from solution are corrosive sublimate, strong alcohol, and tannic acid.

According to Wanklyn, gelatin is distinctly differentiated from such substances as *casein* and *albumin* by a marked difference in behaviour when treated successively with boiling potash and alkaline permanganate. All nitrogenous organic substances yield large quantities of ammonia when decomposed by boiling with these solutions; but whereas albuminoids give up their ammonia at two successive stages, one of which is achieved by the action of potash alone, the other on the subsequent addition of permanganate, gelatin yields the same amount after the action of permanganate alone, as the total obtainable by the successive actions of the two reagents. Now, as there appear to be good grounds for believing the molecule of albuminoids to contain one or more urea-residues, and as urea, and presumably therefore a urea-residue, would yield its ammonia to potash alone, Wanklyn concludes that gelatin differs in constitution from albuminoids by containing no urea. On the other hand, as Foster observes, the behaviour of gelatin as a food (see below), in diminishing the amount of fat used by an animal fed partly on it, as well as the quantity of nitrogen abstracted from other sources, is readily intelligible on the hypothesis that it splits into a urea and a fat moiety.

Although gelatin in a dry state is unalterable by exposure to air, its solution exhibits, like all the proteids, a remarkable tendency to putrefaction; but a characteristic feature of this process in the case of gelatin is that the solution assumes a transient acid reaction. The ultimate products of this decomposition are the same as are produced by prolonged boiling with acid (see below). It has been found that oxalic acid, over and above the action common to all dilute acids of preventing the solidification of gelatin solutions, has the further property of preventing in a large measure this tendency to putrefy when the gelatin is treated with hot solutions of this acid, and then freed from adhering acid by means of carbonate of lime. Gelatin so treated has been called *metagelatin*.

Strange to say, in spite of the marked tendency of gelatin solutions to develop ferment-organisms, and undergo putrefaction, the stability of the substance in the dry state is such that it has even been used, and with some success, as a means of preserving perishable foods. The process, invented by Dr Campbell Morfit, consists in impregnating the foods with gelatin, and then drying them till about 10 per cent. or less of water is present. Milk gelatinized in this way is superior in several respects to the products of the ordinary condensation process, more especially in the retention of a much larger proportion of albuminoids.

Gelatin has a marked affinity for water, abstracting it from admixture with alcohol, for example. Solid gelatin steeped for some hours in water absorbs a certain amount and swells up, in which condition a gentle heat, as that of the water-bath, serves to convert it into a liquid; or this may be readily produced by the addition of a trace of alkali or mineral acid, or by strong acetic acid. In the last case, however, or if we use the mineral acids in a more concentrated form, the solution obtained has lost its power of solidifying, though not that of acting as a glue. By prolonged boiling of strong aqueous solutions at a high, or of weak solutions at a lower temperature, the characteristic properties of gelatin are impaired and ultimately destroyed. After this treatment it acts less powerfully as a glue, loses its tendency to solidify, and becomes increasingly soluble in cold water; nevertheless the solutions yield on precipitation with alcohol a substance identical in composition with gelatin.

By prolonged boiling in contact with hydrolytic agents, such as sulphuric acid or caustic alkali, it yields quantities of *leucin* and *glycocoll* (so-called "sugar of gelatin," this being the method by which glycocoll was first prepared), but no *tyrosin*. In this last respect it agrees with its near allies, chondrin and elastin, and differs from the great body of proteids, the characteristic solid products of the decomposition of which are leucin and tyrosin. At the same time the formation of glycocoll differentiates it from chondrin, from which, moreover, it can be readily distinguished by its non-precipitability by acetate of lead.

When it is mixed with copper sulphate a bright green liquid is formed, from which the copper cannot be thrown down free of organic matter. Addition of potash to the liquid merely changes the colour from green to violet, which by boiling is further transformed into a pale red, but without any precipitation of hydrate. Hence the inapplicability of Trommer's sugar test in presence of gelatin, the cuprous oxide being soluble in gelatin solutions.

Treated with strong oxidizing agents, such as a mixture of sulphuric acid and bichromate of potash, or binoxide of manganese, it exhibits a close resemblance in behaviour to casein, formic and valerianic acids being the principal products, along with a small quantity of benzoic aldehyde. When solution of gelatin is mixed with chromate of potash alone, it forms a medium very sensitive to light, which converts it into an insoluble yellow mass.

As bones are capable of yielding one-third of their weight of solid gelatin, it follows that, if gelatin had a value equivalent to albuminoids, the bones of an animal would contain one-fifth of the total nutritive material in its body. Accordingly, at a time when gelatin was in high esteem for its food-value, recourse was had largely to this source, more especially in France, for a cheap nutritive soup for soldiers, pauper establishments, and hospitals. To prepare such a soup the bones may be either simply boiled in water under pressure, as in a Papin's digester, or without pressure, or they may be previously freed from salts of calcium by treatment with dilute hydrochloric acid. On the large scale the crushed bones are submitted to the combined action of steam at high pressure and a current of water percolating through the fragments. The bones, preferably in a fresh condition, or preserved by thorough drying or by antiseptic agents such as brine, are crushed by passing them between solid iron cylinders grooved longitudinally and kept revolving. They are then packed into a cylindrical cage, which can be lowered into a cylindrical jacket of rather larger diameter than itself, the whole closing with a well-fitting lid. A pipe for the entrance of water, regulated by a stopcock, projects from the top of the outer cylinder, and is connected before the lid is put on with an adjustable nozzle, through which the water trickles down among the caged bones. Another pipe is connected with the bottom of the apparatus for the passage of high-pressure steam. The gelatin solution may be removed at intervals by means of a stopcock at the bottom. The quantity of water percolating through the bones is carefully regulated in accordance with the varying pressure of the steam, so as to produce a soup of nearly uniform consistence.

As to the nutritive value of such a soup very different opinions have been entertained at different times. It was at the time of the first French Revolution, when the question of the improvement of the diet of soldiers and people was much discussed, that attention began to be directed to gelatin as a cheap and useful food; and at that time such men as Proust and D'Arcet were trying improved methods of extracting it from bone. The discovery of nitrogen as a constituent of foods generally led to its being regarded as the special criterion of food-value, and, as this element was found to exist in large proportion in gelatin, the percentage of gelatin extractable from any substance was held as determining its worth as food.

In 1802 a commission appointed by the Academy to investigate the question reported that, though it might to a certain extent replace flesh in soups, yet it could not be taken as the measure of food-value. Meanwhile experiments on men and dogs, especially by Donné, Gannal, Edwards, and Balzac, along with the results of hospital rations at St Antoine and St Louis, showed the impossibility of feeding upon gelatin alone, and in general its unsatisfactory character as a food. Accordingly, a second commission was appointed by the Academy in 1841, who reported very strongly against the use of gelatin at all as an article of diet, alleging that, besides being valueless itself, it actually diminishes the value of otherwise nutritious food; but this latter part of the indictment was overturned by the Netherlands' commission (*Compt. Rend.*, 1844). It ended by the Academy in 1850 declaring that gelatin was positively injurious to the digestive organs; and the natural result of this extreme reaction was of course a complete cessation of its use as food.

In Germany, Liebig had declared, in his *Thierchemie* (1843), that gelatin, being a product of the decomposition of albumen, could not take the place of albumen as food, though it might be conceived to be useful for the growth of gelatinous tissue. Boussingault's experiments on ducks (*Ann. Chem. Phys.*, 1846) showed that, contrary to what should happen if the report of the French Academy were true, gelatin did not pass unaltered into their fæces, but that a large increase of uric acid was found in their urine, a result which was confirmed by Frerichs and Bischoff, who found in the urine of dogs fed on gelatin large amounts of urea—uric acid in birds and urea in mammals being the characteristic forms in which nitrogen is eliminated from the system of these animals. The conclusion they arrived at was that the use of gelatin as a food was limited to its power of undergoing decomposition in the body, like the carbohydrates, to yield heat, but that it cannot replace the other nitrogenous constituents of the body. In 1853 Dr Donders of Utrecht published a treatise on foods, in which he dealt with gelatin, and expressed opinions that have pretty much held their ground since, and only been confirmed in detail by subsequent investigators. Large quantities of gelatin, he says, are detrimental to digestion. In moderate quantity it gets decomposed in the body, and acts as a food probably by diminishing the otherwise necessary amount of albumen, the sole use of which, he remarks, is not merely to form tissues. In 1860 Bischoff and Voit published the result of their experiments on the subject, which completely established the fact that gelatin can take the place of albumen to a limited extent, in a way that fat cannot, so that the body-weight maintains itself on a smaller supply of albumen and that gelatin has a function therefore of a higher character than a mere heat-producer like starch and sugar. In a more recent memoir by Voit, from which the previous historical sketch is mostly borrowed (*Zeitschrift für Biologie*, viii., 1872), the results of an extensive series of careful experiments are given, in which the same conclusion comes out. He finds, moreover, that the saving of albumen is even more marked when a moderate amount of fat accompanies the gelatin, but that no combination of fat and gelatin can replace albumen or prevent the animal from losing flesh; but, on the contrary, when a dog was fed on equal parts of gelatin and fat it lost more flesh than when fed on gelatin alone. Fed on gelatin alone, it after a time evinced such a repugnance to the food that it would rather starve than feed; and, if it was induced to eat, vomiting and diarrhœa were the results. The time which gelatin takes for its complete metamorphosis in the body is far less than in the case of albumen, never exceeding 24 hours, in the course of which time all its nitrogen may be found in the urine and fæces.

A parallel series of experiments to determine how far gelatin could replace fats or carbohydrates in food showed that, though it could not be substituted for them to any large extent, it does somewhat diminish the amount of fat used up. As Voit puts it at the end of his paper, gelatin cannot, any more than fats or carbohydrates, take the place of that moiety of albumen which he calls the organic albumen,—the part which goes to build the organs and tissues; it cannot produce new blood-corpuscles to replace those that are worn out, or form muscles or any tissues, not even the gelatigenous. What it is capable of doing is to act as a substitute to some extent for that other and far larger part of the albumen of food which, never at any time forming part of any organ, circulates in the blood, and is carried to all the tissues, undergoing continual metamorphoses.

A later series of experiments by Etzinger, a pupil of Voit, was undertaken in order to elucidate the action of the digestive fluids on gelatin or gelatigenous tissue. Direct experiments showed that these substances are scarcely altered by prolonged contact with a dilute (0·3 per cent.) solution of hydrochloric acid at the ordinary temperature of the body. But when gelatin or tissues yielding it, such as *ligamentum nuchæ*, tendons, and bones were treated at the same temperature with an artificial gastric juice made by acidifying with acid of the above strength glycerin extract of pigs' stomach, a large quantity of these substances speedily disappeared to form a solution which did not gelatinize. The solution thus obtained exhibits physical and chemical characters so analogous to those of the peptones formed by a similar process from albuminoids that it has been called by some authors *gelatin-peptone*.

In a quite recent research by Hofmeister (*Zeitschrift für Physiol. Chem.*, ii. [5] 299, 1878) an attempt has been made to study the product formed in this digestion transformation. Taking the soluble gelatin obtained by prolonged boiling of gelatin in water to be the same material as is produced by the action of gastric juice, the author found that from the solutions so obtained two distinct substances could be separated, one precipitable by perchloride of platinum, which he calls *semiglutin*, and the other not so precipitable, and also more soluble in alcohol, which he calls *hemicollin*. Semiglutin forms definite salts with platinum and copper, analyses of which agree pretty well with the formula $C_{55}H_{85}N_{17}O_{22}$ as the simplest expression for the substance. Similarly the copper-salt of hemicollin gave results indicating for hemicollin a formula $C_{47}H_{70}N_{14}O_{19}$. Both of these substances yield leucin and glycocoll when treated by boiling with hydrochloric acid and stannous

chloride. Further, this author states that, according to his analyses, collagen differs from gelatin by one molecule of water, and from the sum of the molecules of semiglutin and hemicollin by three molecules of water, so that a probable empirical formula for gelatin would be $C_{102}H_{151}N_{31}O_{39}$, agreeing pretty fairly with the percentage numbers given in an earlier part of this article.[1]

[1] See Hoppe-Seyler, *Medicinisch-Chemische Untersuchungen*, 1866 and 1871, and his *Physiologische Chemie*, just being published; Gmelin's *Handbook*, vol. xviii., 1871; Watts's *Dictionary of Chemistry*, vol. ii. For the digestion of gelatin, see Carl Voit, *Zeitschrift für Biologie*, viii. 297, 1872; Etzinger, same work, x. 84, 1874; and for constitution of collagen, Hofmeister, *Zeitsch. für Physiol. Chemie*, ii. [5] 299, 1878. (D. C. R.)

Industrial Relations of Gelatin.

Glue.—Glue is a form of gelatin, which, on account of its impure condition, is employed only as an adhesive medium for wood, leather, paper, and like substances. There is, however, no absolute distinction between glue and gelatin, as they merge into each other by imperceptible degrees; and although the dark-coloured varieties of gelatin which are known as ordinary glue are in no case treated as food, yet for several purposes the fine transparent kinds, prepared chiefly for culinary use, are employed also as adhesive agents. Neither again, except in respect of its source, is there any chemical or physical distinction between these two substances and isinglass or fish glue, and therefore the preparation and industrial applications of these three varieties of commercial gelatin—glue, gelatin, and isinglass—will be here noticed.

The gelatin-yielding substances in the animal kingdom are very numerous, comprising the skins of all animals, tendons, intestines, bladders and fish sounds, bones, horns, and hoofs. Chondrin, the substance yielded by cartilaginous tissue, which is simply an impure variety of gelatin (see above), has greatly inferior power of adhesion. In the preparation of ordinary glue the materials used are the parings and cuttings of hides from tan-yards, the ears of oxen and sheep, the skins of rabbits, hares, cats, dogs, and other animals, the parings of tawed leather, parchment, and old gloves, and many other miscellaneous scraps of animal matter. Taking tan-yard refuse to be the principal material, it is first steeped for some weeks in a pit with lime water, and afterwards carefully dried and stored. The object of the lime steeping is to remove any blood and flesh which may be attached to the skin, and to form a lime soap with the fatty matter it contains. So prepared the "scrows" or glue pieces, as they are termed, may be kept a long time without undergoing change. Before being boiled, the glue pieces are thoroughly washed. They are then placed in hemp nets and introduced into an open boiler, which has a false bottom, and a tap by which liquid may be run off. The boiler is heated by direct firing, a series of boilers being arranged in the manner best fitted to obtain the greatest possible heating effect from one fire. As the boiling proceeds test quantities of liquid are from time to time examined and when a sample is found on cooling to form a stiff jelly, it is ready to draw off. Usually the first boiling occupies about eight hours, and when the liquid has been drawn off, more water is added and the boiling process repeated. In this way the gelatinous matter is only exhausted after six separate boilings, occupying about two days, the last boiling yielding a darker-coloured glue than the first. It is essential that the boiling out of a charge should not be continued longer than is necessary for yielding a sufficiently stiff gelatinous solution, as it is found that, when the liquid is long exposed to a heat at or above boiling point, the gelatin loses its power of congealing. From the boiler the sufficiently concentrated solution is run to a tank or "setting back," in which a temperature sufficient to keep it fluid is maintained, and in this way any impurity is permitted to subside. The glue solution is then run into wooden troughs or coolers about 6 feet long by 2 feet broad and 1 foot deep, in which it sets to a firm jelly. When set, a little water is run over its surface, and with knives of suitable form it is detached from the sides and bottom, cut into uniform slices about an inch thick, and squares of these are placed on nets stretched between upright wooden frames or hurdles for drying. The drying operation, which requires very special care, is best done in the open air; the plastic masses must, however, be protected from rain. Frost and strong dry heat are equally injurious, and the best results are obtained in spring and autumn weather, when the glue dries in from twelve to eighteen days. When the pieces have become quite hard and sonorous, they are washed to remove dust from their surface, and to give them a glazed or polished appearance. A good quality of glue should be free from all specks and grit, and ought to have a uniform, light brownish-yellow, transparent appearance, and it should break with a glassy fracture. Steeped for some time in cold water it softens and swells up without dissolving, and when again dried it ought to resume its original properties. Under the influence of heat it entirely dissolves in water, forming a thin syrupy fluid with a not disagreeable smell. The adhesiveness of different qualities of glue, on which quality its value depends, differs considerably; and there are several methods of measuring the comparative value of commercial samples, the most reliable of which are based on actual experiment. Glue is also made from bones by first boiling them to remove the fatty matter they contain, and then treating them with strong hydrochloric acid till they become quite soft and translucent. In this condition, after they are washed and the acid neutralized, they are enclosed in a covered vessel and submitted to the action of steam, by which a concentrated gelatinous solution is first obtained. At a subsequent stage the whole mass is boiled by direct heat, and a further quantity of glue is so procured. The glue yielded by bones has a milky hue, owing to the phosphate of lime it carries with it

Commercial Gelatin.—Gelatin, as a commercial product, is prepared in a manner similar to that followed in the manufacture of glue; but the materials used are selected with great attention to purity, and the various operations are carried out with the most scrupulous care and cleanlines. In the manufacture of the well-known sparkling gelatin of Messrs Cox of Gorgie, near Edinburgh, the following is the process followed, according to their patent obtained in 1844. The shoulders and cheeks of ox-hides are preferred, but other parts may be used. The hide and skin pieces are cleansed in water, cut in small ieces by a machine, and reduced to pulp in a pulp mill. The pulp is pressed between rollers, mixed with water, and then subjected to heat varying from 150° to 212° F., whereby gelatin is produced. When a very pure quality is required, liquid gelatin is mixed with a small quantity of ox blood at a temperature not exceeding 160° or 170°, and further heated. The albumen of the blood becomes coagulated, and rises as a scum; the heat is then withdrawn, after which the scum is removed and the purer liquor allowed to settle, and afterwards it is run into coolers to congeal and dry. The gelatin is evaporated *in vacuo* to avoid the injury caused by long subjection to heat; but it may also be dried on a steam-heated surface. In Nelson's process the gelatin is extracted by steam heat from hide pieces which have been submitted to the bleaching action of sulphurous acid. The strained and purified product is spread in a thin layer on a marble slab till it partly solidifies, when it is cut up and washed to free it from all traces of acid. It is again redissolved at the lowest possible temperature, then resolidified and dried in thin sheets on nets. Heuze of Berlin prepares a pure transparent gelatin, having a fine meaty flavour, from very impure materials, by intimately mixing with the hot solution of impure dark-coloured gelatinous material a mixture of wood charcoal and animal charcoal, leaving the whole together for some hours, then redissolving and straining off the clarified gelatin.

Isinglass.—Isinglass or fish glue, in its raw state, is the swimming-bladder or sound of various species of fish. The sounds undergo no other preparation than careful drying, but in the drying they are variously treated and made up, so that the isinglass comes into commerce under the names of "leaf," "staple," "book," "pipe," "lump," "honeycomb," and other designations, according to its form. The finest isinglass, which comes from Russia, is prepared by cutting open the sounds, steeping them in water till the outer membrane separates from the inner, then washing the latter and exposing it to dry in the air. Russian isinglass is obtained from several species of sturgeon (*Acipenser*), found in the Volga and other tributaries of the Caspian Sea, in the Black Sea, and in the Arctic Ocean. Brazilian isinglass, obtained from Brazil and Guiana, is the produce of a large fish, *Silurus parkerii*, and probably some other species; and Manila and East Indian isinglass are yielded by species of fish not yet satisfactorily determined. The sounds of the common cod, the hake, and other *Gadidæ* are also used as a kind of isinglass. The principal uses to which isinglass is applied are for jellies and confections, and as a clarifying or filtering medium for wine, beer, and other liquids. When used for culinary and confectionery purposes, isinglass is rolled into thin sheets and cut into fine shreds to facilitate its solution. For clarifying liquids its fibrous structure is of great value, as it forms a fine network in the liquid in which it is disseminated, and thereby mechanically carries down all the minute particles which render the liquid thick and turbid. Isinglass dissolved in strong acetic acid forms a powerful cement, much used for repairing glass, pottery, and similar small objects.

Uses of Gelatin.—The gelatin derivable from bones enters very largely into human food, in the stock for soups, &c., and as prepared gelatin, "calves foot jelly," and isinglass. In addition to the uses already alluded to, gelatin has many other applications in the arts. It is employed as a sizing agent in paper-making, and by painters it is also used for sizing or priming, and for preparing tempera colours. Further, it is used in the preparation of elastic moulds of undercut work, and in the manufacture of inking rollers for printing. Gelatin treated with bichromate of potash, under the influence of light, undergoes a remarkable chemical and physical change, whereby it is rendered entirely inabsorbent of and insoluble by water. The change is due to the oxidizing effect of the bichromate; and the circumstance has given rise to the numerous so-called carbon-processes introduced into photography by Swan, Johnson, Woodbury, Albert, Edwards, and others, in all of which an image is produced in gelatin oxidized by chromium compounds. An insoluble glue may be prepared by adding to dissolved glue, just before using, a proportion of a solution of bichromate of potash, and such a preparation forms a useful waterproofing medium. Glue may be kept liquid at ordinary temperatures by the addition of concentrated acetic acid or of weak nitric acid. Dumoulin's liquid glue, which possesses powerful adhesive properties, is composed of glue in the proportion of 2 ℔ dissolved in 1 quart of water with 7 oz. of nitric acid (sp. gr. 1·335) added. Mouth or lip glue is prepared by adding $\frac{1}{2}$ ℔ or thereby of sugar to each pound of dissolved glue. It forms solid but easily dissolved cakes, and as it can be sufficiently softened by the tongue, it is for many purposes extremely convenient. Transparent gelatin, brightly coloured by dyeing substances, and cast in excessively thin sheets, is largely used for ornamental wrappings for bon-bons, &c.

Various adhesive but non-gelatinous substances are, on account of their properties, known commercially as glue, and are used as substitutes for ordinary glue. Thus marine glue, employed in shipbuilding and for other purposes, is a compound of india-rubber and shell-lac dissolved in coal-tar naphtha. Glue substitutes are also prepared from the albuminoids casein and gluten, but they are not likely to become substances of any considerable commercial importance. (J. PA.)

GELDERLAND, GELDERN. See GUELDERLAND, GUELDERS.

GELÉE, CLAUDE. See CLAUDE OF LORRAINE.

GELL, SIR WILLIAM (1777–1836), classical scholar and antiquarian, was born at Hopton in Derbyshire in 1777. After the usual preliminary education, he entered Emmanuel College, Cambridge, taking his B.A. degree in 1798, and afterwards becoming a fellow. About the beginning of the century he was sent on a diplomatic mission to Greece; and on his return in 1803 he was knighted. In the following year he published his *Topography of Troy and its Vicinity, illustrated and explained by drawings and descriptions.* His *Geography and Antiquities of Ithaca* was published in 1807. In 1810 appeared *The Itinerary of Greece, with a Commentary on Pausanias and Strabo, and an account of monuments of antiquity existing in that country.* This was followed in 1816 by the *Itinerary of the Morea, being a description of the routes of that peninsula,* a new edition of which was published in 1823, under the title of *Narrative of a Journey in the Morea.* His best known work is *Pompeiana, or Observations on the Topography, Edifices, and Ornaments of Pompeii,* in which he was assisted by Mr J. P. Gandy. The first part of this was published in 1817–19, and was translated into French in 1828; the second part appeared in 1830–31. It was followed in 1834 by the *Topography of Rome and its Vicinity.* In Italy, whither he had retired on account of his health, he became acquainted with Queen Caroline, and his noble and disinterested behaviour during her trial exhibits his moral character in a very favourable light. The queen showed her sense of his co-operation in her defence by appointing him one of her chamberlains in 1820. He died at Naples in 1836. His drawings, representing a very large series of views of classical ruins and localities, and executed, if not with much artistic skill, yet with great detail and exactness, are now in the print room of the British Museum.

GELLERT, CHRISTIAN FÜRCHTEGOTT (1715–1769), German fabulist, hymn-writer, and moral philosopher, was born 4th July 1715 at Hainchen, in the Saxon Erzgebirge. He was educated at the university of Leipsic, where in 1751 he was appointed an extraordinary professor of philosophy, a position which he occupied till his death, 13th December 1769. He wrote a romance, *Leben der schwed. Gräfin von G . . .* (2 vols., Leipsic, 1746), of little value, and several pastorals and comedies of, if possible, even less. His best works were his *Fabeln und Erzählungen* and *Geistliche Oden und Lieder.* Both are marked by a simple and easy directness of style. The latter express the maxims of a liberal piety, and were received by Catholics and Protestants with equal favour. They are still widely popular in Germany. The best known is the hymn entitled "Die Ehre Gottes aus der Natur." Not a little of Gellert's fame is due to the time when he lived and wrote. The German literature of the period was dominated by the pedant Gottsched and his school. A band of high-spirited youths, of whom Gellert was one, resolved to free themselves from the conventional trammels of such dictators, and began that revolution which was finally consummated by Schiller and Goethe. Gellert's share in the attempt was enhanced by the excellence of his personal character, his gentle piety, and his singular knack of gaining the reverence and love of young people. Part of his influence was also doubtless attributable to his position as a professor, and to his widely popular lectures.

See Gellert's *Sämmtliche Werke* (first edition, 10 vols., Leipsic, 1769–74, last edition, Berlin, 1867). His *Sämmtliche Fabeln und Erzählungen* and his *Geistliche Oden und Lieder* have often been published separately; the latest editions being those of Leipsic, 1874, and Berlin, 1873. See translation by J. A. Murke, Gellert's *Fables and other Poems* (London, 1851). Lives of Gellert have been written by J. A. Cramer (Leipsic, 1774) and by Döring (2 vols., Leipsic, 1833).

GELLIUS, AULUS, author of the *Noctes Atticæ,* was born in the first half of the 2d century of the Christian era, most probably in Rome, and died about 180. Nothing is known of his personal history except from incidental notices in his own book. He studied grammar and rhetoric at Rome and philosophy at Athens, after which he returned to Rome, and held there a judicial office. His only work, the *Noctes Atticæ,* takes its name from having been begun during the long nights of a winter which he spent in Attica. He afterwards continued it at Rome. It is compiled out of an "Adversaria," or common-place book, in which he had jotted down everything of unusual interest that he heard in conversation or read in books, and it comprises notes on grammar, geometry, philosophy, history, and almost every other branch of knowledge. The work, which is utterly devoid of sequence or arrangement, is divided into twenty books. All these have come down to us except the eighth, of which nothing remains but the index. The *Noctes Atticæ* is valuable for the insight it affords into the nature of the society and pursuits of those times, and for the numerous excerpts it contains from the works of lost ancient authors.

The *editio princeps* of Aulus Gellius appeared at Rome in 1469, and was speedily followed by many others in various cities of Italy, especially Venice. The best editions are those of Gronovius (Leyden, 1706), Lion (Göttingen, 1824–1825), and Hertz (Leipsic, 1853). Aulus Gellius has been translated into English by Beloe (London, 1795); into French by the Abbé de Verteuil (Paris, 1776–89), and by Victor Verger (Paris, 1820–30); into German by Walterstern (Lemberg, 1785), and by Weiss, 2 vols. (Leipsic, 1875–76).

GELON, succeeded Hippocrates as tyrant of Gela in 491 B.C., and, by supporting the plebs of Syracuse in their quarrels against the aristocracy, became tyrant also of that city in 485 B.C. He used his power so discreetly that under him Syracuse attained an extraordinary degree of wealth and influence. The great event in Gelon's subsequent history was his defeat of the Carthaginians under Hamilcar at Himera, according to tradition on the same day that the Greeks defeated Xerxes at Salamis, 480 B.C., the result of his victory being that he obtained the lordship of the whole of Sicily. After Gelon had thus established his power, he made a show of resigning it; but his proposal was rejected by the multitude, and he reigned without opposition till his death 478 B.C. His memory was held in such respect that, 150 years after his death, when Timoleon was erasing from Sicily every vestige of the tyrants that had once reigned there, he spared the statues of Gelon. See SYRACUSE.

GELSEMIUM, a drug, consisting of the root of *Gelsemium* (or as sometimes less correctly called *Gelseminum*) *sempervirens,* a climbing shrub of the natural order *Loganiaceæ,* having a milky juice, opposite, lanceolate shining leaves, and axillary clusters of from one to five large, funnel-shaped, very fragrant yellow flowers, whose perfume has been compared to that of the wallflower. The fruit is composed of two separable jointed follicles, containing numerous flat-winged seeds. The stem often runs underground for a considerable distance, and indiscriminately with the root it is used in medicine. The plant is a native of the United States, growing on rich clay soil by the side of streams near the coast, from Virginia to the south of Florida. In the United States it is commonly known as the wild, yellow, or Carolina jessamine, although in no way related to the true jessamines, which belong to the *Oleaceæ.* It was first described in 1640 by John Parkinson, who grew it in his garden from seed sent by Tradescant from Virginia; at the present time it is but rarely seen, even in botanical gardens, in Great Britain.

The root, on analysis by Kollock in 1855, was found to contain an alkaloid (now called *Gelsemine* or *Gelsemia*), a dry acrid resin, $\frac{1}{2}$ per cent. of a volatile oil heavier than water, fatty resin, fixed oil, yellow colouring matter, gallic acid, starch, albumen, gum, pectic acid, extractive matter, lignin, and 3·17 per cent. of mineral matter, consisting chiefly of salts of potassium, calcium, magnesium, iron, and silica. The leaves and flowers were found to contain the same ingredients in less quantity. Eberle, who examined the root in 1869, states that the central woody portion of the root does not contain any alkaloid, and that therefore the bark is the physiologically active portion. In addition to the above, Wormley, in 1870, discovered in the root a crystalline substance named by him gelseminic acid, whose solution in alkalies exhibits a powerful blue fluorescence. It has, however, since been shown by Sonnenschein to be identical with æsculin, a crystalline glucoside found in the bark of the horse chesnut, *Æsculus Hippocastanum.* The active properties of gelsemium root have been proved by Wormley and Bartholow to depend upon the alkaloid *gelsemine* ($C_{11}H_{19}NO_2$), which in the pure state is a colourless, odourless solid, not yet obtained in a crystalline form, readily soluble in ether and chloroform, less so in alcohol, and very sparingly in water, except in the presence of hydrochloric acid, and having an intensely persistent bitter taste, perceptible in a solution containing only $\frac{1}{1000}$th part of it by weight.

The readiest and best test for gelsemine, detecting the smallest traces, appears to be the cherry-red colour developed when ceroso-ceric oxide is added to its solution in concentrated sulphuric acid. The dose of the alkaloid is from $\frac{1}{80}$th to $\frac{1}{20}$th of a grain; larger quantities are poisonous, $\frac{1}{8}$th of a grain having proved fatal in an hour and a half to a strong cat.

The pharmaceutical preparation known as gelsemin consists chiefly of the resin, combined with uncertain proportions of the other constituents of the root, and is prepared by precipitation with water from the strong tincture.

The medicinal properties of the root were discovered by accident, the infusion having been administered instead of that of some other root, with the result of curing the fever for which it was taken. It was then experimented upon by the American eclectic practitioners. In 1852 Professor W. Proctor called the attention of the medical profession to its valuable properties; and in 1864 it was placed on approval in the secondary list, and in 1873, so rapidly had it risen in favour, in the primary list of remedies of acknowledged value in the United States pharmacopœia. It has latterly attracted considerable attention in England as a remedy for certain forms of facial neuralgia, especially those arising from decayed teeth, or involving branches of the fifth nerve. In the United States it is more particularly valued for controlling nervous irritability in fevers of a malarial type, in which it is said to excel every other known agent. The physiological action of the drug has been carefully examined by Bartholow, Ott, and Ringer and Murrell, from whose investigations it appears that it has a paralysing action on the motor centres, affecting successively the third, fifth, and sixth nerves, its fatal action being due to its causing paralysis of the respiratory muscles, and thus producing death by asphyxia. In large doses it produces alarming symptoms, which occasionally terminate fatally. These appear to vary slightly in different cases, but the more prominent are pain in the forehead and in the eyeballs, giddiness, ptosis, a feeling of lightness in the tongue slurred pronunciation, laboured respiration, wide dilatation of the pupils, and impossibility of keeping an erect posture. The mind in most cases remains clear until shortly before death. The earliest and most prominent symptom of a fatal or dangerous dose is the drooping of the eyelids, which indicates the immediate administration of stimulants, for when the paralysis of the tongue which ensues extends to the epiglottis, deglutition becomes impossible, and the epiglottis is apt, unless the sufferer be placed in a forward position to flap back and close the windpipe. The antidotes which have been found the most successful are carbonate of ammonia, brandy, aromatic spirits of ammonia, and morphia. It has been found that death may be averted by keeping up artificial respiration until the poison is eliminated by the kidneys.

See *Eclectic Dispensatory*, p. 186; *Pharm. Journ.*, 3d ser., vol. vi.; by Ringer and Murrell, &c. in *Lancet*, 1873, 1875–78; Hales, *New Remedies*, p. 390; Bartholow, *Materia Medica*, p. 380; *American Journ. Pharm.*, 1855, 1870; *Proc. Amer. Pharm. Assoc.*, 1873, p. 652; *Practitioner*, 1870, p. 202; Grover Coe, *Positive Medical Agents*, p. 114; Hughes, *Pharmacodynamy*, vol. i. p. 372; Sonnenschein, *Berichte der deutsch. chem. Ges.*, xi. 1182; Bentley and Trimen, *Med. Plants*, pt. xix. No. 181.

GEMINIANI, Francesco (*c.* 1680–1762), a celebrated violinist, born at Lucca about 1680. He received lessons in music from Alessandro Scarlatti, and studied the violin under Lunati, and afterwards under Corelli. In 1714 he arrived in London, where his performance and compositions attracted much attention. He was taken under the special protection of the earl of Essex. After visiting Paris and residing there for some time, he returned to England in 1755. In 1761 he went to Dublin, where a servant robbed him of a musical manuscript on which he had bestowed much time and labour. His vexation at this loss is said to have hastened his death, which took place at Dublin on 17th September 1762. He appears to have been a first-rate violinist, but most of his compositions are dry and deficient in melody. His *Art of Playing the Violin* is a good work of its kind, but his *Guida Armonica* is a miserable production. He published a number of solos for the violin, three sets of violin concertos, twelve violin trios, *The Art of Accompaniment on the Harpsichord, Organ, &c.*, *Lessons for the Harpsichord*, and some other works. His musical opinions had no foundation in truth or principle.

GEMISTUS, or PLETHO, Georgius, held high office under the Byzantine emperors during the first half of the 15th century, and derived his name, which signifies the Replete, from the extraordinary amount of his erudition. He is, however, chiefly memorable for having been the first person who introduced Plato to the Western world. This took place upon his visit to Florence in 1438, as one of the deputies from Constantinople on occasion of the general council. Cardinal Bessarion became his disciple; he produced a great impression upon Cosmo de' Medici; and though not himself making any very important contribution to the study of Plato, he effectually shook the exclusive domination which Aristotle had exercised over European thought for eight centuries. He promoted the union of the Greek and Latin Churches as far as possible, but his efforts in this direction bore no permanent fruit. He probably died before the capture of Constantinople. The most important of his published works are a treatise on the distinction between Plato and Aristotle as philosophers, and one on the religion of Zoroaster. In addition to these he compiled several volumes of excerpts from ancient authors, and wrote a number of works on geography, music, and other subjects, many of which still exist in MS. in various European libraries.

GEMS (*ψῆφοι*, gemmæ), engraved with designs, whether adapted for sealing (*σφραγίς*, sigillum, intaglio), or mainly for artistic effect (imagines ectypæ, cameo), exist in a very large number of undoubtedly genuine examples, extending from the mists of Babylonian antiquity to the decline of Roman civilization, and again starting with a new but unnatural impulse on the revival of art. Apart from workmanship they possess the charms of colour deep, rich, and varied, of material unequalled for its endurance, and of scarcity which in many instances has been enhanced by the strangeness of the lands whence they came, or the fortuity of their occurrence. These qualities united within the small compass of a gem were precisely such as were required in a seal as a thing of constant use, so inalienable in its possession as to become naturally a personal ornament and an attractive medium of artistic skill, no less than the centre of traditions or of religious and legendary associations. As regards the nations of classical antiquity all seals are classed as gems, though in many cases the material is not such as would strictly come under that heading. On the other hand, gems properly so called were not always seals. Many of the Babylonian cylinders could not have been so employed without great difficulty, and when Herodotus (i. 195) speaks of every Babylonian wearing a seal (*σφρηγίς*), it may have been in most cases no other than a talisman having an inherent power derived from the subject of its design, consisting perhaps mostly of figures of protecting deities. He adds that every Babylonian carried also a staff on which it was unlawful for him not to have the figure of an apple, a rose, a lily, an eagle, or something else, as his badge or *ἐπίσημον*, from which it may perhaps be inferred that having selected some such badge for his staff he would necessarily have the same for the seal with which he attested his name. But if that had been the case, then the great mass of existing cylinders could not have been seals in the ordinary sense. In Greece and Rome within historic times, gems were worn engraved with designs to show that the bearer was an adherent of a particular worship, the follower of a certain philosopher, or the attached subject of an emperor. It cannot be said that these gems may not have been used systematically as seals, but it is clear that they primarily served a different purpose. Again, when the sense of personal ornament naturally attaching to a seal increased, and the resources both of material and skill were enlarged, the process of engraving gems in cameo, that is, with the design in relief mostly in such stones as by their differently coloured layers could be made to present a variety of surfaces, came largely into fashion (see article Cameo, and figs. 18, 19 in Plate I.). As a rule these cameos are of a date subsequent to that of Alexander the Great; but there are exceptions in an Egyptian cameo in the Louvre, said to belong to the 12th dynasty, about 3000 B.C., and in some few Etruscan scarabs, which having designs in intaglio on the face have also reliefs engraved on the back, apparently in the same archaic manner of art as the intaglios. Such a scarab in carnelian was found at Orvieto in 1874 in a tomb along with vases dating from the beginning of the 5th century B.C., and it will be seen from the engraving of this gem (*Archäol. Zeit.*, 1877, pl. xi., fig. 3, compare figure of Siren on back of scarab engraved in Wieseler, *Denkmäler der alten Kunst*, No. 752) that, while the design on the face presents evidently the same subject which occurs on a scaraboid found in the treasury of Curium in Cyprus by General Cesnola (see his *Cyprus*, pl. xxxix., fig. 5, p. 381), the half-length figure of a Gorgon on the back seems to be the same in subject and treatment as a carnelian fragment, apparently cut from the back of a scaraboid, now in the British Museum. As further examples of the same rare form of cameo, the following scaraboids in the British Museum may be mentioned:—(1) a carnelian cut from back of a scaraboid, with head of Gorgon surrounded by wings; (2) carnelian scaraboid: Gorgon running to left, on face of gem an intaglio of Thetis giving armour to Achilles; (3) carnelian scaraboid:

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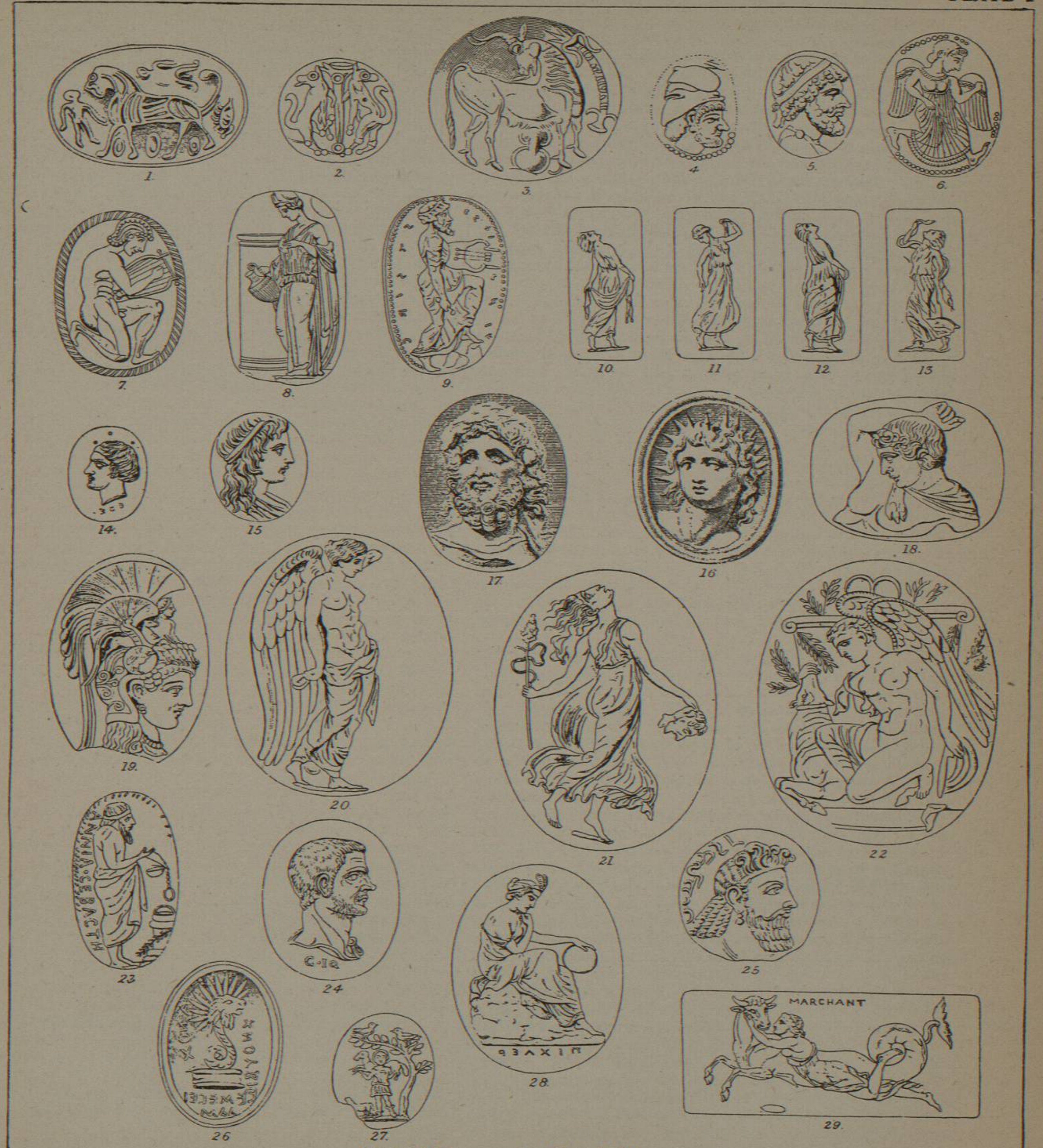

Engraved Gems in the British Museum

Matt. W. Webb del. ENCYCLOPÆDIA BRITANNICA, NINTH EDITION Eng'd by Leopold Lowenstam