some other diseases; for example, *scirrhus* and *cancer*, *cutaneous diseases*, *bronchocele*, &c. As a local application, a solution of it has been used as a wash in herpetic eruptions, and as a collyrium in scrofulous ophthalmia.

In pharmacy and chemistry it is extensively employed as a test for sulphuric acid and the sulphates.

Administration.—It is used in the form of aqueous solution.

Antidotes.—The antidotes for the barytic salts are the sulphates, which form therewith an insoluble sulphate of baryta. Hence, sulphate of soda, sulphate of magnesia, alum, or well or spring water (which contains sulphate of lime) should be copiously administered. Of course the poison should be removed from the stomach as speedily as possible. To appease any unpleasant symptoms caused by the continued use of large medicinal doses, opiates may be employed.

LIQUOR BARII CHLORIDI, L. (U. S.;) *Solutio Barytæ Muriatis*, E.; *Barytæ Muriatis Aqua*, D.; *Solution of Chloride of Barium.*—(Chloride of Barium, ʒj.; Distilled Water, f℥j.; *L. E.*—Muriate of Baryta, *one part;* [ʒj. U. S.] Distilled Water, *three parts;* [℥iij. U. S.] *D.* Dissolve.) Dose of the solution of the London Pharmacopœia, ten drops, gradually and cautiously increased until nausea or giddiness is experienced. It is employed also as a test for sulphuric acid or the sulphates. Common water, and all liquids containing sulphates, carbonates, or phosphates in solution, are incompatible with it.

4. BARY'TÆ NI'TRAS, *E.*—NITRATE OF BARYTA.

History.—This salt was formed soon after the discovery of baryta.

Preparation.—It "is to be prepared like the muriate of baryta [chloride of barium, see p. 484,] substituting pure nitric acid for the muriatic acid."—*Ph. Ed.*

Properties.—It crystallizes in octohedrons. It is soluble in water, but insoluble in alcohol. It is decomposed, with decrepitation, by a bright red heat, and furnishes pure baryta.

Characteristics.—As a nitrate, it is known by the tests for this class of salts already mentioned (see p. 267.) The characters of the barytic salts have been before stated (see p. 485.)

Composition.—The crystallized salt is anhydrous. Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Baryta	1	77	58·7	58·8
Nitric Acid	1	54	41·3	41·2
Nitrate of Baryta	1	131	100·0	100·0

Physiological Effects.—Similar to those of the chloride of barium.

Uses.—It is employed as a test. Fire-work makers use it to communicate a green tinge to flame.

SOLUTIO BARYTÆ NITRATIS, E. *Solution of Nitrate of Baryta.* (Nitrate of Baryta, 40 grs.; Distilled Water, 800 grs. Dissolve the salt in the water; and keep the solution in well-closed bottles.) Employed as a test for sulphuric acid.

Order XIV.—COMPOUNDS OF CALCIUM.

1. CALX, *L. E.* (U. S.)—LIME.

(Calx recens usta, *D.*)

History.—Lime, and the mode of obtaining it by burning the carbonate, were known in the most remote periods of antiquity. Hippocrates (*Popularium*, ii. sect. 5.) employed this earth in medicine. Dr. Black, in 1755, first explained the nature of the process for making it. In 1808 Davy showed that this substance was a metallic oxide, and hence it has been termed the *Oxide of Calcium.* To distinguish it from the hydrate of lime, it is called *Caustic Lime*, or *Quicklime* (*Calx viva*,) or *Burned Lime* (*Calx usta*.)

NATURAL HISTORY.—It occurs in both kingdoms of nature.

α. IN THE INORGANIZED KINGDOM.—In the mineral kingdom lime is found in the form of carbonate, sulphate, phosphate, silicate, arseniate, tungstate, borate, and titanate. Its base, calcium, occurs in combination with fluorine. "Lime is also disseminated through sea water, though in small quantities; so that calcium is widely distributed in land and water, being principally abundant in the central and higher parts of the fossiliferous rocks, and widely dispersed, in small quantities, throughout the more ancient rocks, and in the waters of the ocean." (De la Beche, *Research. in Theor. Geol.* p. 21.)

β. IN THE ORGANIZED KINGDOM.—In vegetables, lime (or calcium) is an invariable ingredient, except, it is said, in the case of *Salsola Kali*. (De Candolle, *Phys. Végét.* p. 382.) It is found combined with carbonic, sulphuric, phosphoric, nitric, and various organic acids (as oxalic, malic, citric, tartaric, and kinic:) calcium occurs in combination with chlorine. In animals, lime is found principally as carbonate and phosphate.

PREPARATION.—For use in the arts lime is usually obtained by burning the carbonate with coals, coke, and other fuel, in a kind of wind furnace called a *kiln*.[1]

All the British Colleges admit, as officinal, the lime of commerce; but the London and Edinburgh Colleges also give directions for the preparation of pure lime.

The *London College* orders of Chalk, lbj. Break it into small pieces, and burn it in a very strong fire for an hour.

The *Edinburgh College* orders White Marble, broken into small fragments, to be heated "in a covered crucible at a full red heat for three hours, or till the residuum when slaked and suspended in water no longer effervesces on the addition of muriatic acid."

By the heat employed the carbonic acid of the carbonate is expelled. It is well known that water or a current of air facilitates the escape of the carbonic acid: their effect is probably mechanical, and is due to the diffusion of one gas or vapour in another. (See Gay-Lussac, in Jameson's *Journal*, vol. xxii. 1837.) Iceland Spar or White Carrara Marble yields the purest lime.

PROPERTIES.—Lime (commonly termed *Quicklime*) when pure is a white or grayish solid, having a sp. gr. of 2·3. A variety of commercial lime has a gray colour, and is called *gray lime*. Lime has an acrid, alkaline taste, and reacts powerfully on vegetable colours as an alkali. It is difficult of fusion: but by the oxy-hydrogen flame it may be both fused and volatilized. Exposed to the air it attracts water and carbonic acid. If a small portion of water be thrown on lime, part of it combines with the lime, and thereby causes the evolution of a considerable degree of heat, by which another portion of the water is vaporized. The lime swells up, cracks, and subsequently falls to powder: in this state it is called *Slaked Lime* (*Calx extincta*,) or the *Hydrate of Lime* (*Calcis Hydras*, L.) By heat the water may be again expelled. Lime is slightly soluble in water. Its solubility in this liquid is very remarkable; cold water dissolving more than hot. According to Mr. Phillips,

A pint of Water at 32° dissolves 13·25 grains of lime.
Ditto........ 60° .... 11·6 ditto.
Ditto........ 212° .... 6·7 ditto.

So that water at 32° dissolves nearly twice as much lime as water at 212°.

Characteristics.—An aqueous solution of lime is recognised by its reddening yellow turmeric paper, and rendering the infusion of red cabbage green; by the milkiness produced in it on the addition of carbonic acid or a soluble carbonate, and by the white precipitate (*oxalate of lime*) on the addition of a solution of oxalic acid or an oxalate. Sulphuric acid affords no precipitate with lime water. Solutions of the calcareous salts are known by the following characters:—The hydrosulphurets, and, if the solution be dilute, the sulphates, occasion neither a precipitate nor a change of colour: the soluble carbonates, phosphates, and oxalates, produce white precipitates. The calcareous salts (especially chloride of calcium) give an orange tinge to the flame of alcohol.

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[1] Vide Loudon's *Encycl. of Agricult.* 3d ed. p. 625; Gray's *Operative Chemist*; and Ure's *Dict. of Arts.*

COMPOSITION.—The following is the composition of lime and its hydrate:—

	Atoms.	*Eq. Wt.*	*Per Ct.*	*Berzelius.*
Calcium	1	20	71·42	71·91
Oxygen	1	8	28·57	28·09
Lime	1	28	99·99	100·00

	Atoms.	*Eq. Wt.*	*Per Cent.*
Lime	1	28	75·67
Water	1	9	24·32
Hydrate of Lime	1	37	99·99

PURITY.—The lime used in the arts is never absolutely pure, but usually contains variable quantities of carbonate of lime, silica, alumina, and oxide of iron, and sometimes magnesia.

Water being added it [lime] cracks and falls to powder. Its other properties are as hydrate of lime. *Ph. L.*

It is slaked by water: muriatic acid then dissolves it entirely, without any effervescence; and the solution does not precipitate with ammonia.

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—Quicklime is poisonous to plants. Notwithstanding this, however, it is used as a manure, its efficacy depending on its decomposing and rendering soluble the vegetable matter of the soil, during which the lime attracts carbonic acid and becomes innocuous. (Davy, *Agricult. Chemistry.*)

β. *On Animals.*—On dogs, Orfila (*Toxicol. Générale.*) found that quicklime acted as a caustic poison, but not very energetically; and that it occasions death by producing inflammation of the texture with which it comes in contact.

γ. *On Man.*—Quicklime, like the fixed alkalis, is a powerful escharotic. Its use in promoting the decomposition of the bodies of persons who have died of contagious diseases, or on the field of battle, and its employment by the tanner to separate the cuticle and hair from skins, sufficiently establish its causticity. Its escharotic and irritant action is well seen in the ophthalmia produced by the lodgment of small particles of lime in the eye.

When applied to suppurating or mucous surfaces, lime water checks or stops secretion, and produces dryness of the part: hence it is termed a desiccant. In this it differs from the fixed alkalis.

When administered internally, it neutralizes the free acid of the gastric juice, diminishes the secretions of the gastro-intestinal membrane, and thereby occasions thirst and constipation. It frequently gives rise to uneasiness of stomach, disordered digestion, and not unfrequently to vomiting. After its absorption it increases the secretion of urine, and diminishes the excessive formation or deposition of uric acid and the urates. With this exception, it does not, as the alkalis, promote the action of the different secreting organs, but, on the other hand, diminishes it, and has in consequence been termed an astringent. But it does not possess the corrugating action of the astringent vegetables, or of many of the metallic salts: it is rather a drying remedy, or desiccant. In this respect lime differs from the alkalis, but is analogous to the oxide of zinc (see p. 210.) Vogt (*Pharmakodynamik.*) considers it to be intermediate between the two. Weickard and others have ascribed to lime an antispasmodic property: and if this be true, its relation to zinc is still farther proved.

A power of exciting and changing the mode of action of the absorbing vessels and glands has been ascribed to lime water, and probably with foundation. At any rate, under the use of it, glandular enlargements have become softer and smaller. In other words, it operates as a resolvent. Sundelin (*Heilmittellehre.*) says that the excessive use of lime does not, as in the case of the alkalis, bring about a scorbutic diathesis, but a general drying and constriction, analogous to that caused by zinc.

Lime in large doses, acts as a poison: the symptoms in one case were thirst, burning in the mouth, burning pain in the belly, obstinate constipation, and death in nine days. (Christison, *Treatise on Poisons.*)

USES.—Quicklime has been employed as a *caustic*, but alone is now rarely resorted to. It is sometimes applied in the form of *Potassa cum Calce* (see p.

420,) and is a constituent of the ordinary depilatories (see p. 211.) As an *antidote*, lime water, in conjunction with milk, was recommended by Navier (*Contre-poison de l'Arsenic*, &c. 1777, quoted by Richter, *Ausf. Arzneimittellehre*,) in poisoning by arsenious acid. In the absence of more appropriate antidotes, lime water may be administered in poisoning by the common mineral and oxalic acids. As a *lithontriptic* it possessed at one time considerable celebrity, partly from its being one of the active ingredients of Miss Joanna Stephens' *Receipt for the Stone and Gravel*, as well as from experiments and reports of professional men. As this lady had acquired no slight fame by her mode of treatment, a great desire was manifested to know the nature of her remedies, and she therefore offered to discover them on the payment of a suitable reward. A committee of professional men was appointed to examine the efficacy of her treatment, and her medicines were given to patients known to have calculi. The report made by the committee, (*Gentleman's Magazine* for 1740, vol. x. p. 185.) as to the effects, was so favourable, that Parliament was induced to grant a reward of £5000, a notice of which appeared in the *London Gazette* of March 18, 1739! (D'Escherny, *A Treatise of the Causes and Symptoms of the Stone*, 1755.) The essential parts of her remedies were lime (prepared by calcining egg-shells and snails,) soap, and some aromatic bitters; viz. camomile flowers, sweet fennel, parsley, and burdock leaves, &c. (*Gentleman's Magazine* for 1739, vol. ix. p. 298.) That the patients submitted to treatment obtained relief by the remedies employed cannot, I think, be doubted, but no cure was effected; that is, no calculus was dissolved, for in the bladder of each of the four persons whose cure was certified by the trustees, the stone was found after their death. (Alston's *Lectures on the Materia Medica*, vol. i. p. 268. London, 1770.) Notwithstanding the favourable reports to the contrary, (Chevallier, *Lond. Med. Gaz.* vol. xx. p. 460.) it appears to me that no rational ground of hope can now be entertained that lime water is capable of dissolving urinary calculi in the kidneys or bladder: but there is abundant evidence to prove that patients afflicted with the uric acid diathesis have sometimes experienced extraordinary benefit from its use. (Van Swieten's *Commentaries upon Boerhaave's Aphorisms*, vol. xvi. p. 299.) Chevallier (*Lond. Med. Gaz.* vol. xx. p. 584.) accounts for its efficacy in the treatment of gravel and stone by the circumstance of the combination of the lime with uric acid forming a very soluble salt, viz. urate of lime; and he even thinks that lime water may be useful in phosphatic calculi, either by depriving them of a portion of the uric acid which they contain, and thus rendering them less dense; by decomposing the ammoniacal salt which enters into the composition of some; or by acting on the animal matter which holds the molecules of these calculi together. As an *antacid* in dyspepsia, accompanied by acidity of stomach, it is sometimes useful. "Mixed with an equal measure of milk, which completely covers its offensive taste, it is one of the best remedies in our possession for nausea and vomiting dependent on irritability of stomach. We have found a diet, exclusively of lime water and milk, to be more effectual than any other plan of treatment in dyspepsia, accompanied with vomiting of food. In this case one part of the solution to two or three of milk, is usually sufficient." (*United States' Dispensatory*.) In the dyspepsia of gouty and rheumatic subjects, and which is usually accompanied with a copious secretion of uric acid by the kidneys, I have seen lime water serviceable. As a *desiccant* or *astringent*, it is useful as a wash for ulcers attended with excessive secretion. In some scrofulous ulcers in which I have employed it, its power of checking secretion has been most marked. In diarrhœa, when the mucous discharge is great, and the inflammatory symptoms have subsided, lime water is useful as an astringent. As an injection in leucorrhœa and gleet it sometimes succeeds where other remedies have failed. The internal use of lime water has also been serviceable in checking secretion from various other parts, as from the bronchial membranes, the bladder, &c.

Besides the above, lime water has been employed for various other purposes. Thus, as an antispasmodic, in hypochondriasis and hysteria, with habitual excessive sensibility of the nervous system, it has been found useful by Weickard. (Richter's *Ausf. Arzneim.* iii. 585.) It has also been given as an alterative in glandular enlargements and venereal affections, and to promote the deposite of bone earth in diseases accompanied with a deficiency of this substance. In skin diseases (tinea capitis, scabies, prurigo, &c.) it has been applied as a wash.

ADMINISTRATION.—From half an ounce to three or four ounces may be taken three times a-day. As already mentioned, it may be conveniently administered in combination with milk.

1. **LIQUOR CALCIS**, L. (U. S.;) *Aqua Calcis*, E. D.; *Lime Water* (Lime, lbss.; Distilled Water, Oxij. Upon the lime, first slaked with a little water, pour the remaining water, and shake them together; then immediately cover the vessel, and set it by for three hours: afterwards, keep the solution, with the remaining lime, in stoppered glass vessels; and, when it is to be used, take from the clear solution.—The *Edinburgh College* uses Lime *one part*, and Water *twenty parts*.—The *Dublin College* employs of fresh-burnt Lime *one part*, and Water *thirty-one parts*; one of which is to be hot, and added just to slake the lime, the other is to be cold, and is added afterwards.) [The U. S. Pharmacopœia orders Lime, four ounces; Distilled Water, a gallon.] Lime water is colourless and transparent; but, by exposure to the air, becomes covered with a film of carbonate of lime, which is deposited on the sides and bottom of the vessel, and is succeeded by another. Hence lime water should be preserved in well-stoppered vessels with some undissolved lime, and, when used, the clear liquor poured off. Its taste is unpleasant and alkaline, and it has an alkaline re-action on vegetable colours. The dose of lime water is from f℥ss. to f℥iij. or f℥iv. three times a day. It may be conveniently administered in milk. Its uses have been above stated.

2. **LINIMENTUM CALCIS**, E. D.; (U. S.) *Liniment of Lime; Carron Oil.*—(Linseed Oil, (E. U. S.) [Olive Oil, *D.*,] Lime Water, of each equal measures; Mix and agitate them together.) Linseed and olive oils are each composed of oleic and margaric acids and glycerine. When mixed with lime water an oleo-margarate of lime (*calcareous soap*) is formed. It has long been celebrated as an application to burns and scalds, and is employed for this purpose at the Carron Iron-works—hence one of its names. Though the Dublin College orders olive oil, it is almost invariably prepared with linseed oil. Turpentine is sometimes advantageously added to it.

2. CAL'CII CHLO'RIDUM, *L.* (U. S.)—CHLORIDE OF CALCIUM.

(Calcis Murias, *E. D.*)

HISTORY.—This salt, obtained in the decomposition of sal ammoniac by lime, was known, according to Dulk, (*Die Preuss. Pharm. übersetst.* &c. ii. 293, 2te Aufl. Leipsig, 1830.) in the fifteenth century, to the two Hollands, who called it *Fixed Sal Ammoniac* (*Sal Ammoniacum fixum.*) Its composition was not understood until the eighteenth century, when it was ascertained by Bergman, Kirwan, and Wenzel. It is commonly termed *Muriate of Lime*.

NATURAL HISTORY.—It occurs in both kingdoms of nature.

α. IN THE INORGANIZED KINGDOM.—It is found, in small quantity, in sea and many mineral and well waters.

β. IN THE ORGANIZED KINGDOM.—It has been detected, in a few instances, in vegetables. Thus Pallas recognised it in the root of *Aconitum Lycoctonum*.

PREPARATION.—The following are the methods of preparing it:

The *London College* orders it to be obtained as follows:—Take of Chalk, ℥v.; Hydrochloric Acid, Distilled Water, of each, Oss. Mix the acid with the water, and to these gradually add the chalk to saturation. Then, the effervescence being finished, strain; evaporate the liquor until the salt is dried. Put this into a crucible, and, having melted it in the fire, pour it out upon a flat clean stone. Lastly, when it is cold, break it into small pieces, and keep it in a well-closed vessel.

The *Edinburgh College* orders of White Marble, in fragments, ℥x.; Muriatic Acid (commercial) and Water, of each, Oj. Mix the acid and water; add the marble by degrees; and, when the effervescence is over, add a little marble in fine powder till the liquid no longer reddens litmus. Filter, and concentrate to one-half. Put the remaining fluid in a cold place to crystallize. Preserve the crystals in a well-closed bottle. More crystals will be obtained by concentrating the mother liquor.

Chloride of calcium is a secondary product in the manufacture of the hydrated sesquicarbonate of ammonia, (see p. 283) as well as of solution of ammonia; (see p. 274) and from this source it is usually procured.

The *Dublin College* orders of the liquor which remains after the distillation of the water of caustic ammonia any requisite quantity. Filter the liquor, and expose it in an open vessel to heat until the muriate of lime becomes perfectly dry. Let it be preserved in a vessel completely closed.

In this process one equivalent or 37 parts of hydrochloric acid react on one equivalent or 50 parts of carbonate of lime, and produce one equivalent or 22 parts of carbonic acid, which escape in a gaseous form, one equivalent or 9 parts of water, and one equivalent or 56 parts of chloride of calcium.

MATERIALS.		COMPOSITION.		PRODUCTS.	
1 eq. Carbonate of Lime..........	50	1 eq. *Carb^c Acid*	22	1 eq. Carbonic Acid....	22
		1 eq. *Oxygen*....	8	1 eq. Water...........	9
		1 eq. *Calcium*...	20		
1 eq. Hydrochloric Acid...........	37	1 eq. *Hydrogen*..	1		
		1 eq. *Chlorine*...	36	1 eq. Chloride Calcium..	56
	87		87		87

By heat the crystals of this salt lose their water, and the anhydrous chloride of calcium is obtained.

Properties.—Anhydrous chloride of calcium is a white translucent solid, of a crystalline texture. Its taste is bitter and acrid saline. It is fusible, but not volatile. It deliquesces in the air, and becomes what has been called *Oil of Lime* (*Oleum Calcis*.) When put into water it evolves heat, and readily dissolves in a quarter of its weight of this fluid at 60° F., or in a much less quantity of hot water. By evaporation the solution yields striated crystals (*Hydrated Chloride of Calcium*,) having the form of regular six-sided prisms, and which, therefore, belong to the rhombohedric system. These crystals undergo the watery fusion, when heated, are deliquescent, readily dissolve in water with the production of great cold, and, when mixed with ice or snow, form a powerful frigorific mixture. Both anhydrous and hydrous chloride of calcium are readily soluble in alcohol.

Characteristics.—This salt is known to be a chloride by the tests for this class of salts before mentioned (p. 218.) The nature of its base is ascertained by the tests for lime (p. 488.)

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

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Ure.*		*Atoms.*	*Eq. Wt.*
Calcium............	1	20	35·71	36·7	Chloride Calcium....	1	56
Chlorine...........	1	36	64·28	63·3	Water..............	6	54
Chloride of Calcium..	1	56	99·99	100·0	Crystall^d Chl^de Calc^m	1	110

Purity.—Chloride of calcium, when pure, is colourless, evolves no ammonia when mixed with lime, and undergoes no change of colour nor gives any precipitate with caustic ammonia, chloride of barium, or hydrosulphuric acid.

The fused chloride is free from colour; slightly translucent; hard and friable; totally soluble in water: the solution gives no precipitate on the addition of ammonia or chloride of barium, nor, when diluted with much water, with ferrocyanide of potassium. *Ph. Lond.*

The crystallized salt is "extremely deliquescent. A solution of 76 grains in one fluid ounce of distilled water, precipitated by 49 grains of oxalate of ammonia, remains precipitable by more of the test." *Ph. Ed.*

Physiological Effects. α. *On Animals.*—Three drachms and a-half given to a dog caused quick breathing and snorting, with convulsive but vain efforts to vomit, a profuse secretion of saliva, and death in six hours. The mucous membrane of the stomach and small intestines was very blood-shot and in many places almost black, and converted into a gelatinous mass. (Beddoes, *Duncan's Annals of Medicine*, vol. i. Lustr. ii. 208.)

β. *On Man.*—In *small doses* it promotes the secretions of mucus, urine, and perspiration. It operates, therefore, as a liquefacient (see p. 193.) By continued use it appears to exercise a specific influence over the lymphatic vessels and glands, the activity of which it increases; for under its use glandular and other swellings and indurations have become smaller and softer, and ultimately disappeared altogether. In *larger doses* it excites nausea, vomiting, and sometimes purging; causes tenderness of the præcordium, quickens the pulse, and occasions faintness, weakness, anxiety, trembling, and giddiness. In *excessive doses* the disorder of the nervous system is manifested by failure and trembling of the limbs, giddiness, small contracted pulse, cold sweats, convulsions, paralysis, insensibility, and death. (Vogt, *Pharmakodynamik.*) Considered in reference to other medicines, it has the closest resemblance in its operation to chloride of of barium. Hufeland (Quoted by Wibmer, *Die Wirkung*, &c.) says its operation is more irritant than the last mentioned substance, and that its use requires greater caution,—a statement which is directly opposed to the experience of Dr. Wood, (*Edinb. Med. and Surg. Journ.* i. 147.) and of most other practitioners.

Uses.—It has been principally employed in scrofulous affections, especially those attended with glandular enlargements. Beddoes (*Op. cit.*) gave it to nearly a hundred patients, and he tells us there are few of the common forms of scrofula in which he has not had successful experience of it. Dr. Wood (*Op. cit.*) tried it on an extensive scale, and with decided benefit. It has been found most efficacious in the treatment of tabes mesenterica, checking purging, diminishing the hectic fever, allaying the inordinate appetite, and in many cases, ultimately restoring the patient to perfect health. It has also been recommended in chronic arthritic complaints, in bronchocele, in some chronic affections of the brain (as paralysis,) and in other cases where the object was to excite the action of the absorbents.

Occasionally, though rarely, it has been employed externally. Thus a bath containing two or three ounces of it, either alone or with chloride of sodium, has been used in scrofula. (Vogt, *op. supra cit.*)

In pharmacy fused chloride of calcium is used in the rectification of spirit (p. 313,) on account of its strong affinity for water; and in chemistry it is employed in the drying of gases. In the crystallized state, mixed with half or two-thirds of its weight of ice or snow, it is used for producing an intense degree of cold. Its solution is used as a salt water bath for chemical purposes.

Administration.—Chloride of calcium is always used medicinally in the form of aqueous solution.

LIQUOR CALCII CHLORIDI, L. (U. S.;) *Calcis Muriatis Solutio*, E.; *Calcis Muriatis Aqua*, D. (Chloride of Calcium [fused,] ℥iv.; Distilled Water, f℥xij. *L.*—Muriate of Lime [crystals,] ℥viij; Water, f℥xij. *E.*—Muriate of Lime [dry,] *two parts;* Distilled Water, *seven parts*, D.—Dissolve and [if necessary] strain.) Dose from ♏xl. or ♏l. to fʒij., or gradually increased until nausea is produced.

The uses of it have been above noticed. [The U. S. Pharmacopœia orders Marble in fragments, nine ounces: Muriatic Acid, a pint; Distilled Water, a sufficient quantity. Mix the Acid with half a pint of the Distilled Water and gradually add the Marble. Towards the close of the effervescence apply a gentle heat, and when the action has ceased pour off the clear liquor and evaporate to dryness. Dissolve the residuum in its weight and a-half of Distilled Water, and filter the solution.]

3. CAL'CIS HYPOCHLO'RIS.—HYPOCHLORITE OF LIME.

(Calx Chlorinata, *L. E.*) (U. S.)

History.—In 1798, Mr. Tennant of Glasgow, took out a patent for the manufacture of this substance as a bleaching powder, which in consequence was long known as *Tennant's Bleaching Powder*. According to the views entertained of its composition it has been successfully termed *Oxymuriate of Lime*, *Chloride of Lime* or *Chloruret of the Oxide of Calcium*, *Chlorite of Lime* (Berzelius,) and *Chlorinated Lime*.

Preparation.—Chloride of lime is prepared on a very large scale for the use of bleachers. The *London College*, however, has thought fit to give the following directions for its preparation:—

Take of Hydrate of Lime, lbj.; Chlorine as much as may be sufficient; pass Chlorine to the Lime, spread in a proper vessel, until it is saturated. Chlorine is very readily evolved from Hydrochloric Acid added to binoxide of Manganese, with a gentle heat (see p. 217.)

On the large scale the gas is generated in large, nearly spherical, leaden vessels heated by steam. The ingredients employed are binoxide of manganese, chloride of sodium, and diluted sulphuric acid. The gas is washed by passing it through water, and is then conveyed by a leaden tube into the combination room, where the slaked lime is placed in shelves or trays, piled over one another to the height of five or six feet, cross bars below each, keeping them about an inch asunder, that the gas may have free room to circulate. The combination room is built of siliceous sandstone, and is furnished with windows to allow the operator to judge how the impregnation is going on. Four days are usually required, at the ordinary rate of working, for making good marketable chloride of lime. (Ure, *Quart. Journ. of Science*, xiii. 1.) At Mr. Tennant's manufactory at Glasgow, the lime is placed in shallow boxes on the floor of the combination chambers, and is agitated once during the process by iron rakes; the handles of which pass through boxes filled with lime, which serves as a valve.[1] The supply of chlorine is then shut off, and a man enters the chambers and rakes the lime over. The chambers are then closed, and more chlorine introduced, until the lime is saturated.

Theory of the Process.—Chemists are by no means agreed as to the constitution of the substance called chloride of lime, and, therefore, as to the nature of the changes which occur during its preparation.

α. Some regard it as a compound of *chlorine*, *water*, and *lime*. On this view, when chlorine gas comes into contact with slaked lime, the two substances are supposed to enter into combination. An objection to this view is, that the odour of chloride of lime is that of hypochlorous acid, and not that of mere chlorine.

β. Another view supported by the discoveries of Balard, (*Researches* in Taylor's *Scientific Memoirs*, vol. i. p. 269.) is, that chloride of lime is a mixture or compound of hypochlorite of lime and chloride of calcium. Its formation may, then, be explained as follows:—When chlorine comes into contact with slaked lime, a portion of the latter is decomposed: its base (calcium) combines with chlorine, to form chloride of calcium, while its oxygen unites with another portion of chlorine and forms hypochlorous acid, which combines with some undecomposed lime, to form hypochlorite of lime.

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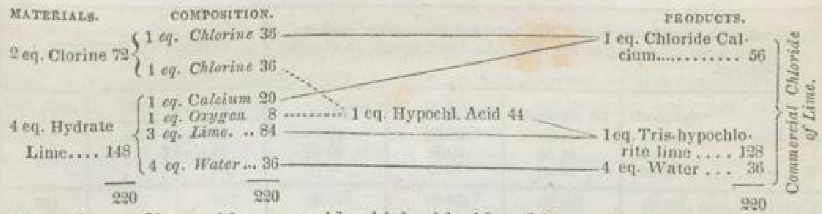
[1] *American Journ. of Science*, vol. x. No. 2, Feb. 1826, and Dumas' *Traité de Chimie*, ii. 806.



The odour of hypochlorous acid which chloride of lime possesses, strongly supports this view. On the other hand it may be objected, that if chloride of lime contained so large a quantity of chloride of calcium, it would be deliquescent. But to this it may be replied, that the chloride of calcium may be in chemical combination with the hypochlorite of lime.

γ. More recently, Millon (*Journal de Pharmacie*, t. xxv. p. 595. 1839.) has discovered some new facts which he asserts are inexplicable on the view just explained; and he suggests that chloride of lime is a substance analogous to peroxide of calcium, but in which one equivalent of the oxygen of the peroxide is replaced by an equivalent of chlorine. His view, which Professor Graham (*Elements of Chemistry*, vol. i. p. 501.) regards as "simpler" than the preceding, is supported by the fact that many of the precipitates formed in metallic solutions by a solution of chloride of lime, are composed of one equivalent of the metallic oxide and one equivalent of chlorine.

Properties.—Chloride of lime, as met with in commerce, is a white or brownish white powder, having a feeble odour of hypochlorous acid, and a strong bitter and acrid taste. Exposed to the air it attracts carbonic acid, evolves chlorine, and is thereby converted into a mixture of carbonate of lime and chloride of calcium, the latter of which deliquesces. Digested in water the chloride or hypochlorite of lime dissolves, as well as any chloride of calcium present, and a small portion of caustic lime: any carbonate and the excess of caustic lime remain undissolved. The solution, which has a slight yellow colour, first reacts on vegetable colours as an alkali, and afterwards bleaches them, especially if an acid be added. Its bleaching and disinfecting properties depend either on the oxidizement or on the dehydrogenization of the colouring or infectious matter: if an acid be employed in the process, chlorine is evolved, which produces oxygen at the expense of the elements of water: if, on the contrary, no acid be used, Balard (*Researches*, in Taylor's *Scientific Memoirs*, vol. i. p. 269.) supposes that both the hypochlorous acid and lime give out their oxygen, and thereby become chloride of calcium. When chloride of lime is heated it evolves first chlorine and subsequently oxygen.

Characteristics.—Its smell and bleaching properties are most characteristic of it. The acids (as sulphuric or hydrochloric) separate chlorine from it. An aqueous solution of it throws down white precipitates with nitrate of silver, the alkaline carbonates, and with oxalic acid or the oxalates. The supernatant liquor from which chloride of silver has been thrown down by nitrate of silver possesses a decolourizing property.

Composition.—The quantity of chlorine absorbed by slaked lime varies with the pressure, the degree of exposure, and the quantity of water present. Hence the substance sold as chloride of lime is not a uniform product. Moreover, it would appear from Dr. Ure's experiments, not to have any definite atomic constitution. The following table contains the most important results of his experiments:—

Prepared with Protohydrate of Lime, without pneumatic pressure. The process was carried on until the Lime ceased to absorb Chlorine.					Commercial Specimens.		
	Synthesis.	1st *Analysis.*	2nd *Analysis.*	*Mean.*	1.	2.	3.
Chlorine	39·39	40·00	40·62	40·31	23	22	28
Lime	46·00	44·74	46·07	45·40	46	78	71
Water	14·60	15·26	13·31	14·28	31		
Chlord of Lime	100·00	100·00	100·00	100·00	100	100	100

Mr. Brande[1] and Mr. Philips (*Translation of the Pharmacopœia*, 4th ed. p. 234.) give the following as the atomic proportions of chlorine, lime, and water, in chloride of lime of the best quality:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Chlorine	1	36	32·73
Lime	2	56	50·91
Water	2	18	16·36
Chloride of Lime	1	110	10 000

Constitution, according to Mr. Philips.	*Atoms.*	*Eq. Wt.*
Bihydrated Chloride of Lime	1	82
Lime	1	28
	1	110

"When water is added to this, the chloride of lime dissolves, leaving nearly all the lime insoluble." (Philips.)

If, with Berzelius and Balard, we regard bleaching powder as constituted of hypochlorite of lime, chloride of calcium, and water, its composition, corresponding with the proportions assumed by Mr. Brande and Mr. Philips, will be as follows:—

	Atoms.	*Eq. Wt.*	*Per Ct.*
Trishypochlorite of Lime	1	128	58·18
Chloride of Calcium	1	56	25·45
Water	4	36	16·36
Chloride of Lime	1	220	99·99

When bleaching powder is digested in water, a bleaching liquor is obtained, while a portion of lime remains undissolved. The trishypochlorite is supposed to be decomposed by the action of water; and to deposite two equivalents of lime, while one equivalent of chloride of calcium, and one equivalent of neutral hypochlorite of lime are dissolved.

CHLOROMETRY.—In order to estimate the bleaching power of the chloride of lime of commerce, various chlorometrical methods have been devised. One method is to determine the quantity of chlorine gas which is given out by a certain weight of chloride on the addition of liquid hydrochloric acid. (Ure, *Quarterly Journal of Science*, vol. xiii.) The liquid may be brought into contact with the chloride placed over mercury, contained in a graduated syphon-tube, closed at one end, (Fig. 77, A.) When the gas is evolved, the mercury flows out, by the orifice B, into a basin ready to receive it. The resulting film of chloride of calcium protects the surface of the metal from the action of the chlorine. If carbonic acid be suspected, the mercury by agitation absorbs the chlorine, leaving the carbonic acid. Ten grains of bleaching powder yield from three to four cubic inches of chlorine, equivalent to twenty or thirty per cent. by weight.

FIG. 77.

Syphon-tube for chlorometrical purposes.

Another chlorometrical method is to ascertain the bleaching power of the chloride on a standard solution of indigo; (Gay-Lussac, *Ann. of Phil.* xxiv. 218; also in Alcock's *Essay*, before quoted, p. 135.) but it is not susceptible of accuracy.

A chlorometrical method, which Professor Graham (*Elements of Chemistry*, p. 502.) considers to be entitled to preference," is founded on

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[1] *Manual of Chemistry*, 5th ed. p. 676. "Upon the whole," says Mr. Brande, "it is not improbable that bleaching powder consists of a chloride of lime, containing one proportion of chlorine and one of lime, mixed with a varying proportion of hydrate of lime."

the fact, that chloride of lime converts sulphate of the protoxide of iron into sulphate of the peroxide. Red ferroprussiate of potash (*ferrosesquicyanide of potassium*) is employed to ascertain the change in the degree of the oxidation of the iron, since it gives a blue precipitate with the protosalts, but not with the persalts, of this metal. A quantity of solution of chloride of lime capable of peroxidising 78 grains of sulphate of iron, contains 10 grains of chlorine.

The *Edinburgh College* gives the following characteristics of good chloride of lime:—

> "Pale grayish white: dry: 50 grains are nearly all soluble in two fluid ounces of water, forming a solution of the density 1027, and of which 100 measures, treated with an excess of oxalic acid, give off much chlorine, and if then boiled and allowed to rest twenty-four hours, yield a precipitate which occupies nineteen measures of the liquid."

The precipitate produced in the solution by oxalic acid is oxalate of lime, and, therefore, this process is one for the detection of lime (or calcium.)

The *London College* merely observes that chlorinated lime—

> "Dissolves in dilute hydrochloric acid, emitting chlorine."

Neither College, therefore, gives directions for estimating the real value of chloride of lime.

PHYSIOLOGICAL EFFECTS.—The local action of chloride of lime is that of an irritant and caustic. A solution of it applied to suppurating and mucous surfaces is a powerful desiccant, probably in part at least from the uncombined lime in solution. When the secretions are excessive and extremely fetid, it not only diminishes their quantity, but much improves their quality; so that, considered in reference to suppurating and mucous surfaces, it is not only a desiccant, but, in morbid conditions of these parts, a promoter of healthy action. Applied in the form of ointment (composed of a drachm of chloride to an ounce of fatty matter) to scrofulous swellings, Cima[1] found that it provoked suppuration, caused strong redness, promoted the suppurating process, and dispersed the surrounding hardness.

Taken internally, in *small doses* (as from 3 to 6 grains, dissolved in one or two ounces of water,) it sometimes causes pain and heat in the stomach, and occasionally, according to Cima, purging. Under the continued use of it, hard and enlarged absorbent glands have become softer and smaller, from which circumstance it has been supposed to exercise a specific influence over, and to promote the healthy action of, the lymphatic system. During its employment, Cima says he did not find it necessary to give purgatives. Dr. Reid[2] gave it in the epidemic fever, which raged in Ireland in 1826, and he tells us that it rendered the tongue cleaner, abated the delirium, and promoted the cutaneous functions. In dysentery it soon put a stop to the bloody evacuations, the umbilical pain, and the tenesmus.

I am not acquainted with any facts respecting the effects of chloride of lime *in large or poisonous doses*. Analogy would lead us to expect that it would produce the combined effects of a caustic and of an agent specifically affecting the nervous system.

USES.—The chlorides (hypochlorites) of lime and soda are extensively employed as disinfectants and antiseptics. I have already stated (p. 221) that chlorine gas stands unrivalled for its power of destroying putrid odours and checking putrefaction, and where uninhabited chambers or buildings are to be purified, fumigations with this gas should be adopted. But its powerful action on the organs of respiration precludes its use in inhabited places; and, in such cases, the alkaline chlorides (chloride of lime, on account of its cheapness) are to be substituted. When these substances are in contact with organic matter, it is supposed the hypochlo-

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[1] Configliachi and Brugnatelli's *Giornale di Fisica*, 1825; quoted by Dierbach, *d. neust. Entd. in d. Mat. Méd.* 1828, 2te Abt 597.

[2] *Trans. of the Associat. of Fellows and Licentiates of the College of Physicians in Ireland*, vol. v. 1828.

rite gives out oxygen, and is converted into a metallic chloride; the oxygen being the effective disinfecting and antiseptic agent; or it may act by abstracting hydrogen. When, however, the solution of the chloride (hypochlorite) is exposed to the air, carbonic acid is attracted by the lime, and hypochlorous acid set free, which immediately reacts on any organic matter present. Hence, these chlorides (hypochlorites,) when exposed to the air, evolve chlorine so slowly and in such moderate quantities, as not to produce any noxious effects, though their action on organic matters is very powerful. Their most obvious effect is that of destroying the unpleasant odour of putrid matter. Their action on hydrosulphuric acid, ammonia and hydrosulphate of ammonia (substances evolved by decomposing animal matters) can be readily and easily demonstrated. Other odorous principles given out by putrid matters are, by the experience of most persons, admitted to be destroyed by the alkaline chlorides, though Piorry (*Journ. Chim. Méd.* ii. 601.) has asserted, they are only overpowered by the stronger smell of the chlorine.

The alkaline chlorides (hypochlorites) possess another valuable property,—that of stopping or checking the putrefactive process; and hence they are called antiseptics.[1]

These two properties, viz. that of destroying offensive odours and that of preventing putrefaction, render the alkaline chlorides most valuable agents to the medical practitioner. We apply them to gangrenous parts, to ulcers of all kinds attended with foul secretions, to compound fractures accompanied with offensive discharges, to the uterus in various diseases of this viscus attended with fetid evacuations: in a word, we apply them in all cases accompanied with offensive and fetid odours. As I have before remarked, with respect to chloride of soda (p. 461,) their efficacy is not confined to an action on dead parts, or on the discharges from wounds and ulcers; they are of the greatest benefit to living parts, in which they induce more healthy action, and the consequent secretion of less offensive matters. Farthermore, in the sick chamber, many other occasions present themselves on which the power of the chlorides to destroy offensive odours will be found of the highest value: as, to counteract the unpleasant smell of dressings or bandages, of the urine in various diseases of the bladder, of the alvine evacuations, &c. In typhus fever a handkerchief, or piece of calico, dipped in a weak solution of an alkaline chloride, and suspended in the sick chamber, will be often of considerable service both to the patient and the attendants.

The power of the chlorides (hypochlorites) to destroy infection or contagion, and to prevent the propagation of epidemic diseases, is less obviously and satisfactorily ascertained than their capability of destroying odour. Various statements have been made by Labarraque, and others, (Vide Alcock's *Essay*, p. 155, *et. seq.*) in order to prove the disinfecting power of the chlorides with respect to typhus and other infectious fevers. But, without denying the utility of these agents in destroying bad smells in the sick chamber, and in promoting the recovery of the patient by their influence over the general system, I may observe that I have met with no facts which are satisfactory to my mind as to the chemical powers of the chlorides to destroy the infectious matter of fever. Nor am I convinced by the experiments made by Pariset and his colleagues, (*Bullet. des Sciences Méd.* xix. 233.) that these medicines are preservative against the plague. Six individuals clothed themselves with impunity in the garments of men who had died of plague, but which garments had been plunged for six hours in a solution of chloride of soda. But, as Bouillaud (*Dict. de Méd. Prat.*, art. *Contagion.*) has truly observed, the experiments, to be decisive, should have been made with clothing which had already communicated the plague to the wearers of it. In Moscow, chlorine was extensively tried and found unavailing,

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[1] For various facts in proof of this, I must refer to the late Mr. Alcock's *Essay on the Use of the Chlorurets.* Lond. 1827.

nay, apparently injurious, in cholera. "At the time," says Dr. Albers, (*Lond. Med. Gaz.* viii. 410.) that the cholera hospital was filled with clouds of chlorine, then it was that the greatest number of the attendants were attacked." (See also Dierbach, *Die neust. Entd. in d. Mat. Med.* i. 411, 2te Ausg. 1837.) Some years ago chlorine was tried at the Small-Pox Hospital, with a view of arresting the progress of erysipelas: all offensive smell, as usual, was overcome, but the power of communicating the disease remained behind. (*Lond. Med. Gaz.* viii. 472.) Bousquet (*Rev. Med.* Fev. 1830, p. 264.) mixed equal parts of a solution of chloride of soda and the vaccine lymph, and found that the latter still possessed the power of producing the usual cow-pock vesicle. These are a few of the facts which are adverse to the opinion that chlorine or the alkaline chlorides possess the power of preventing the propagation of infectious, contagious, or epidemic diseases. In opposition to them there are but few positive facts to be adduced. Coster (Richter, *Ausf. Arzneimittell.* Suppl. Band. 539.) found that a solution of chloride of soda destroyed the infectious properties of the syphilitic poison, and of the poison of rabid animals. The statements of Labarraque (Alcock's *Essay*, pp. 56, 58, &c.) and others as to the preservative powers of the chlorides in typhus, measles, &c. are too loose and general to enable us to attach much value to them.

Considered in reference to medical police, the power of the alkaline chlorides (hypochlorites) to destroy putrid odours and prevent putrefaction is of vast importance. Thus chloride of lime may be employed to prevent the putrefaction of corpses previously to interment, to destroy the odour of exhumed bodies during medico-legal investigations, to destroy bad smells, and prevent putrefaction in dissecting-rooms and workshops in which animal substances are employed (as cat-gut manufactories,) to destroy the unpleasant odour from privies, sewers, drains, wells, docks, &c., to disinfect ships, hospitals, prisons, stables, &c. The various modes of applying it will readily suggest themselves. For disinfecting corpses, a sheet should be soaked in a pailful of water containing a pound of chloride, and then wrapped around the body. For destroying the smell of dissecting-rooms, &c. a solution of the chloride may be applied by means of a garden watering-pot. When it is considered desirable to cause the rapid evolution of chlorine gas, hydrochloric acid may be added to chloride of lime.

Chloride of lime (or chloride of soda) is the best *antidote* in poisoning by hydrosulphuric acid, hydrosulphuret of ammonia, sulphuret of potassium, and hydrocyanic acid. It decomposes and renders them inert. A solution should be administered by the stomach, and a sponge or handkerchief soaked in the solution, held near the nose, so that the vapour may be inspired. It was by breathing air impregnated with the vapour arising from chloride of lime, that the late Mr. Roberts (the inventor of the miner's improved safety lamp,) was enabled to enter and traverse with safety the sewer of the Bastile, which had not been cleansed for 37 years, and which was impregnated with hydrosulphuric acid. (Alcock's *Essay*.) If a person be required to enter a place suspected of containing hydrosulphuric acid, a handkerchief moistened with a solution of chloride of lime should be applied to the mouth and nostrils, so that the inspired air may be purified before it passes into the lungs.

A solution of chloride of lime has been used as a wash in some skin diseases. Derheims (*Journ. de Chim. Méd.* iii. 575.) used a strong solution with great success in scabies. This mode of curing itch is much cleaner and more agreeable than the ordinary method by sulphur frictions. It has likewise been found successful by Fantonetti (*Ibid.* ix. 305.) in tinea capitis: where the discharge is copious, washes of the chloride may be used with advantage. In burns and scalds, Lisfranc employed lotions of chloride of lime either immediately after the accident, or subsequent to the application of emollient poultices.

Solutions of chloride of lime have been employed with great benefit in ophthalmia. Dr. Varlez, surgeon to the military hospital at Brussels, (*Med. and*

Phys. Journ. Nov. 1827.) states that in 400 cases it never disappointed him once. Mr. Guthrie has also reported favourably of it in three cases; as have likewise MM. Colson, Delatte, and Raynaud. The solution used by Dr. Varlez was composed of from a scruple to three or four drachms of chloride, and an ounce of water. It was dropped into the eye or injected by a syringe, or applied by means of a camel's hair pencil. Of course other means (bleeding, purging, cold, and, in chronic cases, blisters) should be conjoined. I have found a weak solution of the chloride very successful in the purulent ophthalmia of infants. Gubian (*Journ. de Chim. Méd.* vi. 315.) proposed to apply a solution of chloride of lime to prevent the pitting from small-pox. The fully maturated pustules are to be opened and washed with a weak solution of this salt: desiccation takes place very promptly, and no marks or pits are said to be left behind.

Chloride of lime may be employed *internally* in the same cases that chloride of soda is administered (p. 460.) It has been used with great success by Dr. Reid (*Trans. of the King and Queen's College of Physicians in Ireland*, v. 266.) in the epidemic fever of Ireland. In some of the very worst cases it acted most beneficially, causing warm perspiration, rendering the tongue cleaner and moister, checking diarrhœa, and inducing quiet sleep. I also can bear testimony to the good effects of it in bad cases of fever. In disease of the pulmonary organs resulting from febrile excitement, Dr. Reid also found it advantageous. In dysentery likewise it was most valuable. He used it by the mouth, and also in the form of clyster. It corrected the intolerable stench of the evacuations, and improved their appearance. Cima (Richter, *Ausf. Arneimitt.* iv. 305.) used it both internally and externally in scrofula.

Administration.—*Internally*, chloride of lime may be given in doses of from one grain to five or six grains, dissolved in one or two ounces of water, sweetened with syrup. As the dry chloride of the shops deposites hydrate of lime when put into water, the solution (of the hypochlorite of lime and chloride of calcium) should be filtered, to get rid of this. To destroy the unpleasant smell of the breath, and to restore the white colour of the teeth when stained by tobacco, &c., *tooth-powders* (see p. 212) and *lozenges* (*Journ. de Chim. Méd.* t. iii. p. 496.) containing chloride of lime have been used. An *ointment* (composed of ʒj. of chloride to ℥j. of lard or butter) has been employed, by way of friction, to reduce scrofulous enlargements of the lymphatic glands, when the use of mercurial ointment has failed.

Antidotes.—Administer albuminous liquids (as eggs beat up with water) or milk, or flour and water, or oil, or mucilaginous drinks, and excite vomiting; combat the gastro-enteritis by the usual means. Carefully avoid the use of acids, which would cause the evolution of chlorine gas in the stomach.

LIQUOR CALCIS CHLORINATÆ; *Solution of Chlorinated Lime; Solution of Chloride of Lime.* A solution of chloride of lime is used for *lotions* and *gargles*. Its strength must vary according to the quality of the chloride and the nature and seat of the disease for which it is employed. The average proportions are from ʒj. to ʒiv. of chloride, and Oj. of water. In the cure of itch, Derheims employed a wash composed of ℥iij. of chloride, and Oj. of water. The changes produced in the chloride by the action of water have been already explained (see p. 496.) The solution should be filtered to get rid of the hydrate of lime. A solution containing from ten to fifteen grains of the chloride is useful as an *enema* when the alvine evacuations are very offensive. A formula for a disinfecting *mouth-wash* has been already given (see p. 212.)

4. CAL'CIS CAR'BONAS.—CARBONATE OF LIME.

(1. Creta, *L. E. D.*—2. Marmor, *L. E. D.* (U. S.)—3. Testæ præparatæ, *L.*)

History.—Some varieties of carbonate of lime were distinguished and employed in the most remote periods of antiquity. Marble was probably used for building 1050 years before Christ. (1 *Chron.* xxix. 2.) Pliny (*Hist. Nat.* xxxvi.) tells us that Dipœnus and Scyllis were renowned as statuaries of marble in the 50th Olympiad (*i. e.* 557 years before Christ.) The *Creta*, mentioned by Horace (*Sat.* iii. lib. 2.) and Pliny was probably identical with our chalk. (On the chalk of the ancients, consult Beckmann's *History of Invent.* i. 212.)

NATURAL HISTORY.—Carbonate of lime occurs in both kingdoms of nature.

α. IN THE INORGANIZED KINGDOM.—It forms a considerable portion of the known crust of the earth, and occurs in rocks of various ages. It is found in the inferior stratified rocks, but more abundantly in the different groups of the fossiliferous rocks, particularly towards the central and higher parts of the series. (De la Bache, *Researches in Theoretical Geology*, 21.)

In the crystallized form it constitutes *Calcareous Spar* and *Arragonite*. The first of these is most extensively distributed, and presents itself under many hundred varieties of shapes. (See Bournon's *Traité Complet de la Chaux Carbonatée.* Londres, 1808.)

Granular carbonate of lime (the *Granular Limestone* of mineralogists) more commonly occurs in beds, but sometimes constitutes entire mountains. The whitest and most esteemed primitive limestone is that called *Statuary Marble*, or, from its resemblance to white sugar, *Saccharoid Carbonate of Lime*. That from Carrara, on the eastern coast of the Gulf of Genoa, is the kind usually employed by the statuary, and being very pure, should be employed for pharmaceutical purposes; it is the *Marmor* of the British pharmacopœias,

Chalk constitutes the newest of the secondary rocks, and occurs abundantly in the southern parts of England. It lies in beds, and contains abundance of marine as well as terrestrial organic remains. The upper part of a considerable portion of the chalk of England contains numerous flints, which are supposed to have belonged to poriferous animals. (Dr. Grant, *Lect. on Comp. Anat.* in the *Lancet*, Nov. 2, 1833.)

There are various other native forms of carbonate of lime constituting the substances called by the mineralogists *Schiefer Spar*, *Rock Milk*, *Earth Foam*, *Stalactitic Carbonate of Lime*, *Anthraconite*, *Oolite*, *Pisolite*, *Marl*, *Tufa*, &c.

Carbonate of lime is an ordinary ingredient in mineral and common waters, being held in solution by carbonic acid, and, therefore, deposited when this is expelled by boiling or otherwise.

β. IN THE ORGANIZED KIDGDOM.—Carbonate of lime is found in some plants, and is obtained from the ashes of most. It is an abundant constituent of animals, especially of the lower classes. Thus in the Radiate animals we find it in the hard parts of Corals, Madrepores, &c.; in the Molluscs (as the Oyster,) it is in the shells. In the articulated animals it forms, with phosphate of lime, the crusts which envelop these animals (as the Crab and Lobster;) in the higher classes it is found in bone, but the quantity of it is very small.

PREPARATION.—Several forms of carbonate of lime are employed in medicine; viz. Marble, Chalk, Precipitated Carbonate of Lime, and Carbonate of Lime from Animals. Most of these require to be submitted to some preparation before they are fitted for use.

1. Marble; *Marmor. Carbonas Calcis* (*dura*,) L. *Massive Crystalline Carbonate of Lime: White Marble*, E. *Marmor album*, D.—This is employed for the preparation of carbonic acid (p. 301) and for other purposes. White or statuary marble from Carrara should be selected on account of its freedom from Iron. It requires no preparation.

2. Chalk; *Creta. Calcis Carbonas* (*friabilis*,) L.—*Creta. Friable Carbonate of Lime: Chalk*, E. (and U. S.)—*Creta alba*, D.—This is found in great abundance in the southern parts of England. It is ground in a mill, and the finer particles separated by washing them over in water, letting the water settle, and making up the sediment into flat cakes, which are dried in this air. In this state it is called *Whiting*. All the British Colleges give directions for the preparation of chalk by elutriation. By this means it is separated from siliceous and ferruginous particles. The product is called *Prepared Chalk* (*Creta Præparata*, L. E. D.) and (U. S.) It is usually made up into little conical loaves.

The *London College* orders of Chalk, lbj.; Water as much as may be sufficient; add a little Water to the Chalk, and rub it that it may become fine powder. Put this in a large vessel with the rest of the Water; then stir it, and after a short interval pour off the supernatant water, still turbid, into another vessel, and set it by that the powder may subside; lastly, the

Water being poured off, dry this powder and keep it for use. In the same way shells, first freed from impurities and washed with boiling water, are prepared.

The directions of the *Edinburgh* and *Dublin Colleges* are essentially the same, except that no mention is made of the preparation of chalk from shells.

3. Precipitated Carbonate of Lime. (*Calcis Carbonas præcipitatum*, D.)—Carbonate of lime prepared by precipitation is employed by some druggists in the preparation of *Aromatic Confection.* It is also preferred to the ordinary prepared chalk for making *Camphorated Cretaceous Tooth-powder.* The Dublin College directs it to be employed in the preparation of the *Hydrargyrum cum Cretâ*, D. The following is the mode of preparing it:—

Take of Solution of Muriate of Lime, *five parts;* add of Carbonate of Soda dissolved in four times its weight of distilled water, three parts. Let the precipitate be mixed with water, and suffered to subside, and let this operation be three times repeated with a sufficiently large quantity of water: lastly, when collected, let the powder be dried on a chalk stone or on paper. *Ph. Dub.*

It should be prepared with cold solutions, otherwise the deposite is finely granular.

4. Carbonate of Lime from Animals.—Carbonate of lime is obtained from various animal substances; as from Oyster shells, Crab's claws, Crab's stones, and Red Coral. These substances yield carbonate of lime intimately blended with animal matter.

α. Prepared Oyster Shells; *Testæ præparatæ*, L.—See *Ostrea edulis.*

β. Prepared Crab's Claws; *Lapilli Cancrorum præparati; Chelæ Cancrorum præparatæ.*—See *Cancer Pagurus,*

γ. Prepared Crab's Stones; *Lapides Cancrorum præparati; Prepared Crab's Eyes; Oculi Cancrorum præparati.*—See *Astacus fluviatilis.*

δ. Prepared Red Coral; *Corallium rubrum præparatum.*—See *Corallium rubrum.*

Properties.—Pure carbonate of lime is a tasteless, odourless solid. When heated to redness in a current of air its carbonic acid is expelled, leaving quicklime. It is almost insoluble in water; one part of carbonate requiring 1600 parts of water to dissolve it. It is much more soluble in carbonic acid water: the solution reddens litmus, but changes the yellow colour of turmeric paper to brown; and by boiling, or exposure to the air, gives out its carbonic acid, by which the carbonate of lime is deposited.

Carbonate of lime is a dimorphous substance; that is, it crystallizes in two distinct and incompatible series of forms. Thus the forms of *Calcareous Spar* belong to the rhombohedric system, while *Arragonite* belongs to the right rectangular prismatic system. According to Gustav Rose, (*Lond. and Edinb. Phil. Mag.* June 1838.) both calcareous spar and arragonite may be formed in the humid way, but the first at a lower, the latter at a higher temperature:[1] in the dry way, calcareous spar alone is formed. Both minerals doubly refract the rays of light, and expand unequally in their different parts when heated; but calcareous spar has only one axis of no double refraction (see p. 168, figs. 29 and 30,) whereas arragonite has two.

Granular limestone (of which *white marble* is the purest kind) is massive, and consists of small grains of minute crystals, presenting a lamellar structure and brilliant lustre, but intersecting each other in every direction, and thereby giving a glimmering lustre to the mass.

Chalk is massive, opaque when pure white, and has an earthy fracture. It is usually soft to the touch, and adheres to the tongue.

Characteristics.—Carbonate of lime is recognised as a carbonate by the tests already mentioned for this class of salts (p. 302.) As a calcareous salt it is known by the characters before described (p. 489) for lime.

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[1] Colonel Yorke states that the deposite made by water on the interior of a copper boiler is artificial arragonite (*Proceedings of the Chemical Society*, No. 1.)

Composition.—Carbonate of lime has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Marcet.*	*Stromeyer.*	*Berzelius. Ure.*
Lime	1	28	56	56·1	56·35	56·4
Carbonic Acid	1	22	44	43·9	43·65	43·6
Carbonate of Lime	1	50	100	100·0	100·00	100·0

Purity.—Pure marble or chalk should be perfectly soluble, with effervescence, in hydrochloric acid, by which the absence of silica is shown. Ammonia should not cause any precipitate with this solution, by which its freedom from alumina, oxide of iron, &c. may be inferred: nor should a solution of sulphate of lime throw down any thing by which the absence of baryta and strontia is proved.

Totally soluble in hydrochloric acid, with effervescence. From this solution, after it has been boiled, when ammonia is dropped in, it throws down nothing, *Ph. Lond.*

"A solution of 25 grains in ten fluid-drachms of pyroligneous acid,[1] when neutralized by carbonate of soda, and precipitated by 32 grains of oxalate of ammonia, continues precipitable after filtration by more of the test." *Ph. Ed.*

Physiological Effects.—The local effects of chalk are those of an absorbent, antacid, and mild *desiccant* (see p. 209.) When swallowed it neutralizes the free acid of the gastric juice, and in this way alone must, by continued use, injure the digestive functions. It causes constipation, an effect commonly observed from the use of a few doses in diarrhœa. By the action of the free acids (acetic and hydrochloric) of the alimentary canal, it is converted into two soluble calcareous salts (acetate of lime and chloride of calcium,) which become absorbed. Hence the continued use of carbonate of lime is attended with the constitutional effects of the calcareous salts, and consequently the statements which have been made as to the influence of chalk over the lymphatic vessels and glands, and its effect in diminishing excessive secretion, may be correct. Sundelin (*Heilmittellehre*, i. 179.) thinks it may even promote the deposite of bone-earth in diseases attended with a deficiency of this substance. Carbonate of lime, prepared from animal matter, has been erroneously supposed to be more digestible than chalk, and, therefore, less likely to occasion dyspeptic symptoms. (Wibmer, *Die Wirkung*, &c. ii. 10.) Dr. A. T. Thomson (*Elements of Materia Medica*, ii. 82.) says, that "after chalk has been used for some time, the bowels should be cleared out, as it is apt to form into hard balls, and to lodge in the folds of the intestines."

Uses.—As an *absorbent* and *desiccant*, prepared chalk is used as a dusting powder in moist excoriations, ulcers, the intertrigo of children, burns and scalds, erysipelatous inflammation, &c. In the form of ointment it has been recommended by Mr. Spender (*Observations on Ulcers.*) in ulcers.

As an *antacid* it is exhibited in those forms of dyspepsia accompanied with excessive secretion of acid; and as an antidote in poisoning by the mineral and oxalic acids.

It has also been used in some diseases which have been supposed to depend on, or be accompanied by, excess of acid in the system—as in gouty affections, which are usually attended with the excessive production of uric acid, and in rachitis, which some have ascribed to a preponderance of phosphoric acid, or to a deficiency of lime in the system.

To diminish alvine evacuations, it is employed in diarrhœa. Its efficacy can hardly be referred solely to its antacid properties, for other antacids are not equally successful; but to its desiccating properties already referred to. Moreover, in many cases of diarrhœa in which chalk is serviceable, no excess of acidity can be shown to exist in the bowels. Aromatics are useful adjuncts to chalk in most cases of diarrhœa. In old obstinate cases, astringents (as catechu or kino) may

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[1] This quantity of acid is unnecessarily large. According to Mr. Phillips (*Lond. Med. Gaz.* N. S. vol. ii. 1838-9, p. 759,) it is capable of dissolving more than four times the above quantity of chalk.

be conjoined with great advantage; and in severe cases, accompanied with griping pains, opium.

Administration.—Prepared chalk is given in the form of powder or mixture, in doses of from ten grains to one or two drachms. It enters into a considerable number of officinal preparations.

1. **MISTURA CRETÆ**, L. E. D.; (U. S.) *Chalk Mixture; Cretaceous Mixture.* (Prepared Chalk, ℥ss.; Sugar, ʒiij.; Mixture of Acacia, f℥iss.; Cinnamon Water, f℥xviij. Mix. *L.*—Prepared Chalk, ʒx.: Pure Sugar, ʒv.; Mucilage, f℥iij.; Spirit of Cinnamon, ℥ij.; Water, Oij. Triturate the chalk, sugar, and mucilage together; and then add gradually the water and spirit of cinnamon, *E.*—Prepared Chalk, ℥ss.; Refined Sugar, ʒiij.; Mucilage of Gum Arabic, ℥j.; Water, Oj. [*wine measure.*] Mix. *D.*)—[Prepared Chalk, half an ounce; Sugar, Gum Arabic, in powder, āā two drachms; Cinnamon Water, Water, āā four fluid ounces.—U. S. P.]—A convenient and agreeable form for the exhibition of chalk. It is in very common use for diarrhœa. Aromatics (as *aromatic confection,*) astringents (as *kino* or *catechu,*) and narcotics (*opium,*) are frequently combined with it. Dose, f℥ss. to f℥ij.

2. **PULVIS CRETÆ COMPOSITUS**, L. E. D. *Compound Power of Chalk.* (Prepared Chalk, lbss.; Cinnamon, ℥iv.; Tormentil Root; Acacia Gum, of each, ℥iij.; Long Pepper, ℥ss. *L. D.*—Prepared Chalk, ℥iv.; Cinnamon, in fine powder, ʒiss.; Nutmeg, in fine powder, ʒj. Triturate them well together.)—Aromatic and astringent. Used in diarrhœa. Dose, grs. x. to ℈j.

3. **TROCHISCI CRETÆ**, E. *Chalk Lozenges.* (Prepared Chalk, ℥iv.; Gum Arabic, ℥j.; Nutmeg, ʒj. Pure Sugar, ℥vj. Reduce them to powder, and beat them with a little water into a proper mass for making lozenges.)—Mildly antacid and astringent. Used in acidity of stomach and diarrhœa.

4. **CAMPHORATED CRETACEOUS TOOTH-POWDER.** (Precipitated Carbonate of Lime, *three parts;* Camphor, finely pulverized, *one part.* Mix.)—Extensively used as a dentifrice (see p. 211.)

5. CAL'CIS SUBPHOS'PHAS.—SUBPHOSPHATE OF LIME.

History.—In 1769 Scheele discovered that bones contained an earthy salt composed of phosphoric acid and lime. As these two substances combine together in several proportions to form phosphates, chemists distinguish the combination found in bones by the name of the *Bone Phosphate*, or the *Subphosphate of Lime.*

Natural History.—Subphosphate of lime constitutes the principal part of the earthy matter of the bones of the *Vertebrata* and of the crustaceous envelopes of the *Articulata*. According to Dr. Wollaston (*Phil. Trans.* for 1797.) the same subphosphate is found in the ossification of the arteries, veins, valves of the heart, bronchiæ, and tendinous portion of the diaphragm. Moreover, the tartar of the teeth is composed of it.

The calcareous phosphate found in urine, and which is sometimes deposited from this fluid in a pulverulent form, is the neutral phosphate of lime ($C\,a\,O + P\,O^{2\frac{1}{2}}$.) The phosphate of lime calculus, prostatic calculi, and pineal concretion, also contain, according to Dr. Wollaston, the neutral phosphate. The same salt is held in solution by carbonic acid in some mineral waters. (Berzelius *Traité de Chimie*, t. iv.) The calcareous phosphate found crystallized in some plants is probably the neutral phosphate.

The mineral called *Apatite* is the subsesquiphosphate of lime ($^{3}C\,a\,O + {}^{2}P\,O^{2\frac{1}{2}}$.)

Preparation.—When bones are ignited in close vessels, they yield as a fixed residue *Bone Black* (see p. 290 and 299.) If, however, they be calcined in open vessels, the whole of the carbonaceous matter is burnt off, and the white product is called *Bone Ash* (*Ossa usta alba; Ossa de usta; Ossa ad albedinem usta; Ossa calcinata; Spodium album,*) or the *Bone Earth* (*Terra Ossium.*)

A similar product is obtained by calcining the antlers (*Cornua*) of the Deer (*Cervus.*) In this case the product, when reduced to a fine powder, is called *Burnt Hartshorn.* (*Cornu ustum*, L.; *Pulvis Cornu Cervini usti*, D.) Finely powdered Bone Ash is, however, usually substituted in the shops for Burnt Hartshorn.

The *Dublin College* gives the following directions for the preparation of *Precipitated Phosphate of Lime* (*Calcis Phosphas præcipitatum*, D.)

Take of Bones, burnt and reduced to powder, *one part;* Diluted Muriatic Acid; Water, of each *two parts.* Digest them together during twelve hours, and filter the liquor: add to this, of water of Caustic Ammonia as much as may be sufficient to throw down the Phosphate of Lime. Let this be washed with a sufficiently large quantity of water, and then dried.

Bone ash is composed principally of subphosphate with a little carbonate of lime. By digestion with hydrochloric acid, the subphosphate is dissolved, and the carbonate is decomposed with the evolution of carbonic acid and the formation of water and chloride of calcium. On the addition of ammonia, the subphosphate is precipitated. It is washed to deprive it of all traces of chloride of calcium and muriate of ammonia.

PROPERTIES.—Subphosphate of lime is white, tasteless, odourless, insoluble in water, but soluble in nitric, hydrochloric, and acetic acids, from which solutions it is thrown down, unchanged in composition, by ammonia, potash, and their carbonates. When exposed to a very intense heat, it fuses, and undergoes no other change.

Characteristics.—It is known to be a phosphate by its solubility in hydrochloric acid, and its being again thrown down as a white precipitate when the acid solution is supersaturated with caustic ammonia. If it be digested in a mixture of sulphuric acid and alcohol, sulphate of lime is precipitated, and an alcoholic solution of phosphoric acid obtained. The acid may then be recognised by the tests for it already mentioned (p. 394.) If the precipitated sulphate of lime be dissolved in water, the solution may be known to contain lime by the tests before described for the calcareous salts (p. 488.) The subphosphate of lime of bones is distinguished from the neutral phosphate by its fusing with greater difficulty, and dissolving more readily in hydrochloric acid. A very delicate test of the neutral phosphate is its crystallizing from hydrochloric acid by evaporation. (Wollaston, *Phil. Trans.* for 1797, p. 396 and 397.)

COMPOSITION.—The composition of subphosphate of lime is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Lime	8	224	51·0	51·55
Phosphoric Acid	6	216	49·0	48·45
Bone Subphosphate of Lime	1	240	100·0	100·00

PHYSIOLOGICAL EFFECTS.—Its effects are not very obvious. "As phosphate of lime is very difficultly soluble," observes Wibmer, (*Die Wirkung*, &c. ii. 9.) "it is absorbed in small quantity only, and then acts more or less like lime, as a slight astringent on the tissues and secretions, and increases, incontestably, the presence of calcareous salts in the bones, the blood, and the urine. Large doses disorder the stomach and digestion by their difficult solubility."

USES.—It has been administered in rickets, with the view of promoting the deposition of bone-earth in the bones. The sesquioxide of iron may be advantageously conjoined with it. Its principal use is in the preparation of phosphorus (p. 392) and phosphate of soda (p. 465.) In the arts it is employed for polishing, for the preparation of cupels, &c.

ADMINISTRATION.—Dose from grs. x. to ʒss. For internal use the preparation of the Dublin College is to be preferred.