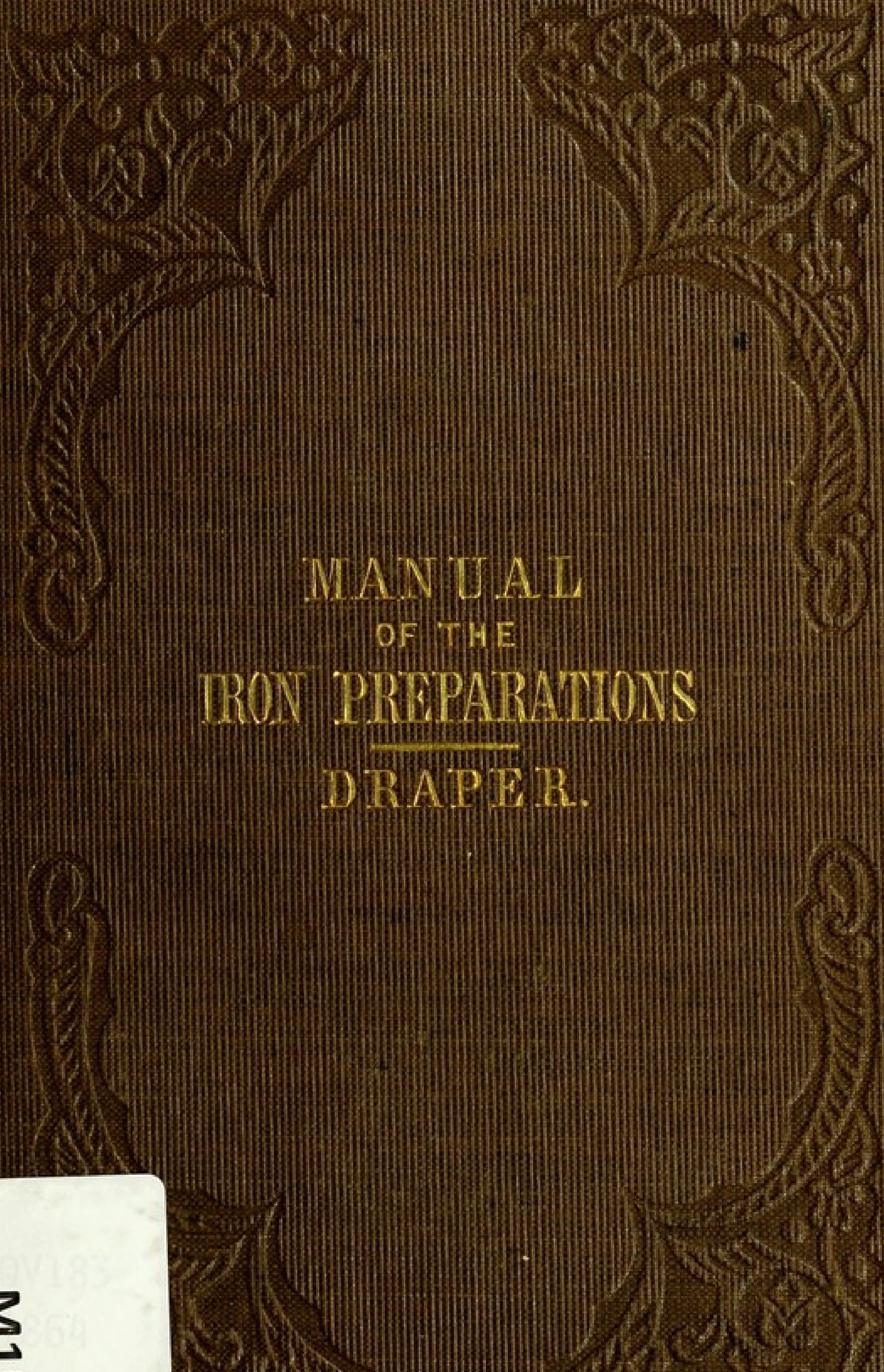
Manual of the medicinal preparations of iron : including their preparation, chemistry, physiological action, and therapeutical use with an appendix containing the iron preparations of the British pharmacopoeia / by Harry Napier Draper.

Draper, Harry Napier.

Dublin : Fannin ; London : Robert Hardwicke, 1864.



MANUAL
OF THE
IRON PREPARATIONS

DRAPER.

MANUAL

OF THE

MEDICINAL PREPARATIONS OF IRON,

INCLUDING

THEIR PREPARATION, CHEMISTRY, PHYSIOLOGICAL ACTION,
AND THERAPEUTICAL USE.

WITH AN APPENDIX,

CONTAINING THE

IRON PREPARATIONS OF THE BRITISH PHARMACOPŒIA.

BY

HARRY NAPIER DRAPER, F.C.S.

DUBLIN:
FANNIN AND CO., 41, GRAFTON STREET.
LONDON: ROBERT HARDWICKE.
EDINBURGH: MACLACHLAN AND STEWART.
1864.

ERRATUM.

Page 117, last line, for "3 grains" *read* "1 grain."

led to the introduction of some very elegant and efficient preparations, has at the same time imposed upon the prescriber the troublesome task of choosing between a great variety of forms of the same remedy, and has rendered it imperative upon the pharmaceutist to keep prepared a collection of salts, solutions, syrups, *et hoc genus omne*, which are in many instances very perishable.

There is perhaps no remedy to which these remarks more forcibly apply than to the metal iron. Of repute in the treatment of certain diseased conditions from almost the earliest period from which history hands us down any record of medicine, it has continued to acquire popularity,

PREFACE.

The object which I have endeavoured to attain in the following pages may be explained in very few words. Of late years it has become customary to multiply to a perplexing extent the compounds of the inorganic bodies employed in medicine. It is no part of my intention to criticise this feature of modern pharmacy or to advance any opinion of my own as to the desirability of a system which, while it has certainly led to the introduction of some very elegant and efficient preparations, has at the same time imposed upon the prescriber the troublesome task of choosing between a great variety of forms of the same remedy, and has rendered it imperative upon the pharmaceutist to keep prepared a collection of salts, solutions, syrups, *et hoc genus omne*, which are in many instances very perishable.

There is perhaps no remedy to which these remarks more forcibly apply than to the metal iron. Of repute in the treatment of certain diseased conditions from almost the earliest period from which history hands us down any record of medicine, it has continued to acquire popularity, until in our own time we find it holding among therapeutic agents a position not second to that of any other substance. This is without doubt due to the circumstance that iron is one of the few remedies, the action of which is to a certain degree understood, and which on scientific principles combats abnormal conditions which can be traced to their origin.

I am not prepared to say whether the multiplication of the forms in which a medicine may be administered is to be taken as a proof of its value; but were this the case, then indeed should Iron hold a high rank in the materia medica. There is no other body which has been made to furnish to pharmacy so many compounds, or which has been united to so great a variety of active medicaments. Many of these compounds have long been contained in the Pharmacopœias of the Colleges, but there are many others frequently prescribed for which there are no recognized formulæ, and which are only to be found in the pages of the medical and pharmaceutical periodicals. I have attempted in this little book to do for this latter class of ferruginous preparations, that which I believe it would be advantageous to do with new or improved medicinal compounds of all other organic and inorganic bodies; namely, to collect them into a convenient manual and describe them and the methods of their production upon a systematic plan. I have selected the preparations of iron for an attempt of this kind; firstly, because of the importance of iron as a remedy; secondly, because of the extent and variety of its compounds. Much of the matter of these articles will be familiar to the readers of the DUBLIN MEDICAL PRESS, in the pages of which periodical a considerable part of it has appeared; but in reprinting it in a more convenient form for reference, I have not only taken the opportunity of making some needful emendations, but have also been able to embody many quite recent formulæ, by the addition of which each article is made as exhaustive and complete as possible.

It will be observed that not a few of the compounds introduced have little claim to novelty, as, for example, *Pulvis Ferri*, the *Iodide* and *Sesquichloride* of iron. They are included, however, because there have recently been many improvements made in the mode of their preparation, or because new modes of administering them have been devised.

The plan of arrangement adopted is as follows. The salts are placed in alphabetical order as being the most convenient for reference. Each compound is treated of under distinct heads. Firstly, its PREPARATION is detailed, the best process being selected, or in some cases, as in that of *Reduced Iron*, all the published processes are introduced; secondly, its PHYSICAL CHARACTERS; thirdly, its CHEMISTRY; fourthly, its CONTAMINATIONS and the TESTS by which their presence may be determined; fifthly, its PHYSIOLOGICAL ACTION and THERAPEUTICAL USE; and sixthly, the DOSE in which it may be given. Lastly, formulæ for pills, syrups, and other preparations into which the compound enters, are added.

My aim has been to produce a handbook having no higher pretension than that of usefulness; which should present to the physician a description of preparations which constantly force themselves upon his notice in the perusal of the medical journals, and concerning which the accounts in most treatises on materia medica are frequently meagre and insufficient; and, to the pharmaceutist, those details of preparation and chemical characters which he can best appreciate.

While the last sheets were in the hands of the printer, the British Pharmacopœia was published. Several preparations of iron not before officinal have now become so, and I have considered it well to include in an Appendix, not only these, but the whole of the pharmacopœial iron compounds, commenting upon them only so far as has seemed necessary for the explanation of any novel features which they present.

In the Appendix will also be found a Synoptical Table showing at a glance the composition and dose of each of the iron preparations.

The weights and measures adopted throughout are those of the British Pharmacopœia.

HARRY NAPIER DRAPER.

Dublin, April, 1864.

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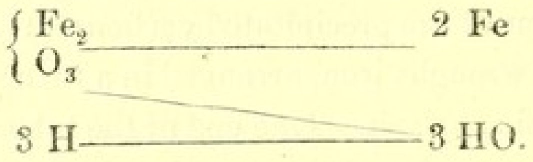
PREPARATIONS OF IRON.

FERRI PULVIS—POWDER OF IRON.

Iron by Hydrogen—Reduced Iron—Quevenne's Iron—Fer Reduit. PREPARATION.—Peroxide of iron (obtained by the calcination of the precipitated carbonate) is introduced into a tube of wrought iron, arranged in a furnace such as is used in organic analysis. One end of the tube is connected with an apparatus for the generation of hydrogen from zinc and dilute sulphuric acid; two bottles, one containing a solution of acetate of lead, and the other milk of lime, being interposed. The other extremity of the tube terminates in a bent tube dipping into a vessel of water. All the joints of the apparatus being made air-tight by luting, a stream of hydrogen is passed through it to expel all the atmospheric air which it contains. When this has been accomplished, the iron tube is surrounded with ignited charcoal so as to raise it to a dull red heat, and a continuous current of hydrogen is kept up until the bubbles of gas escape through the water at apparently the same rate as that at which they pass through the solution of acetate of lead and the milk of lime, and the reduction is thus judged to be complete. The charcoal is now removed (a slow current of hydrogen being still continued), and when the iron tube is cool the apparatus is disconnected, and the contents of the tube extracted and preserved in an accurately-stoppered bottle.

In this process, which is in all essential particulars that of the last Dublin Pharmacopœia, sesquioxide of iron $Fe_2 O_3$ is subjected at a high temperature to the reducing influence of hydrogen which has been previously freed from sulphide of hydrogen and from acid by passing through acetate of lead and milk of lime. The oxygen of the iron combines with the hydrogen to form water, leaving the iron in the metallic state.



The precaution adopted by the Dublin College, of first passing the hydrogen through caustic potash and sulphuric acid in order to dry it, is unnecessary, and is well replaced by the use of the solution of acetate of lead and the milk of lime directed by the United States Pharmacopœia. The first of these removes any trace of sulphuretted hydrogen, and the second any acid which may be carried over with the gas.

Several precautions must be observed in the preparation of reduced iron in order to obtain a successful result and an absolutely pure product. In the first place, the heat must be carefully regulated, for if it be too low, part of the oxide will escape reduction; and if, on the contrary, it be too intense, the reduced metal will agglutinate, forming a mass not easily reduced to powder. The purity of the oxide of iron employed must also be ensured, and particularly its freedom from sulphate of soda, a salt which it is very liable to contain if the washing has been imperfectly conducted. As sulphate of soda is reduced by hydrogen at a high temperature to the state of sulphuret of sodium, the resulting powder of iron will of course contain it, and occasion eructations of sulphuretted hydrogen when taken into the stomach. In order to ensure the absence of sulphur compounds, several modifications of the above given process have been proposed. M. S. de Luca* proposes the substitution of oxide of iron, obtained by decomposing a previously boiled acid solution of the chloride with ammonia. Any sulphides which may have been present are decomposed, and the boiling serves to expel all traces of sulphuretted hydrogen. With a similar object, M. Guicciardi† employs, in place of the sesquioxide, the oxalate of iron prepared by precipitating a concentrated solution of pure protosulphate of iron with a hot saturated solution of oxalic acid.

If vulcanized india-rubber tubes be used for connecting the different parts of the apparatus employed in the preparation of reduced iron, they should, according to M. de Luca, be first boiled in solution of potash, in order to remove the sulphur which they contain.

The action of other reducing agents besides hydrogen may be also made available in the preparation of powder of iron. Mr. Arthur Morgan of Dublin recommends the

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* *Jour. de Pharm. et de Chim.* t. xxxviii., p. 275.

† *Repertoire de Pharmacie*, Dec. 1859.

following proceeding, in which the reducing agent is ferrocyanide of potassium. This salt in a perfectly dry state is mixed with sesquioxide of iron and carbonate of potash, and calcined at a low red heat. The oxide is completely reduced, and the product only requires to be washed to free it from soluble salts, and dried at a low temperature. A process much more calculated to afford a pure product is that of Zäangerle.* Five parts of protoxalate of iron are mixed with six parts of anhydrous ferrocyanide of potassium and $1\frac{3}{4}$ parts of anhydrous carbonate of potash. This mixture is ignited until gas ceases to be evolved from the melted mass. When cold the product is washed until the last traces of soluble matter are removed, and then dried.

PHYSICAL CHARACTERS.—When properly prepared, reduced iron is in the form of an impalpable powder of a more or less dark slate colour. It is strongly attracted by the magnet, and burns on the application of flame, leaving a residue of sesquioxide. When a portion of it is placed on an anvil and smartly struck with a hammer, a brilliant metallic scale is produced. Powder of iron is tasteless.

CHEMISTRY.—Pulvis Ferri may be regarded as nearly pure metallic iron (Fe). It is soluble in dilute hydrochloric and sulphuric acids with evolution of hydrogen, a protosalt of the metal being produced. When exposed to damp air it becomes rapidly oxidized, and should therefore be preserved in well-closed bottles.

CONTAMINATIONS AND TESTS.—The reduced iron of commerce is seldom perfectly pure. This arises usually, not from intentional sophistication, but from the diffi-

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* *Neues Repertorium für Pharmacie*, vi. 27.

culty of entirely freeing the oxide of iron from which it is prepared from other substances, want of care in the purification of the hydrogen, and from imperfect reduction of the oxide. It may thus contain sulphide and oxide of iron and silica. The substances which have been used as adulterants are magnetic oxide of iron, carbon—either in the form of charcoal or as plumbago—and fine filings of ordinary iron. When pure it should dissolve without residue in dilute sulphuric acid, and the evolved hydrogen should not change the colour of paper moistened with solution of acetate of lead. Ten grains of the sample heated with 40 grains of iodine and half an ounce of water, and the mixture diluted with water, transferred to a filter, and the excess of iodine dissolved out with a solution of *pure* iodide of potassium should leave no residue. If any residue do remain it is estimated as follows:—Being first washed with distilled water it is treated with nitro-hydrochloric acid, which will dissolve it if consisting only of oxide of iron, and it may then be converted into sesquioxide by precipitation with ammonia, dried and weighed. If carbon or silica be present in the sample they will be found upon the filter. 10·3 grains of pure pulvis ferri should yield by solution in nitric acid and precipitation by ammonia not much less than 14·7 grains of sesquioxide, the quantity procurable from 10·3 grains of absolutely pure iron.

Physiological Action and Therapeutical Use.—The pulvis ferri possesses similar medicinal properties to the other preparations of iron; but from its state of minute division is perhaps more readily soluble in the acid secretion of the stomach than any other. Its freedom from the inky taste of most ferruginous compounds is by no means an inconsiderable advantage, especially in administering it to children. It is from this cause rapidly growing into favour. When obtained pure it is open to only one objection, that of sometimes causing unpleasant eructations of hydrogen. Like other preparations of iron it blackens the stools. Pulvis ferri has been used with advantage in debilitated conditions of the digestive organs, in anæmia, chlorosis, amenorrhœa, chorea, and in enlargement of the spleen following intermittent fever. It is given in the form of pill or powder in doses of from two to six, or even ten grains. In America it is sometimes administered in the form of lozenges or *bonbons* made with chocolate. This would appear to be the most elegant and convenient form for its exhibition.

Powder of iron is also used as an external covering, in conjunction with balsam of tolu, for pills of iodide of iron, with the object of preserving the salt from oxidation.

DOSE.—From two to ten grains.

FERRI ALBUMINAS—ALBUMINATE OF IRON.

HISTORY.—A compound of iron and albumen was originally recommended by Lassaigne, upon grounds, the substance of which will be found below, as possessing advantages over the ordinary salts of this metal. This preparation has, however, probably from the imperfect formulæ which were given for its production, been but little employed. More recently the subject of its probable therapeutic action has been approached by M. Angelico

Fabri,[*] who advises a formula which, although somewhat complex, is capable of yielding a much more definite result than those hitherto employed. It must be observed, however, that prepared as sometimes directed (see for example, Wood and Bache, U.S. Dispensatory, p. 1366), the compound formed contains sesquioxide of iron, while the formula of M. Fabri given below is for the preparation of an albuminate of the protoxide. It is clear, however, that by replacing with a solution of the persulphate, the protosulphate of iron ordered, the former oxide may, if desired, be introduced.

PREPARATION.—*(Solution of Albuminate of Iron and Soda.)*

Sulphate of iron . . .	104 grains.
Caustic soda	112 ,,
Whites of eggs	Four.

Having dissolved the sulphate of iron and the soda, each in a sufficient quantity of distilled water, pour the solutions upon the albumen previously well beaten up; let all now be shaken together and poured upon a filter to separate the hydrated oxide of iron which is thrown down, since all the iron is not in this case converted into albuminate. To the filtered liquid, which now contains, in addition to the albuminate, sulphate of soda formed by the decomposition of sulphate of iron by the soda present in excess, lime water is to be added to decompose the sulphate of soda, by which an insoluble sulphate of lime is precipitated. To separate the latter the mixture is to be again filtered; and as the filtered fluid will contain an excess of lime, it is to be subjected to the action of a stream of carbonic acid, care being taken to avoid an excess of the latter, and again

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[*] *Chemical News*, vol. vi., p. 127.

filtered to get rid of the insoluble carbonate of lime thus formed. The filtered fluid is now to be allowed to evaporate in a wide, shallow vessel until it is reduced to a pint. (A. Fabri.)

If the solution be still further evaporated, and sufficient sugar added to convert it into a pint of syrup, not only will the taste of the preparation be more agreeable, but it will be likely to keep better.

Physical Characters.—Made as above directed, the solution of albuminate of iron and soda is a clear, reddish yellow fluid, having a taste somewhat alkaline, but quite free from astringency or inkiness.

Chemistry.—When albumen is added to a neutral solution of a salt of iron a precipitate is produced, which, although insoluble in water, is readily dissolved by solutions of the alkalies. The fluid thus formed is not coagulated upon the application of heat, nor do the ferro or ferridcyanides of potassium produce with it any precipitate unless an acid be previously added. In the present imperfect state of our knowledge of the compounds of metallic oxides with albumen, it is not possible to ascribe a definite constitution to this combination, and it may even be objected that it has a very doubtful claim to a name which would indicate it to be a salt. The solution of M. Fabri, however, contains 1·33 grains (nearly) of protoxide of iron in each fluid ounce, or, according to M. Fabri himself, "approximately, four grains of the albuminate, plus an excess of albumen and soda." It has, therefore, an alkaline reaction, and in administering it it must be remembered that acids are incompatible.

Physiological Action and Therapeutical Use.—The theory upon which the use of this compound in preference to other salts is recommended, is at least plausible. It may be thus shortly stated:—The blood containing albumen, soda, and iron, the latter in such a form as not to be rendered evident by reagents until the organic combination is broken up, it is inferred that the metal exists as an albuminate of iron and soda, and that in cases where iron is indicated its exhibition in a like form is most calculated to ensure its absorption and assimilation. How far this may be found to be actually the case remains to be proved, and the efficacy of the preparation to be established by careful trial; but there is no doubt that in many cases in which the ordinary salts of iron disagree it might be employed with probability of good result. The facts of its alkalinity and that it can be combined with, or used in conjunction with alkaline remedies, together with its freedom from all chalybeate taste, will not unfrequently recommend it.

DOSE.—From half an ounce to one ounce.

FERRI ARSENIAS—ARSENIATE OF IRON.

Ferrum Oxydulatum Arsenicum: Arseniate of Protoxide of Iron. PREPARATION.—To a solution of protosulphate of iron is added one of arseniate of soda, potassa, or ammonia, until no further precipitate is produced. This precipitate is collected on a filter, washed with distilled water, and dried at a temperature not exceeding 212°.

PHYSICAL CHARACTERS.—A greenish white powder, becoming darker by exposure to the air.

Chemistry.—Arseniate of iron consists of three equivalents of protoxide of iron united with one equivalent of arsenic acid, and combined with six atoms of water, as represented by the formula $3\ FeO, AsO_5, 6\ HO$. Its equivalent weight is 277. It is very sparingly soluble in water, but easily so in dilute acids. By contact with atmospheric air it is oxidized, and must therefore be preserved in well-closed bottles.

Contaminations.—This salt is not liable to intentional adulteration, but may contain from careless preparation sesquioxide of iron.

Physiological Action and Therapeutical Use.—The action of arseniate of iron is similar to that of arsenious acid and the other preparations of arsenic, but according to M. Duchesne Dupare,* it may be administered in sufficient doses without producing any of the ill effects with which these are often attended. Topically it acts as a caustic.

It has been used by Biett† in lupus, elephantiasis, psoriasis, chronic eczema, and lichen, and, according to the researches of Dupare, it possesses unquestionable efficacy in the treatment of these affections. According to the authority last quoted, it must always be given in graduated doses, beginning with one-twentieth, one-tenth, or even one-fifth of a grain, according to the age, constitution, and the state of the digestive organs of the patient. M. Dupare states his conviction that the dose of one-fifth of a grain is competent, if continued uninterruptedly for the necessary time, to effect the cure in an adult of an herpetic or squamous

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* *Medical Times and Gazette*, Sept. 2, 1854, p. 246; and Pereira, *Mat. Med.*, vol. i., p. 857.

† Pereira, *Op. Cit.*, p. 857.

affection, no matter how long established or extensive, but that no absolute rule can be laid down as to the duration of the treatment; this must vary with differences in the age and constitution of the patient, with the severity of the disease, and with the degree of toleration manifested for the remedy itself. Arseniate of iron may be given in conjunction with the internal or external use of mineral waters—provided these contain no sulphur compounds—and may be aided by the use of topical remedies. Externally it has been used in the form of ointment, made by triturating from twenty to thirty grains of the finely powdered arseniate with one ounce of simple cerate or lard.

As a dressing in ulcerated cancer it was used by Mr. Carmichael,* by applying from thirty to sixty grains, diluted with four times its weight of phosphate of iron, to the ulcerated surface. In about half an hour its use was followed by considerable uneasiness, continuing for several hours; this is followed by swelling, especially in the case of ulcers of the face, and in a few days a slough is formed. Its employment in this way requires of course much caution, as the arsenic is absorbed.

Dose.—From one-twentieth to one-fifth of a grain.

FERRI BROMIDUM—BROMIDE OF IRON.

Preparation.—One part of iron filings is heated under a stratum of water with one part of bromine until the fluid becomes of a greenish colour; it is then filtered and

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* *Essay on the Effects of Carbonate and other Preparations of Iron upon Cancer.* 1809.

rapidly evaporated to dryness in a capsule of porcelain or polished iron. The action attending the union of bromine with iron is very violent, and care must be taken to employ sufficient water to moderate it.

PHYSICAL CHARACTERS.—A brick red, very deliquescent, solid, with an acrid, styptic taste. On account of its liability to oxidation and to absorb moisture it must be carefully excluded from the air.

CHEMISTRY.—Bromide of iron is composed of equal equivalents of bromine and iron ($FeBr$.) Its atomic weight is 106·4. In its chemical properties it closely resembles the iodide, being also like it decomposed by the action of the air into free bromine and a sesquioxide of the metal. It is very soluble in water.

PHYSIOLOGICAL ACTION AND THERAPEUTICAL USE.—Bromide of iron is tonic and alterative, and is used as a substitute for the iodide. It is but little employed in this country, but is spoken of in very favourable terms by some American physicians who have used it in tetter, scrofulous tumours, chronic and acute glandular inflammation, erysipelas, and amenorrhœa. Magendie gave it in cases where iodine did not appear to be sufficiently active, or where the patient had become accustomed to the use of the latter. According to Neligan, it has been used on the Continent, and, as stated, with success, in hypertrophy of the uterus.

The dose of bromide of iron in the form of pill is from one to three grains. The solid form is, however, not a good means of exhibiting this salt. It is much more conveniently given in combination with syrup, which effectually preserves it from oxidation. It is also used externally in the form of ointment.

Syrupus Ferri Bromidi—Syrup of Bromide of Iron.

Take of	Bromine .	200 grains.
	Iron filings .	85 "
	Water . .	2000 "
	Sugar . .	1400 "

Heat the bromine, iron filings, and water together until the solution becomes of a light-green colour; filter, and in the clear liquid dissolve the sugar with a gentle heat. Preserve the syrup thus formed in small bottles filled quite full, and instead of corking, tie them over with gutta percha tissue or bladder. Syrup of bromide of iron is employed in America in phthisis and other tuberculous diseases, and in bronchocele.

DOSE.—20 minims, three times a-day, gradually increased.*

Pilulæ Ferri Bromidi—Pills of Bromide of Iron.

Bromide of iron . .	12 grains.
Confection of roses . .	18 "
Powdered gum arabic .	12 "

Mix, and divide into 20 pills; two to be taken morning and evening.†

Unguentum Ferri Bromidi—Ointment of Bromide of Iron.

Bromide of iron . . .	1 part.
Glycerine . . .	1 "
Pure lard . . .	14 "

Dissolve the bromide in the glycerine, and triturate the lard with the solution.

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[*] Parrish, *Practical Pharmacy*, p. 522, and Wood and Bache, *U.S. Dispensatory*, p. 1382.

[†] Magendie, *Formulary*, p. 124.

FERRI CARBAZOTAS—CARBAZOTATE OF IRON.

Carbazotate of Sesquioxide of Iron, Picrate of Iron, Nitro-picrate of Iron. HISTORY.—Picric or carbazotic acid was discovered by Hausmann in 1788, and has been the subject of experiment by Fourcroy, Chevreul, Liebig, Dumas, and many other chemists, who have accurately described its properties as well as those of many of its salts, but it is only within the last few years that any attempt has been made to employ it usefully, either in medicine or in the arts. To Dr. Calvert of Manchester we are indebted for having laboured successfully to introduce the salts of this acid as remedial agents. The iron salts, although promising to be the most useful form of administering it, do not appear to have been accurately examined. A full account of the mode of preparing the acid itself and of its chemical properties will be hereafter given under the proper head.

PREPARATION.—Crystals of pure carbazotic acid are digested with an excess of recently precipitated sesquioxide of iron and water at a gentle heat until the acid has disappeared. The whole is then transferred to a paper filter, and when the deep yellow solution of carbazotate has passed through, the residue on the filter is to be washed with hot water until the filtrate becomes colourless or nearly so. The washings being added to the original solution, the whole is evaporated to dryness at a temperature not exceeding 212°.

PHYSICAL CHARACTERS.—Thus prepared, carbazotate of iron presents the appearance of a reddish brown, amorphous mass, which, when reduced to powder, becomes lighter in colour. Its taste is astringent and intensely and persistently bitter.

Chemistry.—I have not been able to meet with any statement of the constitution of this salt, but it probably consists of three equivalents of carbazotic acid (C_{12} N_3 H_3 O_{14}) united to one of sesquioxide of iron. It is soluble in water and in alcohol, and from its solution in the latter liquid may by evaporation be obtained in needle-shaped crystals.

When suddenly heated it deflagrates, emitting a flash of light. Ferrocyanide of potassium changes the colour of its solution from yellow to a beautiful green, but does not cause a precipitate. When heated with cyanide of potassium and an excess of alkali it gives a deep red liquid. The addition of a salt of potash, as, for example, the nitrate, produces an abundant precipitate of the little soluble carbazotate of potash. This salt, although not nearly so soluble as the compound with protoxide of iron, is to be preferred to the latter as a therapeutic agent on account of its greater permanency. It is important that pure carbazotic acid should be used in its preparation, as otherwise oxalic and indigotic acids may be present. The pure acid is now, however, manufactured on a large scale for use in the arts. The presence of this acid in the urine may be detected in the following manner:—The urine is heated with acetate of lead, and rendered slightly acid by acetic acid. The liquid is then filtered from the white insoluble precipitate, the filtrate evaporated to dryness at a gentle heat, and the residue digested with ether. The etherial solution is next evaporated, and this residue dissolved in water. Boiled white silk is now put into the watery solution, and if carbazotic acid be present it will communicate to it, after the lapse of a greater or less time according to the quantity in which it exists, a decidedly yellow tinge. Or the aqueous solution of the etherial extract may be mixed with alcohol and ammonia, and sulphide of hydrogen be passed through the liquid for half an hour, when, if carbazotic acid be present, it will become red, owing to the formation of *picramic acid.* Calvert and Moffat state that by this means they have detected the presence of this acid in urine containing 1-10·000th of its weight, even after the fluid had been kept for some days.

PHYSIOLOGICAL ACTION AND THERAPEUTICAL USE.—Carbazotic acid and its salts appear to possess very decided tonic and antiperiodic properties, and will most probably prove on more extended trial valuable and economical substitutes for quinine. In large doses the acid is poisonous; according to Taylor,* ten grains have sufficed to kill a dog in less than two hours.

In the hands of Drs. Calvert and Moffat† the carbazotate of iron has proved very successful in the cure of cephalalgia; the same authors have also employed with good effect the ammonia salt in the treatment of anæmia, intermittent fever, and hypochondriasis, and combined with opium and gallic acid in obstinate diarrhœa. They observe that while the acid itself is liable to produce cramps, its compounds with bases are free from this objection. The dose of the salts employed by these experimentalists was from ·05 to ·10 gramme (¾ to 1½ grain) per diem.

More recently, Mr. Alfred Aspland‡ of the Ashton Royal Infirmary, has, at the request of Dr. Calvert, tried carbazotic acid and its salts on a more extensive scale, and with a success which should encourage further experiment. Mr. Aspland treated forty severe cases of ague, giving the

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* *On Poisons*, p. 793.

† *Pharm. Jour.*, vol. xvi., p. 167.

‡ *Med. Times and Gazette*, vol. ii., 1862, p. 289.

acid in doses of a grain three times a day, gradually increased to four grains at each dose. Some of the patients were relieved in forty-eight hours, while in two cases the treatment had to be continued for nine weeks. Mr. Aspland has also employed the acid with good results in diabetes, in anæmia and prostration from loss of blood, in infantile marasmus, in rickets, and as a tonic in cases of debility, and where quinine is usually given; also in dyspepsia and hypochondriasis. He states himself as unable to decide whether the salts of carbazotic acid or the acid itself act better, and does not allude to any inconvenience resulting from the use of either, beyond the peculiar coloration of the skin always attending the continued use of this remedy.

The iron salt will probably be found from its ready solubility one of the best forms of administering carbazotic acid, and especially suitable as a substitute for the combinations of quinine with ferric salts. It should, on account of its intensely bitter taste, be administered in the form of pills.

A most remarkable result produced by the continued exhibition of this acid and its salts is that the skin and conjunctivæ of the eyes become dyed of a deep yellow hue, and the urine acquires an orange colour. This effect is, according to Drs. Calvert and Moffat, generally brought about in a time varying from two to sixteen days after the commencement of the treatment, or when about fifteen grains of the acid have been taken, and they are inclined to attribute the failure of Braconnot in producing this coloration, to the fact that he employed the potash salt, which is almost insoluble. Mr. Aspland, whose experiments have been cited above, finds that the skin becomes most easily tinged in robust subjects, and more in adults than in children. The urine, on the other hand, is more coloured in these cases. The skin in the best dyed cases clears in two or three weeks after the remedy has been discontinued.

Dose.—From half a grain to two grains, gradually increased.

FERRI CARBONAS—CARBONATE OF IRON.

The chemical properties of carbonate of iron are so well understood, and its therapeutic value so clearly established, that it is only introduced here in order that a few preparations which are very great improvements upon the usual forms—the saccharated carbonate, the *pilula ferri composita*, and the *mistura ferri composita*—in which it is usually administered in this country, may be noticed.

Syrupus Ferri Carbonatis.—Syrup of Carbonate of Iron.

Carbonate of iron readily dissolves in simple syrup, and as the sugar exercises a completely preservative influence upon the salt, this is one of the best forms in which it can be exhibited :—

Protosulphate of iron . .	2 ounces.
Carbonate of soda in crystals .	2½ ,,
Water	2 pints.
Sugar	4 ounces.

Dissolve the sulphate of iron and half the sugar in one pint, and the carbonate of soda and the remainder of the sugar in the other pint of water, mix the solutions, allow the precipitate to subside, and decant the supernatant fluid. Then rapidly wash the precipitate by decantation, using for the washing the whole of the following solution, but dividing it between two operations:—

Sugar . . .	5 ounces.
Water . . .	20 ,,

Next digest the washed precipitate in a sufficient quantity of sugar solution of like strength, agitating it repeatedly during some days. When it has all dissolved add—

Sugar	38½ ounces.
Water	19 ,,

Boil to a specific gravity of 1·262 (at boiling point) and flavour with tincture of lemon or orange peel. This syrup contains about ten per cent. of carbonate of iron, is nearly colourless, and without unpleasant taste.

DOSE.—One fluid drachm.

Solutio Ferri Carbonatis.—Aërated Solution of Carbonate of Iron.

When clean iron is placed in a solution of carbonic acid prepared at the ordinary pressure of the atmosphere, it is partly dissolved, and a solution of the carbonate obtained containing one grain in 3000 of water. If the solution be made with the aid of the apparatus employed by the manufacturer of ærated beverages it has the advantage of being less liable to change and of containing an excess of carbonic acid. Prepared in this way, solution of carbonate of iron is one of the most elegant forms of administering the salt with which I am acquainted, and is an admirable substitute for the natural chalybeate waters.

Ferri Carbonas Effervescens—Effervescing Carbonate of Iron.

This very convenient form of administering carbonate of iron was devised by Dr. Skinner of Liverpool,[*] and is prepared by a modification of the process employed in the production of the other granular effervescent compounds which have recently been introduced into medicine.

PREPARATION.—

Take of Tartaric acid	3	ounces.
Bicarbonate of soda . . .	5	,,
Protosulphate of iron . .	$1\frac{1}{4}$	,,
Powdered sugar	$1\frac{3}{4}$	,,
Citric acid	$\frac{1}{4}$	,,

Dry the tartaric acid, bicarbonate of soda, and sulphate of iron, at a temperature not exceeding 200° F. Mix the sulphate with the sugar and half the tartaric acid. Rub the citric acid to fine powder, and mix it intimately with the rest of the tartaric acid and the bicarbonate of soda. Combine both mixtures by trituration, and pass the whole through a fine sieve. The resulting powder is to be heated in a metallic pan set in a water-bath until it begins to granulate, when it is to be rapidly stirred until the whole mass has become divided into granules.

PHYSICAL CHARACTERS.—This preparation closely resembles in appearance the well-known "effervescent granular citrate of magnesia," but is not like it perfectly white, having a slightly greenish tinge, owing to the partial decomposition of the carbonate of iron which it contains—a change which it is impossible wholly to prevent, but which is quite unimportant. When dissolved in water there is copious evolution of carbonic acid with the formation of

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British Med. Journal and *Dublin Medical Press*, June 1862.

a light green-coloured solution of carbonate of iron which, however, becomes reddish brown upon exposure to the air, owing to the formation of peroxide. The taste of the solution if drank during effervescence is agreeable and but slightly ferruginous. This preparation should be kept in a dry place, and well excluded from the air—a precaution which must be observed in the case of all similar compounds.

CHEMISTRY.—When the effervescing carbonate is mixed with water, the carbonate of iron which is produced by the decomposition of the sulphate when the preparation is first made becomes dissolved, owing to the presence of excess of carbonic acid. At the same time, tartrate, citrate, and a little sulphate of soda are also formed. The presence of sugar prevents the oxidation of the iron salt to a considerable extent. Ninety grains, the usual dose of the compound, contain four grains of the carbonate of iron.

PHYSIOLOGICAL ACTION AND THERAPEUTICAL USE.—According to Dr. Skinner, this preparation produces a more manifest chalybeate effect within a given time, and in a smaller dose, than any other combination of iron. It is also, he states, better borne by the stomach. He has found it to act like a specific in relieving those forms of neuralgia which arise from anæmia or other causes relievable by iron. The presence of the citro-tartrate and sulphate of soda is rather advantageous than otherwise, especially in cases where there is intestinal torpidity. At the same time, it is not a suitable preparation to continue for lengthened periods, and will not in such cases replace the uncombined salts of iron.

DOSE.—Sixty to ninety grains in about five ounces of water twice or three times a day.

FERRI CITRAS—CITRATE OF IRON.

Citrate of Sesquioxide of Iron—Ferric Citrate. Citrate of iron was first introduced into medicine by M. Béral of Paris, in 1831.

Preparation.—Take of citric acid eleven ounces, sulphate of iron twenty-four ounces, water ten fluid ounces. Dissolve the citric acid in the water, and having prepared from the sulphate of iron hydrated sesquioxide in the usual manner, add the latter to saturation to the solution of the acid, maintained at a temperature of 150°. Filter the liquid, evaporate to the consistence of a thick syrup, and spread it with a brush in thin layers upon glass plates, which are then to be exposed to a gentle heat until the film is dry. The citrate can then be readily separated from the glass in scales.

In this process the temperature of 150° directed, promotes the union of the oxide of iron with the acid, but it should not be exceeded, as a greater degree of heat interferes with the saturation and prevents the subsequent separation of the salt from the glass plates.

Physical Characters.—Citrate of iron thus prepared is in the form of thin transparent scales of a beautiful garnet colour. It has a ferruginous and slightly acid taste.

Chemistry.—This salt consists of one equivalent of citric acid united to one equivalent of sesquioxide of iron, as shown by the formula $Fe_2\ O_3,\ C_{12}\ H_5\ O_{11}$. Its atomic weight is 245. It is difficultly soluble in cold, but readily in boiling water, and is uncrystallizable. As it is more easily soluble when freshly prepared, the process of scaling is sometimes dispensed with, and the salt kept in the state of a concentrated solution, from which it has no tendency to separate. Such a solution may conveniently contain ten grains to each fluid drachm, and possesses only this disadvantage, that it is liable to be attacked by a species of mucor if kept for a long period. If, however, the solution be made stronger, say 240 grains to the fluid ounce, it will, according to Procter,* keep perfectly.

CONTAMINATIONS AND TESTS.—Not liable to intentional adulteration, but may contain *lead* and *copper* from the improper use of vessels of these metals in its preparation†. When incinerated and the residue treated with nitric acid, diluted with water and filtered, no precipitate should be occasioned by iodide of potassium or sulphide of hydrogen; one hundred grains ignited, treated with nitric acid and precipitated by solution of potash, should give thirty-two grains of sesquioxide of iron.

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* Quoted by Bache, *U.S. Dispensatory*, p. 1054.

† Mr. Lalor (*Amer. Med. Times* and *Dublin Med. Press*, New Series, vol. iii., p. 384,) describes the examination of a specimen of *ammonio-citrate of iron* which contained the enormous proportion of *twenty-five per cent. of citrate of lead*. Mr. Lalor infers that the lead was derived from the use of sulphate of iron containing that metal in the preparation of the citrate. This conclusion is manifestly erroneous, as lead could only exist in any form of protosulphate of iron as the insoluble sulphate, and could not occur at all in the crystalline salt. There is little doubt that the lead had been derived from the employment of some vessel of this metal. The presence of lead in this and similar compounds may be easily overlooked; I have found that solutions of citrate of iron and citrate of ammonia readily dissolve, even at ordinary temperatures, metallic lead, protoxide, and iodide of lead. Iodide of potassium (sometimes prescribed in combination with the citrates of iron) will therefore produce no precipitate in such solutions, and any trustworthy method for the detection of this dangerous impurity must be preceded by the destruction of the organic combination in the manner described in the text.—H.N.D.

Physiological Action and Therapeutical Use.—Citrate of iron resembles in its action the other salts of the metal, but is from its milder action more suitable in irritable conditions of the digestive organs than the compounds with the mineral acids. It is an exceedingly agreeable chalybeate, and if its solution be sufficiently diluted has very little ferruginous taste. The usual dose is five grains taken three times a-day. It may be conveniently given in the form of syrup made by the following formula:—

Citrate of iron . . .	60 grains.
Water	2 fluid drachms.
Simple syrup . . .	6 ,,

Dissolve the citrate in the water by heat, and add the solution to the syrup. The dose of this preparation equivalent to five grains of the salt will be about one fluid drachm.

The *aqua chalybeata* prepared by Messrs. Bewley, Evans, and Co. of Dublin, is a solution of citrate of iron in water containing an excess of carbonic acid and flavoured with orange-peel. It is perhaps the best form in which the salt can be administered, and has become a very general mode of prescribing it. It is usually given in doses of two or three ounces twice or three times a-day. Each ounce contains about two grains of the citrate.

FERRI ET MAGNESIÆ CITRAS—CITRATE OF IRON AND MAGNESIA.

Preparation.—Dissolve in the solution of three ounces of citric acid, the hydrated sesquioxide of iron precipitated by ammonia from three and a quarter ounces of sulphate of iron (previously converted into sesquisulphate), and add carbonate of magnesia to saturation. The solution is best effected at a temperature of 150° (see Ferri Citras). About one ounce of carbonate of magnesia is required for the saturation of the acid. Filter the solution, evaporate to the consistence of a thick syrup, and spread on glass to dry in scales.

PHYSICAL CHARACTERS.—Greenish-yellow scales. Taste, sweetish, ferruginous and slightly acid.

CHEMISTRY.—This salt is not deliquescent like the ammonia compound, and is for this reason sometimes preferred to the latter. It is very soluble in water, but insoluble in alcohol and ether.

PHYSIOLOGICAL ACTION AND THERAPEUTICAL USE.—The action of this salt is, like that of the simple citrate, mildly chalybeate. It may be given in doses of from three to ten grains in simple solution, or with the addition of syrup of orange-peel.

FERRI ET QUINÆ CITRAS—CITRATE OF IRON AND QUININE.

PREPARATION.—There is no recognized formula for the preparation of this very generally employed salt, but it may be made by either of the following methods :—

Citrate of iron	4 ounces.
Recently precipitated quina .	1 ,,
Citric acid	108 grains.
Water	12 ounces.

Heat together in a porcelain capsule at a temperature short of ebullition, filter the solution, evaporate in a water-bath to a syrupy consistence, and spread on plates of glass or earthenware to dry in scales—or

Citrate of iron . . .	4 ounces.
,, quina . . .	1¼ ounces.
Water	12 fluid ounces.

Dissolve the citrate of iron in the water by heat and add the quina salt; when the latter is dissolved filter the solution, and proceed as in the first process.

Physical Characters.—Brilliant scales, varying in colour from garnet red to greenish yellow in the specimens met with in commerce; deliquescent. Taste bitter and slightly ferruginous.

Chemistry.—This salt is a compound of quina, citric acid, and sesquioxide of iron, and if made by the first of the formulæ given above, will contain twenty per cent. of quina. In the absence of any published analysis of the citrate of quina, it is impossible to state accurately the percentage of this salt, but it will be seen by a comparison of the two formulæ that it cannot be far from twenty-five per cent. Citrate of iron and quinine is easily soluble in both hot and cold water.

Contaminations and Tests.—Specimens of this salt are sometimes met with in commerce which contain a much less proportion of quina than the twenty per cent. which appears to be the understood percentage, and which the labels of most respectable makers guarantee. Furthermore, a part or the whole of the quina may be replaced by quinidia, by amorphous quina (quinoidine), or by cinchonia. The assay of a suspected specimen may be thus performed. To the solution of 100 grains of the salt add carbonate of potash in excess, evaporate to dryness at 212°, and boil the residue with anhydrous alcohol; filter, evaporate the solution in a tared capsule, and note the weight of the residue, which must then be examined to detect the presence of cinchonia and quinidia. If quinoidine has been substituted for quina in the manufacture of the salt, the inability of this substance to form a crystalline compound with sulphuric acid will serve for its recognition.

PHYSIOLOGICAL ACTION AND THERAPEUTICAL USE.—This salt is now almost universally adopted in cases where iron and quinine are indicated. Its ready solubility and slight taste give it advantages over any mechanical mixture of iron salts with the disulphate of quina.

DOSE.—From three to six grains, either in pill or in solution with syrup of orange-peel.

FERRI ET QUINÆ STRYCHNIÆQUE CITRAS—CITRATE OF QUININE AND IRON WITH STRYCHNIA.

PREPARATION.—

Citrate of iron and quinine .	980 grains.
Crystallized strychnia . .	10 ,,
Citric acid	10 ,,
Water	10 ounces.

In nine ounces of the water dissolve the citrate of iron and quinine, and having dissolved the strychnia and citric acid in the remaining ounce by boiling, mix the solutions, evaporate to a syrupy consistence, and spread on plates to dry in scales.

PHYSICAL CHARACTERS.—Exactly similar in appearance to the citrate of iron and quinine. Its taste is, however, more persistently bitter than that of this salt.

Chemistry.—This compound contains in each 100 parts one part of strychnia, twenty parts of quina, and seventy-nine of citrate of iron. The presence of strychnia may be detected in the residue from the evaporation of the chloroformic solution of the alkaloids by the usual colour tests.

Physiological Action and Therapeutical Use.—Where the use of iron is not contraindicated, this salt and the one next to be described, furnish perhaps the safest, if not the best, means of exhibiting strychnia. Five grains contain one-twentieth of a grain of strychnia.

Dose.—From two to five grains.

FERRI ET STRYCHNIÆ CITRAS—CITRATE OF IRON AND STRYCHNIA.

Preparation.—

Citrate of iron	980 grains.
Strychnia	10 ,,
Citric acid	10 ,,

Proceed as in the case of the preceding preparation.

Physical Characters.—Indistinguishable in appearance from the simple citrate of iron. Taste: acid, ferruginous, and persistently bitter; deliquescent.

Chemistry.—A combination of citrate of iron with citrate of strychnia; 100 parts contain one part of strychnia. The presence of strychnia may be detected by treating the dried and powdered salt with chloroform, evaporating and applying the usual tests.

Physiological Action and Therapeutical Use.—This salt has been successfully employed in dyspepsia arising from atony, in chorea, and in suppressed menstruation.

Dose.—Three to six grains.

FERRI ET ZINCI CITRAS—CITRATE OF IRON AND ZINC.

Preparation.—

Citrate of sesquioxide of iron	4 ounces.
Carbonate of zinc	1 ,,
Citric acid	3 ,,
Solution of ammonia	A sufficient quantity.
Water	

Dissolve the citric acid in ten ounces of water, and add the carbonate of zinc gradually. Before the point of saturation is attained the solution will deposit the citrate of zinc as an insoluble powder. This is to be collected on a filter, and having ascertained by drying a weighed portion of the mass at 212° how much is equivalent to one ounce of dry citrate, this quantity is to be heated in a capsule with the citrate of iron and ten ounces of water. When the iron salt is dissolved, enough solution of ammonia is to be added to effect solution of the citrate of zinc, an excess of ammonia being avoided. The whole is now evaporated to a syrupy consistence, and spread on glass to dry in scales.

Physical Characters.—Brownish-green scales. Taste ferruginous and slightly "metallic."

Chemistry.—This salt contains, in addition to the citrates of iron and zinc, ammonia, and would therefore be more properly named ammonio-citrate of iron and zinc. Its composition as found in commerce is very variable.

PHYSIOLOGICAL ACTION AND THERAPEUTICAL USE.—This salt is occasionally employed as a tonic in cases where the use of iron is not contraindicated. As an elegant form of administering zinc it is worthy of trial in diseases of the nervous system.

DOSE.—Two to five grains.

FERRI HYPOPHOSPHIS—HYPOPHOSPHITE OF IRON.

Hypophosphite of Sesquioxide of Iron. PREPARATION.—By precipitating a solution of sesquisulphate of iron with one of hypophosphite of soda or ammonia, keeping the former in slight excess.

Crystallized protosulphate of iron .	600 grains.
Hypophosphite of soda . . .	534 ,,

Convert the iron salt into a solution of the persulphate by the addition of sulphuric acid and oxidation by nitric acid in the usual manner, and having dissolved the hypophosphite in a pint of water, and diluted the solution of persulphate to the same volume, mix the solutions. Wash the resulting gelatinous precipitate upon a calico filter previously moistened with water (and as the recently precipitated hypophosphite of iron is to a certain extent soluble, no more water must be used for this purpose than is absolutely necessary), and dry at 212°.

Physical Characters.—A tasteless, white, amorphous powder.

Chemistry.—Hypophosphite of sesquioxide of iron consists of one equivalent of sesquioxide of iron united to three of hypophosphorous acid, as shown hy the formula Fe_2O_3, 3PO. Its atomic weight is therefore 120. It is important that the alkaline hypophosphite employed in its preparation should be free from carbonate, as in this case the resulting iron salt would be contaminated with sesquioxide of the base. In contact with saccharine solutions the hypophosphite of iron is said to have a tendency to become converted into the corresponding protosalt, and as the hypophosphites are frequently prescribed in the form of syrup, the sesquisalt is sometimes replaced by hypophosphite of protoxide of iron, which has the advantage of being more soluble, and is in such solutions much more permanent (see Syrupus Ferri Hypophosphitis, *seq*).

Contaminations and Tests.—From careless preparation this salt may, as has been already observed, contain sesquioxide of iron. It should dissolve readily and without any trace of effervescence in dilute hydrochloric acid, and when gently heated in a dry test tube evolve the spontaneously inflammable phosphide of hydrogen.

Physiological Action and Therapeutical Use.—The hypophosphites were originally introduced as medicinal agents by Dr. Francis Churchill of Paris, and were recommended by him in accordance with his theory that tubercular disease depends upon a diminution in the quantity of oxidizable phosphorus present in the body, as specific remedies for phthisis. Dr. Churchill argued, that to supply this deficiency phosphorus must be presented to the system in some lower state of oxidation than that in which it exists as phosphoric acid. Although up to the present time the results of experimental research have not gone far to support this hypothesis, and although it is in fact not now believed that the hypophosphites are capable of any specific action in arresting or preventing the formation of tubercle, there appears to be little doubt that they contribute to the increase of nerve force, and give tone to the alimentative and nutritive functions, so that they may prove valuable adjuncts to other therapeutical means in the treatment of phthisis. In chronic dyspepsia they have proved successful when given in small doses in conjunction with ether and aromatic spirit of ammonia. The hypophosphite of iron possesses, in addition to the effects of ferruginous preparations, the specific tonic properties upon which the increasing popularity of the salts of hypophosphorous acid is based, and has proved successful in the treatment of cases of general debility and loss of nervous energy. Dr. Churchill is, however, of opinion that, given in conjunction with the ferruginous preparations, hypophosphorous acid has a tendency to excite hæmorrhage, so that this salt cannot be considered so eligible as the potash, soda, and lime compounds, in the treatment of phthisis.

DOSE.—Hypophosphite of sesquioxide of iron may be given in doses of from five to ten grains, either in the form of pill or as a powder mixed with sugar. It enters into the composition of the compound syrup of hypophosphites in conjunction with the lime, soda, and potash salts of the same acid.

This salt may, however, be very conveniently replaced by the proto-hypophosphite, which, although seldom prepared in the solid state, is conveniently prescribed in the form of syrup.

*Syrupus Ferri Hypophosphitis.—Syrup of Hypophosphite (of protoxide) of Iron.**

Protosulphate of iron . . .	185 grains.
Carbonate of soda	240 ,,
Hypophosphorous acid (sp. gr. 1036)	3½ ounces.
Sugar	12 ,,
Water	q.s.

Dissolve the sulphate of iron and carbonate of soda, each in four ounces of water, and mix the solutions. Wash the precipitate of carbonate of iron with two pints of water, holding in solution 500 grains of sugar, and drain on a calico filter. Transfer the carbonate to a porcelain capsule, and while applying a gentle heat, add the hypophosphorous acid until a clear solution is obtained, then water to make up eight ounces of fluid, and finally convert into a syrup with the sugar. This syrup contains very nearly one grain of the hypophosphite in each drachm, so that the dose for an adult will be a tablespoonful.

Syrupus Ferri et Quinæ Hypophosphitis.—Syrup of Hypophosphite of Iron and Quinine.

Syrup of hypophosphite of iron .	10 fluid ounces.
Hypophosphite of quinine .	20 grains.

Rub the quinine salt in a porcelain mortar with an ounce of the syrup, and having placed the remainder of the syrup in a capsule, add this to it, and apply a gentle heat until a clear solution is produced.

This is an exceedingly useful and elegant form of exhibiting quinine in combination with iron and the phosphorized compound, and may advantageously replace the

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* Parrish.

double salt of citric acid in cases in which it is desired to exhibit hypophosphites.

DOSE.—A tablespoonful—containing four grains of hypophosphite of iron and one grain of hypophosphite of quinine.

It may be observed that, although the hypophosphite of iron is decomposed by solutions of gallo-tannic acid with production of a black colour, no such decomposition takes place with the tannic acid of cinchona bark, catechu, or rhatany, and it may therefore be prescribed in conjunction with these remedies.

FERRI IODIDUM—IODIDE OF IRON.

WHEN iodide of iron was first introduced as a remedial agent it was customary to employ it in the form of aqueous solution, a mode of administration which suffered under at least two disadvantages; the unpleasant taste of the preparation was in no way concealed, and the solution rapidly decomposed. The introduction of sugar as a preservative agent is said to be due to Frederking of Riga*, but the formulæ of the British Pharmacopœias for the syrup are based upon one which was proposed by the late Dr. A. T. Thompson. It is probable that as a means of exhibiting the salt in medicine, syrup of iodide of iron will never be superseded, nevertheless several preparations have been proposed, all of which are ingenious, and some of which

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* *Buchner's Repertorium*, 1839.

well fulfil the intention of their contrivers—the more perfect preservation of this easily decomposed compound. The mode of preparing the syrup itself has also during the last few years received considerable attention, and the *modus operandi* of the Colleges has been so far improved upon as to leave little to be desired by the commonly careful manipulator. It is only then, on the one hand, to introduce these additional compounds, and on the other, to give somewhat in detail the improvements which have been made in connexion with the syrup, that a salt of iron so well and favourably known as a therapeutic agent as the iodide, is included in this series.

Ferri Iodidi Syrupus—Syrup of Iodide of Iron.

Preparation.—Formulæ for the production of this syrup are given by the three British Colleges, but it is very doubtful whether the directions of either, whether as regards the proportion of sugar or the mode of manipulation, are ever strictly carried out by the manufacturer who has to prepare it upon a large scale. In order to understand the full value of the improvements which have been effected it will be well to consider the authorized processes somewhat in detail. So far as the preparation of the solution of iodide of iron is concerned, the general principle is the same in each case; iodine is heated with water and excess of iron wire or turnings until the liquid from being deep red becomes of a pale green colour. This solution is then filtered, and is in the London and Edinburgh formulæ converted into a syrup by the addition of solid sugar. The Dublin College, on the other hand, directs the admixture of simple syrup with the filtered solution. This latter plan is unquestionably the better one, as not only is the conversion of the solution into syrup troublesome, but heating the sugar in contact with it is very liable to produce a highly coloured product, and the necessarily prolonged exposure to the air to decompose some of the iodide with the same result. But the Dublin formula is open to the great objection that the quantity of syrup ordered is quite insufficient to protect the very unstable iodide from change, especially when the bottles in which it is preserved are frequently opened. Indeed, as the whole art of preparing a permanent syrup lies in the introduction of sufficient saccharine matter, the best formula will be that which contains the most sugar. The relations in this respect of the different formulæ will be seen by the following tabular statement, giving the percentage of sugar in the product of each. For the purpose of comparison the saccharine contents of the *Liquor Ferri Iodidi* of the United States Pharmacopœia and of simple syrup (sp. gr. 1·326) are added :—

	Sugar in 100 parts by weight.*
Edinburgh	63·0
London	57·6
Dublin	53·1
United States	51·2
Simple syrup	66·6

It will be observed that the formula of the Edinburgh College is the only one which at all approaches simple syrup—that is a solution of sugar having a specific gravity of 1·326—in saccharine content, while the proportion of sugar intro-

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* In calculating these numbers, the increased specific gravity given by the iodide of iron has not been taken into account, and the hundred parts represent simply the sum of the weights of the sugar and water.

duced in that of the Dublin Pharmacopœia is so low, that the designation *liquor*, given by the American College, would more correctly describe its product.

Now as the method, peculiar to the Dublin formula, of mixing a solution of the iodide with simple syrup is without doubt more advantageous than that of dissolving sugar in a weaker solution of the salt, a very slight modification will render this formula perfect. The problem is, to get as much sugar into a syrup prepared in this manner as is present, say, in the Edinburgh product, a proportion perhaps as large as is consistent with sufficient fluidity. This can only be accomplished either by employing a more concentrated syrup or by reducing the volume of water used for the solution of the iodide. And as one ounce of water is quite enough for the conversion of 273·4 grains of iodine (the quantity ordered by the Dublin College for the preparation of eight fluid ounces of syrup), if one half the quantity now employed, be used, we shall obtain an easily filtered solution, which, added to seven fluid ounces of simple syrup, will give a product containing 61·1 per cent. of sugar, or seven per cent. more than the present preparation.

Mr. Tichborne* has, however, combined both devices for obtaining a less aqueous product. He advises the preparation of a concentrated simple syrup by dissolving five and a-half pounds (avoirdupois) of sugar, in two pints of water. This syrup has a specific gravity of 1·352 at 60° F., and as it cannot be kept without depositing crystals of sugar, it must be prepared for the occasion. For the production of eight fluid ounces of syrup of iodide of iron, the iodine is added to an excess of iron filings covered by *one ounce* of water. The combination should be effected in a

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* *Phar. Journal*, vol. i., New Series, p. 170.

thin flask, and when nearly complete, a very gentle heat suffices to finish the operation. The solution of the iodide is now to be filtered into a vessel containing seven fluid ounces of the strong syrup, being covered during the filtration by a layer of syrup in order to prevent access of air. The neck of the funnel should also dip into the syrup contained in the recipient.

Mr. Tichborne's formula is perhaps the best which has yet been published, and may be advantageously substituted for those of the present Pharmacopœias, especially as it retains their proportion of iodide. The quantities for eight fluid ounces of syrup will be as follows:—

Iodine	273·4	grains.
Filings of iron	100	,,
Water	1	ounce.
Simple syrup (sp. gr. 1·352) .	7 fluid	,,

This syrup will contain 62·2 per cent. of sugar, thus approaching closely in saccharine content to that of the Edinburgh College.

It has been proposed by some experimentalists to add *citric acid* to this preparation with a view of preserving it from oxidation, but Mr. Tichborne finds that this addition is without any practical advantage. Citric acid may, however, as he suggests, be useful if added with the object of preventing crystallization in the syrup, and thus enabling more sugar to be introduced. If, however, it were desirable to increase still farther the proportion of saccharine matter—and such a proceeding would undoubtedly add to the stability of the preparation—perhaps the best means of doing so would be to substitute for ordinary syrup a very concentrated solution of uncrystallizable sugar. Such a syrup may be made by adding a very small proportion of sulphuric acid to a boiling solution of cane sugar, neutralizing the acid with carbonate of baryta or lime, and filtering. Very careful manipulation is, however, required to produce a colourless product.*

In preparing syrup of iodide of iron on the large scale, the application of artificial heat in effecting the combination of the iodine and iron is unnecessary, as, if the proportion of water be not greater than that above indicated, the action is so energetic as sometimes to vaporize a portion of the iodine. This may be prevented by using turnings or borings of iron instead of filings, or by placing the vessel in which the union is effected in ice-cold water.

PHYSICAL CHARACTERS.—Syrup of iodide of iron is, when properly prepared, of a pale green colour, which is scarcely distinguishable when the light passes only through a thin stratum of the fluid. By exposure to the direct rays of the sun it may be rendered colourless, but this also involves, as will be afterwards seen, a chemical change. The taste of the syrup may be best described as *sub-sweet.* This is due to a peculiar effect of iodide of iron on the gustative papillæ.

CHEMISTRY.—It is very important that the iodine used in preparing the syrup should be *pure* and dry. The rough iodine of commerce frequently contains lead, and if this metal once find its way into the syrup it is almost impossible to remove it. Nor is the presence of lead apparent until the strong solution of the iodide (in which iodide of

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* Highly concentrated solutions of this form of sugar may be met with occasionally in commerce. I have elsewhere described a product of this kind possessing great viscidity and transparency, and which was found in the market under the name of "German Glycerine."—(*Vide Chemical News*, October 25, 1862.)

lead is soluble) has been diluted by admixture with the syrup. Then, however, it is precipitated, forming a yellowish-white cloud in the liquid. The subsidence of this precipitate is no evidence of the removal of iodide of lead from the syrup, as will be shown farther on. If *damp* iodine be used, the syrup will be of course deficient in strength, as a less proportion of iodide will be present. For both these reasons, therefore, it is imperative that none but iodine which has been resublimed, and is in the form of large well-defined crystals, should be employed. The use of an excess of iron in preparing the solution of iodide is not only useful by preventing its oxidation, but it acts also to some extent as a safeguard against the introduction of copper (which may be present in the iron itself) into the syrup. When syrup of iodide of iron is exposed to atmospheric air, either in an open vessel or in partially closed bottles, it becomes decomposed, iodine being set free and sesquioxide of iron depositing.

$$2\mathrm{Fe\,I} + 3\ \mathrm{O} = \mathrm{Fe_2\,O_3} + 2\ \mathrm{I}.$$

The free iodine dissolves in the undecomposed solution, forming the compound which has been erroneously described as sesqui-iodide of iron.

When exposed for a short time to the direct rays of the sun, or for a longer period to diffuse daylight, this syrup is said to become perfectly colourless,* and according to Mr. Maisch,† the action of light bleaches syrup which has become coloured by oxidation. This is in his opinion due to the formation of *iodate of iron*. M. Fougera‡ has in-

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* Parrish, *Practical Pharmacy*, p. 521; *Phar. Jour.*, vol. i., New Series, p. 352.

† *Amer. Jour. of Phar.*, Sept. 1854, and May, 1855.

‡ *Chemical News*, vol. ii., p. 89.

vented an hypothesis more ingenious than tenable to account for this action of light on the altered syrup. He thinks that the *sugar* first decomposes some of the iodide, and that the liberated iodine then under the influence of light combines with the sugar and *protoxide* of iron to form a new chemical compound.

It has, however, been satisfactorily shown by Mr. Gordon* that the bleaching is due to the conversion of the iodine into hydriodic acid (HI). Mr. Gordon obtained hydriodic acid from a specimen of the altered syrup by distillation. According to the Messrs. Smith of Edinburgh,† the action of light may not be always evident at first, but may be continued even when the syrup has been removed to a dark place.

It is thus quite evident that as the bleaching action of sunlight upon this preparation involves a chemical change, it is not an admissible expedient for the restoration of a spoiled specimen. The deposit of glucose, said sometimes to occur, is probably due to the action of hydriodic acid upon the cane sugar. I have not myself, however, met with an instance in which this has happened.

The best means of preserving this syrup from oxidation has from time to time occupied the attention of experimentalists. Among other expedients, the introduction of a coil of bright iron wire, extending from the top to below the middle of the liquid, has been suggested by Dr. Battey of Georgia.‡

This method, however convenient when the preparation is kept by the dispenser only to enter into the composition of

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* *Chemical News*, vol. iv., p. 117.

† *Phar. Jour.*, vol. i., New Series, p. 352.

‡ Parrish, *Practical Pharmacy*, p. 521.

other mixtures, is very objectionable when the syrup itself has to be sent to a patient, as the latter may be not a little puzzled to know what part of his treatment is subserved by the spiral, or how it is to be taken. Moreover, this precaution is unnecessary, as if the syrup be made to contain the proportion of sugar given in the above formula, and be put into bottles which are filled quite full, and tied over with oiled silk or varnished animal membrane, it will be found to remain transparent and to preserve its original colour for many months.

CONTAMINATIONS AND TESTS.—Syrup of iodide of iron may contain from careless preparation, the use of impure salts and contact of metals in the process, and from imperfect preservation; iodides of other metals beside iron, free iodine, or hydriodic acid. Mr. Maisch* has found that it dissolves comparatively large quantities of the iodides of copper, lead, silver and mercury, and that while the presence of the first of these is not sensibly prevented by the use of a large excess of iron in preparing the solution, a piece of bright steel immersed in syrup containing copper will become coated with the metal after some hours contact. The recently prepared syrup is without action on metallic copper, but according to the authority just quoted, it readily dissolves it when containing free iodine. The best means of detecting the presence of this metal will be to pass a current of sulphide of hydrogen into the syrup previously acidulated with hydrochloric acid, and diluted with an equal volume of water. If free iodine be present, it will be at once recognized from the altered colour of the syrup, and by its action on starch paper. If there be reason to suspect the occurrence of hydriodic acid, the

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* *Phar. Jour.*, vol. xvii., p. 39.

syrup must first be tested with blue litmus paper, and if it be reddened, the presence of this acid may be inferred, but can only be demonstrated by distilling a quantity of the syrup, and subjecting the distillate to examination.

Specimens of this syrup are sometimes met with which contain less than the proper proportion of iodide of iron. For example, the syrup of the present London Pharmacopœia should contain thirty-nine grains of iodide per fluid ounce. Mr. E. Smith* examined four specimens obtained from different makers, with the following results :—

No. 1	Grains of iodide of iron	per	fluid	ounce		10·5
,, 2	,,	,,	,,	,,		15·0
,, 3	,,	,,	,,	,,		27·3
,, 4	,,	,,	,,	,,		35·4

This culpable divergence from the directions of the Pharmacopœia is to be traced to a very general predilection for a perfectly colourless preparation, and has not, as might be imagined, merely the object of saving so much iodine. Perhaps the best method of performing the assay of a syrup which there is reason to believe deficient in iodide is that of Messrs. T. and H. Smith of Edinburgh,† which is founded on the production of insoluble biniodide of mercury when a soluble iodide is treated with bichloride of mercury. A solution of the bichloride of mercury is prepared, containing exactly one grain in each fluid drachm, and very gradually added to a fluid ounce of the syrup diluted with four times its volume of water until no further precipitate is produced. Towards the close of the precipitation the precipitant must be cautiously used, and a little of the fluid filtered off, and tested separately with the mer-

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* *Phar. Jour.*, vol. i., New Series, p. 272.

† *Phar. Jour.*, vol. i., New Series, p. 352.

curial solution. When the operation is complete, the number of fluid drachms of the precipitant employed is read off, and the proportion of iodide of iron calculated. Suppose, for example, that 35 fluid drachms of the mercurial solution had been found necessary, then

$$Hg\,Cl_2 = 271 : 2\,Fe\,I = 310 :: 35 : 40{\cdot}3 ;$$

or the syrup under examination contained 40·3 grains of iodide of iron per fluid ounce.

Glycerina c. Ferri Iodido—Glycerole of Iodide of Iron.

It has been suggested by some pharmaceutists that glycerine would probably be found to exert a greater preservative action on iodide of iron than syrup of cane sugar. Practically, however, this substitution has not been found to possess any advantage which is sufficient to warrant its adoption, while the high price of pure glycerine of sufficient density will, of course, prevent any but a very limited use of the preparation.

Preparation.—Several formulæ for this compound have been given by different authors, but the only one directing the employment of sufficient glycerine is that of Messrs. T. and H. Smith of Edinburgh,* which is here given :—

Glycerine (sp. gr. 1267) . .	$2\frac{3}{4}$ fluid ounces.
Water	$\frac{1}{4}$,,
Iodine	. 100 grains.
Iron wire	. 60 ,,

Put the iodine, iron wire (cut into short pieces), and water into a one-ounce phial and having secured the cork or stopper, shake until the froth becomes white. Then

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* *Phar. Jour.*, vol. xvii., p. 621.

decant the liquid from the residual iron into a small filter placed in a funnel, the tube of which dips under the surface of the glycerine. When the whole has passed through, wash out the phial in which the combination has been effected with ten minims of water, and with this wash out the filter also. To complete the process, agitate the bottle containing the glycerine and solution of iodide until a uniform mixture is obtained. The product of this process is, according to its authors, quite colourless, and is of the same strength as the Syrupus Ferri Iodidi of the Edinburgh Pharmacopœia. A similar preparation may conveniently be made upon a larger scale by following the directions given for the production of the syrup, but substituting pure glycerine for the simple syrup.

Ferri Iodidi Citromel—Citromel of Iodide of Iron.

According to the experiments of Mr. Tichborne, quoted in the article on Syrupus Ferri Iodidi, the presence of citric acid exerts no appreciable effect in retarding the oxidation of solutions of iodide of iron. Mr. Horncastle,* however, adduces a series of experiments which in his opinion favour an opposite conclusion. He prepared a solution containing in each fluid ounce five grains of iodide of iron, and added citric acid in proportions varying from one to five grains per ounce. The phials containing the solutions were exposed to the light and merely covered with paper. The following results were obtained. While a solution containing no acid had become considerably altered at the end of a week, no appearance of alteration was observed

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* *Phar. Jour.*, vol. xviii., p. 256.

in the others until the termination of the undermentioned periods:—

Solution with	1 grain of citric acid	.	21 days.
,,	2 ,, ,,	.	30 ,,
,,	3 ,, ,,	.	60 ,,
,,	4 ,, ,,	.	74 ,,
,,	5 ,, ,,	.	93 ,,

Mr. Horncastle states that the solutions were tested with starch-paper, but he does not tell us whether he examined them with a view to the discovery of hydriodic acid. Now, as the solutions were exposed to the light, this acid is almost certain to have been produced, and the sesquioxide of iron, which, had no citric acid been present, would have been thrown down, probably entered into combination with the latter. This view of the question is supported by the circumstance that citric acid is quite ineffectual even, according to this experimentalist, in preventing the sensible alteration of strong solutions of ferrous iodide—*i.e.*, of solutions in which the decomposition provides sesquioxide of iron in excess of the citric acid present. In my opinion the experiments cited in no way prove that there is any preservative action to be attributed to citric acid, but Mr. Horncastle's formula for the "Citromel" may nevertheless be given with this observation, that its product can never, I think, be relied upon as containing unaltered iodide of iron, even though it present no sensible evidence of decomposition.

Ferri Iodidi Citromel.

PREPARATION.—

Solution of iodide of iron	.	1 fluid ounce.
Honey	.	12 ounces.
Citric acid	.	360 grains.
Boiling distilled water	.	q.s.

Liquefy the honey by heat, and add, firstly, the citric acid dissolved in an ounce of water, then the solution of the iodide, and lastly, sufficient water to make the whole measure twelve fluid ounces. The solution of iodide of iron here indicated may be of course of any known strength. That used by Mr. Horncastle contained 480 grains of the iodide in a fluid ounce, and this gives, according to him, a strength to his formula nearly corresponding to that of the P.L.

Ferri Iodidi Pilulæ.—Pills of Iodide of Iron.

Preparation.—M. Blancard, in 1850, introduced the excellent pills of iodide of iron which bear his name. The exact process by which they are prepared has not, of course, been made public, but it is stated that they are formed directly by the union of iodine with iron, and that the materials used to bring the salt to a pilular consistence are honey and the powdered root of marshmallow. When made, the pills are rolled in reduced iron, and are finally coated with an etherial solution of tolu balsam. The use of *iron* pill machines, which it is said are employed by M. Blancard, while it may not be an unimportant precaution where the production of these pills is carried on on a manufacturing scale, is quite unnecessary to ensure their purity when only a small number is prepared at one operation. Several definite formulæ have from time to time been proposed, and a few of these are here given, which in careful hands give good results.

I.*

Iodine	127 grains.
Iron wire	240 ,,
Distilled water . . .	75 minims.

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* Mr. Leslie of Glasgow, quoted by Christison, Pereira, and Neligan.

Reduce the iodine to fine powder, and introduce it together with the water and iron wire (which should be of the thickness of a thin quill, and cut into short pieces) into a strong phial, and having secured the stopper, shake until the froth becomes white. Next decant the solution of iodide upon—

Powdered sugar . . .	120 grains

contained in a small mortar; triturate for a few minutes, and then add gradually a mixture of the following powders in the undermentioned proportions:—

Powdered liquorice . .	240 grains.
,, gum acacia . .	90 ,,
Flour	60 ,,

Form into a mass, and divide into 144 pills. Each of these pills will weigh 5·1 grain, and contains 1·08 grain of iodide of iron.

II.[*]

Iodide of iron . . .	12 grains.
Reduced iron	6 ,,
Sugar of milk	6 ,,
Confection of dog-rose . .	12 ,,

Make into a mass, and divide into twelve pills. Each pill contains one grain of iodide, and half a grain of metallic iron.

III.[†]

Iodide of potassium . .	80 grains.
Protosulphate of iron . .	60 ,,
Powdered tragacanth . .	10 ,,
,, sugar . . .	30 ,,

Beat into a mass with a sufficient quantity of syrup, and divide into forty pills. Each pill contains 1·8 grains of

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[*] Neligan, *Mat. Med.*, p. 507.

[†] *United States Pharmacopœia.*

iodide of iron, together with 0·1 grain of iodide of potassium, and the sulphate of potash resulting from the decomposition of the salts.

REMARKS.—The first of these formulæ gives very good results, and is open only to one objection, that of making the pills inconveniently large. It would be improved by the substitution of powder of iron for part—say twenty grains—of the sugar. If care be taken to employ well, and recently prepared iodide, perhaps the product of the second formula is still better as regards keeping properties, and the weight of each pill is only three grains. The American method of preparing this pill, given under III., depends of course upon the double decomposition of the iodide of potassium and sulphate of iron, so that it contains beside the active ingredient, sulphate of potash. As the iodide of potassium is used somewhat in excess, a trace of this salt is also present.

The agitation of iodine, iron wire, and water, as directed for the first formula, is a very elegant mode of making a solution of the iodide for this purpose. It is, however, somewhat tedious, and may be conveniently replaced by the following device, in which the same proportions are preserved. Weigh out

Iodine	127 grains.
Powder of iron . . .	48 ,,

Rub together with seventy-five minims of water, add the sugar, and proceed as before. In this way the union of the iodine and iron, instead of occupying perhaps half an hour, is instantaneous. The excess of iron, of course, is introduced into the mass, and contributes to its preservation.

Prepared by any of these methods, the pills of iodide of iron are extremely deliquescent and prone to decomposition. These inconveniences can only be prevented by the application of a coating of some resinous varnish which shall exclude air, as was, I believe, originally suggested by M. Blancard. The resin usually employed for this purpose is tolu, and this is used in preference to mastic or sandarac resins from an opinion, which is not, I believe, founded upon any experimental evidence, that the latter are less soluble in the gastric fluids. The sandarac or mastic, used either alone or in combination with the tolu, would certainly give greater brilliancy and hardness to the varnish than tolu alone. The solvents in ordinary use are ether and chloroform, but I have found that *pure benzine*, which is quite as volatile, and which is not liable to contain either water or alcohol, answers the purpose much better. The following proportions make a varnish of suitable consistence, drying almost instantly, and when dry giving a coating brilliant and free from stickiness :—

Tolu resin	30 grains.
Mastic resin	30 ,,
Benzine	½ fluid ounce.

Dissolve with a gentle heat, applied by means of a water-bath. There are two modes of applying the varnish. Before, however, either be adopted, the pills should be dried. This may be conveniently effected by placing them in a dish and putting them in a closed box, or under a bell glass, with some pieces of dry lime. The pills of M. Blancard are said to be rolled in powder of iron before the varnish is applied, but when formulæ which contain an excess of iron are employed, this precaution will be unnecessary. One plan of using the varnish is to attach each pill to the point of a sharp pin or needle, and to dip each one singly into the resinous solution. Where only a small number has to be prepared, this is certainly the neatest method, but it is in this case imperative that the aperture left by the removal of the pin be subsequently closed by touching it with a hair pencil dipped in the solution. Until the coating of varnish is dry the free ends of the pins may be conveniently inserted in a mass of plastic clay. On a larger scale the varnish may be applied by putting the pills into a covered pot, adding a few drops of the solution, then shaking until they are uniformly coated, and turning out on a slab to dry.

The most careful operator, although obtaining results sufficiently good for all practical purposes, can scarcely hope to rival the exquisite finish of the pills prepared by M. Blancard. These are indeed so perfectly spherical and so uniform in size that it would seem as if some more perfect contrivance had replaced the ordinary pill machine in their manufacture. The cork of each bottle is provided with a covering of silver foil, so that the continuity of the resinous coating on the pills cannot be broken without the presence of free iodine becoming apparent by its action on the bright surface of the metal. The same security may be obtained in a different way by first varnishing and then silvering the pills, as has been proposed by M. Perrens of Bordeaux.* Pills of iodide of iron must be preserved in bottles from which air and moisture are perfectly excluded.

Ferri Iodidum Saccharatum.

Mr. Davenport has proposed the evaporation of syrup

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* Bache, *U.S. Dispensatory*, p. 1060.

of iodide of iron so as to form a solid semi-crystalline mass, which is said not to be liable to deliquescence or decomposition.*

Oleum Morrhuæ c. Ferri Iodido—Cod-liver Oil with Iodide of Iron.

PREPARATION.—Iodine is dissolved in cod-liver oil, either at a temperature of 140°, or in the cold by trituration. Powder of iron (reduced by hydrogen) is then added in excess, and the mixture heated until the disappearance of the red colour given by the iodine.

This process was patented by Mr. Horsley in 1855.† The proportions stated by him are fifty-five grains of iodine to a pint of oil. This would give 3·3 grains of iodide of iron in each fluid ounce. The degree of heat necessary in this process for the combination of the iodine with the iron is calculated to impart a more or less disagreeable odour and taste to the oil; a much better plan is to prepare a solution of iodide of iron in absolute alcohol and to add this in proper proportion to the oil, applying subsequently a degree of heat just sufficient to expel the alcohol. A convenient strength is two grains of iodide to each fluid ounce.

CHEMISTRY.—This preparation is simply a solution of the iodide of iron in the oil, the latter undergoing no chemical change. If, however, reduced iron be employed in its production, free iron will also be present, for it has been shown by M. Vezu‡ that both metallic iron and its protoxide dissolve even in the cold in cod-liver oil.

DOSE.—Two to four drachms.

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* Pereira, *Mat. Med.*, p. 852.

† *Phar. Jour.* vol. xvii., p. 36.

‡ *Repertoire de Pharmacie* and *Phar. Jour.*, vol. xvii., p.192.

Preservative Action of Cocoa-nut Oil.

M. Vezu proposes, with a view to the better preservation of iodide of iron, to combine it with cocoa-nut butter. He states that the iodide dissolves in the fat without exerting any sensible chemical action upon it. M. Vezu directs four parts of iodine to be dissolved in the melted oil, and that six parts of reduced iron be then added, and the mixture kept in a semi-fluid state until it becomes of a bottle-green colour, and ceases to colour moistened starch paper.*

Emplastrum Ferri Iodidi—Plaster of Iodide of Iron.

A plaster of iodide of iron has been proposed by M. Alquié,† and is strongly recommended by him as an application in lymphatic enlargements.

PREPARATION.—

Iodine	1 part.
Levigated iron filings . .	2 ,,
Plaster of Burgundy pitch .	30 ,,
Alcohol.	10 ,,

Melt the plaster with a gentle heat; add first the filings of iron, and then the iodine, previously dissolved in the alcohol, stirring the mass with an iron spatula until it assumes a greenish-brown colour. The plaster is spread on leather, which may be then cut into strips for convenience of application.

An improvement on this formula would be effected by the substitution of reduced iron for the levigated filings of the metal.

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* *Chemical News*, vol. v., p. 10.

† *U.S. Dispensatory*, eleventh edition, p. 1061, *note*.

Syrupus Ferri et Manganesii Iodidi—Syrup of Iodide of Iron and Manganese.

PREPARATION.*—

Iodide of potassium	1000	grains.
Protosulphate of iron	630	,,
Protosulphate of manganese	210	,,
Iron filings	100	,,
White sugar	4800	,,
Distilled water	q.s.	

Powder the iodide and the sulphates separately, and having mixed them with the filings, add half an ounce of distilled water, and triturate to a uniform paste. Then add another half-ounce of water to the paste, and triturate again, and after an interval of fifteen minutes, a third half-ounce, and mix well. Next transfer the magma to a moistened filter, and allow it to drain into a bottle holding a little more than twelve fluid ounces and containing the sugar. When all liquid has drained from the mass, add boiled cold water, by small portions at a time, until the solution of the iodides has been displaced from the crystalline mass of sulphate of potash. Finally, add sufficient water to make the whole measure *twelve fluid ounces.*

The use of the metallic iron in this preparation is to prevent the decomposition of the iodides and the liberation of iodine. This syrup has, when carefully prepared, a pale straw colour. Each fluid ounce contains fifty grains of the mixed iodides in the proportion of three parts of iodide of iron to one of iodide of manganese.

PHYSIOLOGICAL ACTION AND THERAPEUTICAL USE.—Mr. Hannon conceives that manganese is peculiarly suited to the treatment of anæmic cases in which iron has either failed or is slow in its action, but instead of entirely substi-

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* Procter, *Amer. Jour. Phar.*, May, 1853, p. 198.

tuting a preparation of the former metal, prefers the intermediate course of combining both remedies. M. Pétrequin also speaks highly of the good effects produced by syrup of iodide of iron and manganese, not only in anæmic conditions, but in scrofulous, syphilitic, and cancerous affections.*

Dose.—From ten to thirty minims.

Syrupus Ferri et Quinæ Iodidi—*Syrup of Iodide of Iron and Quinine.*

Preparation.—(Bouchardat).

Iodine . . .	60 grains.
Iron filings . . .	30 ,,
Distilled water . .	Half an ounce.

Convert into a solution of iodide of iron, and filter into a bottle containing twenty-eight ounces of simple syrup, then add

Sulphate of quinine . .	12 grains,

dissolved by means of dilute sulphuric acid in 120 minims of water.

Chemistry.—The name given to this syrup is scarcely appropriate, as the quinine is introduced, not in combination with iodine, but with sulphuric acid. Crystalline hydriodate of quinine might, however, be substituted for the sulphate. It will be observed that this preparation is very weak, containing only 2·5 grains of iodide of iron, and 0·4 grain of sulphate of quinine in each ounce. If, however, the syrup be made to approximate in strength to the simple syrup of iodide of iron, it will be found to be opaque, owing to the deposition of a compound little soluble

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* *U.S. Dispensatory*, p. 1447.

in cold water, and which I believe to be a double salt of quinine and iron with iodine. This decomposition is, however, worthy of investigation.

FERRI LACTAS.—LACTATE OF IRON.

Lactate of Protoxide of Iron—Ferrous Lactate. PREPARATION.—Lactate of iron is best obtained by the process of Lepage, in which double decomposition is effected between solutions of lactate of lime and protosulphate of iron.

Lactate of lime . . .	100 parts.
Boiling water . . .	500 ,,
Protosulphate of iron . .	62 parts.
Boiling water . . .	500 ,,
Lactic acid . . .	2 ,,

Mix both solutions, and having heated the mixture in a water-bath with agitation, filter to separate the precipitated sulphate of lime. Then boil the filtrate in a porcelain dish containing a little iron wire, until reduced to one-half its original volume; filter, and allow it to stand for twenty-four hours. Collect the deposited crystals, wash them with a small quantity of alcohol, and dry them by pressure between folds of bibulous paper. The mother liquor is to be evaporated as long as it continues to afford crystals.

The lactate of lime may conveniently be prepared by the process of Gobley,* in which casein is made to convert

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* *Jour. de Phar.*, 3e Sér., vi., 54.

sugar of milk into lactic acid by fermentation at a suitable temperature. The details of this method are as follows:

Into a jar capable of containing six pints, put—

Skimmed milk . . .	2 pints.
Sugar of milk . . .	8 ounces.
Powdered chalk . .	7 „

Fill the jar with water, and expose it to a temperature between 80° and 90° Fahr., until the evolution of carbonic acid ceases, stirring it frequently during the whole period, and replacing the water lost by evaporation. In about twelve days the chalk powder becomes granular, and a sour, cheese-like odour is developed. The whole is then boiled for fifteen minutes, and strained through flannel to separate the casein, which is washed with boiling water, and the washings added to the filtered fluid, which is now a solution of lactate of lime. The entire liquid is next diluted with water, filtered through paper, and evaporated with a gentle heat to a syrupy consistence. After twenty-four hours the lactate of lime which has separated is removed, and the liquid further concentrated, and again set aside to crystallize. The salt is now strongly pressed between folds of canvass and dried. If the process has been well conducted the product should weigh about eleven ounces.

Physical Characters.—Lactate of iron occurs in the form of yellowish-white needles, or in greenish-white crusts and grains composed of slender rectangular needles. It is also sometimes found in commerce as a pale green powder. Taste sweetish and slightly chalybeate.

Chemistry.—This salt consists of one atom of protoxide of iron combined with one atom of lactic acid. The crystals contain three equivalents of water, $FeO, C_6H_5O_5+3HO$.

It has an acid reaction, and the crystals redden litmus paper. When dry, crystals of lactate of iron are permanent in the air at ordinary temperatures, but when exposed in an open vessel to a temperature of 140° Fahr., they turn brown, and finally black, becoming changed by absorption of oxygen into *ferric* lactate. They dissolve in forty-eight parts of water at 50° Fahr., forming a pale, yellow-green solution, and in twelve parts of boiling water. They are sparingly soluble in cold weak alcohol, and not at all in strong, unless at its boiling point, when they dissolve with tolerable facility. The aqueous solution oxidizes rapidly when exposed to the air, but does not form a precipitate.

M. S. Martin* states that lactate of iron has the property of converting cane into grape sugar. If fifteen parts of the salt be dissolved in 100 parts of simple syrup, the mixture after some time becomes coloured, and its sugar uncrystallizable, and by the aid of the polariscope is found to have been changed into glucose.

CONTAMINATIONS AND TESTS.—Lactate of iron may, from want of care in preparation, contain *sulphate of iron*, *lactin*, or *lime*. The presence of the first impurity may be detected by the addition of a solution of chloride of barium; the second, by boiling with five parts of nitric acid, and crystallizing the resulting mucic acid; and the third by oxalate of ammonia. The presence of *starch*, said to be sometimes employed as an adulterant of the powdered salt, may be readily discovered by adding a drop of alcoholic solution of iodine.

PHYSIOLOGICAL ACTION AND THERAPEUTICAL USE.—Lactate of iron has the general medicinal properties of the

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* *Jour. de Chim. Méd.* and *Phar. Jour.*, vol. iv., N.S. p. 235.

other organic acid salts of the metal. It was, however, put forward as a superior preparation by Gélis and Conté on the theory that all other iron salts are in the stomach converted into the lactate. It was successfully employed in chlorosis and atonic amenorrhœa by Andral, Fouquier, Bally, Bouillaud, and others. It is said to have a marked effect in increasing the appetite. Pereira, however, endorses the opinion of Mialhe, that this salt possesses no advantages over the salts of iron with the vegetable acids, as the tartaric and citric.

Dose.—One to two grains, repeated at intervals, and gradually increased. As much as from twelve to twenty grains may be given in the course of the day.

Lactate of iron may be exhibited in the form of *syrup*, *pill*, or *lozenge*. The salt has also been made to enter into the composition of bread, which, under the name of *chalybeate bread*, is stated to have been successfully employed in one of the Paris hospitals in the treatment of chlorosis. When used in the proportion of one grain to the ounce, the bread is said not to be in the least injured in taste or quality.

Syrupus Ferri Lactatis.—Syrup of Lactate of Iron.

Lactate of iron . .	60 grains.
Sugar . . .	12½ ounces.
Water . . .	6½ „

Rub the salt with half an ounce of the sugar, to powder and dissolve the mixture quickly in the water by heat. Next pour the liquid into a flask containing the rest of the sugar in small pieces, and apply heat until solution is effected. Then filter the syrup, and preserve it in small, well-secured bottles (Cap).

This syrup is of a pale amber colour, and contains in each fluid ounce about four grains of lactate of iron.

Dose.—From two to four fluid drachms.

Trochisci Ferri Lactatis.—Lozenges of Lactate of Iron (Cap).

Lactate of iron . .	342 grains.
Sugar . . .	11½ ounces.
Mucilage . . .	q.s.

Mix, and divide into lozenges weighing each ten grains. Each of these will contain about three-fourths of a grain of the salt.

The Pill may be prepared by making the powdered lactate into a mass with sufficient liquorice powder and honey, so that each pill shall contain a grain of the salt.

FERRI PERNITRAS—PERNITRATE OF IRON.

Persesquinitrate of Iron.—Ferrum nitricum oxydatum.—

The only preparation of this salt which is employed in medicine is the solution or *Liquor Ferri Pernitratis* of the Dublin Pharmacopœia. This solution is so well known, and its value so thoroughly established, that it is only introduced here in order that the improvements which have been made in the process for its preparation may be described.

Ferri Pernitratis Liquor—Solution of Pernitrate of Iron.

Preparation.—In the process of the Dublin Pharmacopœia an ounce of iron wire is placed in contact with three fluid ounces of nitric acid diluted with sixteen ounces of water until gas ceases to be disengaged. The solution is then filtered, and made up to thirty ounces by the addition of water. Thus prepared it is at first perfectly transparent and of a bright orange colour, but after a short time begins to grow turbid from the formation of basic nitrate, and is soon completely spoiled. Mr. Ker,* who introduced the preparation, recommended, with the view of preventing this alteration, the addition of sixty grains of hydrochloric acid to the solution. With the same object, the United States Pharmacopœia, adopting a suggestion of Professor Procter's, directs that the iron be added to the diluted acid in small portions—about sixty grains—at a time. By this means the great loss of nitric acid, which is in the Dublin process inevitable, is avoided, and the result of the process is a pale green solution consisting of a mixture of mono-nitrate and ternitrate of iron. The liquid is then heated to 160°, and nitric acid is very gradually added until the solution, which now changes in colour to a bright reddish brown, ceases to give any trace of *black* precipitate with ammonia. Solution of pernitrate of iron thus prepared keeps, as I have found, very well indeed, but is not always of the same shade of colour. Moreover, the process is tedious and requires considerable attention. Professor Procter has since published† an amended formula, which he states to give a product uniform and unchangeable, while the process has certainly the merit of simplicity. Nitric acid having a specific gravity of 1·42 is diluted and added gradually to an excess of iron. In this

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* *Edin. Med. and Surg. Jour.*, vol. xxxvii., p. 99.

† *Amer. Jour. of Phar.*, July, 1857, p. 306.

way a solution is obtained which contains mono-nitrate of iron only. This is then converted into ternitrate by the addition of a quantity of nitric acid equal to two-thirds of that originally employed. The change is accompanied by a copious disengagement of red vapours of nitrous acid. The solution is finally made up to a determinate volume with water, and filtered through paper. In the following formula the proportions of acid are so adjusted that the product is of the same strength as those of the Dublin and United States Pharmacopœias—that is, it contains rather more than 1·8 grains of metallic iron in each fluid drachm :

Iron turnings or wire . .	1½ ounce.
Nitric acid (sp. gr. 1·42) .	3¾ fluid ounces.
Distilled water	24 ,, ,, or q.s.

Into a glass or porcelain vessel put the iron together with three ounces of water, and having diluted two and a quarter fluid ounces of the nitric acid with ten ounces of water, add the diluted acid in quantities of half an ounce at a time to the iron, not adding a new portion until the preceding has become perfectly neutralized. When the whole of the diluted acid has been thus employed, filter the liquid from the excess of iron and add to it the remaining ounce and a half of acid. When the evolution of nitrous acid has ceased make up the volume of the solution to thirty ounces.

Physical Characters.—The solution of pernitrate of iron prepared as above described is of a pale straw colour, and has an acid and very astringent taste.

Chemistry.—The principles involved in the preparation of the solution by Procter's process have been already explained. When the product of the Dublin formula decomposes, as it nearly always does, the precipitate consists of a basic nitrate of iron. The new solution gives upon the addition of ammonia pure sesquioxide of iron. Pernitrate of iron has been obtained in the form of colourless or delicate lavender-coloured crystals containing eighteen equivalents of water, deliquescent and very soluble in water.

PHOSPHATES OF IRON.

Four compounds of iron with the different modifications of phosphoric acid have been, from time to time, proposed as remedial agents. Three of these have a definite chemical composition:

Tribasic phosphate of the protoxide $= 2\,\mathrm{Fe\,O,HO,}\ c\mathrm{PO_5}$
Tribasic phosphate of the sesquioxide $= \mathrm{Fe_2O_3}\ c\mathrm{PO_5}$
Bibasic phosphate of the sesquioxide $=2\,\mathrm{Fe_2O_3},\ 3b\,\mathrm{PO_5}$

The fourth, which has been called a superphosphate, is of uncertain composition, being a compound of the tribasic protophosphate with the metaphosphoric or monobasic acid ($\mathrm{HO, PO_5}$). There is, perhaps, no series of preparations about which it is more difficult to obtain precise information, or the accounts of which in works on pharmacy and materia medica are so confused and unsatisfactory as the different ferric and ferrous phosphates. There is no evidence whatever that the action of any one of them upon the system is in the least different to that of any other, yet there would appear to exist almost a mania for multiplying their solutions and syrups to an extent which has already become bewildering. At the same time it must be admitted that, in accordance with the prevailing tendency of modern pharmacy, some of these modifications possess the advantages of agreeable taste and appearance, and have become of sufficient importance to justify their introduction into a systematic description of the new or improved preparations of iron.

FERRI PHOSPHAS—PHOSPHATE OF IRON.

Protophosphate of iron; ferrum phosphoricum cœruleum; ferrum phosphoricum oxydulatum cum oxydo ferri; phosphas ferroso-ferricus; blue phosphate of iron.—The protophosphate of iron is officinal in the United States Pharmacopœia, under the name of *ferri phosphas.* The Codex Medicamentarius Hamburgensis directs that when simply phosphate of iron is ordered, this phosphate is to be used.

Preparation.—(U.S.P.)—

Sulphate of iron . .	five ounces.
Phosphate of soda . .	six ,,
Water . . .	one gallon.

" Dissolve the sulphate of iron and phosphate of soda severally in four pints of the water; then mix the solutions, and set the mixture by that the powder may subside; lastly, having poured off the supernatant liquor, wash the phosphate of iron with hot water, and dry it with a gentle heat."

In this process the tribasic phosphate of soda (2 NaO,

HO,PO_5), which is the officinal salt, is decomposed by a solution of protosulphate of iron, one equivalent requiring two equivalents of the sulphate. The result is one equivalent of neutral tribasic phosphate of iron, and two equivalents of sulphate of soda ($2\ (FeO,SO_3)+2NaO,HO,PO_5 = 2FeO,HO,PO_5+2\ (NaO,SO_3)$)

PHYSICAL CHARACTERS—When first precipitated, protophosphate of iron is perfectly white, but when exposed to the action of air becomes at first green, and finally blue. As usually met with it is in the form of a fine powder of a bright slate-blue colour, which does not appear to become more intense by further atmospheric oxidation.

CHEMISTRY.—This phosphate of iron is a compound of the tribasic or *c* phosphoric acid ($3HO,PO_5$), with protoxide of iron. Closely analogous phosphates occur in nature, and are known to mineralogists as *vivianite* and *blue iron earth.* These have the general formula $3FeO,PO_5+8HO$. The formula $2FeO,HO,PO_5$ for the salt under consideration is given on the authority of Bache.*

Tribasic phosphate of protoxide of iron is insoluble in water, but easily soluble in dilute acids, and when freshly prepared, and in the moist state, in ammonia. When first precipitated it contains, provided the ferrous sulphate be pure, only protoxide of iron, but during the process of drying it becomes blue, by absorbing oxygen, and the consequent formation of some phosphate of the sesquioxide. According to Wittstein,† its composition is not constant, the proportion of protophosphate to that of sesquiphosphate being sometimes 9 : 1, and occasionally as low

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* *U.S. Dispensatory*, p. 1069.

† Buchner's *Repertorium*, 1845.

as 2 : 1. According to this authority it is not possible to prepare it by decomposing the mixed per and proto sulphates of iron with a solution of phosphate of soda.

Blue phosphate of iron dissolves in boiling monobasic phosphoric acid, forming the salt known in medicine as superphosphate of iron, but to which no definite composition has been assigned. It is also soluble in a concentrated solution of citric acid, forming a greenish-brown solution, which is not precipitated on dilution, or decomposed by the addition of potash or ammonia.*

Dose.—From five to ten grains.

Syrupus Ferri Phosphatis—Syrup of Phosphate of Iron.

I.†

Phosphate of soda . .	180 grains.
Sulphate of iron . .	150 ,,
Citric acid . .	60 ,,
Lemon syrup . .	3 ounces fluid.
Water . . .	3 ,,

Mix the syrup with the water; dissolve the phosphate in one half, the sulphate of iron in the other half; mix them, and add the citric acid. Each fluid ounce of this syrup contains about twelve grains of phosphate of iron, besides a little sulphate of soda, and the citric acid.

Dose.—From two to four fluid drachms.

II.‡

Sulphate of iron . .	300 grains.
Phosphate of soda . .	360 ,,

Dissolve the salts separately in hot water, containing a

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* *Phar. Jour.* vol. i., New Series, p. 227.

† *Amer. Jour. Phar.* and *Phar. Jour.*, vol. i., N.S., p. 227.

‡ *Phar. Jour.*, vol. i., New Series, p. 227.

little sugar; mix the solutions, and having washed and drained the resulting precipitate, dissolve it with the aid of

Citric acid, 120 grains,

in sufficient water to make the whole measure two fluid ounces, and filter. To this solution add six fluid ounces of simple syrup. Each fluid drachm contains three grains of protophosphate of iron. Should the presence of excess of acid in this syrup be objectionable, ammonia may be added to the citric acid solution of the phosphate in quantity just sufficient to effect neutralization.

DOSE.—From one to two fluid drachms.

FERRI PERPHOSPHAS.—PERPHOSPHATE OF IRON.

Ferri oxyphosphas; ferri sesquiphosphas; ferrum phosphoricum album; phosphas ferricus; white phosphate of iron.

PREPARATION.—By adding to a solution of sesquisulphate of iron a solution of tribasic phosphate of soda until no further precipitate is formed; washing and drying the product.

PHYSICAL CHARACTERS.—A white, tasteless powder.

CHEMISTRY.—Tribasic phosphate of sesquioxide of iron has, according to Wittstein, the composition $Fe_2 O_3$, 3 cPO_5+8HO_1 when the heat employed in drying it does not exceed 140°, but when dried at 212° it contains but 4HO. At a red heat it gives off water, turns yellow, and finally fuses. It is nearly insoluble in water, 1500 parts of this liquid taking up at 212° only one part of the salt.

In dilute acids—except acetic—it is easily soluble. The dry powder remains unchanged in colour when exposed to the air at ordinary temperatures. If a solution of citrate of ammonia or citric acid be added to a solution of sesquichloride of iron, the addition of *c* phosphate of soda produces no precipitate. Neither is a precipitate formed by the mixture of solutions of citrate of sesquioxide of iron and phosphate of ammonia. Moist perphosphate of iron dissolves readily in a solution of citrate of ammonia.*

Dose.—From two to ten grains, either in powder or in the form of pill or electuary.

The following formula for an extemporaneous solution of this phosphate may be found convenient :—

Phosphate of soda . .	40 grains.
Citrate of iron . . .	100 ,,
Water	1½ ounces.

Dissolve the phosphate and sulphate each in half of the water and mix the solutions. Each fluid drachm of this solution will contain about five grains of the perphosphate of iron ; or it may be converted into syrup by the addition either of sugar or simple syrup.

FERRI PYROPHOSPHAS.—PYROPHOSPHATE OF IRON.

Pyrophosphate of sesquioxide of iron ; ferric pyrophosphate.

Preparation.—By decomposing a solution of persulphate or neutral sesquichloride of iron with a solution of pyro-

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* Maisch, *Phar. Jour.*, vol. i., New Series, p. 226.

phosphate of soda ($2NaO, b\,PO_5$), a gelatinous precipitate is obtained, which dries into a tasteless, nearly white powder. In this form the pyrophosphate of iron is not usually employed in medicine. During the last few years, however, several preparations of this salt have been introduced. That which is most commonly met with, and which is known as *soluble pyrophosphate of iron*, or simply as pyrophosphate of iron, is made by dissolving the recently precipitated pyrophosphate in a solution of either pyrophosphate of soda or of citrate of ammonia, evaporating to a syrupy consistence and scaling upon glass. According to Mr. Robbins,* the best result is obtained by using as a solvent citrate of soda. The following formula is based upon the data given by this gentleman:—

Pyrophosphate of soda free from water of crystallization	1 part.
Protosulphate of iron . .	1·3 ,,
Citrate of soda . . .	1 ,,

Dissolve in sufficient water the pyrophosphate of soda, and having converted in the usual manner the protosulphate of iron into a solution of the persalt, mix the solutions. Wash the resulting precipitate thoroughly, and with the aid of heat dissolve it in a solution of the citrate of soda, using as little water as possible. Filter the solution, evaporate to a syrupy consistence, and spread on glass to dry. The process of drying must be conducted at a very low temperature (not exceeding 90° or 100°) in order to ensure success in scaling. Citrate of ammonia may be substituted for the soda citrate.

PHYSICAL CHARACTERS.—Pyrophosphate of peroxide

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* *Chemical News*, vol. i., p. 161.

of iron is, as has before been mentioned, a white tasteless powder, but the salt sold under this name, and which is a compound of the pyrophosphate with an alkaline citrate, is in the form of brilliant greenish scales, sometimes of very beautiful appearance. This salt has no ferruginous but merely a slight saline taste, which is not in the least disagreeable.

CHEMISTRY (*a*)—*Pyrophosphate of iron.*—Two equivalents of tersulphate of sesquioxide of iron are decomposed by three equivalents of pyrophosphate of soda with the formation of one equivalent of pyrophosphate of iron and six of sulphate of soda. $2\ (Fe_2O_3\ 3SO_3)+3\ (2NaO,PO_5)= 2Fe_2O_3\ 3PO_5+6\ (NaO,SO_3)$. The soda salt employed in this decomposition is that obtained by heating to redness the ordinary tribasic phosphate of soda. It is important that an excess of pyrophosphate of soda be avoided, as the precipitated phosphate of iron is soluble in this salt. Nor must the iron solution contain free acid, as in this case the precipitate consists, not of pyrophosphate, but of ordinary phosphate of iron.*

Pyrophosphate of ferric oxide is soluble in citrate of ammonia, citrate of soda, and citrate of potash; in ammonia, carbonate of ammonia, and pyrophosphate of soda. Insoluble in water and dilute acids. One part of the recently precipitated pyrophosphate requires for solution one part of solution of ammonia, sp. gr. 880,† or ·25 parts of pyrophosphate of soda.‡ According to Parrish, sixteen parts of the gelatinous precipitate represent three parts of dry pyrophosphate.

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* Gmelin, *Handbook*, vol. v., p. 227.

† Wilkinson, *Phar. Jour.*, vol. iii., New Series, p. 425.

‡ Parrish, *Pharmacy*, p. 490.

(b) Pyrophosphate of Iron with Soda or Ammonia Citrate.—This, which is the scaled preparation, contains a variable proportion of the salt *a*. A specimen examined by myself gave for 100 parts 23 of sesquioxide, equal to 16·1 of metallic iron. An analysis given by Professor Chapman* for the compound with citrate of ammonia is thus stated:—

Pyrophosphate of iron (anhydrous) .	48·80
Citrate of ammonia (neutral) . .	34·66
Water in combination . . .	16·54
	100·00

Exposed to the air the lustrous scales of this preparation lose their brilliancy and become quite opaque. This is especially the case with the ammonia compound; according to Mr. Robbins, the employment of citrate of soda produces a more permanent product. Scaled pyrophosphate of iron is readily soluble in water, forming a pale greenish solution. A reddish tint is sometimes given to the salt by the addition of a little ammonio-citrate of iron. When pyrophosphate of soda is employed as a solvent for ferric pyrophosphate the resulting salt is, when dry, nearly insoluble. This solution, however, forms the basis of a syrup recommended by Soubeiran, for which the formula is given below. The employment of citrate of ammonia as a solvent appears to have been first adopted by M. Robiquet. It should be observed that the solution in pyrophosphate of soda is liable to decomposition by continued exposure to the air, which is not the case with the alkaline citrate solution.†

Dose.—From three to ten grains.

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[*] *Chemical News*, vol. vi., p. 223.

[†] Parrish, *Pharmacy*, p. 491.

Syrupus Ferri Pyrophosphatis—Syrup of Pyrophosphate of Iron.

I. (Soubeiran.)*

Persulphate of iron .	55·4	grains.
Water . . .	924	,,

Dissolve with a gentle heat, and add the following solution :—

Crystallized pyrophosphate of soda	462	grains.
Water . . .	7¾	ounces.
Peppermint water . .	3½	,,

When the precipitate at first formed is redissolved, filter the solution, and dissolve in it, taking care, if heat be used, that it do not exceed 120° F.

White sugar . . .	21	ounces.

Dose.—A tablespoonful, containing about one-third of a grain of iron.

II. (Robiquet.)†

Sulphate of peroxide of iron . .	50	parts.
Pyrophosphate of soda . .	84	,,
Citric acid	26	,,
Ammonia to neutralise the citric acid .	q.s.	

Dissolve separately and without heat the sulphate of iron and pyrophosphate of soda, and mix the solutions; wash the precipitate, and dissolve it in the citrate of ammonia. Then filter the solution, and evaporate it at a low temperature. To each drachm of simple syrup add three grains of the resulting salt.

Dose.—From one to two drachms.

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[*] *Jour. de Pharmacie* and *Phar. Jour.*, April, 1853, p. 499.

[†] *Chemical News*, vol. i., p. 171.

III. (Procter.)*

Pyrophosphate of soda	120 grains (3 equivalents.)
Solution of persulphate of iron	(to contain 2 equivalents.)
Water	sufficient.
Citric acid	40 grains.
Liquor ammoniæ	sufficient (about fʒiss.)
Syrup of orange flowers	2 fluid ounces.
Simple syrup	sufficient.

"Dissolve the pyrophosphate in four fluid ounces of water, add solution of persulphate of iron till it ceases to precipitate, then wash the white gelatinous salt on a filter till the washings pass tasteless. Triturate the iron salt in a mortar with the citric acid previously powdered, and the ammonia gradually added with constant stirring, until a transparent reddish-brown liquid is obtained, then add the syrup till 14 fluid ounces are attained."

Dose.—A teaspoonful.

Syrup of pyrophosphate of iron may also be readily prepared by simply dissolving the scaled salt of commerce in simple syrup in any desired proportion, and as the pyrophosphate is now manufactured on a large scale, and is very easily soluble, this method presents some advantages, especially when a small quantity only of the syrup is required.

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* Parrish, *Practical Pharmacy*, p. 497. One or two parts of this formula appear indefinite. Firstly, 120 grains is not (in grains) 3 equivalents of pyrophosphate of soda. I presume that the author intends 120 grains to be used, and the persulphate of iron employed in equivalent proportion 3 ($2NaO, PO_5 : 2Fe_2O_3, 3SO_3$) ; but if this be the case, the syrup will be weak—containing about one grain of iron salt in each fluid drachm—which is hardly in accordance with the dose stated. Secondly, if the persulphate of iron be taken in equivalent proportion, why add it "till it ceases to precipitate?" I give the formula as coming from one who is a good authority, pointing out in it, at the same time, what I consider to require explanation.

FERRI SUPERPHOSPHAS.—SUPERPHOSPHATE OF IRON.

Acid Phosphate of Iron. PREPARATION.—By adding to boiling glacial (*a* or *meta*) phosphoric acid, as much blue or protophosphate of iron as it will dissolve, and allowing the liquid to cool. Recently precipitated protophosphate of iron is also soluble in dilute phosphoric acid—a fact which is taken advantage of in the preparation of two of the syrups of superphosphate of iron, for which formulæ are given below.

PHYSICAL CHARACTERS.—A mass of soft consistence without inky taste.

CHEMISTRY.—No exact composition has been assigned to this salt. It is, however, probably identical with the compound formed by acting upon metallic iron with aqueous phosphoric acid. It is readily soluble in water.

DOSE.—From five to ten grains.

Syrupus Ferri Superphosphatis—Syrup of Superphosphate of Iron.

I. (Greenish.)

By dissolving in each fluid drachm of simple syrup five grains of the salt prepared as above described.

II.*

Crystallized sulphate of iron .	3 ounces.
Phosphate of soda	3 ,,
Carbonate of soda . . .	1½ ,,
Water	1½ ,,
Phosphoric acid, P.L. . .	21 ,, fluid.

Rub together the phosphate and carbonate of soda to fine powder, then add the sulphate of iron, and continue

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* Schweitzer, *Chemical News*, vol. i., p. 160.

the trituration—gradually adding the water—until a uniform mass of blue colour is produced. Wash this mass thoroughly with water, and drain it on a filter. Then transfer it while still moist to a graduated measure, and if it measure less than six fluid ounces make it up to this quantity with distilled water. The precipitate is finally dissolved without heat in the twenty-one ounces of dilute phosphoric acid, and the resulting solution filtered and preserved for use. To prepare the syrup, mix—

Solution of phosphate of iron .	5 fluid ounces.
Simple syrup . . .	9 ,, ,,

This syrup contains in each fluid drachm one grain of phosphate of iron, and (nearly) sixteen minims of dilute phosphoric acid. Mr. Schweitzer gives as his object in introducing carbonate of soda in the preparation of the phosphate of iron employed for this syrup the neutralization of excess of sulphuric acid, which would otherwise cause loss of phosphate by solution. I do not, however, think that this addition is necessary.

III.*

Protosulphate of iron .	222 grains.
Phosphate of soda . .	240 ,,
Water . . .	q.s.
Dilute phosphoric acid .	5 fluid ounces.
Sugar . . .	9 ,, ounces.

Dissolve the sulphate of iron and phosphate of soda separately, each in four ounces of water, and mix the solutions. Throw the precipitate on a calico filter, and wash well with water; then squeeze the mass as dry as possible, and add the phosphoric acid. When dissolved,

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* Gale, *Chemical News*, vol. i., p. 170.

filter the solution, which will measure about 6 ounces. In this dissolve the sugar without heat, so that the product shall measure exactly 12 ounces. Each drachm of this syrup will contain about one grain of phosphate of iron, and 25 minims of dilute phosphoric acid. This is nearly equal to five grains of the superphosphate.

DOSE.—One fluid drachm.

PHYSIOLOGICAL ACTION AND THERAPEUTICAL USE OF THE PHOSPHATES OF IRON. *Blue or Tribasic Protophosphate.*—This salt possesses the general properties of the preparations of iron, and has been employed with success in the treatment of amenorrhœa and dyspepsia. Dr. Venables, quoted by Pereira,* proposed its use in the treatment of diabetes, and speaks very highly of its power in restraining the excessive secretion of urine, and of increasing the power of digestion. It was also employed by Mr. Carmichael, externally and internally, in the treatment of cancer. Neligan† speaks of it as peculiarly adapted for the scrofulous affections of children, in which there is softening of the osseous system, and for rickets.

Perphosphate.—This salt was also employed by Mr. Carmichael and by Fuzet Duponget in the treatment of cancer. For this purpose either the per or protophosphates may be used in the form of powder, or mixed with water to a thin paste. If the form of lotion be preferred, the phosphate may be diffused through water.

Pyrophosphate.—The pyrophosphate of iron in solution was proposed as a remedy in France by Persoz in 1848, and in 1849 by Leras. The latter authority claims for the pyrophosphate of iron and soda that it is the only ferru-

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* *Materia Medica*, vol. i., p. 832.

† *Medicines*, p. 513.

ginous preparation which is not precipitated in the stomach, either by the action of the food or gastric juice. Dr. Ure employed it with success in scrofula and as a chalybeate. MM. Follet and Baume found it very successful in the treatment of anæmic diseases, being easily administered and rapidly absorbed.

Professor Chapman has recently communicated to the *Chicago Medical Examiner* an elaborate paper* on the therapeutical advantages of this salt, with especial reference to the citro-ammoniacal variety. Many of the Professor's deductions are, I conceive, somewhat visionary; but his practical experience of the pyrophosphate as a remedy appears to be the result of careful observation. He recommends it on the several grounds of elegant appearance, tastelessness, facility of assimilation, and the absence of any tendency to disorder the stomach. Although, he remarks, it may fail in cases when the digestive function is much impaired, it will not aggravate the disorder. "Besides it appears to possess a tonic power, and will restore the appetite and digestion after the failure of bitters, quinine, wine, &c." He has also found it successful in anæmia, amenorrhœa, and chlorosis. "It seemed to afford just the grade of stimulus required by the stomach, and the improvement thus initiated continued without interruption under this single remedy to the complete cure of the patient."

Superphosphate.—This salt was introduced by Dr. Routh,† who states it to be "far more efficacious and speedy in its curative action than any other preparation of iron in some cases of anæmia and debility brought on by venereal

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* *Vide Chemical News*, vol. vi., p. 223.

† *Medical Times*, vol. xxiii., p. 104.

and other excesses, over-study, or depressing diseases, in which there is a prevalence of nervous symptoms, and a large quantity of phosphates is voided by the urine."

Phosphates of Iron with other Phosphates.

Several preparations of the phosphates of iron with phosphates of the alkalies and of other metals have been, from time to time introduced, principally in the form of syrups, and as these are occasionally prescribed, a few of the leading formulæ are introduced for the convenience of the pharmaceutist.

Syrup of Phosphate of Iron and Ammonia.[*]

Sulphate of iron . .	278 grains.
Phosphate of soda . .	359 ,,
Glacial phosphoric acid .	396 ,,
Liquor ammoniæ . .	sufficient.
Sugar . . .	5½ ounces.
Water . . .	sufficient.

Dissolve separately the phosphate of soda and sulphate of iron; mix the solutions, and wash the precipitate. Dissolve one half the phosphoric acid in one ounce of water, and add liquor ammoniæ to saturation. In the solution of the remainder of the phosphoric acid in another ounce of water, dissolve the phosphate of iron with a gentle heat; then add the solution of phosphate of ammonia and the sugar, and evaporate to seven fluid ounces. This syrup contains in each fluid drachm 4·5 grains of phosphate of iron, 4·75 grains of phosphate of ammonia, and 3·5 grains of phosphoric acid.

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[*] Roberts, Baltimore.

Syrup of Phosphate of Iron and Lime.[*]

Sulphate of iron	124 grains.
Phosphate of soda	142 or q.s.
Phosphate of lime	48 grains.
Hydrochloric acid	q.s.
Liq. ammoniæ	q.s.
Dilute phosphoric acid	5 fl. ounces.
Sugar	9 ,,

Dissolve the sulphate of iron and phosphate of soda separately; mix the solutions and wash the precipitate. Dissolve the phosphate of lime in sufficient hydrochloric acid, diluted with twice its volume of water, precipitate with ammonia and wash. Mix this moist phosphate of lime with the phosphate of iron, and dissolve in the dilute phosphoric acid; filter the solution and dissolve the sugar. Each drachm contains ·75 grain of phosphate of iron, and ·5 grain phosphate of lime, with 25 minims of dilute phosphoric acid.

Syrup of Phosphate of Iron and Manganese.[†]

Protosulphate of iron	124 grains.
Sulphate of manganese	46 ,,
Phosphate of soda	240 ,, or q.s.
Water	q.s.
Dilute phosphoric acid	5 fluid ounces.
Sugar	9 ounces.

Dissolve the sulphates and the phosphate of soda respectively in four ounces of water, mix the solutions, wash the precipitate on a calico filter, and press. Dissolve the resulting magma in the dilute phosphoric acid, filter, and adding the sugar, convert into a syrup without heat. The

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[*] Gale, *Chemical News*, vol. i., p. 171.

[†] Gale, *Chemical News*, vol. i., p. 170.

product should measure twelve ounces. Each drachm contains about ·75 grain phosphate of iron, ·5 grain phosphate of manganese, and twenty-five minims of dilute phosphoric acid.

Syrup of Phosphate of Iron and Nickel.

Protosulphate of iron .	. 124 grains.
Sulphate of nickel .	. 56 ,,
Phosphate of soda .	. 240 ,, or q.s.
Dilute phosphoric acid	. 5 fluid ounces.
Water . . .	. q.s.
Sugar . . .	. 9 ounces.

Proceed as in the last formula, making the product measure twelve ounces. Each drachm contains ·75 grain phosphate of iron, ·25 grain phosphate of nickel, and twenty-five minims of dilute phosphoric acid.

Compound Syrup of Phosphates or “ Chemical Food.”[*]

Protosulphate of iron .	. 600 grains.
Phosphate of soda .	. 720 ,,
Phosphate of lime .	. 720 ,,
Glacial phosphoric acid	. 1200 ,,
Carbonate of soda .	. 40 ,,
Carbonate of potassa .	. 60 ,,
Hydrochloric acid Liquor ammoniæ } of each	. q.s.
Powdered cochineal .	. 120 grains.
Water . . .	. q.s.
Sugar . . .	. 35 ounces.
Orange-flower water .	. 1 fluid ounce.

Dissolve the sulphate of iron in two ounces and the phosphate of soda in four ounces of boiling water. Mix the solutions, and wash the precipitated phosphate of iron. With

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[*] Parrish.

the aid of sufficient hydrochloric acid, dissolve the phosphate of lime in four ounces of boiling water; when cool precipitate with solution of ammonia and wash the precipitate. Mix the phosphates, and add to them the phosphoric acid previously dissolved in water. To the clear solution add the carbonates of potash and soda, also dissolved in water, and then sufficient hydrochloric acid to dissolve any precipitate. Next dilute with water until the whole liquid measures twenty-two fluid ounces, add the sugar and cochineal, dissolve with heat, strain, and when cool add the orange-flower water. Each teaspoonful contains about 2·5 grains phosphate of lime, one grain phosphate of iron, with fractions of a grain of phosphates of soda and potash, besides free phosphoric and hydrochloric acids.

FERRI SESQUICHLORIDUM—SESQUICHLORIDE OF IRON.

LIKE the iodide of the same metal, sesquichloride of iron is a salt, which, though of long standing as a therapeutic agent, and not in any way claiming the title of a new remedy, is of such recognized value that a great deal of pains has been taken by pharmaceutists to improve the processes by which it is made, and to present it in a more stable form. Of late years, too, it has been considerably used as an external surgical agent, and this new use has necessarily led to the introduction of suitable preparations. A few remarks on these improvements and the insertion of the new formulæ may not be found out of place or useless.

The ordinary form in which sesquichloride of iron is prescribed for internal use is, as is well known, that of tincture, a solution of the extemporaneously prepared salt in aqueous alcohol. The formula of the London Pharmacopœia affords, if pure materials be used, a product which keeps well and is of uniform strength and colour. But much of the substance found in commerce under the name of sesquioxide of iron contains variable quantities of magnetic oxide, and this yields a solution which is not only darker in colour than that given by pure sesquioxide, but is liable to decomposition after a time. The best method of ensuring uniformity in the preparation is to use a pure sesquioxide formed by adding to a slightly acid solution of protosulphate of iron, chlorate of potash in the proportion of rather more than one part to every twelve parts of ferrous sulphate employed, and then precipitating by the addition of ammonia or caustic soda. The use of chlorate of potash as an oxidizing agent in this case presents the advantages of definite action and elegance of manipulation. The following formula will serve to give an idea of the reaction, though it is probable that it does not exactly represent the distribution of the elements engaged :

$$12\,FeO,SO_3+KO,CLO_5+6\,SO_3=6\,Fe_2O_3,3\,SO_3+KCL$$

The tincture of the Dublin College is liable to the great defect of readily decomposing. The principal causes of this are insufficient oxidation of the iron, owing to the employment of a too weak nitric acid and deficiency of the hydrochloric acid used to keep it in solution. A solution of the pure sesquioxide, prepared as just described, is a much better preparation, both in point of stability and uniformity of strength. An American physician, Dr. Squibb, has, however, proposed a formula, which, although closely resembling that of the Dublin College, differs from it in one essential particular—namely, the mode of adding the hydrochloric acid. Dr. Squibb's formula is as follows :

Iron filings	2¼ ounces.
Hydrochloric acid (sp. gr. 1·16)	10 fl. ounces.
Nitric acid (sp. gr. 1·42)	q.s.
Alcohol	30 fl. ounces.
Distilled water	6 ,, ,,

To the iron contained in a large flask add six and a half fluid ounces of the hydrochloric acid, diluted with one ounce of water. When the action has ceased, boil gently for four hours, add two ounces of water, heat again to boiling, and filter the hot solution, adding the liquid obtained by washing the flask with one ounce of water. Next add the remainder of the hydrochloric acid, and having heated the mixture, add the nitric acid until it falls into the liquid without effervescence. Then make up the measure to ten ounces by adding water, and mix with the alcohol. In the Dublin formula the whole of the acid is added before the evaporation is begun, and the result of this is that too much of it is lost. By adopting Dr. Squibb's plan this objection is completely avoided, as a considerable proportion of the acid—*i.e.*, that required for the formation of the sesquisalt—is only introduced after the evaporation. The product of this process is said to keep well, and there is no reason why it should not do so. It corresponds in strength with the tincture of the London Pharmacopœia, one fluid ounce containing thirty-two grains of sesquioxide of iron. It is, however, manifest that the same principle may be applied while the proportions of the Dublin College are preserved.

In the formula of the British Pharmacopœia which is given in the appendix, a solution of perchloride of iron is first prepared by the action of hydrochloric and nitric acids on iron wire. This solution has a specific gravity of 1·338, and contains in each fluid drachm 15·62 grains of sesquioxide of iron. The evaporation of the liquid is not carried far enough to dissipate any of the excess of acid employed, and the solution is permanent. From it the tincture is made by simple admixture with spirit, and although much weaker than the Dublin or even the London tincture, has the advantages of definite and, as I think it will be found, unchanging composition.

Solution of Sesquichloride of Iron.

The employment of sesquichloride of iron as a styptic is not unfrequent. It is also sometimes used as a local application for the cure of aneurisms by injection. For these purposes the solution of the salt prepared in the ordinary manner is quite unfit. We owe, however, to M. Burin du Buisson the following formula for the production of a concentrated solution of the sesquichloride, which is perfectly neutral and not liable to alteration.

Saturate as quickly as possible pure colourless hydrochloric acid with gelatinous hydrated peroxide of iron. Evaporate the solution with a gentle heat to the consistence of a thick syrup, avoiding the contact of aqueous vapour. Then add an excess of the gelatinous peroxide of iron diluted with a little water, agitate for a quarter of an hour, and then allow the liquid to rest for several hours. Next add distilled water in sufficient quantity to give the mixture a specific gravity of 1·261, and allow it to stand for eight days in contact with an excess of the peroxide, after which filter and allow it to stand for two weeks.

The solution sp. gr. 1·261 is that which is employed for the cure of varices, but if required for injection into aneurismal tumours, it must be diluted to the density of 1·115.

Other methods for the preparation of a pure and neutral sesquichloride of iron have also been proposed. M. Lebaique recommends the employment of the sublimed salt, which is, according to him, readily obtained by passing a current of chlorine over a quantity of small iron nails or tacks slightly heated in a glass flask. The iron is first converted into protochloride, and then into the sesquichloride. The heat is increased at the end of the operation, so as to sublime the product. Perchloride of iron thus prepared is said to be chemically neutral and of unvariable composition. It is readily soluble in water, affording a clear solution, which keeps without alteration.

M. Adrian, a Paris chemist, adopts the following mode of proceeding with a like object. A solution of protochloride of iron, having a density of 25° Beaumé (sp. gr. 1210), is made by acting on clean iron filings with pure hydrochloric acid. The liquid is at once poured into a number of Woolfe's bottles, through which is passed a current of chlorine for some hours—altering occasionally the position of the bottles in the series—or until all the iron has been converted into sesquichloride. The liquid is then heated for an hour at a temperature not exceeding 122° F., and a current of air passed through it in order to remove the last trace of chlorine. The solution is stated to have now a density of 30° Beaumé (sp. gr. 1261), to be perfectly transparent and of a bright saffron colour. Its taste is very astringent, but not acid. When of the density above indicated, it contains 30 per cent. of anhydrous sesquichloride of iron.

The following table, giving the proportions of anhydrous sesquichloride in a few solutions of different specific gravities, may be found useful :—

Specific Gravity.	*Sesquichloride of Iron per cent.*
1·116	12
1·161	17
1·261	30
1·454	43

Double Chloride of Iron and Sodium—A New Hæmostatic Agent.

Dr. Phipson[*] has called attention to the value of the double chloride of sesquioxide of iron and sodium as a means of arresting the flow of blood from wounds. The discovery is due to Dr. Piazza, Professor of Chemistry in the University of Bologna, and it is said that experiments made to test its efficacy in the hospitals of Parma, Modena, Bologna, and Brussels, have been attended with complete success. In making experiments upon the power possessed by various chemical agents of coagulating blood, Professor Piazza states that the addition of chloride of sodium to blood which had been coagulated by chloride of

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[*] *Chemical News*, vol. vii., p. 252.

iron rendered the mass so compact that the vessel containing it may be inverted without loss.

If chloride of iron alone be used as a hæmostatic it is necessary to employ strong solutions (sp. gr. 1·210 to 1·260), which cause much pain and irritation. The addition of chloride of sodium, however, confers the hæmostatic property upon much weaker solutions (sp. gr. 1·075 to 1·116.) According to Dr. Phipson the best method of preparing the solution is to add to a solution of perchloride of iron, having one or other of these specific gravities, a concentrated (saturated?) solution of pure chloride of sodium. The perchloride of iron employed must not contain free acid, and would probably be best prepared by the method of M. du Buisson already detailed.* The liquid is used by immersing in it the linen employed to bind the wound.

FERRI STEARAS—STEARATE OF IRON.

PREPARATION.—

Sulphate of iron . .	1 part.
Castille soap . .	2 "

Dissolve the sulphate of iron in four times its weight of water, and the soap in a like quantity ; mix the solutions, and having washed and dried the greenish-blue precipitate, melt it at a low temperature.

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* The same object might evidently be easily attained in a different way by neutralizing with carbonate of soda the excess of acid in any solution of perchloride of iron, and then adding the chloride of sodium.

This compound, which was introduced by M. Braile, has been successfully employed in the treatment of phagedenic ulcers. It is applied by melting and spreading upon linen like ordinary plasters. It is said to be adhesive, and not liable to split. Dr. Calvo publishes a case, under the care of M. Ricord,[*] in which phagedenic ulcers affecting both thighs were completely healed in less than a month by this application.

FERRI AMMONIO-SULPHAS—AMMONIO-SULPHATE OF IRON.

Ammonia Iron-Alum; Alumen Ferricum; Ferrico-Ammonic Sulphate; Ammonio-Ferric Alum.

PREPARATION.—

Crystallized protosulphate of iron .	8 ounces.
Sulphuric acid . . .	1 fl. ounce.
Nitric acid	1½ fl. ounces.
Sulphate of ammonia . .	2¼ ounces.

Convert in the usual manner with the aid of the sulphuric and nitric acids the protosulphate of iron into a solution of persulphate, measuring about two pints. Reduce this by boiling to one half, add the sulphate of ammonia, filter while hot, and set aside to crystallize. Wash the crystals in water containing a little sulphuric acid, and dry them either without heat or at a low temperature.

PHYSICAL CHARACTERS.—Octohedral crystals, either

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[*] *Journal of Practical Medicine and Surgery*, June, 1860.

colourless, or more usually of a pale violet tint. Specific gravity 1·712. Taste, astringent, ferruginous.

CHEMISTRY.—This salt and the one next to be described are representatives of that numerous class of chemical compounds, which, from the resemblance in constitution borne by them to ordinary alum, have received the designation of *alums*. The following formula, in which M represents any suitable metal, illustrates the general composition of these salts:—

$$M_2O_3, 3SO_3 + MO,SO_3 + 24HO$$

Crystals of ammonia-iron alum, for example, are thus composed—

$$Fe_2O_3, 3SO_3 + NH_4O, SO_3 + 24HO$$

They are soluble in three parts of water at 59° F. This salt sometimes becomes yellow, probably from loss of ammonia, as it recovers its original colour when recrystallized. According to Rose, the pure iron alums are colourless, and they may be obtained so by crystallizing from slightly acid solutions.

CONTAMINATIONS AND TESTS.—This compound may be distinguished from the salt containing protoxide of iron by the colour of the precipitates given with caustic potash and ferrocyanide of potassium, and from potash-iron alum by the evolution of ammonia when lime or potash is added to its solution.

PHYSIOLOGICAL ACTION AND THERAPEUTICAL USE.—In action this salt precisely resembles the potash-iron alum next to be described, and under the head of which the details concerning its medical use will be found.

FERRI-POTASSIO-SULPHAS—POTASSIO-SULPHATE OF IRON.

PREPARATION.—

Protosulphate of iron	8 ounces.
Sulphuric acid	1 fl. „
Nitric acid	1½ „ „
Sulphate of potash	2½ „ „
Water	

Proceed as in the case of the ammonia compound.

PHYSICAL CHARACTERS.—Octohedral crystals, either colourless or pale violet.

CHEMISTRY.—The composition of the crystals of potash-iron alum is shown by the following formula:—

$$KO,SO_3 + Fe_2O_3, 3SO_3 + 24HO$$

When exposed to the air they slowly effloresce, becoming covered with a white powder. When this iron alum is heated it first fuses in its water of crystallization, and then, losing this water, is converted into a yellowish white spongy mass. More strongly ignited, it fuses and gives off 24·4 per cent. of sulphuric acid, leaving a mixture of sulphate of potash and sesquioxide of iron. The crystals dissolve in five parts of water at 34° F.

PHYSIOLOGICAL ACTION AND THERAPEUTICAL USE.—The therapeutic action of both the potash and ammonia sulphates of iron is alike, and one may be substituted for the other at pleasure. They are said to equal, if not exceed, ordinary alum in astringency, and not to possess the stimulating action of some of the salts of iron.

DOSE.—Three to six grains.

FERRI ET MAGNESIÆ QUINEQUE SULPHAS—SULPHATE OF IRON, MAGNESIA, AND QUININE.

Dr. Fergus of Marlborough College, has, in a communication to the *Medical Times and Gazette*,* proposed the employment of a salt containing these three sulphates. He gives no instructions for its preparation, but states that the following proportions have been found to give good results :—

Sulphate of iron . . .	15 parts.
Sulphate of magnesia . .	80 „
Sulphate of quinine . .	5 „
	100

Dr. Fergus describes the new salt as being unalterable in the solid state, as soluble as sulphate of magnesia, and affording a solution which preserves its transparency for an indefinite period, and which may even be agitated with oxygen without undergoing any change. The addition of gallic acid produces a bluish tint only after the lapse of two or three days, and it is said that many substances which produce an inky colour with the ordinary salts of iron do not affect this compound.

Dr. Fergus further remarks that the therapeutic effect of both iron and quinine is remarkably increased in this preparation, and that both remedies are less apt to disagree with constitutions which ordinarily tolerate iron and quinine with difficulty.†

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* March 17, 1861.

† In a single attempt made at the time when this formula was first published, I was unsuccessful in obtaining the results described by Dr. Fergus; the crystals deposited from a solution of the sulphates in the proportions stated containing no trace of quinine.—H.N.D.

FERRI ET QUINÆ SULPHAS—SULPHATE OF IRON AND QUININE.

Under this name some of the American pharmaceutists describe a compound of sulphate of quinine with sulphate of sesquioxide of iron. It is prepared by converting 125 parts of protosulphate of iron into sesquisulphate in the usual manner, and adding to the solution 480 parts of sulphate of quina. After some months octohedral crystals are formed, which are described as colourless, bitter, and but very slightly soluble in water.

FERRI SULPHAS CUM SACCHARO—SACCHARATED SULPHATE OF IRON.

Preparation.—In 100 parts of boiling distilled water, dissolve 200 parts of pure protosulphate of iron. In 30 parts of boiling distilled water, dissolve 50 parts of pure sugar (white sugar candy), mix the solutions, and filter as quickly as possible. Collect the crystals which form as the liquid cools, dry between folds of bibulous paper, and preserve in a dry bottle.

This preparation has not received the attention which its importance deserves. The facility with which protosulphate of iron in spite of every precaution becomes altered, makes it impossible to overrate the advantage of being able to prevent its oxidation by combining it with a substance, which, like sugar, is medicinally inert. M.

Latour, to whom we owe the new salt, has shown* that not only does the sugar prevent the decomposition of the sulphate, but that it forms with it a definite compound constituted as follows:—

Protosulphate of iron . .	54·57
Water	32·50
Sugar	12·93
	100·00

Saccharine sulphate of iron crystallizes in oblique rhombic prisms of a pale green colour, and readily soluble in water. This salt, if properly dried and preserved with ordinary care, will remain unoxidized for an indefinite period, and is not rapidly decomposed, even in the state of solution.

Dose.—From three to ten grains in aqueous solution.

FERRI TANNAS—TANNATE OF IRON.

Preparation.—Forty-four parts of precipitated carbonate of iron are dissolved in the boiling aqueous solution of nine parts of tannic acid, the solution evaporated to a syrupy consistence and spread on glass to dry, a gentle heat being employed. Tannate of iron thus prepared is in the form of flat pieces of a dark crimson colour, is tasteless, and insoluble in water. It is astringent and tonic, and although now very rarely prescribed, has been successfully

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* *Gazette Médicale de l'Algerie* and *Journal de Pharmacie*, vol. xxxii., p. 328.

employed in the treatment of chlorosis. It is given in the form of pill.

Dose.—From ten to thirty grains.

Syrupus Ferri Tannatis—Syrup of Tannate of Iron.

Citrate of iron . . .	150 grains.
Extract of galls . . .	60 ,,
Raspberry syrup . .	4 ounces.
Simple syrup . . .	12 ,,

Dose.—One tablespoonful.*

FERRI VALERIANAS—VALERIANATE OF IRON.

Preparation.—

Valerianate of soda . .	43 parts.
Protosulphate of iron . .	32 ,,
Water	q.s.

Convert in the usual manner the sulphate of iron into a solution of persulphate measuring 64 parts, and having dissolved the valerianate of soda in 50 parts of water, mix the solutions, taking care that both are cold. Throw the precipitate which forms upon a filter, wash it with 30 parts of *cold* water, and dry it by placing it on filtering paper supported on a porous brick.

In this process, which is in all particulars that of the Dublin Pharmacopœia, three equivalents of valerianate of

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[*] Parrish, *Practical Pharmacy*, p. 517.

soda are made to react on one equivalent of tersulphate of iron, the result being one equivalent of valerianate of iron which is precipitated, and three of sulphate of soda which remain in solution. Both solutions must be cold, for at temperatures much lower than that of boiling water the valerianate of iron is decomposed into peroxide of iron and valerianic acid. Even cold water, if its action be prolonged, causes this decomposition, and for this reason a minimum of water is employed for washing the salt. Nor can artificial heat be used in the process of drying.

PHYSICAL CHARACTERS.—A dark, brick-red, amorphous powder, having a slight odour and taste of valerianic acid.

CHEMISTRY.—Valerianate of iron consists of one equivalent of sesquioxide of iron united to three equivalents of valerianic acid.

$$Fe_2O_3, 3C_{10}H_9O_3$$

Its atomic weight is 359. It is insoluble in cold, and, as already stated, decomposed by hot water; soluble in alcohol. It is also dissolved by hydrochloric acid, and if excess of this acid be not present, the solution is not precipitated blue by ferrocyanide of potassium. According to Wittstein* in this salt the sesquioxide is partially reduced by the valerianic acid to the state of protoxide.

Valerianate of iron, like powdered resin or lycopodium, is not moistened by cold water, even if continuously rubbed with it. Warm water wets it instantly, but produces partial decomposition. Slowly heated it parts with all its acid without fusing; but when heat is more rapidly applied it melts, and its acid is at the same time decomposed, as

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* *Practical Pharmaceutical Chemistry.*

the evolved vapours have a strong odour of butyric acid. This change is thus represented—

$$C_{10}H_9O_3 = C_8H_7O_3 + 2CH$$

CONTAMINATIONS AND TESTS.—When the preparation of valerianic acid was a less simple and expensive matter than it now is, this salt was frequently counterfeited by mixtures of tartrate, citrate, or sesquioxide of iron with oil of valerian. There is now, however, no reason to believe that it is either counterfeited or adulterated. Frauds of the nature mentioned may, however, be at once detected by, in the case of tartrate or citrate of iron, the solubility of the compound in water, and its insolubility in alcohol. This latter test, and another in which advantage is taken of the liberation of valerianic acid from the true salt when treated with weak hydrochloric acid, may be applied in all cases. If the valerianate be deficient in valerianic acid, it will, when strongly heated in a platinum capsule, refuse to melt.

PHYSIOLOGICAL ACTION AND THERAPEUTICAL USE.—Valerianate of iron combines the antispasmodic action of the preparations of valerian with the tonic properties of the salts of iron. It has been given in hysterical affections complicated by chlorosis. Neligan speaks of it in not very favourable terms, and finds its disagreeable odour and the facility with which it is decomposed objectionable. It is, however, certainly much more used than it was some years since.

DOSE.—From half a grain to one grain in pill, with powdered liquorice and mucilage.

APPENDIX.

A

IRON PREPARATIONS OF THE BRITISH PHARMACOPŒIA.

FERRI ARSENIAS—ARSENIATE OF IRON.

Take of Sulphate of iron, nine ounces.
Arseniate of soda, dried at 300°, four ounces.
Acetate of soda, three ounces.
Boiling distilled water, a sufficiency.

Dissolve the arseniate and acetate of soda in two pints, and the sulphate of iron in three pints of the water, mix the two solutions, collect the white precipitate which forms, on a calico filter, and wash until the washings cease to be affected by a dilute solution of chloride of barium. Squeeze the washed precipitate between folds of strong linen in a screw press, and dry it on porous bricks in a warm air-chamber whose temperature shall not exceed 100°.

$3\,FeO, AsO_5$, partially oxidated.

Characters.—A tasteless amorphous powder of a green colour, insoluble in water, but readily dissolved by hydrochloric acid. This solution gives a copious light-blue precipitate with the ferridcyanide of potassium and a still more abundant one of a deeper colour with the ferrocyanide of potassium. A small quantity boiled with an excess of caustic soda and filtered, gives, when exactly neutralized by nitric acid, a brick-red precipitate on the addition of solution of nitrate of silver.

Tests.—The solution in hydrochloric acid when diluted, gives no precipitate with chloride of barium. Twenty grains dissolved in an excess of hydrochloric acid, diluted with water, continue to give a blue precipitate with the ferridcyanide of potassium, until at least seventeen measures of the volumetric solution of bichromate of potash have been added.

[The object of adding acetate of soda to the arseniate of soda in this formula is to replace by acetic acid an equivalent of sulphuric acid set free in the decomposition. Arseniate of iron is dissolved by sulphuric acid, and insoluble in acetic acid. The product would be deficient in quantity without this precaution.

The following equation represents this decomposition :—

$$3\,(Fe\,O,\,SO_3) + 2\,NaO,\,HO,\,AS\,O_5 = 3\,Fe\,O,\,As\,O_5 \\ + 2\,(Na\,O,\,SO_3) + HO,\,SO_3$$

The absence of a precipitate on the addition of chloride of barium to the hydrochloric acid solution of course indicates that no trace of sulphuric acid or a sulphate is present.

The employment of a standard solution of bichromate of potash in the examination of this and other preparations of protoxide of iron is based upon the definite oxidizing action of the bichromate, the *titre* of the solution being such that it is easy to calculate from the number of measures used the quantity of protoxide of iron present in any compound.]

FERRI CARBONAS SACCHARATA—SACCHARATED CARBONATE OF IRON.

Take of Sulphate of iron, two ounces.
Carbonate of soda, two ounces and a half.
Boiling distilled water, two gallons.
Refined sugar, one ounce.

Dissolve the sulphate of iron and the carbonate of soda each in half a gallon of the water, and mix the two solutions with brisk stirring in a deep cylindrical vessel, which is then to be covered as accurately as possible. Set the mixture by for twenty-four hours, and from the precipitate which has subsided separate the supernatant solution by a siphon. Pour on the remainder of the water, stir well, and after subsidence, again remove the clear solution. Collect the resulting carbonate on a calico filter, and having first subjected it to expression, rub it with the sugar in a porcelain mortar. Finally, dry the mixture at a temperature not exceeding 212°.

Carbonate of iron, $Fe\,O, Co_2$, mixed with peroxide of iron and sugar, and forming at least fifty-seven per cent. of the mixture.

Characters.—Small coherent lumps of a grey-brown colour, with a sweet very feeble chalybeate taste. Dissolves with effervescence in warm hydrochloric acid diluted with half its volume of water, and the solution is but slightly affected by the ferrocyanide, but gives a copious blue precipitate with the ferridcyanide of potassium.

Tests.—Its solution in hydrochloric acid gives but a very slight precipitate with chloride of barium. Twenty grains dissolved in excess of hydrochloric acid and diluted with water continue to give a blue precipitate with the ferridcyanide of potassium, until at least thirty-three measures of the volumetric solution of bichromate of potash have been added.

Preparation.—Pilula.

[The proportion of carbonate of iron contained in this preparation is the same as in the product of the formulæ of the London, Edinburgh, and Dublin Colleges (about 45 p. c.*) The instructions concerning the use of boiling water are somewhat ambiguous. If the solutions be mixed at a boiling temperature the precipitate will lose carbonic acid. The intention of the authors is doubtless, not that this should be done, but to ensure the freedom of the water from air, which would convert the carbonate of iron into peroxide.]

FERRI ET AMMONIÆ CITRAS—CITRATE OF IRON AND AMMONIA.

Take of Solution of persulphate of iron, eight fluid ounces.
Solution of ammonia, fourteen fluid ounces, or a sufficiency.
Citric acid, in crystals, five ounces.
Distilled water, half a gallon.

Add the persulphate of iron to two pints of the distilled water, and gradually pour the dilute solution into the solution of ammonia, stirring well for a few minutes; collect on a calico filter the hydrated peroxide of iron which precipitates, and wash it with distilled water until the filtrate ceases to become turbid on the addition of chloride of barium. Dissolve the citric acid in the remainder of the water, and digest the solution at a boiling heat on the oxide of iron. Make the liquid neutral by the

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* A moment's calculation will show that the statement of the Pharmacopœia is incorrect, and that the preparation cannot contain 57 per cent. of carbonate. Also, as the volumetric process is based upon the supposition that it does contain 57 per cent., it must not be depended upon.

addition of solution of ammonia, and evaporate it to dryness in thin layers on flat porcelain or glass plates. Remove the dry salt in flakes, and keep it in stoppered bottles.

$$(Fe_2\ O_3,\ NH_4O,\ HO,\ C_{12}H_5O_{11} + 2HO)\ ?$$

Characters.—In thin transparent scales of a hyacinth red colour with tinge of olive-green, slightly sweetish and astringent in taste; feebly reddens litmus paper; is soluble in water, almost insoluble in rectified spirit. Heated with solution of soda, it evolves ammonia, and deposits peroxide of iron. The alkaline solution from which the iron has separated, does not, when slightly supersaturated with hydrochloric acid, give any crystalline deposit.

Tests.—Its solution in water, when acidulated with hydrochloric acid, gives a copious blue precipitate with the ferrocyanide of potassium, but none with the ferridcyanide. When incinerated with exposure to air it leaves 26·5 per cent. of peroxide of iron.

[The process for the production of this salt is with but slight modification that of the last Dublin Pharmacopœia, the imperfect method of the London College, by which the iron was only partially peroxidized, having been discarded. A boiling temperature is directed for the solution of the oxide, but as I have already pointed out in the article on citrate of iron, the lower the heat used the better will the salt scale.

The absence of a crystalline precipitate, when the solution from which the iron has been separated, is supersaturated with hydrochloric acid is apparently intended to inindicate the absence of *potash.*]

FERRI ET QUINIÆ CITRAS—CITRATE OF IRON AND QUINIA.

Take of Solution of persulphate of iron, three fluid ounces.
Sulphate of iron, one ounce.
Distilled water, a sufficiency.
Solution of soda, thirty-six fluid ounces.
Citric acid, in crystals, two ounces and a quarter.
Sulphate of quinia, three hundred and eighty grains.
Dilute hydrochloric acid, a sufficiency.
Solution of chloride of barium, a sufficiency.
Solution of ammonia, a sufficiency.

Add the solution of persulphate of iron to the sulphate of iron dissolved in ten fluid ounces of the water; mix well, and pour the mixture into the solution of soda with constant stirring. Collect the precipitate on a calico filter, and wash with distilled water until the liquid which passes through ceases to give a precipitate with chloride of barium.

Dissolve the citric acid in twenty fluid ounces of the distilled water, and having then added the washed precipitate, digest the mixture on a water-bath with repeated stirring, until a solution is obtained.

In eight fluid ounces of the water, acidulated with a little of the dilute hydrochloric acid, dissolve the sulphate of quinia, add sufficient of the solution of chloride of barium to precipitate the sulphuric acid, and filter; and having treated the solution with a slight excess of ammonia, collect the precipitate on a paper filter, and wash it with distilled water until chloride of barium dropped into the filtrate gives but a very slight precipitate.

Transfer the washed quinia to the capsule containing the citrate of iron, and digest on a water-bath until the alkaloid is dissolved. Lastly, let this solution be evaporated in thin layers on flat porcelain or glass plates at a temperature below 212°, and let the residue be removed in flakes and preserved in stoppered bottles.

Citric acid, combined with peroxide of iron, protoxide of iron, and quinia.

Characters.—Thin scales of a greenish golden-yellow colour, somewhat deliquescent, and entirely soluble in cold water. The solution is very slightly acid, and is precipitated reddish-brown by solution of soda, white by solution of ammonia, blue by the ferrocyanide and by the ferridcyanide of potassium, and greyish-black by tannic acid.

Tests.—Taste bitter as well as chalybeate. When burned with exposure to air it leaves a residue which yields nothing to water. Fifty grains dissolved in a fluid ounce of water, and treated with a slight excess of ammonia, give a white precipitate, which, when collected on a filter and dried, weighs eight grains. The precipitate is entirely soluble in pure ether, when burned leaves no residue, and when dissolved by the aid of an acid forms a solution, which, when decolorized by a little purified animal charcoal, turns the plane of polarization strongly to the left.

[It is a matter of congratulation that there is now a standard formula for the preparation of this compound.

The object of adding sulphate of iron to the solution of persulphate is to obtain, when the liquid is precipitated by the caustic soda, magnetic oxide of iron. It is the use of this oxide which gives to the citrate of iron and quina of commerce its greenish golden hue.

The method here adopted for obtaining the quina seems needlessly complex. I know of no valid objection against at once precipitating it from an acid solution of the sulphate by ammonia or potash.

The salt prepared as above directed contains sixteen per cent. of quina.]

FERRI IODIDUM—IODIDE OF IRON.

Take of Fine iron wire, one ounce and a half.
Iodine, three ounces.
Distilled water, fifteen fluid ounces.

Introduce the iodine, iron, and twelve ounces of the water into a flask, and having heated the mixture gently for about ten minutes, raise the heat, and boil until the solution loses its red colour. Pass the solution through a small paper filter into a dish of polished iron, washing the filter with the remainder of the water, and boil down until a drop of the solution taken out on the end of an iron wire solidifies on cooling. The liquid should now be poured out on a porcelain dish, and as soon as it has solidified should be broken into fragments, and enclosed in a stoppered bottle.

$$\mathrm{Fe\,I} + 4\mathrm{HO}$$

Characters.—Crystalline, green, with a tinge of brown, inodorous, deliquescent, soluble in water, forming a slightly green solution, which gradually deposits a rust-coloured sediment, and acquires a red colour. It gives a copious blue precipitate with the ferridcyanide of potassium, and one of a similar colour with mucilage of starch on the addition of a minute quantity of chlorine.

Test.—It dissolves almost entirely in water, leaving but a very small quantity of red sediment.

Preparations.—Pilula, Syrupus.

[This formula might almost have been omitted from the Pharmacopœia, as the salt is now rarely used in a solid form, and although stated to enter into the preparation of the pill and syrup, on reference to the processes for these it will be seen that in both cases the iodide is extemporaneously prepared.]

FERRI OXIDUM MAGNETICUM—MAGNETIC OXIDE OF IRON.

Take of Sulphate of iron, six ounces.
Sulphuric acid, three fluid drachms.
Nitric acid, two fluid drachms.
Solution of soda, fifty-eight fluid ounces, or a sufficiency.
Distilled water, a sufficiency.

Add the sulphuric acid to five fluid ounces of the water, and with the aid of heat dissolve in the mixture four ounces of the sulphate of iron. Mix the nitric acid with two fluid ounces of the water, and having added the dilute acid to the solution of sulphate of iron, concentrate by boiling, until on the sudden disengagement of ruddy vapours the liquid passes from a dark to a red colour. To the solution thus obtained add the two remaining ounces of sulphate of iron first dissolved in half a pint of distilled water. Mix well, add to the liquid the solution of soda, and having boiled for five minutes in an iron vessel, collect the precipitate on a calico filter, and wash it with boiling distilled water, until the liquid which passes through ceases to give a precipitate when allowed to drop into a solution of chloride of barium. Lastly, dry the precipitate without heat in a confined portion of air over a capsule containing sulphuric acid, and enclose it in a stoppered bottle.

Synonym—Ferri Oxidum Nigrum *Ed.*

Peroxide of iron Fe_2O_3, with about nine per cent. of protoxide of iron, FeO, and twenty-two of water.

Characters.—Brownish-black, destitute of taste, strongly magnetic. It dissolves in hydrochloric acid diluted with half its bulk of water, and the solution thus obtained gives blue precipitates with the ferrocyanide and with the ferridcyanide of potassium.

Tests.—Twenty grains moistened with nitric acid and calcined at a low red heat, leave 15·8 grains of the peroxide of iron. Twenty grains dissolved in hydrochloric acid continue to give a blue precipitate with the ferridcyanide of potassium until 8·3 measures of the volumetric solution of bichromate of potash have been added.

LIQUOR FERRI PERCHLORIDI—SOLUTION OF PERCHLORIDE OF IRON.

Take of Iron wire, two ounces.
Hydrochloric acid, ten fluid ounces.
Nitric acid, six fluid drachms.
Distilled water, seven fluid ounces.

Dilute the hydrochloric acid with five ounces of the water, and pour the mixture on the iron wire in successive portions, applying a gentle heat when the action becomes feeble, so that the whole of the metal may be dissolved.

To the nitric acid add the two remaining ounces of water, and having poured the mixture into the solution of iron, evaporate the whole until the bulk is reduced to ten fluid ounces.

Perchloride of iron Fe_2Cl_3, in solution in water.

Characters.—An orange-brown solution without smell, but possessing a strong styptic taste; miscible with water and alcohol in all proportions. Diluted with water it is precipitated white by nitrate of silver, and blue by the ferrocyanide, but not by the ferridcyanide of potassium.

Tests.—Specific gravity 1·338. A fluid drachm diluted with two fluid ounces of water gives, upon the addition of an excess of solution of ammonia, a reddish-brown precipitate, which, when well washed and incinerated, weighs 15·62 grains.

Preparation.—Tinctura.

LIQUOR FERRI PERNITRATIS—SOLUTION OF PERNITRATE OF IRON.

Take of Fine iron wire, free from rust, one ounce.
Nitric acid, three fluid ounces.
Distilled water, a sufficiency.

Dilute the nitric acid with sixteen ounces of the water, introduce the iron wire into the mixture and leave them in contact until the metal is dissolved, taking care to moderate the action should it become too violent by the addition of a little more distilled water. Filter the solution, and add to it as much distilled water as will make its bulk one pint and a half.

Pernitrate of iron, Fe_2O_3, $3NO_5$, in solution in water.

Characters.—A clear solution of a reddish-brown colour, slightly acid and astringent to the taste; gives a blue precipitate with the ferrocyanide of potassium. When to a little of it placed in a test tube half its volume of pure sulphuric acid is added, and then a solution of sulphate of iron is poured on, the whole assumes a dark-brown colour.

Tests.—Specific gravity 1·107. One fluid drachm treated with an excess of solution of ammonia gives a precipitate, which, when washed, dried, and incinerated, weighs 2·6 grains. It gives no precipitate with the ferridcyanide of potassium.

[This is without alteration the process of the Dublin College, and is open to all the objections pointed out in the article on this preparation.]

FERRI PEROXIDUM—PEROXIDE OF IRON.

Take of hydrated peroxide of iron, four ounces.

Place the peroxide of iron in a stove or oven until it becomes dry to the touch, and then expose it to a heat of 212° until it ceases to lose weight. Lastly, reduce it to a fine powder and preserve it in a bottle.

$$Fe_2O_3, HO$$

Characters.—A powder of a dark-brown colour, and destitute of taste; dissolves completely, though slowly, with the aid of heat in hydrochloric acid diluted with half its volume of water, forming a solution which gives a copious blue precipitate with the ferrocyanide of potassium.

Tests.—It dissolves completely in hydrochloric acid, and the solution gives no precipitate with chloride of barium, or with the ferridcyanide of potassium.

Preparation.—Emplastrum ferri.

FERRI PEROXIDUM HYDRATUM—HYDRATED PEROXIDE OF IRON.

Take of Solution of persulphate of iron, four fluid ounces.
Solution of soda, thirty-three fluid ounces, or a sufficiency.
Distilled water, one pint.

Add the persulphate of iron to the distilled water, and gradually pour the dilute solution into the solution of soda, stirring well for a few minutes ; collect the precipitate on a calico filter, and wash it with distilled water until the filtrate ceases to give a precipitate with chloride of barium. Lastly, enclose the precipitate, without drying it, in a porcelain pot whose lid is made tight by a luting of lard.

This preparation should be recently made.

Hydrated peroxide of iron, $2Fe_2O_3, 3HO$, with a variable amount of uncombined water.

Characters.—A soft, moist, pasty mass, of a reddish-brown colour. Dissolves readily in dilute hydrochloric acid, without the aid of heat, forming a solution which gives a copious blue precipitate with the ferrocyanide of potassium. A little of it dried at 212° gives off moisture when further heated in a test-tube.

Tests.—Free from grittiness ; leaves on calcination about twelve per cent. of peroxide of iron.

FERRI PHOSPHAS—PHOSPHATE OF IRON.

Take of Sulphate of iron, three ounces.
Phosphate of soda, two ounces and a half.
Acetate of soda, one ounce.
Boiling distilled water, four pints.

Dissolve the sulphate of iron in one-half of the water, and the phosphate and acetate of soda in the remaining half. Mix the two solutions, and after carefully stirring, transfer the precipitate to a calico filter, and wash it with hot distilled water till the filtrate ceases to give a precipitate with chloride of barium. Finally, dry on porous bricks in a stove whose temperature does not exceed 100°. Preserve the dried salt in a stoppered bottle.

Phosphate of iron, $3FeO, PO_5$, partially oxidated.

Characters.—A slate-blue amorphous powder, insoluble in water, soluble in hydrochloric acid. The solution yields a precipitate with both the ferrocyanide and the ferridcyanide of potassium, that afforded by the latter being the more abundant, and when treated with tartaric acid and an excess of ammonia, and subsequently with the solution of ammonio-sulphate of magnesia, lets fall a crystalline precipitate.

Test.—If it is digested in hydrochloric acid with a lamina of pure copper a dark deposit does not form on the metal.

[The acetate of soda here fulfils the same object as in the case of the arseniate of iron, as if the phosphate have the composition above assigned to it (see p. 65), an atom of sulphuric acid is liberated. The test is intended to guard against the presence of *arsenic* in the product.]

FERRI SULPHAS.—SULPHATE OF IRON.

Take of iron wire . .	Four ounces.
Sulphuric acid . .	Four fluid ounces.
Distilled water . . .	One pint and a half.

Pour the water on the iron, placed in a porcelain capsule, add the sulphuric acid, and when the disengagement of gas has nearly ceased, boil for ten minutes. Filter now through paper, and after the lapse of twenty-four hours separate the crystals which have been deposited from the solution. Let these be dried on filtering paper, placed on porous bricks, and preserved in a stoppered bottle.

$$FeO, SO_3+7\,HO.$$

Characters.—In oblique-rhombic prisms, of a green colour and styptic taste; insoluble in rectified spirit, soluble in water. The solution gives a white precipitate with chloride of barium, and a blue one with the ferridcyanide of potassium, and on exposure to the air gradually becomes turbid, depositing a reddish-brown sediment.

Tests.—Crystals free from opaque rust-coloured spots, and dissolving in water without leaving any rust-coloured residue. The aqueous solution gives no precipitate with sulphuretted hydrogen, and one nearly white with ferrocyanide of potassium.

Preparation.—Ferri sulphas exsiccata.

FERRI SULPHAS GRANULATA.—GRANULATED SULPHATE OF IRON.

Take of Iron wire . .	Four ounces.
Sulphuric acid . .	Four fluid ounces.
Distilled water . .	One pint and a half.
Rectified spirit . .	Eight fluid ounces.

Pour the water on the iron, placed in a porcelain capsule, add the sulphuric acid, and when the disengagement of gas has nearly ceased, boil for ten minutes, and then filter the solution into a jar containing the spirit, stirring the mixture so that the salt shall separate in minute granular crystals. Let these, deprived by decantation of adhering liquid, be transferred on filtering paper to porous bricks, and dried by exposure to the atmosphere. They should be preserved in a stoppered bottle.

$$FeO, SO_3 + 7 HO.$$

Characters.—In small granular crystals of a pale green colour and mildly styptic taste, soluble in water, insoluble in rectified spirit.

Tests.—Free from opaque rust-coloured spots, and dissolving in water without leaving any ochry residue. The aqueous solution gives no precipitate with sulphuretted hydrogen, and one nearly white with ferrocyanide of potassium.

FERRI SULPHAS EXSICCATA.—DRIED SULPHATE OF IRON.

Take of sulphate of iron . .	Four ounces.

Expose the sulphate of iron in a porcelain capsule to a moderate heat, which may be finally raised to 400°, until aqueous vapour ceases to be given off. Reduce the residue to a fine powder, and preserve in a stoppered bottle.

FERRUM REDACTUM.—REDUCED IRON.

Take of Peroxide of iron . . .	One ounce.
Zinc, granulated . . .	A sufficiency.
Sulphuric acid of commerce .	A sufficiency.
Chloride of calcium . .	A sufficiency.

Introduce the peroxide of iron into a gun-barrel, confining it to the middle part of the tube by plugs of asbestos. Pass the gun-barrel through a furnace, and when it has been raised to a strong red heat, cause it to be traversed by a stream of hydrogen gas developed by the action on the zinc of some of the sulphuric acid diluted with eight times its volume of water. The gas, before entering the gun-barrel, must be rendered quite dry by being made to pass, first through the remainder of the sulphuric acid, and then through a tube eighteen inches long, packed with minute fragments of the chloride of calcium. The farther end of the gun-barrel is to be connected by a cork with a bent tube dipping under water; and when the hydrogen is observed to pass through the water at the same rate that it bubbles through the sulphuric acid, the furnace is to be allowed to cool down to the temperature of the atmosphere, the current of hydrogen being still continued. The reduced iron is then to be withdrawn, and enclosed in a dry stoppered bottle.

Metallic Iron, with a variable amount of Magnetic Oxide of Iron.

Characters.—A fine greyish-black powder, strongly attracted by the magnet, and exhibiting metallic streaks when rubbed with firm pressure in a mortar. It dissolves in hydrochloric acid with the evolution of hydrogen, and the solution gives a light-blue precipitate with the ferridcyanide of potassium.

Test.—Ten grains added to an aqueous solution of fifty grains of iodine and fifty grains of iodide of potassium, and digested with them in a small flask at a gentle heat, leave not more than five grains undissolved, which should be entirely soluble in hydrochloric acid.

[It will be observed that in this process no precaution is taken to prevent the contamination of the product by sulphur compounds. The interposition of a solution of acetate of lead between the hydrogen generator and the gun-barrel, as described in the text, perfectly prevents this accident.

No very high standard of purity is required by the test, as a mixture of metallic iron and magnetic oxide in equal proportions will conform to its conditions.]

FERRUM TARTARATUM.—TARTARATED IRON.

Take of

Solution of persulphate of iron	Four fluid ounces.
Solution of soda . . .	Two pints, or a sufficiency.
Acid tartrate of potash in powder,	Two ounces.
Distilled water . . .	A sufficiency.

Add the persulphate of iron to a pint of distilled water, and gradually pour the dilute solution into the solution of soda, stirring well for a few minutes; then collect the precipitate on a calico filter, and wash it with distilled water until the filtrate ceases to become turbid on the addition of chloride of barium. To the acid tartrate of potash and thirty ounces of distilled water, placed in a capsule, add the precipitate, and digest the mixture with repeated stirring for six hours at a heat which must be carefully prevented from rising above 140°. After the solution has cooled down to the temperature of the atmosphere, decant it off any undissolved precipitate, and having poured it in a thin layer on flat porcelain or glass plates, evaporate it to dryness at a temperature not exceeding 140°. Lastly, remove the dried salt in flakes and preserve it in stoppered bottles.

Tartrate of iron and potash, Fe_2O_3, KO, $C_8H_4O_{10}+HO$.

Characters.—Thin transparent scales of a deep garnet colour, slightly deliquescent, somewhat sweet, and rather astringent, soluble in water, and sparingly soluble in spirit. The aqueous solution, when acidulated with hydrochloric acid, gives a copious blue precipitate with the ferrocyanide of potassium, but no precipitate with the ferridcyanide. When the salt is boiled with solution of soda, peroxide of iron separates, but no ammonia is evolved, and the filtered solution when slightly acidulated by hydrochloric acid gives, as it cools, a crystalline deposit.

Tests.—By incinerating fifty grains of this preparation at a red heat, and acting on the residue with hydrochloric acid, a solution is obtained which, when digested with a little nitric acid, and afterwards diluted with four fluid ounces of water, and supersaturated with ammonia, yields a precipitate of peroxide of iron weighing 14·92 grains.

Preparation.—Vinum ferri.

EMPLASTRUM FERRI.—CHALYBEATE PLASTER.

Take of Peroxide of iron, in fine powder	One ounce.
Burgundy pitch . . .	Two ounces.
Litharge plaster . . .	Eight ounces.

Add the peroxide of iron to the Burgundy pitch and litharge plaster, previously melted together, and stir the mixture constantly till it stiffens on cooling.

MISTURA FERRI COMPOSITA.—COMPOUND MIXTURE OF IRON.

Take of Sulphate of iron . .	Thirty grains.
Carbonate of potash .	Twenty-five grains.
Myrrh, in powder . .	Sixty grains.
Sugar	Sixty grains.
Spirit of nutmeg . .	One fluid drachm.
Rose water . . .	Eight fluid ounces.

Triturate the myrrh and carbonate of potash with the sugar, the spirit of nutmeg, and seven ounces of the rose water, the latter being gradually added, until a uniform mixture is obtained. To this add the sulphate of iron, previously dissolved in the remaining ounce of rose water, and enclose the mixture at once in a bottle, which should be tightly corked.

[Contains 1·5 grains FeO, CO_2 in each fluid ounce.]

PILULA FERRI CARBONATIS.—PILL OF CARBONATE OF IRON.

Take of Saccharated carbonate of iron,	One ounce.
Confection of roses . .	Quarter of an ounce.

Beat them into a uniform mass.

[10 grains contain 3·6 grains FeO, CO_2]

PILULA FERRI IODIDI.—PILL OF IODIDE OF IRON.

Take of Fine iron wire . . .	Forty grains.
Iodine	Eighty grains.
Refined sugar, in powder .	Seventy grains.
Liquorice root, in powder .	140 grains.
Distilled water . . .	Fifty minims.

Agitate the iron with the iodine and the water in a strong stoppered ounce phial until the froth becomes white. Pour the fluid upon the sugar in a mortar, triturate briskly, and gradually add the liquorice.

[1 grain FeI is contained in 3·6 grains of this pill.]

SYRUPUS FERRI IODIDI.—SYRUP OF IODIDE OF IRON.

Take of Fine iron wire . .	One ounce.
Iodine	Two ounces.
Refined sugar . .	Twenty-eight ounces.
Distilled water . .	Thirteen fluid ounces

Prepare a syrup by dissolving the sugar in ten ounces of the water with the aid of heat. Digest the iodine and the iron wire in a flask, at a gentle heat, with the remaining three ounces of water till the froth becomes white; then filter the liquid while still hot into the syrup, and mix. The product should weigh two pounds eleven ounces, and should have the specific gravity 1·385.

[This is the first pharmacopœial formula for this syrup which directs the use of a sufficient quantity of sugar.

The product will measure as nearly as possible 31 fluid ounces. Each fluid drachm contains 4·3 grains FeI.]

SYRUPUS FERRI PHOSPHATIS.—SYRUP OF PHOSPHATE OF IRON.

Take of Granulated sulphate of iron	224 grains.
Phosphate of soda . .	200 grains.
Acetate of soda . . .	Seventy-four grs.
Dilute phosphoric acid .	Five and a half fluid ounces.
Refined sugar . . .	Eight ounces.
Distilled water . . .	Eight fluid ounces.

Dissolve the sulphate of iron in four ounces of the water, and the phosphate and acetate of soda in the remainder; mix the two solutions, and after careful stirring, transfer the precipitate to a calico filter and wash it with distilled water till the filtrate ceases to be affected by chloride of barium. Then press the precipitate strongly between folds of bibulous paper, and add to it the dilute phosphoric acid. As soon as the precipitate is dissolved filter the solution, add the sugar, and dissolve without heat. The product should measure exactly twelve fluid ounces.

[A fluid drachm contains 3 grains phosphate of iron.]

TINCTURA FERRI PERCHLORIDI.—TINCTURE OF PERCHLORIDE OF IRON.

Take of	Solution of perchloride of iron,	Five fluid ounces.
	Rectified spirit . .	Fifteen fluid ounces.

Mix, and preserve in a stoppered bottle.

Test.—Specific gravity, 0·992.

This tincture has one-fourth of the strength of tinctura ferri sesquichloridi.—*Dub.*

[A fluid drachm contains 7·93 grains $Fe_2\ Cl_3$]

VINUM FERRI.—WINE OF IRON.

Take of	Tartarated iron . . .	160 grains.
	Sherry	One pint.

Dissolve.

[A fluid drachm contains 1 grain of tartarated iron.]

SOLUTION OF PERSULPHATE OF IRON.

Take of

Sulphate of iron .	Eight ounces.
Sulphuric acid .	Six fluid drachms.
Nitric acid . .	Four fluid drachms.
Distilled water .	Twelve fluid ounces, or a sufficiency.

Add the sulphuric acid to ten ounces of the water, and dissolve the sulphate of iron in the mixture with the aid of heat. Mix the nitric acid with the remaining two ounces of water, and add the dilute acid to the solution of sulphate of iron. Concentrate the whole by boiling, until, upon the sudden disengagement of ruddy vapours, the liquid ceases to be black and acquires a red colour. A drop of the solution is now to be tested with ferridcyanide of potassium, and if a blue precipitate forms, a few additional drops of nitric acid should be added, and the boiling renewed, in order that the whole of the protosulphate may be converted into persulphate of iron. When the solution is cold make the quantity eleven fluid ounces by the addition, if necessary, of distilled water.

Persulphate of iron, Fe_2O_3, $3SO_3$, in solution in water.

Characters.—A viscid solution of a dark-red colour, inodorous, and very astringent, miscible in all proportions with alcohol and water. Diluted with ten volumes of water it gives a white precipitate with the chloride of barium, and a blue precipitate with the ferrocyanide, but not with the ferridcyanide of potassium.

Tests.—Specific gravity 1·441. One fluid drachm diluted with two fluid ounces of distilled water gives, upon the addition of an excess of solution of ammonia, a precipitate which, when well washed and incinerated, weighs 11·44 grains.

[Used for the preparation of sesquioxide of iron and its compounds.]

SOLUTION OF SULPHATE OF IRON.

(For Qualitative Analysis.)

Take of Granulated sulphate of iron	Ten grains.
Boiling distilled water .	One fluid ounce.

Dissolve. This solution should be recently prepared.

B

PREPARATION OF SESQUIOXIDE OF IRON.

As sesquioxide of iron is the basis of so many of the preparations of the metal, it is important that we should be in possession of a process whereby it may be made easily and economically, and which will insure the purity of the product.

All these conditions are fulfilled by the method given in the article Sesquichloride of Iron. In carrying it out the following proportions and precautions are to be observed:—24 parts of pure protosulphate of iron are dissolved in 50 parts of water, to which 4 parts of *pure* sulphuric acid have been added. The liquid is then heated to about 180° F., and a solution of three parts of chlorate of potash added. The conversion of the proto into the sesqui salt is immediate. The solution is now rendered distinctly alkaline with ammonia (or on the large scale with carbonate of soda), and the whole thrown upon a calico filter to separate the precipitated peroxide, which is washed with warm—but not boiling—water until the filtrate no longer gives a precipitate with a solution of chloride of barium. Oxide of iron should be prepared only as occasion requires, as when kept even in well-closed vessels it assumes a crystalline condition, and is no longer soluble in weak acids, as acetic and citric; nor is it to be depended upon as an antidote in cases of poisoning by arsenious acid.

The employment of chlorate of potash instead of the nitric acid usually used in effecting the peroxidation of sulphate of iron is, as far as I am aware, due to Sir Robert Kane, who recommends that sulphate of iron, chlorate of potash, and carbonate of soda, be dissolved together in water. But it has recently been pointed out by Mr. Tichborne that if these instructions be carried out literally, the resulting precipitate will consist, not of sesquioxide, but of magnetic oxide of iron, and that it is important that the oxidation should be fully completed before the addition of the alkali. This condition is fulfilled, if the instructions given above be followed.

C

ALBUMINATE OF IRON.

Since the article on Albuminate of Iron has been in type, a Mr. Edwin Smith has published new formulæ for the preparation of this compound. In examining the process of M. Fabri, Mr. Smith finds it objectionable for several reasons, among the most important of which are its complexity and want of permanence in the product. Mr. Smith proposes three preparations, in which the albumen and oxide of iron are respectively combined with soda, potash, and with a mixture of both alkalies.

Albuminate of Iron and Soda.

Solution of tersulphate of iron .	1 fl. ounce.
Pure caustic soda . .	75 grains.
Whites of egg . . .	No. 3.
Water	4 ounces.
Simple syrup . . .	q.s.

Effect the complete mixture of the albumen with two ounces of the water, add the solution of tersulphate of iron, and then the soda previously dissolved in the remainder of the water. Stir constantly until the precipitate dissolves, filter, and add sufficient syrup to increase the volume of the whole to twelve fluid ounces.

Albuminate of Iron and Potassa.

Solution of tersulphate of iron .	1 fl. ounce.
Alcoholic potassa . . .	72 grains.
Whites of egg . . .	No. 3.
Water . . .	4 ounces.
Simple syrup . . .	q.s.

Proceed as in the case of the soda compound, making the volume of the solution twelve fluid ounces.

Albuminate of Iron, Soda, and Potassa.

Use the same proportions of tersulphate of iron and albumen, but employ 36 grains each of pure potassa and soda.

There can be no doubt of the greater simplicity of the method of Mr. Smith, as compared with that of Fabri, but it is in no particular different from the original process of Lassaigne,[*] being, in fact, little more than a transcript of it. We are not, however, informed of the strength of the solution of tersulphate of iron, and therefore of the syrup itself. If it be desired to make it contain as much iron as the preparation given in the text—that is, 1·03 grains of iron per fluid ounce—the ounce of sesquisulphate solution must represent 62 grains of crystallized protosulphate of iron. Lassaigne's syrup contained one centigramme of iron in ten grammes of fluid.

D

IODIDE OF IRON.

M. Foucher of Orleans finds that in *manna* we have an excellent means of preserving iodide of iron.[†]

He forms the salt into dragées with this substance mixed with powdered marshallow and liquorice. No details as to proportions or manner of preparation are given. The dragées or pills are, however, said to keep well without becoming hard, and to present when broken across the greenish colour which is characteristic of the unaltered iodide. M. Foucher considers, too, that the manna may

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[*] *Vide* Soubeiran, *Traité de Pharmacie*, vol. ii., p. 460.

[†] *L'Union Médicale* and *Dublin Medical Press*, Oct. 1863.

serve another purpose, and by its laxative action, not only facilitate the absorption of the iodide of iron, but prevent that tendency to constipation often produced by ferruginous preparations.

E

EFFERVESCING CARBONATE OF IRON.

When this preparation is made by the process of Dr. Skinner, the product consists of greenish granules. It, however, becomes darker by absorbing oxygen, and does not present a very elegant appearance.

The compound sent out in London under this name is, on the other hand, nearly white, and does not alter if kept dry. I find, on examination, that it is not prepared after Dr. Skinner's formula, but consists merely of tartrate of soda granules, to which anhydrous sulphate of iron in fine powder has been made to adhere.

An effervescing *citrate* of iron is also sold, which does not—or rather the samples which I have examined did not—differ in any appreciable manner from the so-called carbonate.

F

MALATE OF IRON.

Solution of Malate of Iron.—Beat to a pulp six pounds of unripe crab apples, to which add one pound of iron wire in coils; digest in a water bath for eight days, take out the wire and express; evaporate the clear liquid in a porcelain vessel with constant stirring to the consistence of a soft extract. One part of this extract should be mixed with twelve parts of water to form the solution.*

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* *Phar. Jour.*, vol. v., N. S., p. 236.

G

TINCTURE OF ACETATE OF IRON.

Tinctura Ferri Acetatis. The following formula will give a product identical in strength with that of the Dublin Pharmacopœia :—

Take of

Solution of persulphate of iron Ph.B.	11 fluid ounces.
Acetate of potash	8 ounces.
Rectified spirit	4 pints.

In two pints of the spirit dissolve the acetate of potash, and add the solution of persulphate of iron to the other two pints. Mix the solutions ; allow the mixture to stand for half an hour and filter through calico. Sp. gr. ·891.

H

SYNOPTICAL TABLE OF THE MEDICINAL PREPARATIONS OF IRON.

Name.	Composition.	Dose.
Ferri Pulvis	Fe with Fe O and Fe_2 O_3	2 to 10 grains
Ferri Acetatis Tinctura	Fe_2 O_3, 3A ; Alcohol, water	min.20 to min.60
Ferri et Sodæ Albuminatis Solutio	Fe_2 O_3 or Fe O ; Albumen, Soda	½ to 1 fl. ounce
Ferri Arsenias	3Fe O, As O_5+6HO	1-20 to 1-5 grain
Ferri Bromidum	Fe Br	1 to 3 grains
Ferri Carbonatis Pilula	36 per cent. Fe O, CO_2	5 to 20 grains
Ferri Carbonatis Syrupus	10 per cent. Fe O, CO_2	1 fl. drachm
Ferri Carbonas Effervescens	5 per cent. Fe O, CO_2	90 grains
Ferri Carbonas Saccharata	45 per cent. Fe O, CO_2	5 to 30 grains
Ferri Carbazotas	Fe_2 O_3, C_{12} N_3 H_3 O_{14} (?)	½ to 2 grains
Ferri Citras	Fe_2 O_3, C_{12} H_5 O_{11}	5 to 10 grains
Ferri et Ammoniæ Citras	Fe_2 O_3, NH_4O, Ci+2HO(?)	5 to 8 grains

SYNOPTICAL TABLE (*Continued*).

Name.	Composition.	Dose.
Ferri et Magnesiæ Citras	Fe_2O_3, MgO, $Ci+2HO$ (?)	3 to 10 grains
Ferri et Quinæ Citras	(Ph. Britt.) 16 p. c. Quina	3 to 6 grains
Ferri et Quiniæ, Strychniæque Citras	1 per cent. Strychnia, 20 per cent. Quina	2 to 5 grains
Ferri et Strychniæ Citras	1 per cent. Strychnia	3 to 6 grains
Ferri et Zinci Citras	Fe_2O_3 with ZnO and Ci	2 to 5 grains
Ferri Hypophosphis	Fe_2O_3, $3PO$	5 to 10 grains
Ferri et Quinæ Hypophosph. Syrup		4 fl. drachms
Ferri Iodidum	FeI	2 to 5 grains
Ferri Iodidi Pilula	3·6 grains=one grain FeI	
Ferri Iodidi Syrupus	(Ph. Britt.) 4·3 grs. in flʒi.	min. 20 to 1 fl. drachm
Ferri et Manganesii Iod. Syrup		min. 10 to 30
Ferri et Quinæ Iodid. Syrup		min. 20 to 1 fl. drachm
Ferri Lactas	FeO, $C_6H_5O_5+3HO$	1 to 2 grains
Ferri Mistura Composita	1·5 grains, FeO, CO_2 in 1 fl. ounce	1 to 2 fl. ounces
Ferri Oxidum Magneticum	(Ph. Britt.) Fe_2O_3+9 per cent. $FeO+22$ p. c. water	5 to 20 grains
Ferri Perchloridum	Fe_2Cl_3	
Ferri Perchloridi Tinctura	(Ph. Britt.) 7·93 grs. Fe_2Cl_3 in 1 fl. drachm	min. 40 to 2 fl. drachms
Ferri Peroxidum	Fe_2O_3, HO	
Ferri Phosphas	(Ph. Britt.) $3FeO$, $PO5$	5 to 10 grains
Ferri Phosphatis Syrup	(Ph. Britt.) 3 grs. in flʒi.	1 to 3 fl. drachms
Ferri Perphosphas	Fe_2O_3, $3PO_5+8HO$	2 to 10 grains
Ferri Perphosphatis Solutio	Five grains in 1 fl. drachm	½ to 2 fl. drachms
Ferri Pyrophosphas	Variable	3 to 10 grains
Ferri Superphosphas	,,	5 to 10 grains
Ferri Stearas	,,	used externally
Ferri Sulphas	FeO, SO_3+7HO	1 to 5 grains
Ferri et Ammoniæ Sulphas	Fe_2O_3, $3SO_3+NH_4O$, SO_3+24HO	3 to 6 grains
Ferri et Potassæ Sulphas	Fe_2O_3, $3SO_3+KO$, SO_3+24HO	3 to 6 grains
Ferri Sulphas cum Saccharo	54 per cent. FeO, SO_3	3 to 10 grains
Ferrum Tartaratum	Fe_2O_3, KO, $C_8H_4O_{10}+HO$	5 to 20 grains
Ferri Tannas		10 to 30 grains
Ferri Tannatis Syrupus		4 fl. drachms
Ferri Valerianas	Fe_2O_3, $3C_{10}H_9O_3$	½ to 1 grain
Ferri Vinum	(Ph. Britt.) one grain tartarated iron in 1 fl. drachm	½ to 1 fl. ounce

I

ANALYTICAL NOTE.

METALLIC IRON.

$(Fe) = 28$.

The purest form of metallic iron for pharmaceutical purposes is that of fine wire. Carefully selected turnings or borings of malleable—not cast—iron may also be employed. Filings are objectionable from the facility with which they oxidize and their liability to contain other metals.

PROTOXIDE OF IRON.

$(FeO) = 36$.

A black powder. The hydrate is white, and in a moist state rapidly absorbs oxygen, changing in colour from grey to green, bluish-black, and finally red-brown. Both this oxide and its hydrate are readily soluble in hydrochloric, sulphuric, and nitric acids.

Salts of Protoxide of Iron.

When anhydrous, are white: when hydrated, of a greenish colour. Their solutions are only greenish when concentrated. Solutions of salts of protoxide of iron absorb oxygen when exposed to the air, and are converted into salts of protosesquioxide, sesquioxide of iron being thrown down in combination with part of the acid. They give the following reactions:—

Chlorine or *Nitric Acid* converts them at a boiling temperature into salts of the sesquioxide.

Sulphide of Hydrogen produces in acid solutions no precipitate.

Sulphide of Ammonium produces a black precipitate

(FeS), soluble in hydrochloric and nitric acids; insoluble in alkalies and in excess of the precipitant.

Potassa and Ammonia precipitate the white hydrate (FeO, HO). Salts of ammonia interfere with this reaction.

Ferrocyanide of Potassium produces a white precipitate (K, Fe_3, Cfy_2) which becomes blue by exposure to the air.

Ferricyanide of Potassium produces a blue precipitate ($Fe_3\ Cfd_7$).

SESQUIOXIDE OF IRON.

$(Fe_2\ O_3) = 80.$

A brownish-red powder. The hydrate is reddish brown. Both are soluble in hydrochloric, nitric, and sulphuric acids, the hydrate readily but the anhydrous oxide with difficulty.

Salts of Sesquioxide of Iron.

Are in their anhydrous state nearly white; the basic salts are yellow or slightly red. Their solutions are yellow, and by dissolving excess of sesquioxide become red (Graham). The application of heat renders them darker in colour.

Sulphide of Hydrogen reduces solutions of sesquisalts of iron to protosalts with separation of sulphur.

Sulphide of Ammonium produces a black precipitate (FeS) soluble in hydrochloric and nitric acids; insoluble in alkalies.

Potassa and *Ammonia* precipitate hydrated sesquioxide of iron ($Fe_2\ O_3, HO$), insoluble in excess of the precipitant.

Citrates of the alkalies prevent this reaction in the case of ammonia.

Ferrocyanide of Potassium produces a blue precipitate of ferrocyanide of iron ($Fe_4\ Cfy_3$) insoluble in hydrochloric acid.

Ferricyanide of Potassium produces a reddish-brown coloration but no precipitate.

QUANTITATIVE ESTIMATION OF COMPOUNDS OF IRON.

This is best effected by means of a standard solution of bichromate of potash. One equivalent of this salt ($KO, 2Cr\ O_3$) is capable of effecting the farther oxidation of six equivalents of protoxide of iron.

$$2Cr\ O_3 + 6\ FeO = Cr_2\ O_3 + 3\ Fe_2\ O_3$$

The presence of free acid (hydrochloric or sulphuric) is essential to this decomposition.

A standard solution of the bichromate is prepared by dissolving in distilled water 129 grains of pure and dry crystals of the salt, and then making up the entire volume of the fluid to one pint. Each 1000 grains of this solution correspond to 16·8 grains of iron. The solution is delivered from a burette, and the termination of the process is ascertained by a drop of the iron solution ceasing to give a blue precipitate or even a green coloration with a recently prepared solution of ferricyanide of potassium.

In the application of this method of analysis the iron compound to be examined is first reduced to the state of protoxide by treating it with excess of sulphide of hydrogen or of sulphurous acid, all traces of either reducing agent being subsequently removed by boiling the solution.

In the case of compounds containing both FeO and

Fe_2O_3, the protoxide is first determined in one portion of the solution, and another being reduced as just described, the whole quantity of protoxide is ascertained. By deducting the first from the second result, the quantity of iron existing as sesquioxide may be readily calculated.

1000 grains of the standard solution of bichromate correspond to—

16·8 grains Fe
21·6 ,, FeO
24·0 ,, Fe_2O_3

J

WEIGHTS AND MEASURES OF THE BRITISH PHARMACOPŒIA.

WEIGHTS.

1 pound—lb. = 16 ounces = 7000 grains.
1 ounce—oz. = . = 437·5 ,,
1 grain—gr. = . = 1 ,,

MEASURES.

1 gallon . .	C.	=	8 pints . . .	Oviij.
1 pint . . .	O.	=	20 fluid ounces .	fl. oz. xx.
1 fluid ounce .	fl. oz.	=	8 fluid drachms,	fl. drs. viij.
1 fluid drachm,	fl. drm.	=	60 minims . .	min. lx.
1 minim . .	min.	=	1 minim . .	min. j.

RELATION OF MEASURES TO WEIGHTS OF THE BRITISH PHARMACOPŒIA.

1 gallon . .	=	the measure of	10	pounds	of water.
1 pint . . .	=	,,	1·25	,,	,,
1 fluid ounce .	=	,,	1	ounce	,,
1 fluid drachm	=	,,	54·68	grains	,,
1 minim . .	=	,,	0·91	,,	,,

RELATION OF WEIGHTS OF THE BRITISH PHARMACOPŒIA TO METRICAL WEIGHTS.

1 pound	=	453·5925	grammes.
1 ounce	=	28·3495	,,
1 grain	=	0·0648	,,

RELATION OF MEASURES OF THE BRITISH PHARMACOPŒIA TO METRICAL MEASURES.

1 gallon	=	4·543487	litres.
1 pint	=	0·567936	,,
1 fluid ounce	=	0·028396	,,
1 fluid drachm . . .	=	0·003549	,,
1 minim	=	0·000059	,,

K

SYMBOLS AND EQUIVALENT WEIGHTS OF THE MORE IMPORTANT ELEMENTARY BODIES.

Elementary Bodies.	Symbols.	Equivalent Weights.
Aluminum	Al	13·75
Antimony (Stibium)	Sb	122
Arsenic	As	75
Barium	Ba	68·5
Bismuth	Bi	210
Boron	B	11
Bromine	Br	80
Calcium	Ca	20
Carbon	C	6
Chlorine	Cl	35·5
Chromium	Cr	26·25
Copper (Cuprum)	Cu	31·75
Gold (Aurum)	Au	196·5
Hydrogen	H	1
Iodine	I	127
Iron (Ferrum)	Fe	28
Lead (Plumbum)	Pb	103·5
Lithium	Li	7
Magnesium	Mg	12
Manganese	Mn	27·5
Mercury (Hydrargyrum)	Hg	100
Nitrogen	N	14
Oxygen	O	8
Phosphorus	P	31
Platinum	Pt	98·5
Potassium (Kalium)	K	39
Silver (Argentum)	Ag	108
Sodium (Natrium)	Na	23
Sulphur	S	16
Tin (Stannum)	Sn	59
Zinc	Zn	32.5

MAY, 1864.

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