ports was 81,450 dollars, of domestic exports 36,172 dollars, and of foreign exports 384 dollars. Steamers ply daily between the city and Boston. There are a number of manufactories connected chiefly with the fisheries, and in the neighbourhood there are extensive granite quarries. Gloucester possesses a fine city hall, a high school, seven grammar schools, and a free library. On account of its attractive situation, and the fine scenery of the neighbourhood, it is a favourite summer residence. About 2 miles from it is Norman's Woe, the scene of the wreck of the "Hesperus," celebrated in Longfellow's poem.

Gloucester received its name from the fact that many of its early settlers came from the county of Gloucester in England. It was occupied as a fishing station in 1624, was incorporated as a town in 1642, and was made a city in 1874. It was attacked by the English in 1775 and in 1814, in both cases unsuccessfully. The population in 1800 was 5313; in 1850, 7786; in 1860, 10,904; and in 1870, 15,389, of whom 4007 were foreigners.

GLOUCESTER, Robert of. See Robert of Gloucester.

GLOVE (Saxon *glof*), a covering for the hand, with a separate sheath for each finger. Among our ancestors, to throw down the glove or gauntlet was equivalent to a challenge to single combat, and the person thus defied signified his acceptance of the challenge by taking up the glove, and casting down his own,—which ceremony was regarded as a mutual compact to meet at the time and place specified. This custom, according to Favyn (*Théâtre d'Honneur et de Chevalerie*), was derived from the Oriental mode of contracting sales of land and the like by giving the purchaser a glove, by way of delivery or investiture; and to this effect he quotes Ruth iv. 7 and Psa. cviii. 9, passages where the word commonly translated "shoe" is by some rendered "glove." Du Cange quotes from a charter of the 13th century an instance of re-investiture or restitution symbolized by the person depositing his glove on the earth. The use of gloves is of high antiquity. There is reason to believe the ancient Persians wore them, since it is mentioned in the *Cyropædia* of Xenophon that on one occasion Cyrus went without his gloves; and we know that some kind of protecting coverings for the hands were used by the Greeks and Romans in certain kinds of manual labour, although their precise form is unknown.

The word *gantus*, used for a glove in mediæval Latin, is obviously of Teutonic derivation. In the life of St Columbanus, written by Jonas, abbot of Bobbio, in the 7th century, gloves for protecting the hands in manual labour are spoken of as "tegumenta manuum quæ Galli *wantos* vocant." A pair of gloves are mentioned in the will of Bishop Ricul-fus, who died 915 A.D. Gloves did not become articles of ecclesiastical vestment till the 12th century. They do not appear in the Bayeux tapestry, and they did not come into general use in England till the 13th century. Matthew Paris, noticing the burial of Henry II. (1189), mentions that he was buried in his coronation robes, with a golden crown on his head and gloves on his hands. Gloves were also found on the hands of King John when his tomb was opened in 1797, and on the hands of Edward I. when his tomb was opened in 1774. In the 14th century they were in common use among the better classes. In the 16th century they were frequently embroidered with great elaboration, and in the reign of Charles II. the short sleeves of the ladies' dresses brought in long gloves reaching almost to the elbow. It is an old custom in England that a pair of gloves are given by the sheriff to the judge who presides at a maiden assize; and in Scotland white gloves are given to the judges on a maiden circuit,—that is, when there are no cases for trial.

The manufacture of gloves was early introduced into the British Islands, and such was the dignity of the craft that, as early as the reign of King Robert III., the incorporation of glovers of Perth was chartered—a wealthy guild still existing, although the calling has long ceased to characterize that town. The glovers' company of London received armorial bearings as early as 1464, but the body was not chartered till 1638; and in Worcester, which has long been the principal British centre of the trade, a company was incorporated in 1661.

The glove industry of the present day is both extensive and diversified, seeing that gloves are now almost universally worn, and made of various classes of material and in several different ways. Of yarn, thread, silk, and cloth gloves it is unnecessary to speak, as these varieties are, in comparison with leather gloves, of comparatively little importance. The leather employed by glovers is prepared from the skins of deer, sheep and lambs, goats and kids—the last being by far the most important. The skins are prepared either by the ordinary processes of shamoying for wash-leather and doe or buck leather gloves, or by a special method of tawing in the case of ordinary dress gloves. The kid-skins are principally collected by hawkers in the South European countries, and sold in the Leipsic and Naples fairs. The tawing industry is conducted on a great scale at Annonay, Paris, and Milhau in France. The tawing process differs from ordinary tanning in the greater care and cleanliness of all the operations, in the submission of the dressed skins to a brief fermentation by piling them under the influence of heat, which increases the softness and flexibility of the leather, and in tawing with a mixture of flour, the yellow of eggs, and alum. On the completion of this operation, they are stretched by hand and dried as rapidly as possible. Thereafter they are damped, placed in dozens between linen cloths, and worked about to render them soft and pliable, after which they are planed on the flesh side, dried, and again planed. They are then polished by rubbing with a heavy glass disc or other smooth substance, and dyed by brushing liquid dyes over one side. Finally they are stretched on a marble table, and smoothed with a blunt knife. From a kid skin so prepared the materials of three gloves are obtained. The skins are moistened and stretched, and the various parts are cut out by a machine having steel punches the shape and size desired. The thumb piece, the quirks and the fourchettes inserted between the fingers, and the wrist welt—the latter frequently white—are cut out separately. Machine sewing, in which a kind of button stitch is made, is to a small extent utilized in the manufacture of gloves; but the greater part of the sewing is done by hand. The pieces to be sewn together are placed in a machine between a pair of jaws, the holding edge of which is composed of fine saw teeth, between each of which the sewer passes back and forward her needle, and in this way a neat uniform stitch is secured. There are three kinds of hand-sewing in the glove trade—round sewing or ordinary glove stitch, piqué stitch, and prick seam. After sewing, the backs are stitched or tamboured, the button-hole is formed, the wrist attached, and the button sewed on, thus finishing the glove. After damping and stretching to its utmost length, the glove is ready to be stamped and put up for use.

Paris is, beyond question, the most important centre of glove-making, and for delicacy of material and beauty of workmanship the productions of some Parisian manufacturers are without any rivals; but it is at Grenoble that French gloves are most extensively manufactured. English gloves, of unfailing excellence of material and workmanship, are principally made at Worcester; and in one specialty—"dogskin" gloves made from Cape sheep-skin, having a warm tan colour—English makers have no competitors. A very large quantity of cheap but useful gloves are made at Brussels and Copenhagen. During the year 1876, 1,084,400 dozen pairs, of a value of £1,380,884, were imported into the United Kingdom from France; from Belgium there were 301,305 dozen pairs, valued at £345,174; and the total imports from all quarters amounted to 1,497,437 dozen pairs, of a value of £1,840,956. In 1878 the total imports were 1,060,040 dozen pairs, valued at £1,302,060.

Buckskin gloves are largely made in the United States, and that branch, together with a limited production of kid and other gloves, is chiefly centred in the village of Gloversville, Fulton co., N.Y. It is estimated that from about 140 separate glove factories in that village not less than two-thirds of the gloves made in the United States are sent out. Kid gloves are made to some extent in New York city.

GLOVER, Richard (1712–1785), an English poet, was born in 1712. He was the son of a London merchant, and received his education at Cheam in Surrey. While there he wrote in his sixteenth year a poem to the memory of Sir Isaac Newton, which was appended by Dr Pemberton to his *View of Newton's Philosophy*, published in 1728. Though Glover followed the business of his father, he devoted much of his attention to literary pursuits, and he acquired the reputation of being one of the best Greek scholars and most famous poets of his day. In 1737 he published an epic poem, *Leonidas*, written in celebration of the defence of Thermopylæ. As the praise of liberty formed the subject matter of the poem, it was thought to have a special reference to the politics of the time; and being warmly commended by the regent and his court, by Lord Lyttelton, and the novelist Fielding, it soon passed through several editions. Though exhibiting a well-cultivated taste and some skill in versification, it possesses, however, little poetical merit, and is totally wanting in the higher qualities of epic poetry. A continuation of the *Leonidas*, entitled *Atheniad*, subsequently appeared, but had little or no popularity. In 1739 Glover published a poem entitled *London, or the Progress of Commerce*; and in the same year, with a view to excite the nation against the Spaniards, he wrote a ballad, *Hosier's Ghost*, which is spirited and effective, and was one of the most popular of its day. He was also the author of two tragedies, *Boadicea* (1753) and *Medea* (1761), which, however, on account of their close imitation of Greek models, are unsuited for the modern stage. The success of Glover's *Leonidas* led him to take considerable interest in politics, and in 1760 he entered parliament as member for Weymouth, in which capacity his abilities as a speaker, and his knowledge of commercial questions, acquired for him considerable influence. He died in November 1785. His diary, entitled *Memoirs of a distinguished literary and political Character from* 1742 to 1757, was published in 1813. Glover is one of the reputed authors of *Junius*; but his claims—which were advocated in an *Inquiry concerning the author of the Letters of Junius, with reference to the Memoirs, &c.*, published in 1815—rest on very slight grounds.

GLOWWORM. See Coleoptera, vol. vi. p. 132.

GLUCINUM, or Beryllium (Greek γλυκύς, sweet, from the taste of its salts), is a metal related most nearly in its physical properties to zinc and mercury, symbol G, atomic weight 9·3. It occurs in the beryl and emerald, $G_3Al_2Si_6O_{18}$, or $3GO,Al_2O_3,6SiO_2$ (see vol. iii. p. 613, and vol. viii. p. 170), from which its oxide was earliest obtained by Vauquelin in 1798; also in the minerals euclase ($H_2G_2Al_2Si_2O_{10}$, or $H_2O,2GO,Al_2O_3,2SiO_2$), phenacite (G_2SiO_4), chrysoberyl (GO,Al_2O_3), gadolinite, leucophanite, and helvite. Glucinum was first obtained by Wöhler and Bussy in 1828, in an impure pulverulent form, by the fusion of its chloride with potassium; and by Debray in 1854, in the compact state, by the decomposition in an atmosphere of hydrogen of the vapour of the chloride by that of sodium (*Ann. Chim. Phys.*, ser. iii. vol. xliv. 5). Heated in air the metal oxidizes superficially, or, if in a state of fine division, burns with brilliancy. The spark-spectrum of glucinum presents two brilliant blue lines. Glucinum may be estimated in minerals, after removal of their silica, in the insoluble form or as fluoride, by the separation of aluminium mostly as alum, what remains being then thrown down, with iron, by means of warm solution of ammonium carbonate; to the filtrate excess of hydrochloric acid is added; and finally the glucinum is precipitated as hydrate, $G(OH)_2$, which is washed, dried, and ignited. An alloy of glucinum with iron has been obtained by Davy and by Stromeyer.

On the chemistry of glucinum see further vol. v. pp. 526–8 and 543; also Watts, *Dict. of Chemistry*, ii.; W. Crookes, *Select Methods in Chemical Analysis*, pp. 45, 46, 66; and Roscoe and Schorlemmer, *Treatise on Chemistry*, ii. pt. 1, pp. 231–6.

GLUCK (not, as frequently spelt, Glück), Christopher Willibald (1714–1787), a celebrated operatic composer, was born at Heidenwang, near Neumarkt, in the Upper Palatinate, on July 2, 1714. He belonged to the lower middle class, his father being gamekeeper to Prince Lobkowitz; but the boy's education was not neglected on that account. From his twelfth to his eighteenth year he frequented the Jesuit school of Kommotow in the neighbourhood of Prince Lobkowitz's estate in Bohemia, where he not only received a good general education, but also had lessons in music. At the age of eighteen Gluck went to Prague, where he continued his musical studies under Czernhorsky, and maintained himself by the exercise of his art, sometimes in the very humble capacity of fiddler at village fairs and dances. Through the introduction of Prince Lobkowitz, however, he soon gained access to the best families of the Austrian nobility, and when in 1736 he proceeded to Vienna, he was hospitably received at his protector's palace. Here he met Prince Melzi, an ardent lover of music, who invited Gluck to accompany him to Milan, where the young musician continued his education under Giovanni Battista San Martini, an interesting composer who, although self-taught, was one of the most accomplished musicians of the 18th century, and has been called the model of Haydn. His works belong chiefly to the class of chamber music. In this respect, however, the master's example was not followed by the pupil. Gluck's dramatic instinct was irrepressible, and soon we find him producing operas at the rapid rate necessitated by the omnivorous taste of the Italian public in those days. Eight of these works were produced at various Italian theatres between 1741 and 1745. Although favourably received, they were not much above the ordinary operatic level of the day, and it would be needless even to give their names. Only the first may be mentioned here, *Artaserse*, libretto by Metastasio, first performed at Milan in 1741. To the reputation thus acquired Gluck owed an invitation to London, where in 1745 he became composer for the opera house in the Haymarket. The first opera produced there was called *La Caduta dei Giganti* (1746, words by Metastasio), followed by one of his earlier operas, re-written for the purpose. It is stated that he also appeared as a performer on the musical glasses. The success of the two operas, as well as that of a so-called *pasticcio*, or dramatic medley entitled *Piramo e Tisbe*, was anything but brilliant, and Gluck accordingly left London. But his stay in England, although not accompanied by immediate success, was not without important consequences for his subsequent career. Gluck at this time was neither more nor less than an ordinary producer of Italian opera. Handel's well-known saying that Gluck knew no more counterpoint than his (Handel's) cook, whether true or not, was unfair, for the reason that, if Gluck had known as much counterpoint as the author of *Israel in Egypt* himself, it would have been difficult to make use of it in the style of music

then exclusively cultivated by him. Had the young composer been successful in the ordinary *opera seria*, there is every reason to fear that the great dramatic reform, initiated by him, would never have taken place. The critical temper of the London public fortunately averted this calamity. It may also be assumed that the musical atmosphere of the English capital, and especially the great works of Handel, were not without beneficial influence upon the young composer. But of still greater importance in this respect was a short trip to Paris, where Gluck became for the first time acquainted with the classic traditions and the declamatory style of the French opera—the future scene of his own triumphs. Of these great issues little trace, however, is to be found in the works produced by Gluck during the fifteen years after his return from England. His first opera written for Vienna, called *La Semiramide reconosciuta* (1748), is again an opera seria of the ordinary kind, and little more can be said of *Telemacco* (Rome, 1749), *La Clemenza di Tito* (Naples, 1751), and numerous occasional pieces of a more or less serious kind written for the court at Vienna, where Gluck settled permanently in 1756, having two years previously been appointed court chapel-master, with a salary of 2000 florins, by the empress Maria Theresa. On a previous occasion he had received the order of knighthood from the pope, consequent upon the successful production of two of his works in Rome. During the long interval from 1756 (the date of his opera *Il Rè Pastore*) to 1762, Gluck seems to have matured his plans for the reform of the opera; and, barring a ballet named, like Mozart's opera, *Don Giovanni*, and some *airs nouveaux* to French words with pianoforte accompaniment, no compositions of any importance have to be recorded. His *pièce d' occasion*, *Il Trionfo di Clelia*, produced at Bologna in 1762, is still written in the old manner. But his *Orfeo ed Euridice*, played in October of the same year at Vienna, shows that the composer had entered upon a new career. It is significant that in the original score the work is described as a "dramma per musica" or music-drama, the title opera seria being avoided. Gluck also for the first time had deserted Metastasio, and Raniero Calzabigi furnished the highly dramatic book of *Orpheus*. Quite apart from its significance in the history of dramatic music, *Orpheus* is a work which, by its intrinsic beauty, commands the highest admiration, and does not fail to impress an audience, even now, wherever an adequate representative of the title-part can be found. Orpheus's air, "Che faro," is known to everyone; but finer even is the great *scena* in which the poet's song softens even the *ombre sdegnose* of Tartarus. The ascending passion of the entries of the solo (Deh! placatevi; Mille pene; Men tiranne), interrupted by the harsh but gradually-softening exclamations of the Furies, is of the highest dramatic effect. These melodies, moreover, as well as every declamatory passage assigned to Orpheus, are made subservient to the purposes of dramatic characterization; that is, they could not possibly be assigned to any other person in the drama, any more than Hamlet's monologue could be spoken by Polonius. It is in this power of musically realizing a character—a power all but unknown in the opera of his day—that Gluck's genius as a dramatic composer is chiefly shown. After a short relapse into his earlier manner, Gluck followed up his *Orpheus* by a second classical music-drama named *Alceste*, and first produced in December 1767 at Vienna. In his dedication of the score to the grand-duke of Tuscany, Gluck has fully expressed his aims, as well as the reasons for his total breach with the old traditions. "I shall try," he writes, "to reduce music to its real function, that of seconding poetry by intensifying the expression of sentiments and the interest of situations without interrupting the action by needless ornament. I have accordingly taken care not to interrupt the singer in the heat of the dialogue, to wait for a tedious *ritornel*, nor do I allow him to stop on a sonorous vowel, in the middle of a phrase, in order to show the nimbleness of a beautiful voice in a long *cadenza*." Such theories, and the stern consistency with which they were carried out, were little to the taste of the pleasure-loving Viennese; and the success of *Alceste*, as well as that of *Paris and Helena*, which followed two years later, was not such as Gluck had desired and expected. He therefore eagerly accepted the chance of finding a home for his art in the centre of intellectual and more especially dramatic life, Paris. Such a chance was opened to him through M. Bailli du Rollet, attaché of the French embassy at Vienna, and a musical amateur who entered into Gluck's ideas with enthusiasm. A classic opera for the Paris stage was accordingly projected, and the friends fixed upon Racine's *Iphigénie en Aulide*. After some difficulties, overcome chiefly by the intervention of Gluck's former pupil the dauphiness Marie Antoinette, the opera was at last accepted and performed at the Académie de Musique, on April 19, 1774. The great importance of the new work was at once perceived by the musical amateurs of the French capital, and a hot controversy on the merits of *Iphigénie* ensued, in which some of the leading literary men of France took part. Amongst Gluck's opponents were not only the admirers of Italian vocalization and sweetness, but also the adherents of the earlier French school, who refused to see in Gluck the legitimate successor of Lulli and Rameau. Marmontel, Laharpe, and D'Alembert were opponents, the Abbé Arnaud and others the enthusiastic friends of the German master. Rousseau took a peculiar position in the struggle. In his early writings he is a violent partisan of Italian music, but when Gluck himself appeared as the French champion, he willingly acknowledged the great composer's genius. In a letter to Dr Burney, written shortly before his death, Rousseau gives a close and appreciative analysis of the *Alceste*, the first Italian version of which Gluck had submitted to him for suggestions; and when, on the first performance of the piece not being received favourably by the Parisian audience, the composer exclaimed, "*Alceste* est tombée," Rousseau is said to have comforted him with the flattering *bon-mot*, "Oui, mais elle est tombée du ciel." The contest received a still more personal character when Piccini, a celebrated and by no means incapable composer, came to Paris as the champion of the Italian party. Into the details of the historic battle between Gluckists and Piccinists this is not the place to enter. Volumes have been written on the subject, and the whole affair has been denounced as a sign of the frivolity of the eighteenth century. But to those interested in music and in the drama, the question whether the vocal virtuoso or the true dramatic artist should reign on the lyrical stage is by no means without importance; although, perhaps, the gentlemen of the queen's court, and their friends who applauded her countryman and protegé Gluck from "le coin de la reine," hardly looked upon the matter in so serious a light. The victory at last remained, by common consent (including, it is said, Piccini's own), with Gluck. The succession of the operas written for Paris is the following:—*Orphée et Eurydice* (the *Orfeo* rewritten), 1774; *Alceste* (also an adaptation of the earlier work, 1776); *Armide*, 1777; *Iphigénie en Tauride*, 1779. Some minor compositions, written partly by desire of the queen for the court festivals, it would be needless to mention. Gluck was engaged upon an opera *Les Danaides* when an attack of apoplexy compelled him to relinquish all thoughts of work. He left Paris for Vienna, where he lived for several years in dignified leisure, disturbed only by his declining health. He died on November 18, 1787.

To the general character of Gluck's music some allusion has already been made. He was essentially a dramatic composer, and no notice need be taken of the few works belonging to a different sphere. In connexion with its dramatic purpose his music ought always to be judged. He never was a great contrapuntist in the sense that Bach and Handel were. But neither was there much room for polyphonous display in the music-drama as he understood it. The chorus of Scythians in the second *Iphigenia* ("Il nous falloit du sang") would not gain in effect if it contained an elaborate fugue. This and other choruses in the same great work at the same time illustrate Gluck's power of rendering musically national as well as individual characteristics. As a masterly trait of psychological characterization may further be cited the accompaniment to Orestes's air, also in *Iphigénie en Tauride* ("Le calme rentre dans mon cœur"), where the unfortunate man in vain tries to find relief from the pangs of conscience, distinctly heard in the unceasing semiquavers of the orchestral accompaniment. The severe censure passed on Gluck for drowning the voices by the instruments posterity has converted into one of the composer's highest claims to fame. Not only has Gluck developed the orchestra as regards mere beauty and volume of sound, but he also has made it an important factor in the dramatic organism. Instances from the second *Iphigénie* alone might again be multiplied. The savage Scythians, for instance, are characterized by the noise of brass and percussion; while Iphigénie's simple prayer is accompanied by the strings and two oboes. The care bestowed by Gluck upon a correct and emphatic declamation of the words is another important point in his dramatic reform. Readers interested in the matter will have noticed the striking parallelism between the views and aims advocated by Gluck in the 18th century and by Wagner in the 19th century—a parallelism which may be extended to the bitter animadversions evoked by these theories amongst contemporary critics. The means, however, by which the theories were to be realized are very different in the two cases. Gluck's reform is essentially directed against the encroachments of the singer; Wagner's against those of the composer as an independent artist. Gluck, it is true, felt the necessity of a perfect unity between music and poetry, but he never intended to bring about this desirable effect by surrendering any of the strict forms of his own art. The consequence was that the poet was more than ever bound to adapt his work to the demands of the composer, and that the latter remained practically the omnipotent ruler on the operatic stage. Wagner at last has made dramatic purpose the supreme consideration to which the forms of music, as a separate art, have to submit.

An altogether satisfactory biography of Gluck remains still to be written. With regard to the life, Anton Schmid's *Chr. W. Ritter von Gluck* may be consulted. Herr Marx, in his *Gluck und die Oper*, has attempted to define the composer's position in the history of dramatic music. M. Desnoiresterres's *Gluck et Piccini* refers to the most important portion of the composer's career. For it must always be remembered that Gluck, although a German by birth, belongs as an artist to France rather than to his native country. His works form as it were the musical complement to the tragedy of Corneille and Racine. In France he was first appreciated, and in France also his traditions were continued by a school of highly gifted composers. (F. H.)

GLÜCKSTADT, a town of Prussia, in the province of Schleswig-Holstein, is situated on the right bank of the Elbe, where it receives the small river Rhin, and on the railway from Itzehoe to Elmshorn, 28 miles N.W. of Altona. It has a Protestant and a Catholic church, a synagogue, a gymnasium, a provincial prison, and a provincial penitentiary. The inhabitants are chiefly engaged in commerce and fishing; but the frequent losses from inundations has greatly retarded the prosperity of the town. It suffers at the same time from a very deficient water supply for culinary purposes.

Glückstadt was founded by Christian IV. of Denmark in 1616, and fortified in 1620. It was formerly the seat of the royal dukes of Schleswig-Holstein, who assumed from it the name of Holstein-Glückstadt. In 1627–8 it was besieged for fifteen weeks by Tilly, without success. In 1814 it was blockaded by the allies and capitulated, whereupon its fortifications were demolished. In 1830 it was made a free port. It came into the possession of Prussia along with the rest of Schleswig-Holstein in 1866. The population in 1875 was 5031.

GLUCOSE, a species of sugar, on the chemical and other properties and the occurrence and manufacture of which see articles CHEMISTRY, vol. v. pp. 564, 572; DEXTRIN and DIABETES, vol. vii. pp. 146, 147; FERMENTATION, vol. ix. pp. 93. 94. 96, 97; GALLIC ACID, vol. x. p. 41; and SUGAR.

GLUE. See GELATIN.

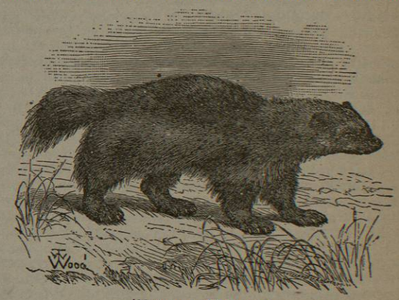
GLUKHOFF, or GLUCHOW, as the name is transliterated in German, a town of Russia, at the head of a district in the government of Tchernigoff, 132 miles E. of Tchernigoff in 51° 54′ N. lat. and 33° 35′ E. long., on the highway between Moscow and Kieff. It is situated on the sloping banks of the Yasmin, a subtributary of the Desna, which in its turn unites with the Dnieper. Among its buildings are eleven churches and two Jewish meeting-houses, a district school, an almshouse, and a hospital. In 1860 its population, mainly engaged in agricultural pursuits and petty commerce, amounted to 10,008, of whom 4998 were males; in 1873 it was 10,747; and according to the *St Petersburg Calendar* for 1878, it has increased to 13,398. The Jews in 1860 numbered 2517. About 4 miles from the town, near the village of Poloshek, there exists an extensive deposit of white clay, which supplies nearly all the porcelain factories in Russia. Glukhoff is mentioned in the Laurentian Chronicle as early as 1152. For some time it was in the hands of a branch of the ducal family of Tchernigoff, which retired before the encroachments of the Tartars in the middle of the 13th century. Before its final incorporation with Russia, it passed under the sway first of the Lithuanians and then of the Poles. On the destruction of Baturin by Peter I. in 1708, it was made the residence of the hetmans.

GLUTEN, a tough, tenacious, ductile, somewhat elastic, nearly tasteless, and greyish-yellow albuminous substance, obtained from the flour of wheat by washing in water, in which it is insoluble. In Martin's apparatus for the preparation of gluten on the large scale, balls of dough are worked backwards and forwards in troughs by means of cylinders, whilst water plays upon them in fine jets delivered by copper pipes. A sack of flour may be thus made to yield about 110 lb of moist gluten, and twice that quantity of dry starch. Good samples of white English wheat contain some 10 or 11 per cent. of gluten; from hard Venezuela wheat as much as 22·75 per cent. has been procured. The outer and inner coats of wheat, separated from it as bran, contain respectively 4 or 5 and 14 to 20 per cent. of gluten. Gluten, when dried, loses about two-thirds of its weight, becoming brittle and semi-transparent; when strongly heated it crackles and swells, and burns like feather or horn. It is soluble in strong acetic acid, and in caustic alkalies, which latter may be used for the purification of starch in which it is present. When treated with ·1 to ·2 per cent. solution of hydrochloric acid it swells up, and at length forms a liquid resembling a solution of albumin, and lævorotatory as regards polarized light. Moistened with water and exposed to the air gluten putrefies, and evolves carbon dioxide, hydrogen, and sulphuretted hydrogen, and in the end is almost entirely resolved into a liquid, which contains leucin and ammonium phosphate and acetate. On analysis gluten shows a composition of about 53 per cent. of carbon, 7 per cent. of hydrogen, and nitrogen 15 to 18 per cent., besides oxygen, and about 1 per cent. of sulphur, and a small quantity of inorganic matter. It is not a

simple substance, and according to Ritthausen consists of *glutencasein* (Liebig's vegetable fibrin), *glutenfibrin*, *gliadin* (Pflanzenleim), *glutin* or vegetable gelatin, and *mucedin*, which are all closely allied to one another in chemical composition. It is the gliadin which confers upon gluten its capacity of cohering to form elastic masses, and of separating readily from associated starch. In the so-called gluten of the flour of barley, rye, and maize, this body is absent (Kreusler and Ritthausen). The gluten yielded by wheat which has undergone fermentation or has begun to sprout is devoid of toughness and elasticity. These qualities can be restored to it by kneading with salt, lime-water, or alum. Koopmans found that a larger amount of raw gluten was digested in a relatively dilute than in a strong artificial gastric juice, the reverse holding good of albumin. From experiments on six pigs and three dogs, he came to the conclusion that the digestive fluid in the stomachs of living animals, even of the same species, dissolves unlike quantities of albumin and gluten, so that if much albumin be digested the loss of weight of gluten present with it is but small, and *vice versa* (see *Brit. and For. Med.-Chir. Rev.*, 1857, ii. pp. 318–25). Gluten is employed in the manufacture of gluten bread and biscuits for the diabetic (see DIABETES, vol. vii. p. 148), and of chocolate, and also in the adulteration of tea and coffee. For making bread it must be used fresh, as otherwise it decomposes, and does not knead well. Granulated gluten is a kind of vermicelli, made in some starch manufactories by mixing fresh gluten with twice its weight of flour, and granulating by means of a cylinder and contained stirrer, each armed with spikes, and revolving in opposite directions. The process is completed by the drying and sifting of the granules.

See H. Ritthausen, "Ueber die Bestandtheile des Weizenklebers," *Erdmann's Journ. f. praktische Chemie*, lxxxv., 1862, pp. 193–229; also *ib.*, lxxvi., 1862, pp. 257–265; and lxxviii., 1863, pp. 141–147; T. Langer, *Lehrbuch der Chemie*, pp. 361–371, Leipsic, 1878; and Payen, *Industrial Chemistry*, ed. B. H. Paul, 1878.

GLUTTON, or WOLVERENE (*Gulo luscus*), a carnivorous mammal, belonging to the *Mustelidæ* or weasel family, but differing from the typical forms of the genus *Mustela* in the greater heaviness and clumsiness of its body, presenting in this respect a striking resemblance to the bear. Its legs are short and stout, with large feet, the toes of which terminate in strong, sharp claws, considerably curved. Its mode of progression is semi-plantigrade. In size and form it is not unlike the European badger, measuring from 2 to 3 feet in length, exclusive of the thick bushy tail, which is about 8 inches long. Its head is broad, its eyes small, with defective vision, and its back arched. Its fur consists of an undergrowth of short woolly hair, mixed with long straight hairs, to the abundance and length of which on the sides and tail the creature owes its shaggy appearance. The colour of its fur is blackish-brown, with a broad band of chestnut colour stretching from the shoulders along each side of the body, the two meeting near the root of the tail; while, unlike the majority of arctic animals, the fur of the glutton in winter-time grows darker in colour. Like other weasels it is provided with anal glands, which secrete a yellowish fluid possessing a highly fœtid odour. The glutton is a boreal animal, inhabiting the northern regions of both hemispheres, but most abundant in the circumpolar area of the New World, where it occurs throughout the British provinces and Alaska, being specially numerous in the neighbourhood of the Mackenzie River, and extending southwards as far as New York and the Rocky Mountains. Many erroneous statements have been made regarding the glutton by early writers on natural history, from Olaus Magnus to Buffon, one of which has perpetuated itself in the animal's common name,—the fact being that the wolverene is not more gluttonous than are the majority of carnivorous animals. It feeds on grouse and the smaller rodents, and on foxes, which it digs from their burrows during the breeding season. Its want of activity, however, renders it dependent for most of its food on the dead carcases of animals. These it frequently obtains by methods which have made it peculiarly obnoxious to the hunter and trapper. Should the hunter, after succeeding in killing his game, leave the carcase insufficiently protected for more than a single night, the glutton, whose fear of snares is sufficient to prevent him from touching it during the first night, will, if possible, get at and devour what he can of it on the second, hiding the remainder beneath the snow. He annoys the trapper by following up his lines of marten traps, which often extend to a length of 40 or 50 miles, each of which he enters from behind, extracting the bait, pulling up the traps, and devouring or concealing the entrapped martens. So persistent is the glutton in this practice, when once it discovers a line of traps, that its extermination along the trapper's route is a necessary preliminary to the successful prosecution of his business. This is, however, no easy task, as the glutton is too cunning to be caught by the methods successfully employed on the other members of the weasel family. The trap generally used for this purpose is one made to resemble a cache, or hidden store of food, such



Glutton, or Wolverene.

as the Indians and hunters are in the habit of forming, the discovery and rifling of which is one of the glutton's most congenial occupations,—the bait, instead of being paraded as in most traps, being in this case carefully concealed, to lull the knowing beast's suspicions. One of the most prominent characteristics of the wolverene is its propensity, akin to that of certain members of the crow family, to steal and hide things, not merely food which it might afterwards need, or traps which it regards as personal enemies, but articles which cannot possibly have any interest for it except that of curiosity. An amusing instance of this is quoted by Coues in his valuable work, recently published, on the *Fur-bearing Animals of North America*, in which he says—"A hunter and his family, having left their lodge unguarded during their absence, on their return found it completely gutted—the walls were there, but nothing else. Blankets, guns, kettles, axes, cans, knives, and all the other paraphernalia of a trapper's tent had vanished, and the tracks left by the beast showed who had been the thief. The family set to work, and, by carefully following up all his paths, recovered, with some trifling exceptions, the whole of the lost property." The cunning it displays in unravelling the oftentimes complicated snares set for it forms at once the admiration and the despair of every trapper, while its great strength and ferocity render it a dangerous antagonist to animals much larger than itself, and occasionally even to man. The rutting season occurs in March, and the female, secure in her burrow, produces her young—four or five at a birth—in June or July. In defence of these she is exceedingly bold, and the Indians, according to Cowes, "have been heard to say that they would sooner encounter a she-bear with her cubs than a carcajou (the Indian name of the glutton) under the same circumstances." The wolverene has a curious habit which has not hitherto been observed in any other of the lower animals. On catching sight of its relentless human enemy, it may be observed, before finally determining on flight, sitting on its haunches, and, in order to get a clearer view of the danger, shading its eyes with one of its forepaws. When pressed for food it becomes fearless, and has then been known to come on board an ice-bound vessel, and in presence of the crew to seize on a canister of meat. The flesh of the glutton is uneatable; it is therefore only valuable for its fur, which, when several skins are sewn together, forms elegant hearth and carriage rugs.

GLYCAS, MICHAEL, a Byzantine historian, often called Siculus. The time when he flourished is very uncertain. He is justly reckoned among the better Byzantine historians on account of the terseness and perspicuity of his style. His MS. letters still extant are addressed to the last Constantine; their authenticity, however, has been questioned. His chief work is Βίβλος χρονική, divided into four parts, treating of history from the creation of the world to the death of Alexis I. Comnenus (1118). The best edition is that by J. Bekker, in the Bonn collection of the Byzantines (1836).

GLYCERIN, GLYCERINE, or GLYCEROL (in pharmacy GLYCERINUM), a sugar-like substance obtainable from most natural fatty bodies by the action of alkalies and similar reagents, whereby the fats are decomposed, water being taken up, and glycerin being formed together with the alkaline salt of some particular acid (varying with the nature of the fat). Owing to their possession of this common property, these natural fatty bodies and various artificial derivatives of glycerin, which behave in the same way when treated with alkalies, are known as *glycerides*. This decomposition into an organic acid and a substance of more or less neutral character is a typical kind of reaction with numerous classes of organic bodies, and is termed *saponification*, from the circumstance that the ordinary process of soap-making consists simply in the formation from natural fatty bodies and alkalies of the alkaline salts of the fatty acids thence derivable, soap being a mixture of these alkaline salts in various proportions, according to the particular purposes for which it is required, and its price. In the ordinary process of soap-making the complementary product, glycerin, remains dissolved in the aqueous liquors from which the soap is separated, and is usually thrown away; in many other instances, however, in which a substance capable of undergoing a reaction of saponification is thus treated, the product complementary to the alkaline salt is the more important of the two.

The fact that soap is obtainable by boiling together oily or fatty substances and alkalies (such as potashes and natron or mineral alkali) was known at an early period of history, being mentioned by Pliny, Galen, Aetius, and Paulus Ægineta. On the other hand, substances referred to in the Old Testament and translated "soap" (*e.g.*, Jeremiah ii. 22, "For though thou wash thee with nitre [properly, natron], and take thee much soap;" Malachi iii. 2, "For he is like a refiner's fire, and like fuller's soap") refer to the alkali itself (viz., *borith* = vegetable alkali, potash; or *neter* = mineral alkali, soda), and not to the substances prepared from oily bodies and these alkaline matters. Similarly Homer makes no mention of soap whilst describing the laundry operations of Nausicaa. The discovery of glycerin, however, is of modern origin, the body having been first described in 1776 by Scheele under the name of oelsüss (principe doux des huiles—sweet principle of oils), and more fully investigated subsequently by Chevreul, Berthelot, and many other chemists, from whose researches it results that glycerin is a trihydric alcohol indicated by the formula $C_3H_5(OH)_3$, the natural fats and oils, and the glycerides generally, being substances of the nature of compound ethers formed from glycerin by the replacement of the hydrogen of the OH groups by the radicals of certain acids, called for that reason "fatty acids."[1] The relationship of these glycerides to glycerin will be more conveniently shown by an example, such as the series of bodies formed from glycerin by replacement of hydrogen by "stearyl" ($C_{18}H_{35}O$), the radical of stearic acid ($C_{18}H_{35}O.OH$):—

Glycerin.	Monostearin.	Distearin.	Tristearin.
$CH_2 . OH$	$CH_2 . O(C_{18}H_{35}O)$	$CH_2 . O(C_{18}H_{35}O)$	$CH_2 . O(C_{18}H_{35}O)$
$CH . OH$	$CH . OH$	$CH . O(C_{18}H_{35}O)$	$CH . O(C_{18}H_{35}O)$
$CH_2 . OH$	$CH_2 . OH$	$CH_2 . OH$	$CH_2 . O(C_{18}H_{35}O)$

These four substances evidently form a progressive series, each number of which differs from the preceding one in the same way, viz., that one more stearyl group replaces hydrogen in the original OH groups.

The process of saponification may be viewed as the gradual progressive transformation of tristearin, or some analogously constituted substance, into distearin, monostearin, and glycerin, or as the similar transformation of a substance analogous to distearin or to monostearin into glycerin. If the reaction is brought about in presence of an alkali, the acid set free becomes transformed into the corresponding alkaline salt; but if the decomposition is effected without the presence of an alkali (*i.e.*, by means of water alone, or by an acid fluid), the acid set free and the glycerin are obtained together in a form which usually admits of their ready separation. It is noticeable that with few exceptions the fatty and oily matters occurring in nature are substances analogous to tristearin, *i.e.*, they are trebly replaced glycerins. Amongst these glycerides may be mentioned the following:—

Tristearin—$C_3H_5(O.C_{18}H_{35}O)_3$. The chief constituent of hard animal fats, such as beef and mutton tallow, &c.; also contained in many vegetable fats in smaller quantity.
Triolein—$C_3H_5(O.C_{18}H_{33}O)_3$. Largely present in olive oil and other saponifiable vegetable oils and soft fats: also present in animal fats, especially hog's lard.
Tripalmitin—$C_3H_5(O.C_{16}H_{31}O)_3$. The chief constituent of palm oil; also contained in greater or less quantities in human fat, olive oil, and other animal and vegetable fats.
Triricinolein—$C_3H_5(O.C_{18}H_{33}O_2)_3$. The main constituent of castor oil.

Other analogous glycerides are apparently contained in greater or smaller quantity in certain other oils. Thus in cows' butter, *tributyrin*, $C_3H_5(O.C_4H_7O)_3$, and the analogous glycerides of other readily volatile acids closely resembling butyric acid, are present in small quantity; the production of these acids on saponification and distillation with dilute sulphuric acid is utilized as a test of a purity of butter as sold. *Trimcetin*, $C_3H_5(O.C_2H_3O)_3$, is apparently contained in cod-liver oil. Some other glycerides isolated from natural sources are analogous in composition to tristearin, but with this difference, that the three radicals which replace hydrogen in glycerin are not all identical; thus kephalin, myelin, and lecithin are glycerides in which two hydrogens are replaced by fatty acid radicals, and the third by a complex phosphoric acid derivative. In no case, however, is the existence of a natural glyceride

[1] The name is often further extended so as to embrace other acids, analogous to the true acids of fats and oils in composition, properties, and chemical characters, but not yet found to exist in natural oils and fats.

analogous to distearin or monostearin substantiated with certainty, bodies of these classes being either formed synthetically by reversing the reactions of saponification, or being produced by the partial saponification of substances analogous to tristearin.

Glycerin is also a product of certain kinds of fermentation, especially of the alcoholic fermentation of sugar; thus it is a constituent of many wines and other fermented liquors, being formed together with small quantities of various other substances by reactions subsidiary only to the main change taking place, and hence varying in their nature and extent with circumstances. According to Pasteur, about $\frac{1}{36}$th of the sugar transformed under ordinary conditions in the fermentation of grape juice and similar saccharine liquids into alcohol and other products becomes converted into glycerin. In certain natural fatty substances, *e.g.*, palm oil, it exists in the free state, so that it can be separated by washing with boiling water, which dissolves the glycerin but not the fatty glycerides; but how far its occurrence in this form is due to the breaking up of the glyceride by a spontaneous saponification is open to some question.

Properties.—In a state of purity glycerin is a viscid, colourless liquid of sp. gr. 1·264, possessing a somewhat mawkish sweet taste; when exposed to a high degree of cold for a long time it sometimes solidifies to a crystalline mass, which then melts at about 7° C. The crystals when once melted often do not resolidify again readily, even when in contact with the solid substance, although sometimes contact with a crystal of the solid at a temperature of about 0° suffices to produce solidification of the whole. This solidification of glycerin is, however, a very exceptional phenomenon, only occurring with extremely pure substance under certain conditions not thoroughly understood, and then only after long continued exposure to a low temperature, as during a cold winter. When containing a minute quantity of water glycerin never solidifies, and to this circumstance several of its useful applications are due. A weak aqueous solution, when chilled sufficiently, allows crystals of ice to form, the glycerin accumulating in the unfrozen portion as alcohol does when a mixture of spirit and water is partially frozen. When heated alone it partially volatilizes, but the greater part decomposes; by reducing the pressure to about $\frac{1}{12}$th of an atmosphere, it can, however, be readily distilled unchanged, boiling under a pressure of 50 millimetres of mercury at about 20° C. In an atmosphere of steam, also, it distils without decomposition under ordinary barometric pressure. In water and alcohol it dissolves readily in all proportions; in ether it is insoluble. Under certain conditions, such as prolonged contact with poor cheese and chalk at about 35° to 40° C., it can be made to ferment partially, becoming changed into alcohol; but under any circumstances, only a small fraction, almost a tenth, becomes thus transformed, the rest remaining unaltered. It possesses remarkable solvent powers on many substances, whence it is employed for numerous purposes in pharmacy and the arts. Its viscid character, and its non-liability to dry and harden by exposure to air, also fit it for various other uses, such as lubrication, &c., whilst its peculiar physical characters, enabling it to blend with either aqueous or oily matters under certain circumstances, render it a useful ingredient in a large number of products of varied kinds. Applied to the living skin (and similarly to untanned leather) it produces a remarkable softening effect, whence it is largely employed as a cosmetic, either by itself or in admixture with other substances. Taken internally it is alleged to be valuable as a substitute for cod-liver oil for phthisical patients, not possessing the disagreeable fishy flavour of that valuable food, and having a fattening tendency. When it is given in moderately small repeated doses to the lower animals, it does not appear to possess any marked injurious action peculiar to itself; when, however, large doses of glycerin are subcutaneously injected into dogs, amounting to from 8 to 10 grammes per kilogramme of animal operated on (0·8 to 1·0 per cent. of the weight of the dog, corresponding to from 1 lb to 1½ lb of glycerin for the weight of an average man), death ensues within twenty-four hours, accompanied by symptoms analogous to those of acute alcoholism (Dujardin, Beaumetz, and Audigé). Like sugar it possesses antiseptic qualities, so that meat, albumin, &c., immersed in it do not for long periods of time undergo putrefactive changes.

Manufacture.—The simplest modes of preparing glycerin in a state of purity are based on the saponification of fats, either by alkalies or analogous basic substances, or by superheated steam, and on the circumstance that, although glycerin cannot be distilled by itself under the ordinary pressure without decomposition, it can be readily volatilized in a current of superheated steam; in this way the glycerin formed is separated from the non-volatile substances present. It was by means of saponification of olive oil or lard with litharge (lead oxide), whereby a lead soap insoluble in water, or nearly so, is formed, together with glycerin, that the existence of glycerin was first demonstrated by Scheele, who obtained it as a bye-product in the formation of the "lead-plaster" of pharmacy made from lard and lead oxide. For a long time this was the only known method of preparing glycerin, the aqueous solution obtained being treated with sulphuretted hydrogen to remove any soluble lead compounds, filtered, and evaporated until almost all the water was driven off, leaving the glycerin behind as a syrupy fluid. By evaporating down the spent leys of the soapmaker (after the soap is separated therefrom by "salting out," and any excess of alkali neutralized with sulphuric acid), and treating the residue with alcohol, glycerin can also be obtained, the alcoholic solution of it thus formed being simply evaporated to drive off the alcohol; but this process is far too costly for ordinary purposes. An improvement on this method was patented in 1858 by H. Reynolds, the concentrated leys being passed into a vessel where they are met by a stream of superheated steam at about 200° C.; the glycerin then passes over with the aqueous vapour, whilst the inorganic salts present are left behind. In the manufacture of stearic acid for candle-making (see CANDLE) one of the older processes was the saponification of tallow with lime, forming an insoluble lime soap and an aqueous solution of impure glycerin, from which the pure substance can be readily obtained by distillation with superheated steam. Less pure products were formerly obtained by treating the crude solution with sulphuric acid to separate lime, boiling to remove small quantities of volatile acids, evaporation, and filtration through animal charcoal to decolorize; or by evaporating, dissolving out by alcohol, and purifying by treating with lead oxide, filtering to separate an insoluble lead compound formed, removing lead from this filtrate by sulphuretted hydrogen, filtering again, and evaporating to a syrup. In practice all these older methods have, however, been superseded by the process patented in 1854 by Wilson & Payne. This consists in heating the fatty matter to be saponified in an appropriate still to a temperature of 290° to 315° C. (550° to 600° Fahr.), and passing in heated steam in such a way that it rises up through the fatty matter in numerous streams; saponification is thus rapidly effected, and the liberated glycerin and fatty acids are volatilized and carried along with the steam to the condensing arrangement. If the temperature do not exceed 310° C. there is no fear of the glycerin being decomposed, whilst under suitable conditions even higher temperatures than this can be employed without causing its decomposition; but there is always a great liability to destruction of glycerin when the temperature of 310° is exceeded. This arises from the tendency of the glycerin to char on heating, and to split up into water and *acrolein* (acrylic aldehyde), thus:—

$$C_3H_8O_3 = 2H_2O + C_3H_4O.$$

When a series of chambers is used as the refrigerator, the compartments nearest the still are found to condense little but fatty acids, the water and glycerin chiefly accumulating in the more distant chambers, the last of which is usually open to the air at the end; so that there is no excess of pressure in the still and condensers; the fatty acids readily separate from the aqueous solutions of glycerin, which only requires concentration by evaporation to be fit for the market. Since the date of Wilson's patent various special forms of apparatus for effecting the transformation have been patented by Wright & Pouché, Gilbee, and others.

This method of saponification is, strictly, only an improvement on former processes invented for the purpose of decomposing the glycerides and obtaining the fatty acids without the use of alkalies, lime, &c.; in these older methods the extraction of glycerin was not an important feature, and they were frequently worked in such a way as to decompose the whole or greater part of the glycerin *pari passu* with its liberation. Thus, as far back as 1825, Chevreul and Gay-Lussac sketched out the idea of the process of saponification by superheated steam, and the method was actually carried out with certain modifications by various chemists and manufacturers. For example, in 1842, E. Price & Co. patented, in the name of Jones & Wilson, a process of the kind, which was largely worked for some years; in this, the fatty matter freed from extraneous impurities is mixed with 6 to 8 per cent. of strong sulphuric acid, and then heated in copper boilers to about 180° C., by superheated steam blown through the mass for about two hours; after which hotter steam at about 300° to 350° is blown through, when fatty acids distil, but little or no glycerin passes over unaltered, almost the whole being charred or decomposed, forming acrolein, &c. Here the saponification and destruction of glycerin are largely effected by the sulphuric acid, as well as by the steam itself. Price's process was suggested to the inventors by Tilghman's method, brought out early in 1854, which consisted in making an emulsion of melted fatty matter and water (or solution of alkali) by agitation, and then pumping it through a long coil of iron tubing kept at a temperature near that of melted lead under a pressure of about 2000 lb to the square inch. In this way complete saponification is effected, fatty acids and an aqueous solution of glycerin being obtained when water is used, and soap with more or less water and glycerin when alkaline liquor is employed. It is noticeable that in this process it is not necessary that the alkali should be caustic, as it must be for the ordinary process of soap-boiling; sodium and potassium carbonates answer just as well as their respective hydrates (caustic soda, caustic potash).

Derivatives.—Among the numerous derivatives obtainable from glycerin by appropriate chemical reactions, may be more particularly mentioned *nitro-glycerin*, which is, strictly speaking, improperly named, inasmuch as it does not belong to the class of true nitro-substitution derivatives, but is simply constituted like tristearin, the radical of nitric acid displacing the hydrogen of the OH groups. By treating glycerin with nitric acid (preferably by dropping pure glycerin into a mixture of nitric and sulphuric acids) the following reaction ensues, the glycerin becoming what would be systematically termed *trinitrin* or *glycerotrinitrin*:—

$$\begin{matrix}CH_2.OH\\CH.OH\\CH_2.OH\end{matrix} + 3NO_2OH = 3H_2O + \begin{matrix}CH_2.ONO_2\\CH.ONO_2\\CH_2.ONO_2\end{matrix}$$

By treating the resulting "nitro-glycerin" with caustic potash, saponification ensues, potassium nitrate being formed and glycerin reproduced precisely as when tristearin is similarly saponified. Two other important products obtainable from glycerin are *isopropyl iodide* and *allyl iodide*, each of which serves as the starting-point of a large series of chemical products, many of them of utility in the arts. These substances are manufactured by heating glycerin with hydriodic acid, and are formed in virtue of the reactions:—

Glycerin.						Isopropyl Iodide.
$C_3H_5(OH)_3$	+	3HI	=	$2I_2$	+ $3H_2O$	+ C_3H_7I
						Allyl Iodide.
$C_3H_5(OH)_3$	+	3HI	=	I_2	+ $3H_2O$	+ C_3H_5I

Again, glycerin is employed in the manufacture of *formic acid*, which is prepared most conveniently by heating together glycerin and oxalic acid. The splitting up of oxalic acid into carbon dioxide and formic acid, which takes place only to a minute extent when oxalic acid is heated alone (owing to the further decomposition of the formic acid), then ensues with but little formation of bye-products, and especially with but little loss of formic acid through further decomposition. This arises from the occurrence of a cycle of changes highly interesting from a chemical point of view, and consisting essentially in the continual formation of a body analogous to monostearin, and its continual breaking up into formic acid, which distils over, and glycerin, which acts over again on a fresh portion of oxalic acid.

Technical Uses.—Besides its use as a starting-point in the production of "nitro-glycerin" and other chemical products, glycerin is largely employed for a number of purposes in the arts, its application thereto being due to its peculiar physical properties. Thus its non-liability to freeze (when not absolutely anhydrous, which it practically never is when freely exposed to the air) and its non volatility at ordinary temperatures, combined with its power of always keeping fluid and not drying up and hardening, render it valuable as a lubricating agent for clockwork, watches, &c., as a substitute for water in wet gas-meters, and as an ingredient in cataplasms, plasters, modelling clay, pasty colouring matters, dyeing materials, moist colours for artists, and numerous other analogous substances which are required to be kept in a permanently soft condition. From its softening property when applied to the skin, it constitutes a chief ingredient in many toilet preparations, creams, and the like. Many of these indeed, sold under fancy names, are nothing but glycerin diluted with water or weak alcohol, or mixed with some oleaginous emulsion or paste, and variously scented. Its solvent power for numerous substances renders it valuable in pharmacy as an ingredient in numerous preparations. In some of these the glycerin acts not merely as a solvent but also as a preservative against decomposition, owing to its antiseptic qualities, which also led to its being employed to preserve untanned leather (especially during transit when exported, the hides being, moreover, kept soft and supple); to make solutions of gelatin, albumen, gum, paste, cements, &c., which will keep without decomposition; to preserve meat and other edibles; to mount anatomical preparations; to preserve vaccine lymph unchanged; and for many similar purposes. Its solvent power is also utilized in the production of various colouring fluids, where the colouring matter would not dissolve in water alone; thus aniline violet, the tinctorial constituents of madder, and various allied colouring matters dissolve in glycerin, forming liquids which remain coloured even when diluted with water, the colouring matters being either retained in suspension or dissolved by the glycerin present in the diluted fluid. It has been proposed to use glycerin as a medium for the extraction of the odoriferous principle of flowers, &c., and as a substitute for sugar in the manufacture of some sorts of tobacco, the aroma of which is liable to be deteriorated should fermentation of the saccharine matter set in. Certain kinds of copying inks are greatly improved by the substitution of glycerin, in part or entirely, for the sugar or honey usually added. In fine, the number of useful adaptations of glycerin as an ingredient in order to confer certain special properties is almost unlimited, and its use in these directions is increasing yearly.

Impurities.—For some of these purposes it is essential that the glycerin should be of considerable purity. The chief impurities liable to be present vary with the mode of preparation. Substances made by saponification of oils, &c., with oxide of lead or lime, are apt to retain more or less of the metallic compounds, whilst glycerin extracted from soap-leys may also contain mineral matters. Such impure substances are readily purified by distillation with steam or under greatly diminished pressure. Glycerin prepared by saponifying clarified tallow, &c., by superheated steam, rarely contains fatty acids; if not deprived of practically all the water with which it is mixed in the distillate first obtained, it is less viscid and has a lower density, so that the specific gravity forms a good test as to whether it contains much water or not. Occasionally glycerin is met with intentionally adulterated with sugar-syrup, gum, mineral matters, &c., but such falsifications are comparatively rare. They may be detected by the substance being not wholly soluble in alcohol, by its leaving a residue on ignition in air, by its precipitating a solution of basic lead acetate (after being dissolved in water), or by other special tests, according to the nature of the impurity sought for. Thus, whilst pure glycerin does not reduce alkaline copper solutions so as to precipitate cuprous oxide when boiled therewith, the precipitation is readily produced by certain kinds of sugar, either without any previous treatment (*e.g.*, glucose), or after boiling for a short time with water acidulated with a mineral acid such as sulphuric acid (*e.g.*, cane sugar). (C. R. A. W.)

GMELIN, JOHANN GEORG (1709–1755), a distinguished naturalist, son of the chemist of the same name, was born at Tübingen, June 12, 1709. Having taken his degree in medicine, he in 1727 repaired to St Petersburg, where in 1731 he was appointed professor of chemistry and natural history. In 1733, by order of the empress Anna, he joined Deslisle, G. F. Müller, and Behring in an expedition for the exploration of Siberia, which was penetrated as far as the Lena. He returned to St Petersburg in 1743. In 1749 he was chosen professor of botany and chemistry at Tübingen, where he died, May 20, 1755. Linnæus named a genus of plants *Gmelina* in his honour.

His chief works are *Flora Sibirica* (4 vols., St Petersburg, 1749–50), and *Reisen Durch Sibirien* (4 vols., St Petersburg, 1752).

GMELIN, LEOPOLD (1788–1853), a celebrated chemist, was born August 2, 1788, at Göttingen, in the university of which city his father, Johann Friedrich Gmelin, was professor of medicine. He studied medicine and chemistry at Göttingen, Tübingen, and Vienna, and in 1813 commenced lecturing on chemistry at Heidelberg, where in 1814 he was appointed extraordinary and in 1817 ordinary professor of medicine and chemistry; the latter office he held till 1850. He died at Heidelberg, April 13, 1853.

Gmelin's fame rests chiefly on his chemical dictionary, the *Handbuch der Chemie*, the first edition of which, in 2 vols., was published at Frankfort in 1817–19. The fourth edition (Heidelberg, 1843, &c.) was written by Gmelin himself as far as the end of vol. v., was continued by Drs List and Kraut and others, and completed by an eighth volume on physiological chemistry, the work of Pro-