

ORDER XXVII.—IRON AND ITS COMPOUNDS.

I. FER'RUM, L. E. D. [U. S.]—IRON.

(Ramenta, L.—Filum; Limatura, E.—Fila; Scobs, Oxydi Squammæ, D.)
[Ferri Filum; Iron Wire, Ferri Ramenta, Iron Filings, U. S.]

HISTORY.—This metal (called by the alchemists *Mars*) was known in the most ancient times. It was employed medicinally at a very early period, namely, above 3200 years ago. Indeed, it appears to have been the first mineral used internally; and a curious anecdote is given of its introduction into medicine. Melampus (a shepherd supposed to possess supernatural powers) being applied to by Iphicles, son of Philacus, for a remedy against impotence, slaughtered two bulls, the intestines of which he cut to pieces, in order to attract birds to an argury. Among the animals which came to the feast was a vulture, from whom Melampus pretended to learn that his patient, when a boy, had stuck a knife, wet with the blood of some rams, into a consecrated chestnut-tree, and the bark had subsequently enveloped it. The vulture also indicated the remedy, namely, to procure the knife, scrape off the rust, and drink it in wine, for the space of ten days, by which time Iphicles would be lusty, and capable of begetting children. The advice thus given by Melampus is said to have been followed by the young prince with the most perfect success! (Le Clerc, *Hist. de la Médecine.*)

NATURAL HISTORY.—Iron is met with in both kingdoms of nature.

α. IN THE INORGANIZED KINGDOM.—Few minerals are free from iron. It is found in the metallic state (*native iron*), in combination with oxygen (*hamatite, micaceous iron, brown iron stone, and magnetic iron ore*), with sulphur (*iron pyrites, and magnetic pyrites*), with chlorine (*pyrosmalite*), and with oxygen and an acid (*carbonate, phosphate, sulphate, arseniate, tungstate, tantalate, titanate, chromate, oxalate, and silicate*.)

β. IN THE ORGANIZED KINGDOM.—It occurs in the ashes of most plants, and in the blood and some other parts of animals.

EXTRACTION.—In Sweden, iron is extracted from magnetic iron ore and micaceous iron: in England, principally from clay iron ore (*carbonate of iron*.)

Clay iron ore (technically called *Mine*) is burned with coal in large heaps, by which it loses carbonic acid, water, and sulphur. It is then smelted with a flux (in South Wales this is limestone; in the forest of Dean, clay;) and coke. The smelted iron is run into moulds, and is then called *Cast Iron (Ferrum fusum)* or *Pig Iron*. This contains carbon, oxygen, silicon, and often sulphur and phosphorus. To separate these, it is submitted to several processes (called refining, puddling, and welding,) by which it is converted into *Wrought Iron (Ferrum cusum)*.¹

PROPERTIES.—The primary form of the crystals of native iron is the regular octohedron. Pure iron has a whitish gray colour, or, according to Berzelius, is almost silver white. When polished it has much brilliancy: its taste is peculiar and styptic; when rubbed it becomes odorous. Its ductility and tenacity are great; its malleability comparatively small. Its sp. gr. is 7.788, but diminishes by rolling or drawing. It is attracted by the magnet, and several of its compounds are capable of becoming permanent magnets; but pure iron retains its magnetic property for a short time only. It requires a very intense heat to fuse it; and it is not volatile at any known temperature; while in the softened state, previous to melting, it is capable of being welded. Its equivalent or atomic weight is 28.

Characteristics.—Iron readily dissolves in diluted sulphuric acid, with the

¹ *Manufacture of Iron, in the Library of Useful Knowledge; also, Treatise on Iron and Steel, in Lardner's Cyclopaedia.*

evolution of hydrogen gas. The solution contains the protosulphate of iron, and produces, on the addition of caustic potash or soda, a greenish-white precipitate (the *hydrated protoxide*;) this precipitate, by exposure to the air, attracts oxygen, and is converted into the red or sesquioxide. Auro-chloride of sodium forms a purple precipitate with the protosalts of iron. By boiling the solution of the protosulphate with a little nitric acid, we obtain a persulphate of iron, recognised by ferrocyanide of potassium, causing a blue precipitate; sulphocyanic or meconic acid, a red colour; gallic or tannic acid, or infusion of galls, a purple or bluish black; and succinate, or benzoate of ammonia, a yellowish precipitate.

PHYSIOLOGICAL EFFECTS. *α. Of the Metallic Iron.*—Iron is probably inert so long as it retains its metallic form, but it readily oxidizes in the alimentary canal, and thereby acquires medicinal power. As acids promote this chemical change, acid wines and fruits assist in rendering the metal active, while alkalis and their carbonates have an opposite effect. The oxidization of the iron is attended with the evolution of hydrogen gas, which gives rise to unpleasant eructations. If sulphur be taken along with iron, hydrosulphuric acid is developed. Like the ferruginous preparations generally, the internal employment of iron causes blackening of the stools. The nature of the effects produced by oxide of iron formed in the alimentary canal will be best examined hereafter, under the head of ferruginous preparations. I may, however, remark here, that it is one of the few metals which by oxidization is not rendered more or less poisonous.

β. Of the Ferruginous Compounds. αα. On Vegetables.—Most of the compounds of iron do not appear to be hurtful to plants: at least this is the case with the oxides. (De Candolle, *Phys. Vég.* 1837.) The sulphate, however, is injurious.

ββ. On Animals.—The effects of the ferruginous compounds on animals generally are similar to those on man. It is stated that in animals to whom iron has been given for a considerable time, the spleen has been found smaller, harder, and denser—an effect which is supposed to be owing to the increased contractile power experienced by the veins of the abdomen. The liver is also said to have been affected in a similar manner, though in a somewhat slighter degree.

γγ. On Man.—The local effects of the sulphate and chloride of iron are those of irritants, and these preparations accordingly rank among poisons: but they are not equal in power to the mercurial or cupreous salts. Most of the ferruginous preparations are astringent; that is, they constrict the parts with which they are in contact, and thereby diminish secretions and check sanguineous discharges. Thus, when swallowed, they repress the secretions and exhalation of the gastrointestinal membrane, and thereby render the alvine evacuations more solid, and even occasion costiveness. The sulphate and chloride of iron are the most powerful of the ferruginous astringents. Administered in large quantities, or when the alimentary canal is in an irritable condition, all the compounds of iron are capable of exciting heat, weight, and uneasiness at the præcordia, nausea, and even vomiting, and sometimes purging.

The constitutional or *remote* effects¹ of the chalybeates are principally observed in the alteration induced in the actions of the vascular and muscular systems, and are best seen in that state of the system denominated *anæmia*, or more properly *hypæmia*, (See p. 44.) in which both the quantity and quality of the blood appear defective.

We have a good illustration of this state in chlorotic patients. The skin appears pale and almost exsanguineous, the cellular tissue is œdematous, and, after death, the larger vessels as well as the capillaries are found to be imperfectly supplied with blood. Patients with this condition of system are affected with great feebleness, loss of appetite, and palpitation; and in

¹ The best account of the physiological effects of iron is that published by Menghini (*De Ferrucarum particularum progressu ad sanguinem*) in the *Comment. Acad. Bonon.* t. ii. pt. iii. p. 475. A notice of these is given by Bayle in the *Bibliothèque de Thérapeutique*, t. iv. Paris, 1837.

females the catamenial secretion is frequently, but not invariably, defective. That the want of uterine action is not the cause, but in some cases is, perhaps, the effect of this condition of system, seems tolerably clear from the circumstance of the same constitutional symptoms of anæmia sometimes occurring with a perfect regularity of the uterine functions; moreover, we occasionally meet with anæmia in men. It is sometimes the consequence of hemorrhages—at other times it occurs spontaneously, and without any known cause. (Andral, *Pathol. Anat.* by Townsend and West, i. 97.)

If in this condition of system we administer iron, the appetite increases, digestion is promoted, the pulse becomes fuller and stronger, the skin assumes its natural tint, the lips and cheeks become more florid, the temperature of the body is increased, the œdema disappears, and the muscular strength is greatly augmented. The alvine evacuations assume a black colour, as they always do under the use of the ferruginous preparations. After continuing the use of iron for a few weeks, we frequently find excitement of the vascular system (particularly of the brain;) thus we have throbbing of the cerebral vessels, and sometimes pain in the head, a febrile condition of system, with a tendency to hemorrhage. Mr. Carmichael (*Essay on the Effects of Carbonate of Iron on Cancer*, Dubl. 1806, p. 396.) considers the *sanguine* temperament (marked by a high complexion, celerity of thought, remarkable irritability of fibre, and a quick pulse) as depending on an excess of iron in the system; whereas the *leucophlegmatic*, or *relaxed*, temperament (characterized by a pale bloated countenance, dull eyes, mind heavy and slow in receiving and forming ideas, little irritability of fibre, and pulse small and feeble) as depending on a deficiency of iron.

When by the use of iron the state of the general system improves, the secretions resume their natural condition; and thus at one time we observe this metal promoting the uterine discharge, at another checking it, according as chlorosis or menorrhagia had been previously present; we cannot, therefore, regard the preparations of this metal as having any direct emmenagogue effect, as some have supposed.

Some refer all the other symptoms of anæmia to the abnormal state of the blood, and ascribe the beneficial influence of iron to the improvement in the quality of this liquid. It is certain that, under the use of the preparations of this metal, the blood frequently acquires a more scarlet colour, owing probably to an increase in the number of its colouring particles; and the crassamentum becomes firmer and more solid, and even increased in quantity. This alteration of the physical and chemical properties of the blood must render it more stimulating, and thus the different organs, receiving a fluid of a more healthy character, resume their normal condition, and perform their functions in a proper manner. Tiedemann and Gmelin¹ have detected it in the serum of the blood of the portal and mesenteric veins of horses and dogs, to whom they administered either the sulphate or chloride. Occasionally, too, iron has been found in the urine. Moreover, Menghini² asserts, that the quantity of iron in the blood of dogs may be increased by feeding them on substances mixed with this metal. Farthermore, it is not to be forgotten, that iron exists in no inconsiderable quantity in healthy blood, and is supposed to contribute to its colour, and probably to its stimulant properties; so that it is not unlikely any variation in the quantity of this metal would be attended with an alteration in the action of every organ.

Iron is a substance not readily absorbed, for it remains in the stomach and intestines many days after it is swallowed: in order, therefore, that the ferruginous preparations should have much effect on the general system, it is necessary that they be employed for some considerable time. It does not, like most other metals, act as a poison when it gets into the blood.

Another circumstance connected with the operation of iron is likewise deserving of notice; namely, that it has no primary or specific effect on the nervous

¹ *Vers. ü. d. Wege auf welech. Subst. aus d. Magen u. Darmk.*

² *De Ferrucarum particul. progressu ad sanguinem.* In *Com. Acad. Bonon.* t. ii. pt. iii. p. 475.

system, as arsenic, mercury, copper, zinc, bismuth, silver, and many other metals. It must not, however, be imagined from these remarks, that the preparations of iron never operate injuriously. On the contrary, we see them sometimes acting as local irritants on the alimentary canal, as already noticed; and by the use of them in too large quantities, or for too long a period of time, they bring on a hypersthenic or phlogistic diathesis.

USES. α. Of Metallic Iron.—Iron filings have been used in those cases where the chalybeate preparations generally have been administered, and which will be hereafter noticed. In some instances, however, the efficacy of iron depends on its being employed in the uncombined state. Thus, when used as an antidote to poisoning by the salts of copper, it is necessary that the iron be administered in the metallic state, in order to reduce the cupreous salts. Iron filings have been regarded as anthelmintic, especially in the small thread-worm (the *Ascaris Vermicularis*;) they have been used also as an astringent application, to repress fetid secretion of the feet.

β. Of the Ferruginous Compounds.—By a careful attention to the known physiological effects of the ferruginous compounds, the indications and contra-indications for their employment may be in great part learned. Thus, the impropriety of administering them where there is irritation or inflammation of the alimentary canal, in plethoric habits, and in persons disposed to inflammatory diseases, or to apoplexy, will be obvious from the foregoing remarks. On the other hand, in all cases characterized by feebleness and inertia of the different organs of the body, by a soft lax condition of the solids, and by a leucophlegmatic state of the system—where the patient appears to be suffering from a state of general anæmia, already described—the preparations of iron are indicated. It is hardly within the scope of my present object to instance particular diseases where this metal may be used, but rather to point out those conditions of system which affect the employment of iron in diseases generally. I may notice a few cases by way of illustration.

As *external or local agents* we rarely employ the preparations of iron, since we have other more efficacious and powerful remedies. Occasionally, however, they have been used as astringents, styptics, and caustics. Thus solutions of the sulphate and chloride have been used in the form of injection, in discharges from the urethra and vagina; and the tincture of the chloride is now and then applied as a styptic, or to repress the growth of spongy granulations.

The ferruginous preparations are usually resorted to with the view of affecting the general system. They are frequently given to *promote the uterine functions*, as in chlorosis, amenorrhœa, dysmenorrhœa, and menorrhagia, and often with success. When chlorosis depends on, or at least is accompanied by, that condition of the system before described under the name of anæmia, the ferruginous preparations are frequently useful; but if it occur in patients of a full habit, or if it arise from inflammation of some organ (as the lungs, stomach, or bowels,) chalybeates will do harm. In cases of impotence, connected with or arising from general feebleness, it may be now and then useful; but in nine out of ten cases which we are called on to treat, this condition arises from indulgence in bad habits, which no medicine can affect. Sometimes iron is resorted to in sterility (though Dioscorides says the rust of iron hinders women from conceiving,) but the conditions under which it is likely to be useful are precisely those before mentioned for other diseases. In discharges from the genital organs, as gleet and leucorrhœa, the internal employment of the tincture of the chloride of iron, sometimes conjoined with the tincture of cantharides, has been found useful.

In some *periodical diseases*—namely, ague, asthma, and tic douloureux—the ferruginous preparations have gained considerable repute. In the first of these diseases (that is, ague,) the sulphate has been used by Marc¹ and others, the subcar-

¹ *Recherches sur l'Emploi du Sulf. de Fer dans le Traitement des Fièvres Interm.* Paris, 1810.

bonate by Buchwald, the ammoniacal chloride by Hartmann; but it has been almost wholly superseded, of late years, by the sulphate of quinine and by arsenic. In asthma, Dr. Bree,¹ who was himself a sufferer from the disease, regards iron as preferable to all other remedies. However, the experience of others has not confirmed his favourable opinion of it. The sesquioxide of iron has latterly been extensively employed, at the recommendation of Mr. B. Hutchinson, (*Cases of Tic Douloureux successfully treated*. 1820.) in tic douloureux, and with variable success; in some cases acting in a most extraordinarily beneficial manner, in others being of no avail.

In *diseases of the spleen and liver*, the ferruginous compounds are occasionally found useful. I have already alluded to the influence which they are supposed to possess over these organs; a supposition the more probable from the occasional remarkable effects produced by them in diseases of these organs. "I regard iron as a *specific*," says Cruveilhier, (*Dict. de Méd. et de Chir. Prat.* t. viii. p. 62.) "in *hypertrophy of the spleen*, or *chronic splenitis*; whether primitive or consecutive to intermittent fevers." After noticing the symptoms attending this condition (such as paleness of the lips, &c., great lassitude, abdominal and cephalic pulsations, brought on by the slightest exertion, pain at the left side, disordered state of the digestive organs, accelerated pulse, and heart easily excited,) he goes on to remark, "By the aid of iron I have obtained the complete resolution of enlargements of the spleen, which have occupied half, or even two-thirds, of the abdomen." In hypertrophy of the liver, iron has not been equally serviceable.

Some years ago the preparations of iron were strongly recommended in *cancer* by Mr. Carmichael. (*Op. supra cit.*) The grounds on which he was led to the use of them were the probability that cancer had an independent life—in other words, that it was a kind of parasite, as some preceding writers, more particularly Dr. Adams, had presumed; and secondly, the efficacy of iron in destroying intestinal worms, which led him to hope that it would be equally destructive to other parasites. With these views he employed (externally and internally) various ferruginous compounds—namely, the ferrotartrate of potash, the subcarbonate (sesquioxide) of iron, and the phosphates. Whatever hopes may have at one time been entertained of these remedies as curative agents, in this most intractable disease, they are now completely destroyed. That these medicines are occasionally useful as palliatives may perhaps be admitted; but they have no curative powers. Indeed this might have been suspected, from the hypothetical grounds on which they were introduced into use. The proofs of the parasitical nature of cancer must be much stronger than any yet offered, ere we can admit this hypothesis. Moreover, the preparations of iron, though useful, are not so "very effectual" in worms as Mr. Carmichael's remarks would lead us to imagine.

In *certain affections of the digestive organs*, the preparations of iron are occasionally used with benefit; as in some forms of dyspepsia, but only in the conditions of system already noticed.

In some *affections of the nervous system* which occur in weak debilitated subjects, it is also useful; for example, in epilepsy, chorea, hysteria, and the shaking palsy produced by the vapour of mercury.

These are the most important diseases for which we employ the ferruginous compounds. There are many other diseases for which chalybeates are occasionally beneficial; but the general principles regulating their use will be readily comprehended from the foregoing remarks, and I have only to add, that in all diseases attended by debility and marked by atony and inertia of organs, more especially in those indicating a disordered state of the hæmatose functions, the preparations of iron will be found in most instances more or less serviceable. Furthermore, I may enumerate scrofula, rickets, dropsy, and gout, as diseases in which iron has been at times used with advantage.

¹ *A Practical Inquiry on Disordered Respiration, distinguishing Convulsive Asthma, its Specific Causes, &c.* Birmingham, 1797.

ADMINISTRATION.—Iron in substance is administered in the form of filings. These are procured from the workshop of the smith, and are usually impure, being mixed with the filings of other metals, &c. The magnet is generally employed to separate the ferruginous from other particles, but it does this imperfectly, as various impurities cling to the iron particles. The only way to procure them pure is by filing a piece of pure iron with a clean file. The dose of iron filings is from ten to thirty grains, given in the form of an electuary made with treacle, honey, or some other thick substance.

2. FER-RI OXYDUM, NIGRUM, D.—BLACK OXIDE OF IRON.

(Ferri Oxidum Nigrum, E.)

HISTORY.—It was first employed as a medicine by Lemery in 1735. It is the *Martial Ethiops* (*Ethiops Martialis*) of some writers, and the *Oxydum ferros-ferricum* of Berzélius. It is sometimes termed the *Magnetic Oxide*.

NATURAL HISTORY.—It occurs in the mineral kingdom under the name of *Magnetic Iron Ore*, the massive form of which is called *Native Loadstone*. It is found in Cornwall, Dovenshire, Sweden, &c.

PREPARATION.—Directions for its preparation are given by both the Edinburgh and Dublin Colleges.

The *Edinburgh College* orders of Sulphate of Iron, ℥vj.; Sulphuric Acid (commercial) fʒij. and fʒij.; Pure Nitric Acid, fʒiv.; Stronger Aqua Ammonia, fʒivss.; Boiling Water, Oij. Dissolve half the sulphate in half the boiling water, and add the sulphuric acid; boil; add the nitric acid by degrees, boiling the liquid after each addition briskly for a few minutes. Dissolve the rest of the sulphate in the rest of the boiling water; mix thoroughly the two solutions; and immediately add the ammonia in a full stream, stirring the mixture at the same time briskly. Collect the black powder on a calico-filter; wash it with water till the water is scarcely precipitated by solution of nitrate of baryta; and dry it at a temperature not exceeding 180°.

The object of the first part of this process is to convert the sulphate of the protoxide of iron into the sulphate of the sesquioxide. This is effected by adding nitric acid to the boiling solution. The acid gives oxygen to the protoxide, while binoxide of nitrogen gas escapes. The additional quantity of sulphuric acid is required to enable the salt to preserve its neutrality, and prevent the deposition of a basic sulphate of the sesquioxide. If, however, the sulphate of iron directed to be used be a pure protosulphate, the additional quantity of sulphuric acid ordered by the Edinburgh College is not sufficient for the purpose. On the addition of ammonia to the mixed solution of the protosulphate and sesquisulphate of iron, a compound of the hydrated protoxide and sesquioxide of iron is precipitated. This is to be washed with water until all traces of sulphuric acid are got rid of. When dried at 180° it constitutes the *Ferri-Oxidum nigrum* of the Edinburgh Pharmacopœia.

The *Dublin College* orders it to be prepared as follows:—Let the scales of Oxide of Iron [*Ferri Oxydi Squamæ*,] which are to be found at the smiths' anvils, be washed with water; and when dried, let them be detached from impurities by application of a magnet. Then let them be reduced to powder, of which let the most subtle parts be detached, according to the mode directed for the preparation of chalk.

Scales of iron are composed of a mixture or combination of protoxide and sesquioxide; but they are not uniform in constitution. The process of the Dublin Pharmacopœia has the advantage of cheapness.

There are several other methods of procuring this compound. In the Paris Codex it is directed to be prepared by covering iron with water and exposing the mixture to the air: then, by elutriation, separating the black powder.

PROPERTIES.—The crystalline form of the magnetic iron ore is the regular octo-

hedron. The black oxide of iron of the Pharmacopœia is a grayish-black powder, with a velvety appearance, and is strongly magnetic. It dissolves in hydrochloric acid without effervescence. Prepared according to the Edinburgh Pharmacopœia its properties are as follows:—

“Dark grayish-black: strongly attracted by the magnet: heat expels water from it; muriatic acid dissolves it entirely; and ammonia precipitates a black powder from this solution.” *Ph. Ed.*

COMPOSITION.—The following is the composition of this oxide:—

	Atoms.	Eq. Wt.	Per Cent.	Gay-Lussac.	Or	Atoms.	Eq. Wt.
Iron.....	3	84	72.414	72.5	Protoxide.....	1	36
Oxygen.....	4	32	27.586	27.5	Sesquioxide....	2	80
Black Oxide of Iron	1	116	100.000	100.0		1	116

It has been above stated that the constitution of scales of oxide of iron is variable. The following is their composition according to Mosander:—

	Outer Layer.		Inner Layer.	
	Atoms.	Eq. Wt.	Atoms.	Eq. Wt.
Protoxide of Iron.....	2	72	3	108
Sesquioxide of Iron.....	1	40	1	40
Scales of Iron.....	1	112	1	148

PURITY.—Black oxide of iron should be readily soluble in hydrochloric acid without effervescence; by which the absence of metallic iron is shown.

PHYSIOLOGICAL EFFECTS AND USES.—These are similar to those of the chalybeates in general, and which have been already described. It does not produce local irritation. It is a more valuable preparation than the sesquioxide, in consequence of being more readily soluble in the fluids of the stomach.

ADMINISTRATION.—Dose from grs. v. to ℥j. or more, twice or thrice daily.

3. FERRI SESQUIOX'YDUM, L.—SESQUIOXIDE OF IRON.

(Ferri Oxidum rubrum E.—Ferri Oxydum rubrum; Ferri Rubigo; and Ferri Carbonas, D.)
[Ferri Sub-Carbonas, Precipitated Carbonate of Iron, U. S.]

HISTORY.—Geber (*Invention of Verity*, p. 280.) was acquainted with this substance, which he calls *Crocus Martis*. It was probably known long before his time. It is the *Red* or *Peroxide of Iron* of some chemists.

NATURAL HISTORY.—It is found native in the crystallized state (*Specular Iron* or *Iron Glance*) and in globular and stalactitic masses (*Red Hæmatite*;) the finest specimens of the first occur in the Isle of Elba; the second is found near Ulverstone, in Lancashire, and in Saxony. The hydrated sesquioxide of iron (*Brown Iron Stone*) is met with in Scotland, and at Shotover Hill, Oxfordshire.

PREPARATION.—There are several modes of preparing this compound:—

1. By precipitation from Sulphate of Iron.

The *London College* orders of Sulphate of iron, ℥iv.; Carbonate of Soda, ℥iv. and ℥ij.; Water boiling, Cong. vj. Dissolve the Sulphate of Iron and Carbonate of Soda, separately, in three gallons of Water; then mix the liquors together, and set them by, that the powder may subside. Lastly, the supernatant liquor being poured off, wash what is precipitated with water, and dry it.

The *Edinburgh College* employs of Sulphate of Iron, ℥iv.; Carbonate of Soda, ℥v.; Boiling Water, Oss.; Cold Water, Oijss. Dissolve the sulphate in the boiling water, add the cold water, and then the carbonate of soda, previously dissolved in about thrice its weight of water. Collect the precipitate on a calico filter; wash it with water till the

water is but little affected with solution of nitrate of baryta, and dry it in the hot-air press, over the vapour bath.

The *Dublin College* orders it [*Ferri Carbonas, D.*] to be prepared with *twenty-five parts* of sulphate of iron, *twenty-six parts* of carbonate of soda, and *eight hundred parts* of water.

[The U. S. P. directs Sulphate of Iron \bar{z} viii; Carbonate of Soda \bar{z} ix. Boiling water a gallon. The mode of proceeding is essentially that of the London College.]

In this process one equivalent or 76 parts of sulphate of iron are decomposed by one equivalent or 54 parts of carbonate of soda: and the products of their mutual reaction are one equivalent or 58 parts of carbonate of the protoxide of iron which are precipitated, and one equivalent or 72 parts of sulphate of soda which remain in solution.

MATERIALS.	COMPOSITION.	PRODUCTS.
1 eq. Carbon. Soda 54	{ 1 eq. Soda 32 1 eq. Carbonic Acid 22	1 eq. Sulphate of Soda 72.
1 eq. Sulphate of Iron 76	{ 1 eq. Sulphuric Acid 40 1 eq. Oxide of Iron 36	1 eq. Carbonate of Iron 58
130	130	130

By exposure to the air during the washing and drying, the carbonate of the protoxide of iron is decomposed, the oxygen of the air combines with the protoxide, and thereby converts it into sesquioxide, while carbonic acid is disengaged.

When prepared according to the above directions its colour is reddish chocolate brown, and it usually contains a small portion of undecomposed carbonate of the protoxide of iron. Manufacturers, however, usually calcine it in an iron pot, by which it acquires a brownish red colour and is more saleable.

Sesquioxide of iron, as thus procured, is frequently termed *Carbonate* or *Subcarbonate of Iron* (*Ferri Carbonas, D.*) or *Precipitated Carbonate of Iron* (*Ferri Carbonas Precipitatus.*)

2. By calcining Sulphate of Iron.

The *Dublin College* orders it [*Ferri Oxydum Rubrum, D.*] to be prepared as follows:—Let sulphate of iron be exposed to heat until the water of crystallization shall be expelled; then with a strong fire, let it be roasted so long as acid vapour rises. Let the red oxide be washed until the washings, when examined by litmus, shall appear free from acid. Lastly, let it be dried on bibulous paper.

In this process the water and sulphuric acid of the crystallized sulphate of iron are evolved. The iron is peroxidized at the expense of a portion of the sulphuric acid, while some sulphurous acid is developed.

Sesquioxide of iron, prepared by this process, is known in commerce as *Colcothar, Caput Mortuum, Vitrioli, Trip, Brown-red, Rouge, Crocus.*¹

3. From Rust of Iron.

The *Dublin College* orders Rust of Iron (*Rubigo Ferri, D.*) to be thus prepared: Take of iron wire any required quantity. Moisten it with water, and expose it to the air until it is corroded into rust. Then let it be rubbed in an iron mortar; and, by the affusion of water, let the most subtle powder be washed off and dried.

It is directed to be prepared from iron-wire on account of its purity. Rust of iron is usually reduced to an impalpable powder by levigation and elutriation; and is then made up into small conical loaves like prepared chalk.

PROPERTIES.—The primary form of the crystals of native sesquioxide of iron is the rhombohedron.

¹ "The scarlet parts are called *rouge*; the red, purple, or bluish parts, being those which have been exposed to the strongest heat, are called *crocus*." (Gray's *Operative Chemist*, p. 696. Lond. 1828.)

The artificial sesquioxide of the shops is a brownish red powder: when it has been exposed to an intense heat it has a purplish tint. It is odourless, insoluble in water, and not magnetic. Prepared according to the London Pharmacopœia it has a styptic taste; when calcined it is tasteless. When quite free from carbonate of iron, it dissolves in hydrochloric acid without effervescence.

Characteristics.—Its hydrochloric solution affords a deep blue precipitate with the ferrocyanide of potassium; a purplish black precipitate with tincture of nutgalls; a brownish-red precipitate with the alkalis; and a red colour with sulphocyanic or meconic acid.

COMPOSITION.—Sesquioxide of iron has the following composition:—

	Atoms.	Eq. Wt.	Per Cent.	Guy Lussac.	Berzelius.
Iron	1	33	70	70.27	69.22
Oxygen	1½	12	30	29.73	30.78
Sesquioxide of Iron.....	1	40	100	100.00	100.00

PURITY.—Adulteration is hardly to be apprehended. If it should contain copper, its hydrochloric solution will deposit this metal on a bright rod of iron. After the sesquioxide has been thrown down by ammonia from the hydrochloric solution, the supernatant liquor should give no indications of containing any other metal in solution; and chloride of barium ought not to occasion any precipitate. Orfila (*Journal de Chimie Méd.* t. vi. 2^{de} Série, p. 646.) obtained traces of arsenic in the sesquioxide of commerce, by boiling this substance for five hours with pure sulphuric acid, and placing the solution in Marsh's apparatus.

Dissolved totally by dilute hydrochloric acid with very slight effervescence, and it is precipitated by ammonia. *Ph. Lond.*

"Entirely soluble in muriatic acid, aided by gentle heat." *Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—It is termed alterative, tonic, and emmenagogue. Its obvious effects on the body are very slight. It produces blackness of the stools; and in large doses occasions nausea, a sensation of weight at the pit of the stomach, and sometimes dyspeptic symptoms. It possesses very little astringency. The constitutional effects, arising from the continued use of it, are those produced by the ferruginous compounds generally, and which have been before described.

USES.—It may be employed in any of the before-mentioned cases in which the ferruginous tonics are indicated.

It has been strongly recommended by Mr. Benjamin Hutchinson (*Cases of Tic Douloureux successfully treated*, 1820.) as a remedy for neuralgia, and in some cases it gives complete, in others partial, relief. But in many instances no benefit whatever is obtained from its use, and in one case in which I prescribed it, the patient fancied it increased her sufferings. Mr. Carmichael, as already stated (p. 685,) has recommended it as a remedy for cancerous diseases.

ADMINISTRATION.—The usual dose, as a tonic and emmenagogue, is from grs. x. to ʒss. In tic douloureux it is given in much larger quantities, as from ʒss. to ʒiij. or ʒiv. It may be administered in the form of an electuary. To enable it to sit easily on the stomach, it may be combined with aromatics.

EMPLASTRUM FERRI, E.—(U. S.) *Emplastrum Thuris, D.; Emplastrum Roborans; Iron, Frankincense or Strengthening Plaster.* (Litharge Plaster, ʒiij.; Resin, ʒvj.; Olive Oil, ℥ʒijss.; Bees'-wax, ʒiij.; Red Oxide of Iron, ʒj. Triturate the oxide of iron with the oil, and add the mixture to the other articles previously liquefied by gentle heat. Mix the whole thoroughly, *Ed.*—Litharge Plaster, lbij.; Frankincense (*Thus*) lbss.; Red Oxide of Iron, ʒiij. *M. D.*) [The same articles in the same proportions are directed by the U. S. P.] Spread on leather, it is employed as a mechanical support and slight stimulant, in muscular relaxation, lumbago, weakness of the joints, &c.

4. FER'RI SESQUIOX'YDUM HYDRA'TUM.—HYDRATED SESQUIOXIDE OF IRON.

(Ferrugo, E).—[Ferri Oxidum Hydratum, U. S.]

HISTORY.—In the year 1834 this preparation was proposed by Drs. Bunsen and Berthold as an antidote for poisoning by arsenious acid.¹

PREPARATION.—The Edinburgh Pharmacopœia gives the following directions for its preparation:—

Take of Sulphate of Iron, ℥iv.; Sulphuric Acid (commercial), ℥ijss.; Nitric Acid (D. 1380) ℥ix.; stronger Aqua Ammonia, ℥ijss.; Water, Oij. Dissolve the sulphate in the water, add the Sulphuric Acid, and boil the solution; add then the Nitric Acid in small portions, boiling the liquid for a minute or two after each addition, until it acquires a yellowish-brown colour, and yields a precipitate of the same colour with ammonia. Filter; allow the liquid to cool; and add in a full stream the Aqua Ammonia, stirring the mixture briskly. Collect the precipitate on a calico filter; wash it with water till the washings cease to precipitate with nitrate of baryta; squeeze out the water as much as possible; and dry the precipitate at a temperature not exceeding 180°.

When this preparation is kept as an antidote for poisoning with arsenic, it is preferable to preserve it in the moist state, after being simply squeezed.

[The U. S. P. directs Sulphate of Iron, ℥iv.; Sulphuric Acid, ℥ijss.; Nitric Acid, ℥vj.; or qs.; Solution of Ammonia, q. s.; Water two pints. Proceed in the same way.]

The sulphate of the protoxide of iron is converted, by the nitric and sulphuric acids, into the sulphate of the sesquioxide (see p. 686.) On the addition of caustic ammonia, the hydrated sesquioxide of iron is precipitated, while sulphate of ammonia remains in solution. The oxide retains in combination with it some ammonia, but this does not prove injurious to its therapeutical use. If potash or soda be substituted for ammonia, we obtain, unless the alkali be in excess, a sub-sulphate, instead of the hydrated oxide of iron: and if we use excess of alkali, a portion of it combines with the oxide. Oxide which has been precipitated by potash has been found not to be equally efficacious as an antidote for arsenic, to that obtained by ammonia.²

PROPERTIES.—Hydrated sesquioxide of iron has a deep reddish-brown colour. Prepared for use, as an antidote to arsenious acid, it should be in the form of a gelatinous moist magma. Though it may be dried at ordinary temperatures without undergoing decomposition, yet in this moist state, it more readily renders arsenious acid, insoluble; and, therefore, to preserve it in this condition, it should be kept under water in a stoppered bottle. If this hydrated sesquioxide (prepared by ammonia) be added in considerable excess to a solution of arsenious acid, and well agitated, the filtered liquor gives no traces of the presence of arsenic. Dr. Maclagan states that "at least twelve parts of oxide, prepared by ammonia, are required for each part of arsenic;"³ and that when the oxide has either been precipitated by potash, or been dried even at a low temperature, that about three or four times larger quantities are requisite." That the arsenious acid has been rendered insoluble is shown by the fact that by washing it cannot be removed from the magma. In the first instance the arsenious acid combines with the sesquioxide of iron to form a subarsenite of the sesquioxide; the composition of which Guibourt (*Journal de Chimie Méd.* t. v. 2^{de} Série, p. 312.) approximatively represents as being, *sesquioxide of Iron* (calcined to redness,) 65.0 *arsenious acid*, 14.50; *water*, 20.50. According to Graham, (*Elements of Chemistry*, p. 636.) the mutual reaction of the hydrated sesquioxide and the arsenious acid gives rise to the formation of the arseniate of the protoxide of iron, $2\text{Fe}^{\text{O}}\text{O}^{\text{3}}$ and $\text{As}^{\text{2}}\text{O}^{\text{3}} = 4\text{FeO} + \text{As}^{\text{2}}\text{O}^{\text{5}}$. The same authority observes, that the constitution of this arseniate is probably $2\text{FeO} \cdot \text{HO}, \text{As}^{\text{3}}\text{O}^{\text{5}} + 2\text{FeO}$.

¹ Poggendorf, *Annalen d. Physik*, Ed. xxxii. S. 124. 1834; also, *Journal de Pharmacie* xx. 567.

² See Bunsen's Memoir before quoted; also Dr. Maclagan *On the Action of Hydrated Sesquioxide of Iron in Arsenic*, in the *Edinburgh Medical and Surgical Journal*, No. 144.

³ "This proportion of twelve parts of the moist ammoniacal oxide to each part of arsenic, is that which has been indicated by several of the French experimentalists as being required to insure its antidotal effects."

COMPOSITION.—It consists of *sesquioxide of iron*, *water*, and a small portion of *ammonia*. One hundred parts of the magma, deprived of water by the decantation, yielded Guibourt from 3.2 to 3.5 of calcined sesquioxide. According to the same authority, 1 litre of the magma, equal to about $1\frac{1}{3}$ imperial pints, (1.7608 imperial pints,) contains 32.35 grammes or $499\frac{6}{10}$ troy grains (499.6134 troy grains) of the calcined sesquioxide. So that one imperial pint contains about 286 grains of the calcined sesquioxide.

PHYSIOLOGICAL EFFECTS.—These are similar to those of the anhydrous sesquioxide before mentioned.

USES.—The power of hydrated sesquioxide of iron to act as an antidote to arsenious acid is proved by three facts:—

- α. It renders this poison insoluble.
- β. Experiments on animals have shown its efficacy as an antidote.
- γ. In poisoning in the human subject it has proved successful.

I have already explained the nature of the reaction between arsenious acid and hydrated sesquioxide of iron, in virtue of which the former is rendered insoluble.

Drs. Bunsen and Berthold (*Op. cit.*) were the first to show that arsenious acid proved innocuous to animals when the hydrated sesquioxide was speedily administered. Their statements have been confirmed by the experiments of Soubeiran and Miquel, (*Journ. de Chim. Méd. t. i. 2^{de} Sér. p. 3.*) of Orfila and Lesueur, (*Ibid. p. 45.*) of Bouley, jun., (*Ibid. p. 46.*) of Borelli and Damaria, (*Ibid. p. 393.*) of Dr. Mackenzie, (Quoted by Dr. Maclagan.) of the Committee (composed of Drs. Deville, Nonat, and Sandras) appointed by the Société de Médecine of Paris, (*Journ. de Chim. Méd. t. v. 2^{de} Série, p. 317.*) and of other experimentalists. (Quoted by Dr. T. R. Beck, in *Lond. Med. Gaz.* Oct. 15, 1841.) Opposed to this mass of evidence we have only the unfavourable results of Mr. Brett (*Lond. Med. Gaz.* vol. xv. p. 220.) and Mr. Orton. (*Lancet*, Nov. 8, 1834.) But of these experimentalists I may remark, in the words of my friend Dr. Maclagan, that “with respect to the former, it may be observed, that he appears uniformly to have used too small quantities of the oxide; and the experiments of the latter hardly seem to have been made with sufficient care, as appears, in one instance at least, from his having injected both poison and antidote into the lungs instead of the stomach of the rabbit.”

A very respectable testimony of the antidotal efficacy of the hydrated sesquioxide of iron in poisoning by arsenic, can now be adduced from its effects on man. In thirty-one cases (Dr. T. R. Beck, *op. cit.*) in which it was given, it proved successful in twenty-nine. In one of these nearly two drachms of arsenic had been taken. (*London Medical Gazette*, vol. xix. p. 177.) In the two unsuccessful cases the antidote could not be retained on the stomach.

It appears to me, therefore, that the threefold evidence of the antidotal power of this preparation is complete.

ADMINISTRATION.—The mode of administering this substance as an antidote in poisoning by arsenic has been already pointed out. (See p. 541.) It must be especially remembered that very large doses of it are required to prove efficacious. It should, therefore, be given in the quantity of a table-spoonful every five or ten minutes, or as often as the patient can swallow it. If hydrated sesquioxide be not at hand, let the common red oxide of iron (see p. 686) be given with water as a substitute; for though not equally efficacious with the hydrated oxide, it appears to possess some antidotal power. (See *Journ. de Chim. Méd. t. v. 2^{de} Série, p. 305. et seq.*)

[The antidote should be as recently prepared as it is possible to obtain it, as in proportion to the time that it is kept does it lose the neutralizing power. This fact was proved by a series of carefully instituted experiments, by Mr. Proctor. From these he has deduced the following conclusions. That hydrated sesqui-

oxide of iron, even when kept under water, gradually decreases in its power of neutralizing arsenious acid. That if kept in the form of a thick magma, it will retain its properties longer than when mixed with much water. For other interesting particulars, see *Amer. Journ. of Pharmacy*, vol. xiv. No. 1.—J. C.]

5. TINCTURA FERRI SESQUICHLORIDI, L.—TINCTURE OF SESQUICHLORIDE OF IRON.

(Ferri Muriatis Tinctura, E.—Muriatis Ferri Liquor, D.)—[Tinctura Ferri Chloridi, U. S.]

HISTORY.—This compound has been long in use, and is commonly termed the *Tincture of the Muriate of Iron*.

PREPARATION.—All the British Colleges give directions for its preparation:—

The *London and Edinburgh Colleges* order of Sesquioxide of Iron, ℥vj.; Hydrochloric Acid, Oj.; Rectified Spirit, Oij. Pour the Acid upon the Sesquioxide of Iron in a glass vessel, and digest for three days, frequently shaking. Lastly, add the Spirit, and strain.

The *Dublin College* orders, of Rust of Iron, one part; Muriatic Acid; Rectified Spirit, of each, six parts. Pour the acid on the rust passed into a glass vessel, and occasionally stir the mixture during three days; then set it apart that the dregs may subside, and pour off the clear liquor: by slow evaporation reduce this to one-third part, and when cold add to it the spirit.

[The U. S. Pharmacopœia directs, Subcarbonate of Iron, half a pound; Muriatic Acid, a pint; Alcohol, three pints. Pour the Acid upon the Subcarbonate of Iron, and shake the mixture occasionally for three days; then set it by that the dregs, if there be any, may subside; lastly, pour off the liquor and add to this the alcohol.]

By digestion in hydrochloric acid the sesquioxide becomes the sesquichloride of iron, while water is formed.

MATERIALS.	COMPOSITION.	PRODUCTS.
3 eq. Hydrochloric Acid. 111	{ 3 eq. Hydrogen 3	3 eq. Water 27
	{ 3 eq. Chlorine . 108	
2 eq. Sesquioxide of Iron 80	{ 3 eq. Oxygen .. 24	2 eq. Sesquichlor. Iron.... 164
	{ 2 eq. Iron 56	
191	191	191

As the sesquioxide of iron employed frequently contains a small portion of protocarbonate of iron, a little protochloride of iron is formed, and slight effervescence, owing to the escape of carbonic acid, takes place. Both the chlorides of iron are soluble in water as well as in spirit.

PROPERTIES.—This tincture is of a reddish brown colour, and stains white paper yellow. It has a sour styptic taste, and an odour of hydrochloric ether, from which it would appear that a mutual reaction takes place between the hydrochloric acid and the alcohol. It reacts on vegetable colours as an acid. "Its sp. gr. is about 0.992, and a fluid ounce yields, when decomposed by potash, nearly 30 grains of sesquioxide of iron." (Mr. R. Phillips, *Transl. of the Lond. Pharm.*)

Characteristics.—Its reaction on vegetable colours, its inflammability, its remarkable odour, its affording chloride of silver when treated by nitrate of silver, and its reaction, like the other ferruginous compounds (p. 689,) are properties sufficient to characterize it. It forms a brown semi-transparent jelly with mucilage of gum arabic.

COMPOSITION.—This tincture consists of *Rectified Spirit*, a small portion of *Hydrochloric Ether*, *Hydrochloric Acid*, *Sesquichloride of Iron*, and a little *Proto-chloride of Iron*. Unless excess of hydrochloric acid be present, sesquioxide of iron is thrown down when the tincture is exposed to the air, owing to the iron of the chloride attracting oxygen, and becoming sesquioxide.

Sesquichloride of iron has the following composition:—

	Atoms.	Eq. Wt.	Per Cent.	J. Davy.
Iron.....	1	28	34.15	35.1
Chlorine.....	14	54	65.85	64.9
Sesquichloride of Iron.....	1	82	100.00	100.0

PURITY AND STRENGTH.—The commercial tincture of sesquichloride of iron varies in its strength, owing to the varying density of the hydrochloric acid employed. Moreover, a diluted spirit is frequently substituted for rectified spirit. These differences can only be discovered by examining the colour and specific gravity of the tincture, as well as the quantity of oxide which it yields.

PHYSIOLOGICAL EFFECTS.—Tincture of sesquichloride of iron is, in its local action, one of the most powerful of the preparations of iron. It acts as an energetic astringent and styptic, and in large doses as an irritant. The large quantity of free hydrochloric acid which the tincture of the shops frequently contains, contributes to increase its irritant properties; and in Dr. Christison's *Treatise on Poisons* is a brief notice of a case in which an ounce and a-half of this tincture was swallowed, and death occurred in about six weeks—the symptoms during life, and the appearances after death, being those indicative of inflammation of the alimentary canal. When swallowed in large medicinal doses it readily disorders the stomach. The general or constitutional effects of this preparation agree with those of other ferruginous compounds. It appears to possess, in addition, powerfully diuretic properties. Indeed it would seem to exercise some specific influence over the whole of the urinary apparatus; for on no other supposition can we explain the remarkable effects which it sometimes produces in affections of the kidneys, bladder, urethra, and even of the prostate gland. It colours the fæces black and usually constipates the bowels.

USES.—It is sometimes, though not frequently, used as a topical agent. Thus it is applied as a *caustic* to venereal warts, and to spongy granulations. As an *astringent* it is sometimes employed as a local application to ulcers attended with a copious discharge; or as a *styptic* to stop hemorrhage from numerous small vessels.

Internally it may be employed as a *tonic* in any of the cases in which the other ferruginous compounds are administered, and which I have already mentioned. It has been especially commended in scrofula.

In various affections of the urino-genital organs it is frequently used with great success. Thus, in retention of urine, arising from spasmodic stricture, its effects are sometimes beneficial. It should be given in doses of ten minims every ten minutes until benefit is obtained, which frequently does not take place until nausea is excited. It has been used with success in this malady by Mr. Cline; (*Med. Records and Researches*, Lond. 1798.) by Mr. Collins; (*Med. and Phys. Journ.* xvi. 250.) by Drs. Thomas, Eberle, and Francis; (*Eberle's Treat. on Mat. Med.* ii. 270, 2d ed.) and by Dr. Davy. (*Paris's Pharmacologia*, ii. 478, 6th ed.) However, Mr. Lawrence, (*Lond. Med. Gaz.* vi. 845.) alluding to Mr. Cline's recommendation of it, observes, "I believe general experience has not led others to place any very great confidence in the use of this remedy." In gleet and leucorrhœa it is sometimes serviceable. I have found it occasionally successful, when given in conjunction with the tincture of cantharides, in the latter stage of gonorrhœa, after a variety of other remedies had failed. In passive hemorrhage from the kidneys, uterus, and bladder, it is likewise employed with benefit.

ADMINISTRATION.—The dose of it is from ten to thirty minims gradually increased to one or two drachms, and taken in some mild diluent.

ANTIDOTES.—In a case of poisoning by it the treatment should be the same as for the mineral acids (see pp. 262 and 409.)

6. FER'RI AMMO'NIO-CHLO'RIDUM, L.—AMMONIO-CHLORIDE OF IRON.

[Ferrum Ammoniatum, U. S.]

HISTORY.—This compound, which was known to Basil Valentine, has had various appellations, such as *Flores Salis Ammoniaci martiales*, *Ferrum ammoniacale*, or *Ferrum ammoniatum*.

PREPARATION.—In the London Pharmacopœia it is directed to be thus prepared:—

Take Sesquioxide of Iron, ℥iij.; Hydrochloric Acid, Oss.; Hydrochlorate of Ammonia, lbjss.; Distilled Water, Oij. Mix the sesquioxide of iron with the hydrochloric acid in a proper vessel, and digest them in a sand-bath for two hours; afterwards add the hydrochlorate of ammonia, first dissolved in the distilled water; strain and evaporate the liquor. Lastly, rub what remains to powder.

[The U. S. Pharm. directs Sub-carbonate of Iron, ℥iij.; Muriatic Acid, f℥x.; Muriate of Ammonia, lbjss.; Distilled Water, Oiv. The steps are the same as above.]

By the mutual reaction of sesquioxide of iron and hydrochloric acid we obtain sesquichloride of iron and water, as explained at p. 692. A small portion of protochloride of iron will be produced if any carbonate of the protoxide of iron be mixed with the sesquioxide. By evaporating the solution thus procured with a solution of hydrochlorate of ammonia, we obtain a mixture of these bodies. There is no reason to believe that any chemical combination takes place.

PROPERTIES.—It is met with in the shops in the form of reddish orange-coloured crystalline grains, having a feeble odour and a styptic saline taste. It is deliquescent, and is soluble in both water and alcohol.

Characteristics.—Rubbed with quicklime or caustic potash, ammonia is evolved. Its solution affords chloride of silver when mixed with the nitrate of silver. It reacts as a persalt of iron (see p. 681.)

COMPOSITION.—It is a mechanical mixture of hydrochlorate of ammonia and sesquichloride of iron, in the following proportions:—

	Per Cent.
Sesquichloride of Iron.....	15
Hydrochlorate of Ammonia.....	85
Ferri Ammonio-Chloridum, Ph. L.....	100

It yields about 7 per cent. of sesquioxide of iron when decomposed by an alkali (Mr. R. Phillips.)

The yellow bands sometimes found in cakes of hydrochlorate of ammonia are probably a true chemical compound of sesquichloride of iron and hydrochlorate of ammonia (vide p. 289.)

Totally soluble in proof spirit and in water. Potash added to the solution throws down sesquioxide of iron; afterwards, when added in excess, it evolves ammonia. *Ph. Lond.*

PHYSIOLOGICAL EFFECTS.—It produces general effects of the ferruginous preparations; but, on account of the small and variable quantity of iron present, it is a compound which is of little value. The hydrochlorate of ammonia, which it contains, renders it alterative, and in large doses aperient.

USES.—It has been employed as a deobstruent in glandular swellings, in amenorrhœa, and other cases where the preparations of iron are usually employed.

ADMINISTRATION.—It may be given in substance in doses of from four to twelve or more grains.

TINCTURA FERRI AMMONIO-CHLORIDI, L. (Ammonio-Chloride of Iron, ℥iv.; Proof Spirit, Oj. M.)—"A fluid-ounce yields by decomposition 5·8 grains of sesquioxide of iron." (Phillips, *op. cit.*) It should be expunged from the Pharmacopœia.

7. FER'RI IO'DIDUM, L. E. D. [U. S.]—IODIDE OF IRON.

HISTORY.—We are indebted to Dr. A. T. Thomson for the introduction of this substance into medicine.¹ To distinguish it from other compounds of iodine and iron it is sometimes termed *Protoiodide of Iron*. Other names for it are *Ioduret*, *Hydriodate* or *Iodohydrate of Iron*.

PREPARATION.—Directions for the preparation of this compound are given both by the London and Edinburgh Colleges.

The *London College* orders of Iodine, ℥vj.; Iron Filings, ℥ij.; Distilled Water, Ojvss. Mix the Iodine with four pints of the water, and to these add the Iron. Heat them in a sand-bath, and when it has acquired a greenish colour, pour off the liquor. Wash what remains with the half-pint of water, boiling. Let the mixed and strained liquors evaporate at a heat not exceeding 212° in an iron vessel, that the salt may be dried. Keep it in a well-stoppered vessel, access of light being prevented.

[The U. S. Pharm. directs Iodine, ℥ij.; Iron filings, ℥i.; Water, Oiss. The same steps are to be taken.]

The *Edinburgh College* orders any convenient quantity of Iodine, Iron-wire, and Distilled Water in the proportions for making solution of Iodide of Iron [see *Ferri Iodidi Syrupus*.] Proceed as directed for that process; but before filtering the solution concentrate it to one-sixth of its volume, without removing the excess of iron-wire. Put the filtered liquor quickly in an evaporating basin, along with twelve times its weight of quicklime around the basin, in some convenient apparatus in which it may be shut accurately in a small space not communicating with the general atmosphere. Heat the whole apparatus in a hot air-press, or otherwise, until the water be entirely evaporated; and preserve the dry iodide in small well-closed bottles.

Fine soft iron-wire employed by the *Edinburgh College* is to be preferred to the iron filings used by the *London College*. It should be recently cleaned to free it from all rust.

In this process one equivalent or 126 parts of iodine combine with one equivalent or 28 parts of iron, and thereby form one equivalent or 154 parts of protoiodide of iron.

The *Edinburgh College* directs a considerable excess of iron to be used. The object of this is to prevent the deposition of sesquioxide of iron (formed by the union of part of the iron of the iodide with the oxygen of the air) during the evaporation of the solution of the iodide. For the same reason also, the general atmosphere is directed to be excluded during the evaporation, which is ordered to be carried on over quicklime, in order that the latter may absorb the aqueous vapour.

PROPERTIES.—By evaporation with as little contact of air as possible, solution of iodide of iron yields green tabular crystals. (Mr. R. Phillips, *Translation of the Pharmacopœia*.) If the solution be evaporated to dryness and the residue be moderately heated, this salt is fused, and on cooling becomes an opaque, iron-gray crystalline mass, with a metallic lustre.

Iodide of iron has a styptic taste. It is fusible, volatile, very deliquescent, and very soluble in both water and alcohol. It readily attracts oxygen from the air, and is thereby converted into a mixture of sesquioxide and sesquiodide of iron. "A solution of protoiodide of iron dissolves iodine abundantly, becoming brown, and possibly containing the sesquiodide $Fe^2 I^3$, but it is more likely that the iodine is not combined, as it is sensible to the test of starch." (Kane, *Elements of Chemistry*, p. 732.)

Characteristics.—When heated in the air it evolves violet vapours of iodine, while the iron attracts oxygen from the air and is converted into sesquioxide. If this be dissolved in an acid (hydrochloric, nitric, or sulphuric,) the liquid reacts as a solution of a persalt of iron (see p. 681.) Alkalis throw down from it the reddish brown sesquioxide of iron. Solution of protoiodide of iron, like that of other protosalts of iron, is green.

¹ *Observat. on the Preparation and Medicinal Employment of the Ioduret and Hydriodate of Iron*, 1834.

COMPOSITION.—The composition of crystallized iodide of iron is, according to Mr. R. Phillips, as follows:—

	Atoms.	Eq. Wt.	Per Cent.
Iron.....	1	93	14
Iodine.....	1	126	63.3
Water.....	5	45	22.7
Hydrated Iodide of Iron.....	I	199	100.0

PURITY.—It should be perfectly soluble in water. By exposure to the air it forms sesquioxide and sesquiodide of iron: (Cogswell, *Essay on Iodine and its Compounds*, p. 128, et seq.) the latter is soluble, the former is insoluble, in water. To preserve a solution of this salts, a coil of soft iron wire is to be kept immersed in it: this prevents the formation of sesquioxide of iron.

Emits violet vapours by heat, and sesquioxide of iron remains. When fresh prepared it is totally soluble in water. From this solution, when kept in a badly-stoppered vessel, sesquioxide of iron is very soon precipitated; but with iron wire immersed in it, it may be kept clear in a well-stoppered vessel. *Ph. Lond.*

Entirely soluble in water, or nearly so; forming a greenish solution. *Ph. Ed.*

PHYSIOLOGICAL EFFECTS. *α. On Animals.*—Three drachms of iodide of iron were administered to a dog: vomiting and purging were produced, but in three days the animal was well. One drachm dissolved in a drachm of water killed a rabbit in three hours and a-half, with the appearance of gradually-increasing debility: the stomach was found congested, and its lining membrane decomposed. Forty grains injected into the jugular vein of a dog killed the animal within twelve hours: the symptoms were dilatation of the pupils, staggering, vomiting, and bloody stools.¹

β. On Man.—In *small and repeated doses* its effects are not very obvious, save that of blackening the stools. It sometimes sharpens the appetite and promotes digestion. It passes out of the system in the urine, and both of its constituents may be detected in this fluid. When it does not purge, it frequently acts as a diuretic. In *full doses*, as ten grains, it on one occasion caused uneasy sensation at the epigastrium, nausea, slight heachach, copious black stool, and, in two hours, a larger quantity of urine, containing both iron and iodine. (Dr. A. T. Thomson, *op. cit.*) Its medicinal influence on the body seems to be stimulant, tonic, and alterative or deobstruent. It possesses the combined properties of iron and iodine.

USES.—Iodide of iron is indicated as a tonic and resolvent in cases of debility accompanied with a soft and relaxed condition of the solids, and paleness of the skin. It is especially applicable in scrofulous and strumous affections of the glandular system, in which the use both of iodine and iron is indicated.

In *tabes mesenterica*, and swellings of the cervical lymphatic glands, it often proves highly advantageous. In chlorosis, and in atonic amenorrhœa, Dr. Thomson found it serviceable; and his testimony of its good effects has been supported by that of others. Its operation must be promoted by exercise and an invigorating diet. In a case of anæmia, without any disturbance of the uterine function, I found it useless; while the compound iron mixture was of essential service. In secondary syphilis, occurring in debilitated and scrofulous subjects, it is in some cases, according to the testimony of both Dr. Thomson and Ricord, (*Journ. de Pharm.* xxiii. 303.) a valuable remedy. The last-mentioned writer employed it in the form of injection (composed of from half a drachm to a drachm of iodide dissolved in eight ounces of water) in blenorrhœas, and in that of lotion in venereal and carious ulcers. Dr. Pierquin (Quoted by Dierbach, *Neueste Entd. in d.*

¹ Sesqui-iodide of iron is said to produce the same effects, but to be more active than the iodide (*Lond. Med. Gaz.* June 15, 1841)

Mat. Med. 2^{te} Ausg.) employed it internally and externally in leucorrhœa and amenorrhœa. It has also been used in incipient cancer and in atonic dyspepsia (Thomson.)

ADMINISTRATION.—The dose of it is three grains gradually increased to eight or ten or more. Ricord has given forty grains per day. It may be exhibited in the form of tincture or of aqueous solution, flavoured with a little tincture of orange-peel. It must be remembered that acids, alkalis, and their carbonates, most metallic salts, all vegetable astringents, and many organic solutions, decompose it. Pierquin gave it in chocolate, Bourdeaux wine, distilled water, diluted spirit, or made into lozenges with saffron and sugar. In leucorrhœa and amenorrhœa he employed an ointment (composed of a drachm of iodide to an ounce of lard,) by way of friction in the upper part of the thighs.

FERRI IODIDI SYRUPUS, E.—*Syrup of Iodide of Iron.* (Iodine, dry, 200 grs.; Fine Iron-wire, recently cleaned, 100 grs.; White Sugar, in powder, ʒivss.; Distilled Water, f ʒvj. Boil the iodine, iron, and water together in a glass matrass, at first gently to avoid the expulsion of iodine-vapour, afterwards briskly, until about two fluid ounces of liquid remain. Filter this quickly, while hot, into a matrass containing the sugar. Dissolve the sugar with a gentle heat; and add distilled water, if necessary, to make up six fluid ounces.—Twelve minims contain one grain of iodide of iron.) This preparation is a very convenient form for the exhibition of iodide of iron, as it is not so readily decomposed as an aqueous solution of this salt.¹ In the Edinburgh Pharmacopœia it is described as being "colourless, or pale green; transparent; without sediment, even when exposed to the air."

[An analogous preparation is the *Liquor Ferri-Iodidi*, U. S., prepared as follows. Iodine, two ounces; Iron Filings, an ounce; Prepared Honey, five fluid ounces; Distilled Water, a sufficient quantity. Mix the Iodine with ten fluid ounces of the Distilled Water in a porcelain or glass vessel, and gradually add the Iron Filings, stirring constantly. Heat the mixture gently until the liquor acquires a light greenish colour; then having added the Honey, continue the heat a short time and filter. Lastly, pour Distilled Water upon the filter and allow it to pass until the whole of the filtered liquor measures twenty fluid ounces. To be kept in closely stopped bottles. The dose is 10 to 30 min. This formula is in accordance with the suggestion of Mr. Wm. Procter, jr.]

8. FERRI SULPHURETUM, E. D.—SULPHURET OF IRON.

NATURAL HISTORY.—In the mineral kingdom sulphur and iron are frequently met with in combination. *Common Iron Pyrites*, commonly termed *Mundic*, is a bisulphuret of iron. *White Iron Pyrites*, or *Cockscomb Pyrites*, differs from mundic in its specific gravity, the shape of its crystal, and its tendency to decompose on exposure to the air, and thereby to furnish sulphate of iron. *Magnetic Iron Pyrites* contains a less proportion of sulphur.

PREPARATION.—Directions for the preparation of sulphuret of iron are given in both the Edinburgh and Dublin Pharmacopœias.

The *Edinburgh College* states that "the best sulphuret of iron is made by heating an iron rod to a full white heat in a forge, and rubbing it with a roll of sulphur over a deep vessel filled with water, to receive the fused globules of sulphuret which form. An inferior sort, good enough, however, for pharmaceutical purposes, is obtained by heating one part of sublimed sulphur and three of iron filings in a crucible in common fire till the mixture begins to glow, and then removing the crucible and covering it, until the action, which at first increases considerably, shall come to an end."

¹ For some observations on the chemical properties of Sirup of Iodide of Iron, see Wackenroder in the *Pharmaceutisches Central-Blatt* für 1839, S. 628. See also some remarks on *Ioduretum Ferri Saccharatum*, by Kerner, in *Berlinisches Jahrbuch für die Pharmacie*, Bd. xlii. S. 212, 1839.

The *Dublin College* direct, that a rod of iron should be exposed to the strongest heat of a forge, until it becomes white hot, and, when taken from the fire, let it instantly be applied to a solid mass of sulphur. Let the sulphuret of iron be received in water; and, when separated from the sulphur and dried, let it be preserved in closed vessels.

The sulphur and iron enter into combination, and form sulphuret of iron.

PROPERTIES.—The appearance of sulphuret of iron varies somewhat according to the mode of procuring it. If properly prepared it gives out abundance of sulphuretted hydrogen gas, when mixed with either diluted sulphuric or muriatic acid, while a ferruginous solution is obtained.

COMPOSITION.—Its composition is liable to some variation. The best is a protosulphuret of iron, and consists of 1 equivalent or 10 parts of *sulphur*, combined with 1 equivalent or 28 parts of *iron*. Sometimes, however, a compound containing a larger proportion of sulphur is found.

USES.—It is employed as the source of sulphuretted hydrogen (see p. 412.)

9. FER'RI FER'RO-SESQUICYAN'IDUM.—FERRO-SESQUICYANIDE OF IRON.

(Ferri Percyanidum, L.—Ferri Cyanuretum, D.)—[Ferri Ferro-cyanuretum, U. S.]

HISTORY.—This compound was accidentally discovered at the commencement of the last century by Diesbach and Dippel. It was termed *Prussian* or *Berlin Blue* (*Ceruleum Borussiaicum seu Berolinense*.) It is sometimes termed *Ferroprussiate of Iron*.

PREPARATION.—It is sometimes prepared by mixing a solution of persulphate or perchloride of iron with a solution of ferrocyanide of potassium.

[To obtain *Pure Ferrocyanuret of Iron* the U. S. Pharmacopœia directs, to take Sulphate of Iron, four ounces; Sulphuric Acid, three fluid drachms and a-half; Nitric Acid, six fluid drachms, or a sufficient quantity; Ferrocyanuret of Potassium, four ounces and a-half; Water, two pints. Dissolve the Sulphate of Iron in a pint of the Water, and, having added the Sulphuric Acid, boil the solution. Pour into it the Nitric Acid, in small portions, boiling the liquid for a minute or two after each addition, until it no longer produces a dark colour; then allow the liquid to cool. Dissolve the Ferrocyanuret of Potassium in the remainder of the Water, and add this solution gradually to the first liquid, agitating the mixture after each addition, then pour it upon a filter, wash the precipitate with boiling water until the washings pass tasteless. Lastly, dry it and rub it into powder.]

In commerce it is procured by adding a mixture of two parts of alum and one of sulphate of iron to an impure solution of ferrocyanide of potassium (called blood-lye or *lixivium sanguinis*.) A dingy-green precipitate falls, which, by repeated washing with very dilute hydrochloric acid, and exposure to the air, becomes gradually of a deep blue. It is then collected and drained on a cloth, and afterwards dried.

By the reaction of ferrocyanide of potassium on sulphate of the protoxide of iron, sulphate of potash is formed in solution, and a white precipitate subsides, which, by exposure to the air, becomes blue (see p. 701.) Ferrocyanide of potassium, with sulphate of the sesquioxide of iron, forms sulphate of potash and ferro-sesquicyanide of iron. Commercial Prussian blue contains alumina, (derived from the alum,) and usually some sesquioxide of iron.

The following diagram illustrates the reaction of ferrocyanide of potassium on sulphate of the sesquioxide of iron:—

MATERIALS.	COMPOSITION.	PRODUCTS.
4 eq. Sesquisulph. Iron..... 400	6 eq. Sulphuric Acid..... 240	6 eq. Sulphate of Potash..... 528
	4 eq. Sesquioxide of Iron..... 160	
3 eq. Ferrocyanide of Potassium.... 558	6 eq. Oxyg. 48	6 eq. Sesq. Iron 268
	4 eq. Iron. 112	
	6 eq. Cyanide of Potassium = 396	1 eq. Ferrosesquicyde Iron. 430
	6 eq. Pot. 240	
	6 eq. Cyan. 156	
	3 eq. Cyanide of Iron..... 162	
	958	958

PROPERTIES.—Prussian blue occurs in masses of a rich dark blue colour. It is tasteless and inodorous. When broken it has a copper or bronze tint, somewhat like that of indigo, but which is distinguished from that of the latter by its being removed by rubbing with the nail. It is insoluble in water, alcohol, and the diluted mineral acids. Strong sulphuric acid forms with it a white pasty mass, from which water again separates Prussian blue. Both nitric acid and chlorine decompose it. Hydrochloric acid abstracts part of its iron.

Characteristics.—Its colour and copper tint above described form part of its characteristics. Boiled with water and binoxide of mercury it yields bityanide of mercury (see p. 631.) Boiled with solution of potash it forms ferrocyanide of potassium. Heated in a retort it yields water, hydrocyanate of ammonia, then carbonate of ammonia, and leaves a black, carbonaceous, and ferruginous mass.

The blue precipitate which falls when red prussiate of potash is added to a protosalt of iron, is called TURNBULL'S BLUE. It consists of 5 eq. Iron and 6 eq. Cyanogen; or 3 eq. Protoeyanide of Iron and 2 eq. Sesquicyanide of Iron. Liebig calls it *Ferrideyanide of Iron*. It is distinguished from Prussian blue by the circumstance that when boiled in a solution of yellow prussiate of potash, it affords red prussiate of potash, which dissolves, and a gray insoluble residue of ferrocyanide of iron and ferrocyanide of potassium.

BASIC PRUSSIAN BLUE, or the *Basic Sesquiferrocyanide of Iron*, is a compound of 1 eq. Prussian Blue and two equivalents of Sesquioxide of Iron. It is soluble in water. It is formed by exposing *ferrocyanide of potassium and iron* (the bluish white precipitate formed when yellow prussiate of potash is added to a protosalt of iron) to the air. Oxygen is absorbed, and two products are obtained—viz. Basic Prussian Blue and Yellow Prussiate of Potash. 2 eqs. of Ferrocyanide of Potassium and Iron ($Fe^{10} Cy^{12} K^2$) with 3 eqs. Oxygen (O^2) yield 1 eq. Yellow Prussiate of Potash ($Fe Cy^2 K^2$) 1 eq. Prussian Blue ($Fe^3 Cy^2$) and 2 eqs. Sesquioxide of Iron ($Fe_2 O^2$).

COMPOSITION.—The following is the composition of pure and anhydrous Prussian blue:—

	Atoms.	Eq. Wt.	Per Cent.		Atoms.	Eq. Wt.	Per Cent.
Iron	7	196	45.5	} Protoeyanide of Iron 3	3	162	37.8
Cyanogen	9	234	54.5		} Sesquicyanide of Iron 4	4	268
Ferrosesquicyanide of Iron..	1	430	100.0			1	430

Prussian blue appears to contain also the elements of water, of which it cannot be deprived without the destruction of the compound.

PURITY.—Prussian blue of commerce usually contains alumina and sesquioxide of iron. These may be detected by boiling the suspected compound with diluted hydrochloric acid, which dissolves both the impurities. Caustic ammonia added to the filtered solution throws down the impurities; excess of the alkali will redissolve the alumina.

It is pure if, after being boiled with dilute hydrochloric acid, ammonia throws down nothing from the filtered solution. *Ph. Lond.*

PHYSIOLOGICAL EFFECTS. *a. On Animals.*—Coullon gave it to dogs and sparrows without killing them; and Schubarth states that the only effect produced on a dog by two drachms was dejection. (*Wibmer, Wirk. d. Arzneim.* ii. 356.)

β. On Man.—Its effects on man are not very obvious. It is reputed alterative, tonic, and febrifuge. Sachs (*Handwört. d. prakt. Arzneim.* ii. 557.) calls it a resolvent tonic.

USES.—It has been recommended by Dr. Zollicoffer¹ as a more certain, prompt, and efficacious remedy for intermitting and remitting fevers than cinchona; and particularly adapted for children, on account of its insipidity and smallness of dose. It may be administered during the paroxysm as well as in the intermission, and does not disagree with the most irritable stomach. Hosack,² Eberle, (*Mat. Med.* i. 233.) and others, have borne testimony to its good

¹ *Treatise on the Use of Prussian Blue in Intermitting and Remitting Fevers*, Maryland, 1822.
² *New York Medical and Physiological Journal*, 1823, quoted by Richter, *Ausf. Arzneim.*

effects. Subsequently, Zollickoffer found it useful in dysentery. Kirchoff (Froriep's *Notizen*, Bd. xvij. 340.) used it for many years in epilepsy, with the best results, having cured some cases of several years' standing. It has also been employed by Dr. Bridges, of Philadelphia, (*United States Dispensatory*.) in a case of severe and protracted facial neuralgia, with very considerable relief. Lastly, it has been used in the form of ointment, as an application to foul ulcers.

In pharmacy it is employed in the manufacture of bichloride of mercury.

ADMINISTRATION.—The dose of commercial Prussian blue is from four to six or more grains every four hours. The ointment above referred to may be prepared with a drachm of Prussian blue and an ounce of lard.

10. POTASSII FERROCYANIDUM, L. E.—FERROCYANIDE OF POTASSIUM.

[Potassii Ferrocyanuretum, U. S.]

HISTORY.—This salt was accidentally discovered at the commencement of the last century. It has had a variety of appellations, such as *Prussiate of Potash*, *Ferroproussiate of Potash*, and *Ferrocyanate of Potash*.

PREPARATION.—The usual method of obtaining it is the following:—"Into an egg-shaped iron pot, brought to moderate ignition, project a mixture of good pearl-ash and dry animal matters, of which hoofs and horns are the best, in the proportion of two parts of the former to five of the latter. Stir them well with a flat iron paddle. The mixture, as it calcines, will gradually assume a pasty form, during which transition it must be tossed about with much manual labour and dexterity. When the conversion into a chemical compound is seen to be completed by the cessation of the fœtid animal vapours, remove the pasty mass with an iron ladle. If this be thrown, while hot, into water, some of the Prussic acid will be converted into ammonia, and of course the usual product diminished. Allow it to cool, dissolve it in water, clarify the solution by filtration or subsidence, evaporate, and, on cooling, yellow crystals of the ferroproussiate of potash will form. Separate these, re-dissolve them in hot water, and by allowing the solution to cool very slowly, larger and very regular crystals may be had." (*Ure's Dictionary of Chemistry*.)

"Mr. Charles Mackintosh, of Glasgow, who is one of the largest manufacturers of this salt, informs me that the animal matters employed as the source of cyanogen are chiefly chips of horns, animal hoofs, woollen rags, and the substance called *greaves*, which is the refuse of tallow-melters, and consists chiefly of cellular membrane from which the fat has been expressed: these are burned, and in fact, fused at a very high heat with potash, to form what is called *prussiate cake*; this, when cold, is lixiviated with water, and the evaporated solution yields a first crop of very impure ferroproussiate; it is redissolved, and the second crystallization is allowed to go on very slowly, it being at least a fortnight before the contents of the coolers are disturbed. The iron requisite to the constitution of this salt is derived from the iron pots and stirrers used in the operation, or, if requisite, iron filings are added" (Brande.)

The following explanation of the theory of this process is from Liebig.¹ When animal substances containing carbon and nitrogen are fused with potash at a red heat, the potassium is reduced by the carbon, and forms by its reaction on the other ingredients cyanuret of potassium. The fused mass at a red heat contains no ferrocyanogen, but iron and carburet of iron in the form of a suspended powder. When it is lixiviated with cold water and immediately evaporated, it furnishes no ferrocyanuret; but when the solution is gently heated for several hours in the contact of air, oxygen is absorbed, it acquires a yellow colour, and now contains much ferrocyanuret of potassium. This explains why a solution of cyanuret of potassium in pure water and in the presence of finely divided metallic iron, absorbs the oxygen of the air in passing into the state of oxide of potassium and dissolving the metal; the potassium of the cyanuret, in yielding to the iron the cyanogen with which it was combined, and so forming

¹ See *Phil. Mag.* for June, 1841; also *Proceedings of the Chemical Society*, p. 2.

cyanuret of iron, enables it to combine with the remaining undecomposed cyanuret of potassium to form ferrocyanuret of potassium. In close vessels the solution of iron by cyanuret of potassium evolves hydrogen. The fused mass also contains free potassa, which, by being boiled with the cyanuret of potassium, decomposes it into formiate of potassa and ammonia. When animal substances are fused in open vessels with potassa, cyanate of potassa is formed, which is decomposed by boiling into ammonia and bicarbonate of potassa: the quantity of ammonia formed being in proportion to the loss of cyanuret of potassium.

The best way of converting the whole of the cyanuret into ferrocyanuret of potassium, is to treat one-third of a cold solution of the raw mass with proto-sulphate of iron, as long as a precipitate falls, and then to add the remaining two-thirds of the solution, and heat the whole to the boiling point; the solution may then be evaporated without decomposition, and the sulphate of potassa is easily separated by crystallization from the ferrocyanuret. The original solution of the fused mass generally contains sulphuret and sulphocyanuret of potassium, and formiate and carbonate of potassa, which remain in the mother liquor (Brande.)

Mr. L. Thompson has observed that cyanuret of potassium is abundantly formed when an ignited mixture of coke or charcoal, carbonate of potassa, and iron-filings, is exposed to the action of the air. In that process he says the potassa is decomposed by the iron, and that the evolved potassium combines with the carbon, and also with the nitrogen of the atmosphere; and that the cyanuret of potassium results from this action. He proposes to apply the process to the manufacture of Prussian blue," (Brande.) (*Trans. Soc. Arts*, iii. 24.)

PROPERTIES.—This salt crystallizes in large, beautiful, lemon-yellow, transparent, permanent, inodorous, tabular crystals, whose form is the octohedron with a square base, usually more or less truncated.

FIG. 98.



Truncated octohedron of ferrocyanide of potassium.

FIG. 99.



Octohedron (primary form) of ferrocyanide of potassium.

They have a peculiar toughness or flexibility somewhat analogous to selenite. Their sp. gr. is 1.832. They have a sweetish, yet somewhat bitter, saline taste. They are insoluble in alcohol, but dissolve readily in both hot and cold water. When moderately heated they evolve about 13 per cent. of water of crystallization, and are converted into a white friable powder (anhydrous ferrocyanide of potassium.) When heated to redness in contact with air, the cyanide of iron of the salt is decomposed, and the residuum consists of cyanide of potassium, oxide of iron, and carbon: by a more continued heat hydrocyanic acid and ammonia are evolved, while the residue consists of sesquioxide of iron and carbonate of potash.

Characteristics.—A solution of this salt throws down, with the protosalts of iron, a white precipitate (*ferrocyanide of potassium and iron*, see p. 701.) which by exposure to the air becomes blue (*Basic Prussian Blue*, see p. 701.) With the persalts of iron it forms a deep blue (*Prussian Blue*;) with the salts of copper a deep brown (*Ferrocyanide of Copper*;) and with those of lead a white precipitate (*Ferrocyanide of Lead*.) Heated with dilute sulphuric acid, hydrocyanic acid is evolved, and a white precipitate formed, which, by exposure to the air, becomes blue. Hydrosulphuric acid, the sulphurets, alkalis, or tincture of galls, give no

precipitate with a solution of this salt; showing that the iron which it contains is in some remarkable state of combination. If a solution of the ferrocyanide of potassium be boiled with binoxide of mercury, bicyanide of mercury is formed in solution, and a mixture of sesquioxide and cyanide of iron is precipitated. The presence of potassium is best shown by calcining the salt, and detecting potash by the usual tests in the residuum. If chlorine be passed through a solution of ferrocyanide of potassium, it abstracts one equivalent of potassium from every two equivalents of the ferrocyanide, by which one equivalent of the ferrosesquicyanide of potassium (*Red Prussiate of Potash*) is formed in solution, and by evaporation this salt may be obtained in the form of red crystals, which throw down a blue precipitate (*Turnbull's Blue*, see p. 699) with the protosalts of iron, but occasion no change with the persalts of iron.

COMPOSITION.—Crystallized ferrocyanide of potassium has the following composition:—

	Atoms.	Eq. Wt.	Per Cent.	Or,	Atoms.	Eq. Wt.	Per Cent.
Cyanogen.....	3	78	36.620	Cyanide of iron.....	1	54	25.35
Iron.....	1	28	13.145	Cyanide of Potassium..	2	132	61.97
Potassium.....	2	80	37.500	Water.....	3	27	12.67
Water.....	3	27	12.675				
Crystd. Ferrocyanide } Potassium..... }	1	213	100.000	1	213	99.99

Totally dissolved by water. A gentle heat evaporates 12.6 parts from 100 parts. It slightly [if at all] alters the colours of turmeric. What it throws down from the preparation of sesquioxide of iron is blue, and that from the preparations of zinc is white. When burnt, the residue dissolved by hydrochloric acid is again thrown down by ammonia; 18.7 parts of sesquioxide of iron are yielded by 100 parts. *Ph. Lond.*

PHYSIOLOGICAL EFFECTS. *α. On Animals.*—Schubarth (*Wibmer, Wirk. d. Arzneim.*) gave two drachms to one dog, and half an ounce to another, without observing any injurious consequences. Callies (*Wibmer, op. cit.*; also Christison's *Treat. on Poisons.*) found the commercial ferrocyanide of potassium slightly poisonous, but when prepared with care he remarked that several ounces might be given with impunity. These and other experiments show that this salt possesses very little activity. The rapidity with which it is absorbed and gets into the secretions, as the urine, is most remarkable. Westrumb (*Müller's Physiology*, by Baly, i. 247.) recognised it in the urine, in from two to ten minutes after it was taken into the stomach. Hering (*Lond. Med. Gaz.* iv. 250.) has shown the amazing rapidity with which it traverses the body when it once gets into the blood. Thus, when it was placed in one jugular vein of a horse, he recognised it in the opposite one in from twenty to thirty seconds.

β. On Man.—It has no great influence on man. D'Arcet swallowed half a pound of a solution of this salt, prepared as a test, without any ill effects. (Mérat and De Lens, *Dict. Mat. Méd.* ii. 532.) "Similar results," observes Dr. Christison, (*Treatise*, p. 699.) "were obtained previously with smaller doses by Wollaston, Marcet, Emmert, as well as afterwards by Dr. Macneven and Schubarth, who found that a drachm or even two drachms might be taken with impunity by man and the lower animals."

Dr. Smart, (*Amer. Journ. of Med. Sciences*, xv. 362.) however, regards it as possessed of some activity. He asserts that its primary action is that of a sedative, softening and diminishing the fulness and frequency of the pulse, and allaying pain and irritation. In a healthy person, he says, a full dose will often reduce the number of pulsations ten beats in a minute, in a few minutes after being taken; and in a diseased state of the system, accompanied with increased arterial action, the sedative effects are much more striking. Occasionally also it acts as a diaphoretic (in cases accompanied with excessive vascular action and increased heat of skin) and astringent, as seen in its power of diminishing excessive discharges. In some cases, he says, it caused ptialism, with redness, swelling, and tenderness of the

gums, but unaccompanied with swelling of the salivary glands or fetor. An overdose, he tells us, occasions vertigo, coldness, and numbness, with a sense of gastric sinking; sometimes universal tremors, as in an ague fit. Farther evidence, however, is required to confirm these statements, which do not accord with the observations before reported.

USES.—Hitherto it has rarely been employed in medicine. Dr. Smart employed it as a sedative in diseases of increased action of the vascular system and morbid sensibility of the nerves, as in erysipelas, to allay pain, in cephalalgia, in inflammation of the brain, in chronic bronchitis, &c. In the last-mentioned disease it lessened the frequency of pulse, the sweating, the cough, and the dyspnoea. As an anodyne, he gave it in neuralgia. In hooping-cough he speaks highly of it. As an astringent, he administered it to check colliquative sweating in chronic bronchitis and phthisis, to diminish leucorrhœal discharge and to allay diarrhœa. Rau (Dierbach, *Neueste Entd. in d. Mat. Med.* i. 371. 1837.) employed it in calculous complaints.

ADMINISTRATION.—The dose, according to Dr. Smart, is from ten to fifteen grains, given in the form of solution every four or six hours. Rau gave as much as forty grains at a dose, and I have no doubt that very much larger doses may be given with safety.

11. FERRI SULPHAS, L. E. D. [U. S.]—SULPHATE OF IRON.

HISTORY.—Sulphate of iron is one of the substances which Pliny (*Hist. Nat.* xxxiv. 32.) termed *Chalcanthum*. This is evident from the circumstance of his statement that the Romans called it *Atramentum Sutorium* or *Shoemaker's Black*. It is frequently termed *Copperas*, and in consequence has been sometimes confounded with the salts of copper: (Dr. Cummin, *Lond. Med. Gaz.* xix. 40.) *Green Vitriol* (*Vitriolum Viride*), *Vitriol of Mars* (*Vitriolum Martis*), *Salt of Mars* (*Sal Martis*), *Vitriolated Iron* (*Ferrum Vitriolatum*), are other names by which it is known.

NATURAL HISTORY.—It is found dissolved in some mineral waters, (*sulphated chalybeates*, vide p. 249.) as those of the Hartfell Spa, Scotland. In the *aluminous chalybeate* waters it is associated with sulphate of alumina; as in the water of Sand Rock, Isle of Wight. The strong Moffat chalybeate, and Vicar's Brig chalybeate, contain the sulphate of the sesquioxide of iron. Sulphate of iron is also found in the waters of several copper mines.

Sulphate of the protoxide of iron is rarely met native in the crystallized state. It occurs, however, in Rammelsberg mine, near Goslar; at Schwartzenburg, in Saxony; at Hurlet, near Paisley; and in New England. (Phillip's *Mineralogy*, by Allan.)

Dr. Thomson (*Outlines of Mineralogy*, vol. i.) has described two native sulphates of the sesquioxide of iron, and an aluminous protosulphate.

PREPARATION.—Sulphate of the protoxide of iron is prepared by dissolving clean unoxidized iron in diluted sulphuric acid.

The *London College* orders, of Iron Filings, ℥viiij.; Sulphuric Acid, ℥xiv.; Water, Oiv. Mix the Sulphuric Acid with the Water, and add the Iron to them; then apply heat, and when bubbles have ceased to escape, strain the liquor, and set it aside that crystals may be formed. Evaporate the liquor poured off, that it may again yield crystals. Dry them all.

The *Edinburgh College* observes, that if the Sulphate of Iron of commerce be not in transparent green crystals, without efflorescence, dissolve it in its own weight of boiling water, acidulated with a little sulphuric acid; filter, and set the solution aside to crystallize. Preserve the crystals in well-closed bottles.

The *Dublin College* orders, of Iron Wire, four parts; Sulphuric Acid, seven parts; Water, sixty parts.

[The U. S. Pharm. directs Iron Wire cut into pieces, twelve ounces; Sulphuric Acid, eighteen ounces; Water, a gallon. The subsequent steps are essentially the same as above.]

In this process an equivalent or 28 parts of iron decompose one equivalent or 9 parts of water, combining with an equivalent or 8 parts of oxygen, and setting free an equivalent or 1 part of hydrogen, which escapes in the gaseous form. The equivalent or 36 parts of protoxide iron, thus formed, combines with an equivalent or 40 parts of sulphuric acid, to form an equivalent or 76 parts of sulphate of iron.

MATERIALS.		PRODUCTS.	
1 eq. Water.....	9	1 eq. Hydrogen.....	1
1 eq. Iron.....	28	1 eq. Protoxide Iron	36
1 eq. Sulphuric Acid..	40	1 eq. Sulphate of Iron....	76
	<u>77</u>		<u>77</u>

The *Common Green Vitriol*, or *Copperas* of the shops, is prepared by exposing heaps of moistened iron pyrites (bisulphuret of iron) to the air for several months. In some places the ore is previously roasted. The moistening is effected by rain or by manual labour. The pyrites attracts oxygen, and is converted into a super-sulphate of iron, which is dissolved out by lixiviation; and to the solution thus obtained old iron is added to saturate the free acid. It is then concentrated in leaden boilers, and run off into large vessels (lined with lead) to crystallize.

PROPERTIES.—Sulphate of the protoxide of iron crystallizes in transparent pale bluish green crystals, the form of which is the oblique rhombic prism. Their sp. gr. is 1.82. They have an acid, styptic taste, and redden litmus. By exposure to the air oxygen is absorbed, and they acquire, first, a yellowish and darker green tint, then slightly effloresce, and become covered with a yellow crust, which subsequently changes to brownish (*sulphate of the sesquioxide of iron.*) When heated the crystals undergo the watery fusion, give out water, and become white and pulverulent: at an intense heat they are deprived of their acid. They are soluble in water, but insoluble in alcohol. They require two parts of cold, and three-fourths of their weight of boiling water, to dissolve them. The solution has a bluish green colour, but by exposure to the air it attracts oxygen, becomes reddish yellow, and deposits a tetrasulphate of the sesquioxide of iron.

Characteristics.—It is known to be a sulphate by chloride of barium (see p. 406.) Binoxide of nitrogen communicates a deep olive colour to a solution of this salt (vide p. 266.) Ferrocyanide of potassium causes a white precipitate (*ferrocyanide of potassium and iron*, see p. 701.) which, by exposure to the air, becomes blue (*Basic Prussian Blue.*) If any sesquioxide be present, a bluish precipitate (*Prussian Blue*) is obtained. Alkalis throw down the greenish white hydrated protoxide of iron.

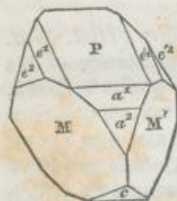
COMPOSITION.—The composition of this salt is as follows:—

	Atoms.	Eq. Wt.	Per Cent.	Berzelius.	Thomson.
Protoxide of Iron.....	1	36	25.9	25.7	26.7
Sulphuric Acid.....	1	40	28.8	28.9	28.3
Water.....	7	63	45.3	45.4	45.0
Crystallized Sulphate of the Protoxide of Iron.....	1	139	100.0	100.0	100.0

PURITY.—This salt is frequently mixed with sulphate of the sesquioxide: this may be known by the yellowish green colour of the crystals, and by the blue colour produced on the addition of ferrocyanide of potassium.

Colour bluish green; dissolved by water. Iron put into the solution does not precipitate copper. *Ph. Lond.*
Pale bluish green crystals, with little or no efflorescencé. *Ph. Edinb.*

FIG. 100.



Crystal of Sulphate of Iron.

The *Common Green Vitriol*, or *Copperas* of the shops, is a mixture of the sulphates of the protoxide and sesquioxide of iron. It sometimes contains copper, which may be recognised by immersing a clean iron spatula in a solution of it; the iron becomes encrusted with copper: or it may be detected by adding excess of caustic ammonia, and filtering the liquor. If copper be present, the liquor will have an azure blue tint. The ammoniacal liquid should yield, by evaporation, no fixed residuum.

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—Sir H. Davy (*Agricult. Chem.* 4th ed. 186.) ascribes the sterility of a soil to the presence of sulphate of iron.

β. On Animals.—C. G. Gmelin (*Vers. u. d. Wirk. &c.* 84.) found that two drachms of sulphate of iron given to a dog caused vomiting only; that forty grains had no effect on a rabbit; and that twenty grains, thrown into the jugular vein of a dog, produced no effect. Dr. Smith, (Quoted by Wibmer and by Christison.) however, found that two drachms proved fatal to a dog when taken into the stomach or applied to a wound. Orfila (*Toxicol. Gén.*) obtained similar results. The effects were local inflammation and a specific affection of the stomach and rectum. According to Weinhold, (Quoted by Richter, *Ausf. Arzneim.* v. 55.) the spleen of animals fed with it becomes remarkably small and compact.

γ. On Man.—This salt acts locally as a powerful astringent, and, when employed in a concentrated form, as an irritant. The latter effect depends on its chemical action on the organic constituents (albumen, &c.) of the tissues. The remote effects of sulphate of iron are analogous to those of other ferruginous compounds, and which have been already described.

Swallowed in *small doses* it has an astringent operation on the gastro-intestinal mucous membrane, and thereby diminishes the quantity of fluids secreted or exhaled: hence its continued use causes constipation. It blackens the stools like other compounds of iron. It becomes absorbed, and operates on the system as a tonic, stimulant, emmenagogue, and astringent. In *large medicinal doses* it readily excites pain, heat, or other uneasiness at the pit of the stomach, and not unfrequently causes nausea and vomiting: this is especially the case in irritable conditions of this viscus. In *excessive doses* it operates as an irritant poison. A girl took, as an emmenagogue, an ounce of it in beer, and was seized, in consequence, with colic pains, constant vomiting and purging for seven hours. Mucilaginous and oily drinks soon cured her. (Christison, from Rust's *Magazin*, xxi. 247.)

USES.—Sulphate of iron is to be preferred to other ferruginous compounds where there is great relaxation of the solid parts with immoderate discharges. Where the long continued use of ferruginous compounds is required, it is less adapted for administration than some other preparations of iron, on account of its local action on the alimentary canal.

It is employed in lump, powder, or solution, as a styptic, to check hemorrhage from numerous small vessels. A solution of it is applied to ulcerated surfaces, and to mucous membranes, to diminish profuse discharges; as in chronic ophthalmia, leucorrhœa, and gleet.

Internally it is administered in passive hemorrhages, on account of its supposed astringent influence over the system generally: also in immoderate secretion and exhalation; as in humid asthma, chronic mucous catarrh, old dysenteric affections, colliquative sweating, diabetes, leucorrhœa, gleet, &c. In intermittents it has been employed as a tonic. It has also been found serviceable against tape-worm. Its other uses are the same as the ferruginous compounds before mentioned.

ADMINISTRATION.—The dose of it is from one to five grains, in the form of a pill. If given in solution the water should be recently boiled, to expel the atmospheric air dissolved in it; the oxygen of which converts this salt into a persulphate. For local purposes, solutions of it are employed of various strengths, according to circumstances. In chronic ophthalmia we may use one or two grains to an ounce of water: as an injection in gleet, from four to ten grains.

1. FERRI SULPHAS EXSICCATUS, E.; *Dried Sulphate of Iron.*—(Expose any
Vol. I.—89

convenient quantity of Sulphate of Iron to a moderate heat in a procelain or earthenware vessel, not glazed with lead, till it is converted into a dry grayish white mass, which is to be reduced to powder.)—By exposure to a moderate heat the crystals lose $\frac{1}{4}$ ths of their water by crystallization; so that 85 grains of dried sulphate are equivalent to 139 grs. of the crystallized sulphate; or 3 grains are equal to $4\frac{1}{10}$ grs. of the crystals. The dried sulphate is used in the following preparation.

2. *PILULÆ FERRI SULPHATIS, E.*; *Pills of Sulphate of Iron.*—(Dried sulphate of Iron, *two parts*; Extract of Taraxacum, *five parts*; Conserve of Red Roses, *two parts*; Licorice-root powder, *three parts*. Beat them together into a proper mass, which is to be divided into five-grain pills.)—Each pill should contain $\frac{1}{5}$ of a grain of dried sulphate of iron.—Dose, one to three pills.

12. FERRI CARBONAS.—CARBONATE OF IRON.

HISTORY.—This compound must not be confounded with the sesquioxide of iron, which is frequently but improperly termed carbonate of iron (see p. 687.)

NATURAL HISTORY.—It occurs native in the crystallized state, constituting the mineral called *Spathose Iron*. It is also found in the *carbonated chalybeate waters* (see p. 248.)

PREPARATION.—It is prepared by adding a solution of an alkaline carbonate to a solution of a protosalt (as the sulphate) of iron, the atmospheric air being carefully excluded. The carbonate of the protoxide of iron is precipitated. When we attempt to collect and dry it, decomposition takes place; oxygen of the air is absorbed, carbonic acid escapes, and sesquioxide of iron remains (see *Ferri Sesquioxylum*, p. 687.) Hence when employed in medicine it must be prepared extemporaneously.

PROPERTIES.—Native protocarbonate of iron is yellow: the primary form of its crystals is the obtuse rhombohedron. Carbonate of iron prepared as above directed is a white precipitate, which by exposure to the air becomes at first greenish, then brown (*sesquioxide*.) It is insoluble in water, but dissolves in sulphuric or hydrochloric acid with effervescence. It also readily dissolves in carbonic acid water: the *acidulo-chalybeate waters* are natural solutions of this kind (see pp. 248 and 250.)

Characteristics.—It dissolves in diluted sulphuric acid with effervescence. The solution possesses the before-mentioned properties of the ferruginous solutions (see p. 682.)

COMPOSITION.—Carbonate of the protoxide of iron is thus composed:—

	Atoms.	Eq. Wt.	Per Cent.	Stromeyer.
Protoxide of Iron	1	36	62	59.6276
Carbonic Acid	1	22	38	38.0352
Carbonate of Iron	1	58	100	97.6628

PHYSIOLOGICAL EFFECTS AND USES.—It is one of the most valuable of the ferruginous compounds, on account of the facility with which it dissolves in the fluids of the stomach, and becomes absorbed. Its local effects are very mild.

Its uses are those of chalybeates in general, and which have been before mentioned.

1. *FERRI CARBONAS SACCHARATUM, E.* *Saccharine Carbonate of Iron.* (Sulphate of Iron, $\mathfrak{z}\text{iv}$.; Carbonate of Soda, $\mathfrak{z}\text{v}$.; Pure Sugar, $\mathfrak{z}\text{ij}$.; Water, Oiv . Dissolve the sulphate and carbonate each in two pints of the water; add the solutions and mix them; collect the precipitate on a cloth filter, and immediately wash it with cold water, squeeze out as much of the water as possible, and without delay triturate the pulp which remains with the sugar previously in fine

powder. Dry the mixture at a temperature not much above 120°.)—Dr. Becker, of Mühlhausen, suggested this compound. His idea was carried out by Klauer;¹ and hence this preparation is known on the continent as Klauer's *Ferrum Carbonicum Saccharatum*. The sugar checks, though it does not completely prevent, the farther oxidation of the iron. This preparation is a greenish powder,² composed of *sesquioxide of iron*, *sugar*, and *carbonic acid*, with some *sesquioxide of iron*. Its characters are, according to the Edinburgh College, as follows:—

Colour grayish-green; easily soluble in muriatic acid, with brisk effervescence.

It may be given in doses of from five to ten grains.

[This preparation is similar to the *Pilulæ Ferri Carbonatis* of the U. S. Pharmacopœia. *Vallet's ferruginous pills*. To make them, take Sulphate of Iron, ℥iv.; Carbonate of Soda, ℥v.; Clarified Honey, ℥ijss.; Syrup, Boiling Water, each a sufficient quantity. Dissolve the Sulphate of Iron and Carbonate of Soda each in a pint of the Water, and to each solution add a fluid ounce of syrup; then mix the two solutions in a bottle just large enough to contain them, close it accurately with a stopper, and set it by that the Carbonate of Iron may subside. Pour off the supernatant liquid, and having washed the precipitate with warm water, sweetened with syrup in the proportion of a fluid ounce of the latter to a pint of the former, until the washings no longer have a saline taste, place it upon a flannel cloth and express as much of the water as possible; then immediately mix it with the Honey. Lastly, heat the mixture, by means of a water bath, until it attains a pilular consistence. Dose the same.]

2. MISTURA FERRI COMPOSITA, L. E. D. (U. S.) *Compound Mixture of Iron; Griffith's Mixture*. (Myrrh, powdered, ℥ij.; Carbonate of Potash, ℥j.; Rose Water, ℥xxvij.; Sulphate of Iron, powdered, ℥ijss.; Spirit of Nutmeg, ℥j.; Sugar, ℥ij. Rub together the Myrrh with the Spirit of Nutmeg and the Carbonate of Potash; and to these, while rubbing, add first the Rose Water with the Sugar, then the Sulphate of Iron. Put the mixture immediately into a proper glass vessel, and stop it. *L.* The processes of the *Edinburgh* and *Dublin Colleges* are essentially the same.)—This is a professed imitation of Dr. Griffith's celebrated antihectic or tonic mixture.³

[The U. S. Pharmacopœia directs, Myrrh, a drachm; Carbonate of Potassa, twenty-five grains; Rose Water, seven fluid ounces and a half; Sulphate of Iron, in powder, a scruple; Spirit of Lavender, half a fluid ounce; Sugar, a drachm. Rub the Myrrh with the Rose Water gradually added, then mix with these the Spirit of Lavender, Sugar, and Carbonate of Potassa, and lastly, the Sulphate of Iron. Pour the mixture immediately into a glass bottle, which is to be well stopped.]

In the preparation of it, double decomposition takes place: by the mutual reaction of carbonate of potash and sulphate of iron we obtain sulphate of potash, which remains in solution, and carbonate of protoxide of iron, which precipitates. To prevent the latter attracting more oxygen, it is to be preserved in a well-stoppered bottle. The quantity of carbonate of potash directed to be used is almost twice as much as is required to decompose the quantity of sulphate of iron ordered to be employed. The excess combines with the myrrh, and forms a kind of saponaceous compound, which assists in suspending the carbonate of iron in the liquid.

When first made, this mixture has a greenish colour, owing to the hydrated ferruginous carbonate; but by exposure to the air it becomes reddish, owing to the absorption of oxygen, by which sesquioxide of iron is formed, and carbonic acid evolves: hence it should only be prepared when required for use.

¹ *Pharmaceutisches Central-Blatt für 1836*, S. 827; also, *Journ. de Pharmacie*, t. xxiii. p. 86.

² For some observations on its chemical properties see a paper by A. Buchner in the *Pharmaceutisches Central-Blatt für 1837*, S. 755.

³ *Pract. Observations on the Cure of Hectic and Slow Fevers, and the Pulmonary Consumption*. 1776.

It is one of the most useful and efficacious ferruginous preparations, and which is owing to its ready solubility, by which it is easily digested and absorbed. Its constitutional effects are analogous to those of the ferruginous compounds in general, and which have been already described. Its tonic and stimulant operation is promoted by the myrrh: the excess of alkaline carbonate must not be forgotten in estimating the sources of activity of this medicine.

It is admissible in most of the cases in which ferruginous remedies are indicated; but it is especially serviceable in anæmia, chlorosis, atonic amenorrhœa, and hysterical affections. It is also employed with benefit in the hectic fever of phthisis and chronic mucous catarrhs. It is contra-indicated in inflammatory conditions of the gastro-intestinal membrane.

The dose of it is one or two fluid ounces three or four times a-day. Of course acids and acidulous salts, as well as all vegetable astringents which contain gallic or tannic acid, are incompatible with it.

3. PILULÆ FERRI COMPOSITÆ, L. D. (U. S.) *Pilulæ Ferri Carbonatis*, E.; *Pilulæ Ferri cum Myrrhâ*; *Compound Pills of Iron*; *Pills of Carbonate of Iron*. (Myrrh, powdered, ℥ij.; Carbonate of Soda; Sulphate of iron; Treacle, of each, ℥j. Rub the myrrh with the carbonate of soda; then having added the sulphate of iron, rub them again; afterwards beat the whole in a vessel previously warmed, until incorporated, L. (U. S.)—The *Dublin College* orders, a drachm of Brown Sugar instead of Treacle.—The *Edinburgh College* orders, of Saccharine Carbonate of Iron, *four parts*; Conserve of Red Roses, *one part*. Beat them into a proper mass, to be divided into five-grain pills.)—Prepared according to the London and Dublin Colleges these pills are analogous in composition, effects, and uses, to the preceding preparation. Double decomposition takes place between the two salts employed, and the products are sulphate of soda and carbonate of iron. The carbonate of soda is preferred to the carbonate of potash, on account of the deliquescence of the latter. These pills, like the mixture, should only be made when required for use. The effects and uses of these pills are similar to those of the *Mistura Ferri composita*.—Dose, from grs. x. to grs. xx.

3. SUPERCARBONATED CHALYBEATES.—Carbonate of the protoxide of iron dissolves in water by the aid of carbonic acid. The *Carbonated Chalybeate Mineral Waters* (see p. 248) are solutions of this kind.

Artificial solutions of the carbonated chalybeates are prepared in various ways. A convenient extemporaneous solution is obtained by mixing intimately sulphate of iron and bicarbonate of soda (*sodæ sesquicarbonas*, L.) and dissolving them in a tumblerful of carbonic acid water (*bottled soda water*.) One hundred and thirty-nine grains of crystallized sulphate of iron require eighty-three grains of *sodæ sesquicarbonas*, L. to yield fifty-eight grains of carbonate of iron. It is advisable, however, to employ an excess of the sesquicarbonate of soda. If 10 grs. of sulphate of iron, and 10 grs. of the sesquicarbonate of soda L. be used, we shall obtain a solution of about 4 grs. of carbonate of iron, $2\frac{1}{2}$ grs. of sulphate of soda, and 5 grs. of sesquicarbonate of soda. The solution should be taken in a state of effervescence.

Another mode of preparing a solution of carbonate of iron is to add bicarbonate of soda to a solution of sulphate of iron acidulated by some acid, as sulphuric, tartaric, or citric acid.

13. POTASSÆ FERRO-TARTRAS.—FERRO-TARTRATE OF POTASH.

(Ferri Potassio-Tartras, L.—Ferrum Tartarizatum, E.—Ferri Tartarum, D.)

[Ferri et Potasse Tartras, U. S.]

HISTORY.—This preparation was first described by Angelus Sala at the commencement of the seventeenth century. Mr. R. Phillips¹ improved its mode of preparation. The late Dr. Birkbeck has described its medical properties. (*Lond. Med. Review*, No. xix. July, 1812.) Besides the above, it has had various other names; such as *Chalybeated Tartar* (*Tartarus chalybeatus seu ferratus*), and *Tartrate of Potash and Iron* (*Potassæ et Ferri Tartras*.)

PREPARATION.—Soubeiran (*Nouveau Traité de Pharmacie*, t. ii. p. 447, 2^{nde} éd.) directs this compound to be thus prepared: Take of Powdered Bitartrate of Potash, *one part*; Distilled Water, *six parts*; Moist Hydrated Sesquioxide of Iron, *as much as may be sufficient*: digest them, at the temperature of from 120° to 140° F., until the liquor ceases to dissolve a fresh quantity of hydrate; then filter, and evaporate to dryness by a gentle heat.

The process of the London College, according to Mr. Phillips, (*Translation of the Pharmacopœia*.) is a modification of that of Soubeiran. It is, however, much more complex.

The *London College* orders of Sesquioxide of Iron, ℥iij.; Hydrochloric Acid, Oss.; Solution of Potash, Oivss., or as much as may be sufficient; Bitartrate of Potash, ℥xiss.; Solution of Sesquicarbonate of Ammonia, Oj., or as much as may be sufficient; Distilled Water, Cong. iij. Mix the sesquioxide of iron with the acid, and digest for two hours in a sand-bath. Add to these two gallons of the water, and set aside for an hour: then pour off the supernatant liquor. The solution of potash being added, wash what is precipitated frequently with water, and while moist boil it with the bitartrate of potash, previously mixed with a gallon of the water. If the liquor should be acid when tried by litmus, pour into it solution of sesquicarbonate of ammonia until it is saturated. Lastly, strain the liquor, and with a gentle heat let it evaporate, so that the salt may remain dry.

[The U. S. P. directs, Subcarbonate of Iron, three ounces; Muriatic Acid, ten fluid ounces; Solution of Potassa, five pints and a-half; Bitartrate of Potassa, seven ounces and a-half; Distilled water a gallon and a-half. The process is essentially the same as above.]

The *theory* of this process is as follows:—By the reaction of sesquioxide of iron and hydrochloric acid we obtain water and sesquichloride of iron (see p. 692.) On the addition of caustic potash the sesquichloride is decomposed, hydrated sesquioxide of iron is precipitated, and chloride of potassium is left in solution. These changes are illustrated by the following diagram:—

MATERIALS.	COMPOSITION.	PRODUCTS.
3 eq. Potash 144	{ 3 eq. Potassium 120 3 eq. Oxygen . . . 24	3 eq. Chloride Potassium . . 228
2 eq. Sesquichlo- ride Iron 164	{ 3 eq. Chlorine . . 108 2 eq. Iron 56	2 eq. Sesquiox- ide Iron 80
Water		
308	308	308

} Hydrated
Sesqui-
oxide of
Iron.

When the hydrated sesquioxide of iron is boiled with bitartrate of potash, one equivalent or 40 parts of the sesquioxide combine with one equivalent or 66 parts of tartaric acid of the bitartrate of potash, and form an equivalent or 106 parts of tartrate of sesquioxide of iron, which combine with an equivalent or 114

¹ *An Experimental Examination of the last edition of the Pharmacopœia Londinensis*. 1811.

parts of tartrate of potash, to form one equivalent or 220 parts of ferrotartrate of potash.

MATERIALS.		PRODUCTS.	
1 eq. Sesquioxide of Iron	40	} 1 eq. Tartrate of Sesquiox. Iron.... 106	} 1 eq. Ferro-tartrate of Potash. 220
1 eq. Bitartrate of Potash	180		
	220		
		} 1 eq. Tartaric Acid.. 66	} 1 eq. Tartrate Potash 114

The *Edinburgh College* orders of Sulphate of Iron, $\mathfrak{z}\text{v}$.; Bitartrate of Potash, $\mathfrak{z}\text{v}$. and $\mathfrak{z}\text{j}$.; Carbonate of Ammonia in fine powder, a sufficiency. Prepare the Rust of iron from the sulphate as directed under Ferrugo, and without drying. Mix the pulpy mass with four pints of water; add the Bitartrate; boil till the rust of iron is dissolved; let the solution cool; pour off the clear liquid, and add to this the carbonate of ammonia so long as it occasions effervescence. Concentrate the liquid over the vapour bath to the consistence of a thick extract, or till the residuum becomes on cooling a firm solid; which must be preserved in well-closed vessels.

The explanation of the formation of hydrated sesquioxide of iron (here called Rust) has been already explained (see p. 690.) The theory of the other part of the process is the same as that of the process of the London Pharmacopœia.

The *Dublin College* orders of Iron, drawn into thin wire, *one part*; Bitartrate of Potash, in very subtle powder, *four parts*; Distilled Water, *eight parts*, or as much as may be sufficient. Let them be mixed, and exposed to the air during fifteen days in a wide vessel. Let the mixture, which is to be occasionally stirred, be kept constantly moist by the daily addition of water, taking care that the iron shall not be entirely covered by the water. Lastly, boil the product in a sufficient quantity of water, and let the filtered liquor evaporate to dryness over a water bath. Let the Tartar of Iron be kept in a well-stopped vessel.

By the united agencies of air and water the iron is converted into the sesquioxide, which combines with the bitartrate of potash to form tartarized iron.

PROPERTIES.—It is an olive-brown inodorous powder, with a styptic inky taste. It reacts on vegetable colours, mildly alkaline. It is slightly deliquescent, probably from the tartrate of potash which it contains. It dissolves in about four times its weight of water, and slightly in alcohol.

Characteristics.—Ferrocyanide of potassium does not occasion any blue colour with it, unless a few drops of acid be added. Potash, soda, and their carbonates, do not decompose it at ordinary temperatures, nor does ammonia or its carbonate even by the aid of heat. Tincture of nutgalls causes a dark-coloured precipitate, Sulphuric, nitric, or hydrochloric acid, throws down the sesquioxide of iron from a solution of this salt; an excess of acid redissolves it: the solution has then a very astringent taste. Tartaric acid causes the formation of crystals of tartar. Heated in a covered crucible, ferrotartrate of potash yields charcoal, carbonate of potash, and protoxide of iron.

COMPOSITION.—The following table exhibits the composition of this salt, according to Soubeiran and Phillips:—

	Phillips.			Soubeiran.	
	Atoms.	Eq. Wt.	Per Cent.		Per Cent.
Tartrate of Sesquioxide of Iron	1	106	48.18	Sesquitartrate of Sesquioxide	45
Tartrate of Potash	1	114	51.82	Tartrate of Potash	55
Ferro-tartrate of Potash	1	220	100.00	"	100

Soubeiran says it contains 13 per cent. of sesquioxide of iron; whereas, according to Mr. Phillips, the quantity is 18.18 per cent.

The ferrotartrate of potash is to be regarded as a double salt, in which tartrate of iron is the acid or electro-negative ingredient, and tartrate of potash the basic or electro-positive constituent. On this view, we comprehend why ferrocyanide

of potassium and the alkalis refuse to act on it in the way they do on the ordinary ferruginous salts, until an acid be added. Geiger (*Handb. d. Pharm.*) regards it as a combination of tartrate of iron and ferrate of potash.

PURITY.—In commerce we frequently meet with an imperfectly prepared compound, in which none or only part of the sesquioxide of iron is in chemical combination with bitartrate of potash. In this state it is only partially soluble in water, and the solution strikes a blue colour with the ferrocyanide of potassium, and throws down a reddish brown precipitate with solution of potash. The following are the characters of the properly prepared salt:—

Totally soluble in water: the solution does not change either litmus or turmeric: nor is it rendered blue by ferrocyanide of potassium; nor is any thing precipitated from it by any acid or alkali. The magnet does not act upon it. *Ph. Lond.*

Entirely soluble in cold water: taste feebly chalybeate: the solution is not altered by aqua potassæ, and not precipitated by solution of ferrocyanide of potassium. *Ph. Edinb.*

PHYSIOLOGICAL EFFECTS.—In its effects on the system it agrees, for the most part, with other ferruginous compounds. Its taste, however, is comparatively slight; its astringency is much less than the sulphate or sesquichloride, and consequently its constipating effects are not so obvious; and its stimulating influence over the vascular system is said to be somewhat milder. These peculiarities in its operation are supposed to depend on the tartaric acid and potash with which it is in combination.

USES.—It is not frequently employed, yet it is a very eligible preparation of iron, and may be employed wherever the ferruginous tonics are indicated.

ADMINISTRATION.—The dose of it is from ten grains to half a drachm, in the form of solution or bolus, combined with some aromatic.

14. FERRI ACETAS, D.—ACETATE OF IRON.

HISTORY.—A solution of iron in acetic acid has long been known and used in the arts. It constitutes the *Iron Liquor* of the dyer.

PREPARATION.—The *Dublin College* orders it to be prepared as follows:—

Take of Carbonate [Sesquioxide] of Iron, *one part*; Acetic Acid, *six parts*. Digest during three days, and filter.

PROPERTIES.—It is a deep-red liquid, having an acid chalybeate taste. It reddens litmus.

Characteristics.—When heated, it yields acetic acid. Ferrocyanide of potassium strikes a blue colour with it; infusion of galls a purplish black.

COMPOSITION.—It consists of the *Acetate of the Protoxide* and *Acetate of the Sesquioxide of Iron*.

The **PHYSIOLOGICAL EFFECTS** and **USES** are the same as other ferruginous compounds.—The dose is from ten to twenty-five drops, in water.

1. **FERRI ACETATIS TINCTURA, D.** (Acetate of Potash, *two parts*; Sulphate of Iron, *one part*; Rectified Spirit, *twenty-six parts*. Rub together the acetate and sulphate, then dry, and add the spirit. Digest for seven days in a well-stoppered bottle; then pour off the clear liquor, and preserve in a vessel perfectly closed.)—In this process sulphate of potash and acetate of iron are formed: the latter, as well as the excess of the acetate of potash, dissolves in the spirit. It is a claret-coloured tincture. It possesses the usual properties of a ferruginous compound. It is said to be an agreeable chalybeate, and was introduced into the *Dublin Pharmacopœia* by Dr. Perceval.—The dose is from half a drachm to a drachm.

2. **TINCTURA ACETATIS FERRI CUM ALCOHOLE, D.** (Sulphate of Iron; Acetate of Potash, *aa* ʒj.; Alcohol, Oij. [*wine measure*]. Triturate together the sulphate and acetate, then dry them, and when cold add the alcohol. Digest in a well-stoppered bottle for twenty-four hours.)—The dose is from twenty drops to a drachm.

OTHER FERRUGINOUS COMPOUNDS.

1. **FERRI PERSULPHAS**; *Persulphate of Iron*.—The mode of converting sulphate of the protoxide into sulphate of the sesquioxide of iron has been already pointed out (see p. 690.) Persulphate of iron combines with albumen to form a pale yellowish compound; (*Journ. de Chim. Méd.* t. vi. 2^e Série, p. 308.) on this property depends its chemical action on the tissues. Dr. Osborne (*Lond. Med. Gaz.* March 6, 1840, p. 892.) says, "Widow Welch's pills are composed of 'sulphate of peroxide of iron, with a small quantity of insipid vegetable matter, probably gum, as much as is requisite for adhesion.'" It is more probable, however, that they are prepared with the common sulphate of the shops, which is a mixture of protosulphate and persulphate of iron.

2. **FERRI PERNITRAS**; *Pernitrate of Iron*.—A solution of this salt has been employed as an astringent in diarrhœa.¹ It is prepared by dissolving iron in diluted nitric acid to saturation.

3. **AMMONIÆ FERRO-TARTRAS**; *Ferro-Tartrate of Ammonia*; *Tartrate of Iron and Ammonia*; *Aikin's Ammonia-Tartrate of Iron*. This salt was first employed in medicine by Mr. Aikin. (*Lond. Med. Gaz.* vol. viii. p. 438.)

It may be prepared by adding caustic ammonia to a solution of tartrate of iron (prepared by digesting together, for two or three days, one part of tartaric acid, dissolved in hot water, with two or three parts of iron filings.) The green solution thus obtained is to be evaporated to dryness by a gentle heat. (Aikin, *op. cit.*)

[The following formula for preparing this salt is communicated by Mr. Procter, *Am. Journ. of Pharmacy*, vol. xii. p. 276. Take of Tartaric Acid, ℥xij. and ℥iv; Carbonate of Ammonia, ℥iv., ℥vij. and ℥j; Sesquioxide of Iron, ℥vj., ℥v. and ℥j; Hydrochloric Acid, f℥xxij. f℥iv; Solution of Ammonia and water of each a sufficient quantity. Dissolve the tartaric acid in a gallon of the water and add the carbonate of ammonia gradually. A considerable quantity of a white crystalline powder subsides, which is bitartrate of ammonia and with which the supernatant liquid is saturated. Dissolve the sesquioxide of iron in the hydrochloric acid, by means of a gentle heat, dilute the solution with six pints of water and add a sufficient quantity of solution of ammonia to precipitate the sesquioxide. Separate this on a flannel filter, wash it with water until the washings pass tasteless, and add it to the solution containing the bitartrate of ammonia; then apply a gentle heat, by means of a water bath, until the whole of the sesquioxide of iron is dissolved and a deep reddish brown solution results. The solution thus obtained should be evaporated to dryness by means of a water bath.]

It is in the form of shining brittle fragments of a deep red colour, not very unlike pieces of deep-coloured shell-lac. It is very soluble in water. Its taste is strongly saccharine.

Its general effects are analogous to those of the other ferruginous compounds, except that it has very little if any astringency. Its advantages over other chalybeates are its ready solubility in water, its palatable taste, and the facility with which it may be mixed with various saline substances, without undergoing decomposition. It contains more oxide of iron than the same quantity of sulphate. The dose for an adult is five or six grains in powder, pill, or solution. It may be exhibited in porter without being detected by the taste. It may be added to the compound decoction of aloes without suffering decomposition.

A *Ferro-citrate of Ammonia* (called *Citrate of Iron*) is met with in the shops. Its properties are similar to those of the preceding preparation.

4. **FERRI LACTAS**; *Lactate of Iron*.—This salt occurs in beautiful small, green, acicular crystals. It has been used in medicine, (*British and Foreign Medical Review*, vol. x. p. 565.) though it does not appear to present any advantages over the other preparations of iron.

5. **VINUM FERRI**, Ph. L. 1809; *Wine of Iron*. (Iron Filings, ℥ij; Wine, [Sherry] Oij. [*wine measure*].) Mix and set the mixture by for a month, occasionally shaking it; then filter it through paper.—The iron is oxidized by the air and water, and the sesquioxide combines with the tartaric acid of the wine. It is properly discarded from the pharmacopœias.—Dose, ℥j. to ℥iv.

¹ See Dr. S. W. Williams, in the *Boston (U. S.) Medical and Surgical Journal*, April 7, 1841.