Composition.—The composition of subsesquiphosphate of lime is as follows:—

	Eq.	Eq.Wt.	Per Cent.	Berzelius. (Artificial.)	Fuchs. (Artificial.)	Vauquelin. (Apatite.)
Lime	1½	42	53·85	51·68	54·74	54·28
Phosphoric Acid	1	36	46·15	48·32	45·26	45·72
Subsesquiphosphate of Lime	1	78	100·00	100·00	100·00	100·00

Bone-ash obtained from the bones of the ox consists of subsesquiphosphate of lime, carbonate of lime, phosphate of magnesia, and a trace of fluoride of calcium.

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 the secretions, and increases, incontestibly, 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.

Administration.—The dose of subsesquiphosphate of lime is from ten grains to half a drachm. For internal use the preparation of the Dublin College is to be preferred.

Order 14. Compounds of Magnesium.

Magne'sia.—Magne'sia.

History.—It was first chemically distinguished from lime in 1755, by Dr. Black, who also shewed the difference between magnesia and its carbonate. From the mode of procuring it, it is frequently termed ***calcined*** or ***burnt magnesia*** (*magnesia calcinata* seu *usta.*) It is sometimes called ***talc earth*** (*Talkerde*), or ***bitter earth*** (*Bittersalzerde.*)

Natural History.—It occurs in both kingdoms of nature.

(*a.*) ***In the inorganized kingdom.***—Magnesia is found native, in the solid state or in solution, in sea or some mineral waters, in combination with water and various acids (carbonic, sulphuric, boracic, silicic, and nitric.) Chloride of magnesium exists in sea water, as also in some springs.

(*b.*) ***In the organized kingdom.***—Combined with acids it is found in some vegetables (as ***Salsola Kali*** and ***Fucus vesiculosus***), and animals (as in the urine and some urinary calculi of man.)

Preparation.—Magnesia is obtained by exposing the subcarbonate to a full red heat for two hours in a crucible, so as to drive off the carbonic acid.

Properties.—It is a light, fine, white, colourless, odourless, and tasteless powder, having a sp. gr. 2·3. When moistened with water it reacts as an alkali on test papers. It is very slightly soluble in water, and like lime is more soluble in cold than in hot water. Dr. Fyffe states that it requires 5142 parts of cold, and 36000 parts of hot water to dissolve it. Unlike lime it evolves scarcely any heat when mixed with water. By the combined voltaic and oxy-hydrogen flames it has been fused by Mr. Brande (***Manual of Chemistry.***) It absorbs carbonic acid slowly from the atmosphere.

CHARACTERISTICS.—It is soluble in the dilute mineral acids without effervescence. The solution does not occasion any precipitate with the ferrocyanides, hydrosulphurets, oxalates, or bicarbonates. The neutral alkaline carbonates, when unmixed with any bicarbonate, throw down a white precipitate. Ammonia with phosphate of soda causes a white precipitate (ammoniacal-phosphate of magnesia.) Magnesia is insoluble in alkaline solutions, and is thereby distinguished from alumina. Its solution in sulphuric acid is remarkable for its great bitterness.

COMPOSITION.—Magnesia has the following composition:—

	Eq.	Eq.Wt.	Per Cent.	Wollaston.	Gay-Lussac.	Berzelius.
Magnesium	1	12	60	59·3	59·5	61·29
Oxygen	1	8	40	40·7	40·5	38·71
Magnesia	1	20	100	100·0	100·0	100·00

PURITY.—Its freedom from any carbonate is shewn by its dissolving in dilute mineral acids without effervescence. Its hydrochloric solution should occasion no precipitate with the oxalates, bicarbonates, and barytic salts, by which the absence of lime and sulphates may be inferred.

PHYSIOLOGICAL EFFECTS.—When taken into the stomach, magnesia neutralizes the free acids contained in the stomach and intestines, and forms therewith soluble magnesian salts. In full doses it acts as a laxative; but as it occasions very little serous discharge, Dr. Paris (*Pharmacologia*, vol. i. art. *Cathartics*) ranks it among purgatives "which urge the bowels to evacuate their contents by an imperceptible action upon the muscular fibres." Part of its laxative effect probably depends on the action of the soluble magnesian salts (chloride of magnesium and acetate of magnesia) which it forms by union with the acids of the alimentary canal. Magnesia exercises an influence over the urine analogous to that of the alkalies, namely, it diminishes the quantity of uric acid in the urine, and when continued for too long a period occasions the deposit of the earthy phosphates in the form of white sand. (W. T. Brande, *Phil. Trans.* 1810, p. 136; and 1813, p. 213.) On account of its greater insolubility, it requires a longer time to produce these effects than the alkalies. When taken in too large quantities and for a long period it has sometimes accumulated in the bowels to an enormous extent, and being concreted by the mucus of the bowels, created unpleasant effects. A lady took every night during two years and a half, from one to two teaspoonfuls of Henry's calcined magnesia (in all between 9 and 10 lbs. troy) for a nephritic attack, accompanied with the passage of gravel; subsequently she became sensible of a tenderness in the left side just above the groin, connected with a deep-seated tumor, obscurely to be felt on pressure, and subject to attacks of constipation, with painful spasmodic action of the bowels, tenesmus, and a highly irritable state of stomach. During one of these attacks she evacuated two pints of "sand;" and on another occasion voided soft light brown lumps, which were found to consist entirely of subcarbonate of magnesia concreted by the mucus of the bowels, in the proportion of 40 per cent. In another case a mass of a similar description, weighing from 4 to 6 lbs., was found imbedded in the head of the colon, six months after the patient had ceased to employ any magnesia. (E. Brande, *Quart. Journ. of Science*, i. 297.)

USES.—As an *antacid* it is as efficacious as the alkalies, while it has an advantage over them in being less irritant, and thereby is not so apt to occasion disorder of the digestive organs. It may be employed to neutralize acids introduced into the stomach from without, (as in cases of poisoning by the mineral acids) or to prevent the excessive formation of, or to neutralize when formed, acid in the animal economy. Thus it is administered to relieve heartburn arising from, or connected with, the secretion of an abnormal quantity of acid by the stomach: its efficacy is best seen in persons of a gouty or rheumatic diathesis, in which the urine contains excess of uric acid. It often relieves the headache to which such individuals are not unfrequently subject. It is most efficacious in diminishing the quantity of uric acid in the urine, in calculous complaints, and according to Mr. Brande (*Phil. Trans.* 1813, p. 213) it is sometimes effectual where the alkalies have failed. It will be found of great value in those urinary affections in which alkaline remedies are indicated, but in which potash and soda have created dyspeptic symptoms.

As a *laxative*, magnesia is much employed in the treatment of the diseases of children. It is tasteless, mild in its operation, and antacid,—qualities which render it most valuable as an infant's purgative. Independently of these, Hufeland ascribes to it a specific property of diminishing gastro-intestinal irritation by a directly sedative influence. In flatulency it is combined with some carminative water (dill or anise); in diarrhœa, with rhubarb. It is employed as a purgative by adults in dyspeptic cases—in affections of the rectum, as piles and stricture—and in diarrhœa. It is associated with the carminative waters—with some neutral salts, as sulphate of magnesia, to increase its cathartic operation—or in diarrhœa, with rhubarb.

ADMINISTRATION.—As a purgative, the dose, for adults, is from a scruple to a drachm; for infants, from two to ten grains. As an antacid, the dose is from ten to thirty grains twice a day. It may be conveniently given in milk. It is sometimes administered in combination with lemon juice: the *citrate of magnesia* thus formed acts as a pleasant and mild aperient.

Magne'siæ Subcar'bonas.—Subcar'bonate of Magne'sia.

HISTORY.—Subcarbonate of magnesia, also called *magnesia alba* and *carbonate of magnesia*, was exposed for sale at Rome at the commencement of the 18th century, by Count di Palma, in consequence of which it was termed *Comitissæ Palmæ pulvis*. In 1707, Valentini informed the public how it might be prepared.

NATURAL HISTORY.—Neutral carbonate of magnesia is found native in various parts of Europe, Asia, and America. It constitutes a range of low hills in Hindostan, from whence it has sometimes been imported in considerable quantities into this country, but has been found, as I am informed, unsaleable here. The samples offered for sale about two years since consisted of reniform, opaque, dull masses, adherent to the tongue, having a conchoidal fracture, and considerable hardness. Internally, they were whitish; externally, greyish or yellowish white. The same substance was brought over about a year ago in the calcined state, and was nearly white. It was called *calcined Indian magnesia*. Carbonate of magnesia is found in some mineral waters.

Preparation.—Subcarbonate of magnesia is prepared by mixing solutions of sulphate of magnesia (or chloride of magnesium) and carbonate of soda (or carbonate of potash). The directions of the London Pharmacopœia are as follow:—Dissolve separately four pounds of sulphate of magnesia, and four pounds and eight ounces of carbonate of soda, in two gallons of water, and strain: then mix the liquors, and boil for a quarter of an hour, constantly stirring with a spatula: lastly, having poured off the liquor, wash the precipitated powder with boiling distilled water, and dry it.

Two kinds of subcarbonate of magnesia are known and kept in the shops, the *light* and the *heavy*. *Heavy magnesia* (*magnesia ponderosa* of the shops) is thus prepared:—Add one volume of a cold saturated solution of carbonate of soda to a boiling mixture of one volume of a saturated solution of sulphate magnesia, and three volumes of water. Boil until effervescence has ceased, constantly stirring with a spatula. Then dilute with boiling water, set aside, pour off the supernatant liquor, and wash the precipitate with hot water on a linen cloth: afterwards dry it by heat in an iron pot. *Light magnesia* (*magnesia* of the shops) is prepared by employing dilute solutions of the sulphate of magnesia and carbonate of soda. If no heat be used, it is apt to be gritty. A *heavy and gritty* magnesia is prepared by separately dissolving 12 parts of sulphate magnesia and 13 parts of crystallized carbonate of soda in as small a quantity of water as possible, mixing the hot solutions, and washing the precipitate.

The *theory* of the process is as follows:—When sulphate of magnesia and carbonate of soda are mixed, double decomposition takes place: the sulphuric acid combines with the soda to form sulphate of soda, and the carbonic acid with the magnesia. The neutral carbonate of magnesia, which we presume to be first formed, is immediately resolved by the water into a subcarbonate, which, with some water, precipitates, and the bicarbonate which remains is dissolved in the cold liquid. 5 eq. of the neutral carbonate, with 4 eq. of water, produce 1 eq. of bicarbonate; while the 4 eq. of magnesia, 3 eq. carbonic acid, and 4 eq. of water, precipitate. If we mix the boiling solutions together, 4 eq. of the neutral carbonate give out 1 eq. of free carbonic acid, and a precipitate is formed consisting of 4 eq. of magnesia, 3 eq. of carbonic acid, and 4 eq. of water. The precipitate in both of these cases constitutes the subcarbonate of magnesia of the shops.

Properties.—Subcarbonate of magnesia, as usually met with, is in the form of a white, inodorous, and tasteless powder. The *light* variety occurs as a very fine light powder, or in large rectangular masses with bevelled edges, or in smaller cubical cakes. The *heavy* carbonate is, as its name indicates, of greater specific gravity than the light. Both kinds moistened with water have a feebly alkaline reaction on test paper, but when boiled in water do not communicate this property to water. Subcarbonate of magnesia is nearly insoluble in water: it readily dissolves in carbonic acid water.

Characteristics.—It is distinguished from caustic or calcined magnesia by the effervescence which takes place on the addition of a dilute mineral acid. Its other characteristics are the same as for the latter substance (vide p. 361.)

COMPOSITION.—The following is the composition of subcarbonate of magnesia of the shops :—

	Kirwan.	Bergman.	Klaproth.	Bucholz.		Berzelius.	Phillips.
				Light.	Heavy.		
Magnesia	45	45	40	33	42	41·60 to 43·2	40·8
Carbonic Acid	34	25	33	32	35	36·58 — 36·4	36·0
Water........	21	30	27	35	23	21·82 — 20·4	23·2
Magnesia alba	100	100	100	100	100	100·00 — 100·0	100·0

Several reasons have led chemists to reject the idea of this compound being an ordinary subsalt (vide Berzelius, *Traité de Chém.* iv. 101); but they are not agreed as to the precise mode in which the constituents are combined, as the following table shews :—

Berzelius.	Eq.	Eq. Wt.	Brande.	Eq.	Eq. Wt.		Brande.	Eq.	Eq. Wt.	Phillips.	Eq.	Eq. Wt.
Hydr^{d}. Carb. Magn.	3	148·59	Carb. Magn.	1	42	or	Hydr^{d}. Carb. Magn.	1	51	Hydr^{d}. Carb. Magn.	4	204
Hydr^{te}. Magnes...	1	29·72	Quadrihydr.	1	56		Trihydr^{te}. Magn. ..	1	47	Bihydr^{d}. Magn. ..	1	38
Magnesia alba	1	178·31		1	98			1	98		1	242

PURITY.—Subcarbonate of magnesia should be perfectly white and tasteless. The water in which it has been boiled should have no alkaline reaction on turmeric paper, nor throw down anything on the addition of chloride of barium or nitrate of silver: by which the absence of alkaline carbonates, sulphates, and chlorides, is proved. Dissolved in dilute sulphuric acid the oxalates and bicarbonates should occasion no precipitate, by which the non-existence of any calcareous salt is shewn.

PHYSIOLOGICAL EFFECTS.—The effects of subcarbonate of magnesia are nearly the same as those of pure magnesia. We can readily conceive that the local operation of the first is somewhat milder than that of the latter (as in the case of the alkalies and their carbonates), but the difference is hardly perceptible in practice. As the subcarbonate effervesces with acids it is more apt to create flatulence when swallowed.

USES.—The uses of the subcarbonate are the same as those of calcined magnesia; except where the object is to neutralize acid in the alimentary canal (as in cardialgia and in poisoning by the mineral acids), when the latter preparation is to be preferred on account of its not effervescing with acids, and thereby not causing flatulency.

In the Pharmacopœia, subcarbonate of magnesia is directed to be employed for the extemporaneous preparation of the so-called DISTILLED WATERS (*aquæ distillatæ*). A drachm of any distilled oil is to be carefully triturated with a drachm of subcarbonate of magnesia, and afterwards with four pints of distilled water; the water is then to be strained. For ordinary purposes no objection exists to the use of waters thus prepared, but they are incompatible with bichloride of mercury, on account of the small quantity of magnesia which they hold in solution.

ADMINISTRATION.—The dose of subcarbonate of magnesia, as a purgative, is from ten grains to a drachm; as an antacid, from five grains to a scruple.

AQUA MAGNESIÆ BICARBONATIS. (*Magnesia Water: Aerated Magnesia Water.*)—This solution is prepared by passing a stream of carbonic acid through water in which a given quantity of subcarbonate of magnesia is suspended. Or it may be made extemporaneously by adding subcarbonate of magnesia (or a mixture of sulphate of magnesia and carbonate of soda) to the ordinary bottle-soda water (carbonic acid water.) It is an agreeable mode of exhibiting magnesia in nephritic affections.

Magne'siæ Sul'phas.—Sul'phate of Magne'sia.

HISTORY.—This salt was originally procured from the Epsom waters by Dr. Grew in 1675. It has had a variety of names, such as *Epsom* or the *bitter purging salt, sal Anglicum, sal Seidlitzense, sal catharticum, vitriolated magnesia,* &c.

NATURAL HISTORY.—It is a constituent of sea and many mineral waters: it occurs as an efflorescence on other minerals, forming the *hair salt* of mineralogists; and with sulphate of soda and a little chloride of magnesium, constitutes *Reussite.*

PREPARATION.—The two great sources of the sulphate of magnesia of English commerce are *dolomite* and *bittern.* Dolomite or magnesian limestone is a compound of carbonate of lime and carbonate of magnesia. It occurs in enormous quantities in various counties of England (as those of Somerset, York, and Nottingham), and is employed for building. York Minster and Westminster Hall are built of it. Bittern is the residual liquor of sea-water, from which common salt (chloride of sodium) has been separated. It contains chloride of magnesium and sulphate of magnesia.

Sulphate of magnesia may be extracted from bittern by evaporation, a process practised at Lymington, in Hampshire (Dr. Henry, *Phil. Trans.* 1810, p. 94). If sulphuric acid be added to bittern, a further quantity of sulphate may be obtained by the decomposition of chloride of magnesium. Sulphate thus procured is preferred at Apothecaries' Hall for making magnesia, as it yields a whiter product than sulphate made from dolomite.

Various methods of manufacturing sulphate of magnesia from dolomite have been described. The usual method is to treat this mineral by dilute sulphuric acid: carbonic acid escapes, and a residue, composed of sulphate of magnesia and sulphate of lime, is obtained. These two salts are separated from each other by crystallization.

In 1816, Dr. William Henry, of Manchester (*Repert. of Arts,* vol. xxx. p. 142, 2nd Ser.) took out a patent for the following process:—Calcine magnesian limestone, so as to expel the carbonic acid; then convert the caustic lime and magnesia into hydrates by moistening them with water. Afterwards add a sufficient quantity of hydrochloric (or nitric or acetic) acid (or chlorine), to dissolve the lime, but not the magnesia, which, after being washed, is converted into sulphate by sulphuric acid (or, where the cost of this is objectionable, by sulphate of iron, which is easily decomposed by magnesia). Or the mixed hydrates of lime and magnesia are to be added to bittern: chloride of calcium is formed in solution, while two portions of magnesia (one from the bittern, the other from the magnesian lime) are left unacted on. Or hydrochlorate of ammonia may be used instead of bittern: by the reaction of this on the hydrated magnesian lime, chloride of calcium and caustic ammonia remain in solution, while magnesia is left undissolved: the ammonia is separated from the decanted liquor by distillation.

Carbonate of ammonia has also been employed to separate lime from magnesia: carbonate of lime is precipitated, and the magnesia remains in solution, from which it may be easily separated by ebullition (*Journ. of Science,* iii. 217; vi. 313; ix. 177). At Monte della Guardia, near

Genoa, sulphate of magnesia is manufactured from schistose minerals, containing sulphur, magnesia, copper, and iron. After being roasted, and moistened to convert them into sulphates, they are lixiviated, and the solution is deprived, first, of copper by refuse iron, and afterwards of iron by lime (Dr. Holland, *Phil. Trans.* 1816, p. 294). In Bohemia, sulphate of magnesia is procured, by evaporation, from the waters of Seidlitz and Saidschütz. Hermann (Poggendorff's *Annalen*, xi. 249) extracts it from liquids containing chloride of magnesium, by means of sulphate of soda. At Baltimore, sulphate of magnesia is procured from the siliceous hydrate of magnesia or *marmolite*, by reducing the mineral to powder, saturating with sulphuric acid, and calcining the dried mass to peroxidize the iron. It is then re-dissolved in water (from which solution the remaining iron is separated by sulphuret of lime), and crystallized. By a second crystallization it is obtained nearly pure (D. B. Smith, in the *Dispensatory of the U. S. of America*).

PROPERTIES.—The impure sulphate obtained from bittern is called *singles*, and when purified by re-crystallization, *doubles*. The sulphate usually met with in the shops is in small acicular crystals. By solution and re-crystallization we readily obtain tolerably large four-sided prisms, with reversed diëdral summits, or four-sided pyramids: the primary form of the crystals is the right rhombic prism. Both large and small crystals are colourless, transparent, and odourless, but have an extremely bitter taste. When heated they undergo the watery fusion, then give out their water of crystallization, become anhydrous, and at a high temperature undergo the igneous prism, and run into a white enamel, but without suffering decomposition. Exposed to the air the crystals very slowly and slightly effloresce. It dissolves in its own weight of water at 60°, and in three-fourths of its weight of boiling water. It is insoluble in alcohol.

CHARACTERISTICS.—It is known to contain sulphuric acid by the tests for the sulphates already mentioned (p. 265). The nature of its base is shown by the tests for magnesia before described (p. 361).

COMPOSITION.—The following is the composition of crystallized sulphate of magnesia :—

	Eq.	Eq. Wt.	Per Cent.	Gay-Lussac.	Wenzel.
Magnesia	1	20	16·26	16·04	16·86
Sulphuric Acid	1	40	32·52	32·53	30·64
Water	7	63	51·22	51·43	52·50
Cryst^{d}. Sulphate of Magnesia	1	123	100·00	100·00	100·00

PURITY.—The sulphate of magnesia met with in the shops is usually sufficiently pure for all medicinal and pharmaceutical purposes. It should be colourless, and undergo no change when mixed with ferrocyanides or hydrosulphurets. When obtained from bittern it is sometimes contaminated with chloride of magnesium, which, by its affinity for water, keeps the sulphate in a damp state. By digestion in alcohol the chloride is dissolved, and by evaporating the spirituous solution, may be obtained in the solid state. It is said, that occasionally small crystals of sulphate of soda are intermixed with those of sulphate of magnesia—a fraud I have never met with in English commerce, nor is it likely to occur at the present low price of the magnesian salt. Should such an adulteration be suspected, there are several methods of detecting it: the sophisticated salt would effloresce more rapidly than the pure salt, and would communicate a yellow tinge to the flame of alcohol. Boiled with caustic lime and water, all the magnesian sulphate would be decomposed, and the liquor being filtered, to separate the precipitated magnesia and sulphate of lime, yields, on evaporation, sulphate of soda. If shaken in the cold with carbonate of baryta, a solution of carbonate of soda would be obtained, easily recognized by its alkaline properties. 100 grains of pure sulphate of magnesia, dissolved in water, and mixed with a boiling solution of carbonate of soda, yields 34 grains of subcarbonate of magnesia when dried. If sulphate of soda were present, the precipitate would weigh less. (Phillips, *Transl. of Pharm.*)

Physiological Effects.—Sulphate of magnesia is a mild and perfectly safe antiphlogistic purgative, which promotes the secretion as well as the peristaltic motion of the alimentary canal. It is very similar in its operation to sulphate of soda, than which it is less likely to nauseate, or otherwise disorder the digestive functions, while it acts somewhat more speedily on the bowels. It does not occasion nausea and griping, like some of the vegetable purgatives, nor has it any tendency to create febrile disorder or inflammatory symptoms; but, on the other hand, has a refrigerant influence: hence it is commonly termed a cooling purgative. In small doses, largely diluted with aqueous fluids, it slightly promotes the action of other emunctories: thus, if the skin be kept cool, and moderate exercise be conjoined, it acts as a diuretic; whereas if the skin be warm, it operates as a diaphoretic.

Uses.—On account of the mildness and safety of its operation, its ready solubility, and its cheapness, sulphate of magnesia is by far the most commonly employed purgative, both by the public and the profession. The only objection to its use is its bitter and unpleasant taste. To state all the cases in which it is administered, would be to enumerate nearly the whole catalogue of known diseases. It must, therefore, be sufficient to mention, that it is excellently well adapted as a purgative for febrile and inflammatory diseases, obstinate constipation, ileus, lead colic, even incarcerated hernia, narcotic poisoning, &c. It may be used as an antidote in poisoning by the salts of lead and baryta.

Administration.—As a purgative it is usually administered in doses of from half an ounce to an ounce and a half; but if dissolved in a large quantity of water, a smaller dose will suffice. Thus, two drachms in half a pint or more of water, taken in the morning fasting, will act speedily, sufficiently, and mildly, in ordinary cases; and in delicate females, a drachm, or even less, in the above quantity of water, will usually produce the desired effect. Some carminative or aromatic (as peppermint water or tincture of ginger) is frequently conjoined to obviate flatulency. In febrile and inflammatory diseases, the solution may be acidulated with dilute sulphuric acid with great advantage; or the sulphate may be dissolved in the compound infusion of roses. It is frequently used as an adjunct to the compound infusion of senna, whose purgative effect it promotes, but whose griping tendency it is said to check. In dyspeptic cases, accompanied with constipation, it is conjoined with bitter infusions (as of quassia, gentian, calumba, &c.). As a purgative enema, an ounce or more of it may be added to the ordinary glyster.

The *bitter* purging saline waters (*vide* p. 174), as those of Seidlitz, Epsom, Beulah, Kilburn, and the Cheltenham pure saline, owe their purgative property principally to sulphate of magnesia.