

ORDER XX.—SILVER AND ITS COMPOUNDS.

1. ARGENTUM, L. E. D. (U. S.)—SILVER.

HISTORY.—Silver, like gold, has been known from the most remote periods of antiquity, being mentioned in the earliest books of the old Testament. (*Genesis*, xlv. 2; *Job*, xxii. 25.) It was termed by the alchemists and astrologers *Diana* or *Luna*.

NATURAL HISTORY.—It is found in the mineral kingdom in various states; sometimes nearly pure; or alloyed with other metals (especially gold, antimony, tellurium, arsenicum, and copper;) or combined with sulphur, selenium, iodine, or chlorine. Of these, native silver and the sulphuret are by far the most abundant. A native carbonate of silver is described, but is exceedingly rare.

PREPARATION.—The processes followed for the extraction of silver vary in different places, according to the nature of the ore: they are principally *amalgamation* and *cupellation*. At Freyburg the ore is mixed with common salt, and roasted, by which the sulphuret of silver is converted into the chloride of this metal: water and iron are then added, to remove the chlorine, and the disengaged silver is finally dissolved in mercury (*amalgamation*), and the solution submitted to distillation, by which the mercury is volatilized, and the silver left behind. (J. H. Vivian in Taylor's *Records of Mining*, p. 21.) The process of amalgamation followed in America is somewhat different. (Boussingault, *Annales de Chimie*, li. 337; also, Ward, *Mexico in 1827*, vol. ii. 437.)

Silver is obtained from argentiferous galena, as follows:—The ore is first roasted to expel the sulphur, and afterwards smelted with charcoal. The argentiferous lead is then submitted to cupellation, by which the lead becoming oxidized, is partly volatilized, and partly sinks into the cupel (*cineritium*), leaving the silver. (On the smelting processes of Hungary, Saxony, &c., consult Taylor's *Records of Mining*, p. 51.)

Pure silver is obtained by immersing a copper rod in a solution of the nitrate. The precipitate is to be digested in caustic ammonia, to remove all traces of copper, and afterwards washed with water.

PROPERTIES.—In the native state, silver occurs crystallized in the cube and regular octohedron. When pure this metal is white, with a slight shade of yellow; inodorous and tasteless. It is moderately hard and elastic; very ductile and malleable: a single grain may be drawn out into 400 feet of wire, and leaf silver (*argentum in laminas extensum*; *argentum foliatum*) may be procured, whose thickness is only $\frac{1}{100000}$ of an inch. Its sp. gr. is 10.474. It melts at a bright red heat (1873° F. according to Daniell.) When exposed to the air it does not oxidate, but readily tarnishes by sulphurous vapours. Its equivalent is 108.

Characteristics.—It is soluble in nitric acid.—(For the characteristics of the nitric solution, see p. 573.)

PURITY.—The silver of the shops usually contains traces of gold and copper.

It is totally dissolved by diluted nitric acid. This solution, on the addition of chloride of sodium, throws down a precipitate, which an excess of ammonia dissolves, and it should be free from colour. The chloride of silver being removed, and hydrosulphuric acid added to the solution, it is not coloured by it, and nothing is thrown down. The specific gravity of silver is 10.4. *Ph. L.*

Soluble entirely in diluted nitric acid: this solution, treated with an excess of muriate of soda, gives a white precipitate entirely soluble in aqua ammoniac, and a fluid which is not affected by sulphuretted hydrogen. *Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—Silver in the metallic state is totally inert. It may remain for many months in the alimentary canal without exciting any ill effects. (*Lond. Med. Gaz.* May 20, 1837.) Colic, however, has been ascribed to the handling of silver. (*Journal de Chimie Médicale*, t. vi. 2^{nde} Série, 1840.)

USES.—In pharmacy it is used for the preparation of the nitrate, which is employed as a medicine and as a test.

Silver leaf is used for filling the hollows of decayed teeth, and was formerly employed to cover pills. An amalgam of silver is also used by some dentists for stopping teeth. It is objectionable on account of its becoming black by the sulphuretted or phosphuretted hydrogen evolved by the breath.

2. ARGENTI NITRAS, L. E. (U. S.)—NITRATE OF SILVER.

(Argenti Nitratis Crystalli; and Argenti Nitratis fusum, D.)

HISTORY.—Geber (*Invention of Verity*, ch. xxi.) describes the method of preparing crystallized nitrate of silver. When this salt is fused, it is termed *Lunar Caustic* (*Causticum Lunare*.) The term *Infernal Stone* (*Lapis Infernalis*) is sometimes applied to this salt as well as to hydrate of potash (see p. 414.) Nitrate of silver is sometimes called *Argentum Nitratum*.

PREPARATION.—All the British Colleges give directions for the preparation of this salt.

The *London College* orders of Silver, ℥iiss.; Nitric Acid, f℥j.; Distilled Water, f℥ij. Mix the nitric acid with the water, and dissolve the silver in them in a sand-bath. Afterwards, increase the heat gradually, that the nitrate of silver may be dried. Melt this in a crucible, with a slow fire, until, the water being expelled, ebullition has ceased; then immediately pour it into proper moulds.

The directions of the *Edinburgh College* are essentially similar, except that the salt is ordered to be fused in an earthenware or porcelain crucible, and the fused matter poured into iron moulds previously heated and greased slightly with tallow. Preserve the product in glass vessels.

The *Dublin College* directs two forms of nitrate of silver to be prepared; the one in crystals the other fused. The *crystallized* nitrate is prepared of silver laminated and cut into small fragments, *thirty-seven* parts; Diluted Nitric Acid, *sixty* parts. Let the silver be passed into a glass vessel, and let the acid previously diluted with water, be poured on it. Dissolve the metal with a heat gradually increased; then, by evaporation and refrigeration, let crystals be formed, to be dried without heat, and to be preserved in a glass vessel placed in darkness.

The following are directions for preparing the *fused* nitrate:—Let Silver be dissolved in Diluted Nitric Acid as above described; then let the liquor be evaporated to dryness. Let the remaining mass, passed into a crucible, be liquefied by a slow heat. Let it then be poured into proper moulds, and preserved in a glass vessel.

[The U. S. Pharmacopœia directs Silver in small pieces, an ounce; Nitric Acid, five fluid-drachms; Distilled Water, two fluid-ounces. The process is the same as that of the London College.]

The fusion may be more readily and safely effected in a Berlin porcelain capsule over a spirit or gas lamp, by means of Griffin's lamp furnace, than in a crucible over a slow fire, as directed in the London Pharmacopœia. It is unnecessary and objectionable to grease the moulds, as directed by the Edinburgh College.

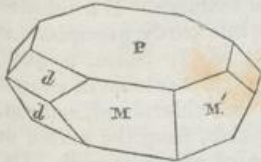
The *theory* of the process is readily comprehended. Three equivalents or 324 parts of silver abstract three equivalents or 24 parts of oxygen from one equivalent or 54 parts of nitric acid, thereby disengaging one equivalent or 30 parts of binoxide of nitrogen, and forming three equivalents or 348 parts of oxide of silver, which unite with three equivalents or 162 parts of nitric acid to form three equivalents or 510 parts of nitrate of silver.

MATERIALS.		PRODUCTS.	
1 eq. Nitric Acid..	54	3 eq. Bin. Nitrog.....	30
3 eq. Silver.....	324	3 eq. Oxygen.....	24
3 eq. Nitric Acid	162		
	540	3 eq. Ox. Silver	348
		3 eq. Nitrate	510
		Silver	510
			540

PROPERTIES.—Nitrate of silver forms transparent, colourless, right rhombic prismatic crystals. Its taste is strongly metallic and bitter. When heated it fuses: if the temperature be increased, decomposition ensues; and metallic silver is obtained. The fused nitrate forms on cooling a whitish, striated mass, having

crystalline texture. The salt is soluble in both water and spirit. It does not deliquesce: when exposed

FIG. 90.



Crystal of Nitrate of Silver.

to the atmosphere and solar light it blackens, probably from the action of organic matter, or hydrosulphuric acid, contained in the atmosphere. Mr. Scanlan (*Athenæum*, August 25, 1838.) finds that nitrate of silver in a clean dry glass tube, hermetically sealed, undergoes no change of colour by exposure to solar light; the contact of organic matter, however, readily occasions it to become black. A solution of nitrate in pure distilled water is unchanged by exposure to solar light; but the presence of organic matter causes the liquid to become black or reddish. (See pp. 242, and 243.)

Characteristics.—It is known to be a *nitrate* by its deflagration when heated on charcoal, and the evolution of nitrous fumes, as well as by the other characters before mentioned for this class of salts (see p. 267.) Its characters as a *salt of silver* are as follows:—It yields with hydrochloric acid a white precipitate (*chloride of silver*;) whose properties have been before stated (see p. 218.) It forms also, with solutions of the alkaline carbonates, oxalates, and ferrocyanides, white precipitates (*carbonate, oxalate, and ferrocyanide of silver*;) With solutions of the alkaline arsenites and phosphates it yields yellow precipitates (*arsenite and subsquiphosphate of silver*;) red with the arseniates (*arseniate of silver*;) and with lime water or the fixed alkalis olive-brown (*oxide of silver*;) Phosphorus and metallic copper each precipitate crystals of metallic silver from the aqueous solution of this salt. Hydrosulphuric acid occasions a black precipitate (*sulphuret of silver*.)

COMPOSITION.—Nitrate of silver is thus composed:—

	Atoms.	Eq. Wt.	Per Cent.	Proust.
Oxide of Silver.....	1	116	68.23	69.5
Nitric Acid.....	1	54	31.76	30.5
Nitrate of Silver.....	1	170	99.99	100.0

PURITY.—Nitrate of silver should be white, and completely soluble in distilled water. By the action of organic matters and light it blackens from a partial reduction. The presence of copper may be detected in its solution by the blue colour produced with caustic ammonia. The watery solution from which the silver has been thrown down by hydrochloric acid, should be unchanged by the addition of hydrosulphuric acid, showing the absence of lead and copper: and be completely volatilized by heat: if any saline residuum be obtained, the nitrate was adulterated. A chemical manufacturer informs me, that he has detected 10 per cent. of nitrate of potash in the nitrate of silver of commerce. It was recognised by precipitating the silver by means of hydrochloric acid, and subsequently crystallizing the nitrate of potash. The white precipitate produced with either hydrochloric acid or chloride of sodium should be readily dissolved by caustic ammonia: if chloride of lead be present the effect will be otherwise.

It is originally white, but blackens by exposure to light. It is entirely soluble in water. Copper put into the solution precipitates silver; its other properties are as above detailed respecting silver. *Ph. Lond.*

Soluble in distilled water, with the exception of a very scanty black powder: twenty-nine grains dissolved in one fluid ounce of distilled water, acidulated with nitric acid, precipitated with a solution of nine grains of muriate of ammonia, briskly agitated for a few seconds, and then allowed to rest a little, will yield a clear supernatant liquid, which still precipitates with more of the test. *Ph. Ed.*

PHYSIOLOGICAL EFFECTS. *a. On Animals.*—Orfila (*Toxicol. Gén.*) found that it acted on animals as a powerfully corrosive poison. When dogs were made to swallow it, gastro-enteritis was induced. No symptoms indicating its absorp-

tion were observed. Dissolved in water, and thrown into the jugular vein, it produced difficult respiration, convulsive movements, and speedy death.

β. On Man.—The local action of nitrate of silver is that of a caustic or corrosive. This might be expected, from observing its action on albumen and fibrin—substances which form the principal part of the animal textures. If a solution of nitrate of silver be added to an albuminous liquid, a white curdy precipitate is formed, composed (Lassaigne, *Journ. de Chim. Méd.* t. vi. II^e Série, p. 306.) of albumen 84·5, and nitrate of silver 15·5. This precipitate is soluble in caustic ammonia, and in solutions of nitrate of silver, albumen, and chloride of sodium. After some time it becomes coloured and ultimately blackish, from the partial or complete reduction of the silver. The action of nitrate of silver on milk, (Dr. C. G. Mitscherlich, *Pharmaceutisches Central-Blatt für* 1839, S. 447.) as well as on fibrin, is analogous to that on albumen; that is, a white compound of nitrate of silver and of these organic substances is at first formed, but gradually the metal is reduced. These facts assist us in comprehending the nature of the changes produced by the application of nitrate of silver to the different tissues.¹

Applied to the skin it produces first a white mark, owing to its union with the coagulated albumen of the cuticle: gradually this becomes bluish-gray, purple, and ultimately black, owing to the partial reduction of the silver. If the integument be moistened, and the nitrate applied three or four times, it causes at the end of some hours vesication, which is usually attended with less pain than that produced by cantharides. In some cases it excites acute pain. In one instance in which I applied it freely to the scalp for a cutaneous affection, fever with delirium was produced, which endangered the life of the patient (a girl of six years.) This is deserving of notice, because in Mr. Higginbottom's work (*Essay on the Use of the Nitrate of Silver*, 2d ed. p. 198.) we are told, that nitrate of silver applied as a vesicant "causes scarcely any constitutional irritation, even in children." In a few days the black and destroyed cuticle cracks and falls off, without any destruction of the subjacent cutis vera.

Applied to the hair or nails the nitrate stains them black, as in the case of the cuticle; and, in consequence, it is one of the substances employed as a hair dye (see p. 212.) When recently applied, the black tint of the hair, and even of the cuticle, may be removed by washing with a solution of chloride of sodium, and then with ammonia-water, to dissolve the chloride of silver which is produced. (*Journ. de Chim. Méd.* vii. 542.) To detect silver in stained hair, the latter is to be treated with chlorine, by which chloride of silver is produced, which is soluble in ammonia, and precipitable from its solution by nitric acid. (Devergie, *Méd. Lég.* ii. 933.) Part of the black colour of the hair stained by the nitrate depends on the formation of sulphuret of silver.

When nitrate of silver is applied to an ulcer it produces a white film (owing to its union with the albumen, and perhaps also with the chloride, of the secretion.) This film in a few hours assumes a dark colour, and ultimately forms a black eschar. This hardens, and in a few days becomes corrugated, separates at the edges, and at length peels off altogether, leaving the surface of the sore beneath in a healed state. (Higginbottom, *op. cit.* p. 10.) The intensity of the pain varies much in different cases; but it is, on the whole, very much less than might be imagined by those who have not tried this remedy.

When applied to mucous membranes, a similar white compound of the nitrate with the animal matter of the secreted mucus is formed, and this defends the living tissue from the action of the caustic; so that the effects are not so violent as might be expected. Thus the solid nitrate may be applied to the mucous surface of the vagina, and even to the os uteri, in cases of leucorrhœa and gonorrhœa, oftentimes without exciting any pain or inflammation: in some instances, however,

¹ See some remarks of Malder on the action of metallic salts on fibrin and albumen, in the *Pharmaceutisches Central Blatt für* 1838, S. 315.

produces smarting pain, which lasts for several hours, but no serious effects have resulted from its use, even when, by accident, two drachms of nitrate have been left to dissolve in the vagina.¹

Its chemical effects on the other mucous membranes are analogous to those just mentioned; but the pain which it produces varies with different membranes, and in the same membrane under different states. Its application to the conjunctiva is attended with acute pain (especially when inflammation is going on,) though in general this soon subsides. On all these surfaces it acts as an astringent.

The safety with which, in most cases, large doses of the nitrate are administered internally, must depend on the presence of the mucus which lines the internal coat of the stomach, and on chlorides and free hydrochloric acid contained in this viscus. These form with the nitrate new compounds (*albuminate* and *chloride*;) less energetic in their local action than the nitrate. It is deserving of especial notice that larger doses may be exhibited without inconveniencing the stomach, in the form of pill, than in that of solution; in consequence, I presume, of the latter acting on a larger surface. Dr. Powell, (*Med. Trans. of the College of Phys.* iv. 85.) in some cases was enabled to give 15 grains at a dose in the form of pills, while he rarely found stomachs that could bear more than five grains in solution. Fouquier (*Dict. Mat. Med.* i. 403.) has also remarked the greater activity of the solution. If cautiously exhibited, beginning with small doses and gradually increasing them, it may be exhibited for a considerable period without producing any obvious changes in the corporeal functions, though it may be exercising a beneficial influence over the constitution, evinced by its amelioration of certain diseases, as epilepsy. In some cases it has caused an eruption. (Sementini, *Quart. Journ. of Science*, xii. 189; Copland, *Dict. Pract. Med.* i. 68.) If the dose be too large it occasions gastrodynia, sometimes nausea and vomiting, and occasionally purging. Taken in an excessive dose it acts as a corrosive poison; but cases of this kind are very rarely met with. Boerhaave mentions an instance in which it caused excruciating pain, gangrene, and sphacelus of the first passage.

All the above-mentioned effects are referrible to its local action, and from them we have no evidence of its absorption, or of the nature of its influence over the general system. But the discolouration of the skin, presently to be noticed, fully proves that absorption does take place when the medicine is exhibited in small but long-continued doses. It exercises a specific influence over the nervous system; at least I infer this, partly from the effects observed by Orfila when it was injected into the veins of animals, and partly from its occasional curative powers in affections of this system, as epilepsy and chorea.

The blueness, or slate colour, or bronze hue of the skin just alluded to, has been produced in several patients who have continued the use of the nitrate during some months or years. (*Medico-Chirurg. Trans.* vii. and ix.) In some of the cases the patients have been cured of the epilepsy for which they took the medicine; in others the remedy has failed. (Rayer, *Treatise on Skin Diseases*, by Willis, 961.) In one instance which fell under my notice, the patient, a highly respectable gentleman, residing in London, was obliged to give up business in consequence of the discolouration; for when he went into the street, the boys gathered around him, crying out "There goes the blue man." In this instance no perceptible diminution of the colour had occurred for several years, but in some cases it fades in intensity. The corion is the essential seat of it. Dr. Baddeley (*Med.-Chir. Trans.* ix. 238.) found that blisters rose white,—a proof that in his patient the colouring matter was below the epidermis. But in some instances the cuticle and corpus mucosum of the face and hands participate in the tint. In one instance the mucous membrane of the stomach and intestines was similarly tinted. A case is mentioned by Wedemeyer (*Lond. Med. Gaz.* iii. 650.) of an epileptic

¹ Dr. Hannay, *Lond. Med. Gaz.* xx. 125; also Mr. Bell, *ibid.* 473; and Dr. Jewell, *Pract. Observ. on Leucorrhœa*.

who was cured by nitrate of silver, but eventually died of diseased liver and dropsy all the internal viscera were more or less blue, and Brande, a German chemist, obtained metallic silver from the plexus choroides and pancreas. The discolouration of the skin is usually regarded as permanent and incurable; but I have been informed that in one instance washes of dilute nitric acid diminished it. If this observation be correct, I would suggest the exhibition of nitric acid internally, as well as its external use. Dr. A. T. Thomson (*Elem. of Mat. Med.* i. 715.) suggests that if nitric acid were conjoined with nitrate of silver the discolouration might be prevented; and the suggestion certainly deserves attention. But I would observe, that if the acid should prove efficacious, his hypothesis, that the colour depends on blackened chloride of silver, will be disproved; for nitric acid can neither prevent the action of the compounds of chlorine on the salts of silver, nor can it dissolve the white chloride or the black subchloride.

USES.—Nitrate of silver has been employed *internally* in a very few cases only; and of these the principal and most important are epilepsy, chorea, and angina pectoris. Its liability to discolour the skin is a great drawback to its use; indeed, I conceive that a medical man is not justified in risking the production of this effect without previously informing his patient of the possible result. Dr. Osborne (*Dublin Med. Journ.* Jan. 1839.) ascribes its good effects to its allaying irritation of the gastric membrane. But in a large number of instances the asserted existence of this irritation is a mere assumption, perfectly devoid of proof.

In *epilepsy* it has occasionally, perhaps more frequently than any other remedy, proved successful. Drs. Sims, (*Mem. of the Med. Soc. of Lond.* iv. 379.) Baillie, R. Harrison, Roget, and J. Johnson, (*Treat. on Nerv. Dis.* by J. Cooke, M. D. ii. Pt. 2, 147.) have all borne testimony to its beneficial effects. Its *methodus medendi* is imperfectly understood. This, indeed, is to be expected, when it is considered that the pathology and causes of epilepsy are so little known; and that, as Dr. Sims has justly observed, every thing concerning this disease is involved in the greatest doubt and obscurity, if we except the descriptions of a single fit, and that it returns at uncertain intervals. In this state of ignorance, and with the already-mentioned facts before us, as to the curative powers of this salt, the observation of Georget, (*Physiol. du Système Nerv.* ii. 401.) that he has great difficulty in conceiving how the blindest empiricism should have led any one to attempt the cure of a diseased brain by cauterizing the stomach, is, I conceive, most absurd and unwarranted. The cases which have been relieved by it are probably those termed by Dr. M. Hall (*Lect. on the Nerv. System*, p. 143.) eccentric. In the few instances in which I have seen this remedy tried, it has proved unsuccessful; but it was not continued long, on account of the apprehended discolouration of the skin.

In *chorea* it has been successfully employed by Dr. Powell, (*Medical Transactions of the College of Physicians*, iv. 85.) Dr. Uwins, (*Edinb. Med. and Surg. Journ.* viii. 407.) Dr. Crampton, (*Transactions of the King and Queen's College of Physicians*, iv. 114.) Lombard, (*Rust's Magazine*, xl.) and others. In *angina pectoris* it has been administered in the intervals of the paroxysms with occasional success by Dr. Cappe (*Duncan's Annals of Med.* iii.) and Dr. Copland. (*Op. cit.*)

In *chronic affections of the stomach* (especially morbid sensibility of the gastric and intestinal nerves) it has been favourably spoken of by Autenreith, (Dierbach's *Neust. Entdeck. in d. Mat. Med.* 1837. i. 528.) Dr. James Johnson, (*On Indigestion*, 2d edit. p. 87.) and Rueff. (Dierbach, *op. cit.*; also, *American Journal of Medical Science*, May, 1837, p. 225.) It has been employed to allay chronic vomiting connected with disordered innervation, as well as with disease of the stomach, (scirrhus and cancer,) and to relieve gastrodynia. The foregoing are the most important of the diseases against which nitrate of silver has been administered internally.

As an *external agent* its uses are far more valuable, while they are free from the danger of staining the skin. It is employed sometimes as a *caustic*, and as such it has some advantages over potassa fusa and the liquid corrosives. Thus, it does not liquefy by its application, and hence its action is confined to the parts with which it is placed in contact. It is used to remove and repress spongy granulations in wounds and ulcers, and to destroy warts, whether venereal or otherwise. It is applied to chancres on their first appearance, with the view of decomposing the syphilitic poison, and thereby of stopping its absorption, and preventing bubo or secondary symptoms. This practice has the sanction of Mr. Hunter. I have several times seen it fail, perhaps because it was not adopted sufficiently early. The nitrate should be scraped to a point, and applied to every part of the ulcer. This mode of treating chancres has been recently brought forward by Ratier (*Arch. Gén. de Méd.* xv. 47; and xvi. 62.) as if it were new, and as forming part of Bretonneau's *ectrotic*, (*ectroïica*, *εκτιρωτικα*, I abort,) method of treating diseases!

The application of nitrate of silver to *punctured wounds* is often attended with most beneficial effects, as Mr. Higginbottom (*Op. cit.*) has fully proved. It prevents or subdues inflammatory action in a very surprising manner. It is equally adapted for poisoned as for simple wounds. To promote the healing of *ulcers* it is a most valuable remedy. In large indolent ulcers, particularly those of a fistulous or callous kind, it acts as a most efficient stimulant. To small ulcers it may be applied so as to cause an eschar, and when at length this peels off, the sore is found to be healed. Mr. Higginbottom (*Op. cit.* p. 11.) asserts that "in every instance in which the eschar remains adherent from the first application, the wound or ulcer over which it is formed invariably heals." Dry lint will, in general, be found the best dressing for sores touched with the nitrate.

Nitrate of silver was proposed by Mr. Higginbottom as a topical remedy for external inflammation. It may be applied with great advantage to subdue the inflammatory action of erythema, of paronychia or whitlow, and of inflamed absorbents. In some cases it is merely necessary to blacken the cuticle; in others, Mr. Higginbottom recommends it to be used so as to induce vesication. In erysipelas nitrate of silver is used by many surgeons as a cautery both to the inflamed and the surrounding healthy parts. But I have so often seen the disease continue its course as if nothing had been done that I have lost confidence in its efficacy. (See also some remarks by Velpeau, in *Lond. Med. Gaz.* Aug. 21, 1840, p. 828.) I have found tincture of iodine (see p. 233) much preferable.

Bretonneau and Serres (*Arch. Gén. de Méd.* viii. 220 and 427.) recommend the *cauterization of variolous pustules* by nitrate of silver, in order to cut short their progress. It is principally useful as a means of preventing pitting, and should be employed on the first or second day of the eruption. The solid caustic is to be applied to each pustule after the apices have been removed. This ectrotic method has also been employed in the treatment of *shingles* (herpes zoster:) in one case the disease was cured in a few hours. (*Arch. Gén. de Méd.* xviii. 439.) Some good rules for its application have been laid down by Rayer. (*Treatise on Skin Diseases*, by Willis, p. 260.)

In some diseases of the eye nitrate of silver is a most valuable remedial agent. It is used in the solid state, in solution, and in ointment: the solution may be used as a wash or injection, or applied by a camel's hair pencil. In deep ulcers of the cornea, a cone of the solid nitrate should be applied,—in superficial ones, a solution (of from 4 to 10 grains of the salt to an ounce of distilled water) may be employed. (Mackenzie, *On the Diseases of the Eye*, 2d edit. 578; also Velpeau, *Lond. Med. Gaz.* Oct. 1839.) There is one drawback to the use of this substance in ulcers of the cornea, as well as other affections of the eye: viz. the danger of producing dark specks in the cornea, or of staining the conjunctiva; (Jacob, *Dublin Hospital Reports*, v. 365.) but this occurrence is certainly very rare. Velpeau

(*Op. supra cit.* p. 107.) has employed it in many hundred cases without ever observing such an effect. In both acute and chronic ophthalmia, Mr. Guthrie (*Lond. Med. and Phys. Journ.* lx. 193; lxi. 1.) employs this salt in the form of ointment (Arg. Nitr. gr. ij. ad gr. x.; Liq. Plumbi Subacet. gtt. xv.; Ung. Cetacei, ʒj.) Of this he directs a portion (varying in size from a large pin's head to that of a garden pea) to be introduced between the lids by the finger or a camel's hair pencil. It causes more or less pain, which sometimes lasts only half an hour, at others till next day. Warm anodyne fomentations are to be used; and the application of the ointment repeated every third day. In acute cases, two or three applications will arrest the disease. With this treatment, blood-letting, and the use of calomel and opium, are preceded or conjoined.¹ While many surgeons hesitate to use nitrate of silver in the first stage of acute purulent ophthalmia, all are agreed as to its value in the second stage of the disease, as well as in chronic ophthalmia. Besides the diseases of the eye already mentioned, there are many others in which the oculist finds this salt of the greatest service, as a caustic, astringent or stimulant.²

In *inflammatory affections and ulcerations of the mucous membrane of the mouth and fauces*, nitrate of silver is sometimes a most valuable application. (Hunt, *Lond. Med. Gaz.* xiii. 194.) When the fibrinous exudation of croup commences on the surface of the tonsils and arches of the palate, its farther progress may be stopped, according to Mr. Mackenzie, (*Edinb. Med. and Surg. Journ.* xxiii. 294.) by the application of a solution composed of a scruple of nitrate of silver and an ounce of distilled water. The solid nitrate has been introduced through an aperture in the trachea, and applied to ulcers on the inner surface of the larynx, in a case of phthisis laryngea, with apparent benefit. (Liston, *Elements of Surgery*, part. ii. p. 256.)

In some forms of *leucorrhœa* the application of nitrate of silver, either in the solid state or in solution, is attended with beneficial effects. This practice was first recommended by Dr. Jewel. (*Practical Observations on Leucorrhœa*, 1830.) It is, I believe, most successful in cases dependent on local irritation or subacute inflammation, and not arising from constitutional debility. The solution may be applied by a piece of lint or sponge, or may be injected by means of a syringe with a curved pipe. Its strength must vary according to circumstances. Dr. Jewel generally employed three grains of the nitrate to an ounce of water; but in the Lock Hospital, solutions are sometimes used containing half a drachm or even two scruples to the ounce. In some cases the solid nitrate has been applied to the cervix uteri and vagina by means of a silver tube. In *gonorrhœa of the female*, a solution of the nitrate of silver, or even this caustic in the solid state, has been used with the best effects. It was first employed by Dr. Jewel, but subsequently, and on a much more extended scale, by Dr. Hannay, (*Lond. Med. Gaz.* xx. 185.) and without any injurious consequences. In many cases the discharge ceased, never to return, in twenty-four hours. The fear of ill effects has prevented the general adoption of this practice. In *gonorrhœa of the male*, the introduction of a bougie, smeared with an ointment of nitrate of silver, is, occasionally, a most effectual cure: but the practice is dangerous. In one case I saw acute and nearly fatal urethritis brought on by its employment. The patient was a dresser at one of the London hospitals, and had practiced this mode of treatment in many instances on the hospital patients with the happiest results. An aqueous solution of the salt has been successfully used in chronic gonorrhœa. (Rogneta, *Lancette Française*, Mar. 31, 1836.)

In *fissured or excoriated nipples* the application of the solid nitrate of silver is of great service. It should be insinuated into all the chaps or cracks, and the

¹ For some judicious remarks on this practice, consult the article *Ophthalmia*, by Dr. Jacob, in the *Cyclopædia of Pract. Med.* iii. 201.

² Vide Dr. Mackenzie's *Treatise on Diseases of the Eye*; and Mr. Ryall's paper, in the *Trans. of the King and Queen's College of Phys. of Ireland*, v. 1.

nipple afterwards washed with tepid milk and water. (*Lond. Med. Gaz.* v. 207; xiv. 674, 719, and 754.)

The application of solid nitrate of silver is a most effectual remedy for the different forms of *porrigo* which affect the heads of children. The caustic should be well rubbed into the parts. I have never known the practice to fail, or to cause the loss of hair. Where the greater portion of the scalp is involved, the different spots should be cauterized successively at intervals of some days; for, as already mentioned, I have seen fever and delirium produced in a child from the too extensive use of the remedy. In *psoriasis* the same medicine was found by Dr. Graves (*Lond. Med. Gaz.* vii. 520.) most effectual. An aqueous solution of the nitrate is also valuable as an astringent wash in other skin diseases, as *impetigo*. The solid nitrate is sometimes employed to stop the progress of irritative or erysipelatous inflammation, by applying it in a circular form around, and at a little distance from, the inflamed portion; but I have frequently observed the inflammation extend beyond the cauterized part. Mr. Higginbottom (*Op. cit.*) reports favourably of the effects of applying the nitrate to *burns* and *scalds*; and his observations have been confirmed by those of Mr. Cox. (*Lond. Med. Gaz.* x. 687.)

In strictures of the urethra and œsophagus, bougies armed with lunar caustic in their points (*the caustic or armed bougie*) are occasionally employed with great advantage, at least in urethral stricture. When the common bougie (*cereolus simplex*) is formed, the point of it should be heated with a conical piercer, and the caustic introduced while the composition is quite soft. The point of the bougie should then be rubbed smooth on a piece of polished marble till no inequality in the size of it appear. (Dr. Andrews, *Observ. on the Applic. of Lunar Caustic to Strictures*, 1807, p. 126.) Notwithstanding that the application of nitrate of silver to stricture of the urethra has been advocated by Mr. Hunter, Sir E. Home, Mr. Wilson, Dr. Andrews, and others, it is now but little employed; yet of its efficacy and safety in many obstinate cases, where the simple bougie fails, I am assured by repeated observation. It is commonly supposed that it acts by burning or destroying the stricture: such is not the fact. It induces some change in the vital actions of the part, which is followed by relaxation of the narrowed portion of the canal, but which change is as difficult to explain as is the subduction of external inflammatory action by the application of this salt. Of the use of the caustic bougie in stricture of the œsophagus I have no experience.

ADMINISTRATION.—Nitrate of silver may be exhibited in doses of one-sixth of a grain, gradually increased to three or four grains, three times a-day. As before mentioned, Dr. Powell has augmented the dose to fifteen grains. The usual mode of administering it is in the form of pills made of bread-crumbs; but the chloride of sodium, which this contains, renders it objectionable: some mild vegetable powder with mucilage is preferable. Common salt or salted foods should not be taken either immediately before or after swallowing these pills. Dr. Johnson (*Essay on Morbid Sensibility of the Stomach and Bowels*, 2d ed. p. 90.) asserts "that there is no instance on record where the complexion has been affected by the medicine when restricted to three months' administration." It is advisable, however, not to continue the use of it beyond a month or six weeks at a time.

For external use an aqueous solution is employed of strengths varying from a quarter of a grain to two scruples, in an ounce of distilled water. The formula for Mr. Guthrie's ointment has already been given.

ANTIDOTE.—The antidote for nitrate of silver is common salt (*chloride of sodium*.) When this comes in contact with lunar caustic, nitrate of soda and chloride of silver is produced: the latter compound is, according to the experiments of Orfila, (*Toxicol. Gén.*) innocuous. The contents of the stomach should be

removed, and the inflammatory symptoms combated by demulcents, blood-letting, and the usual antiphlogistic means.

When the local use of nitrate of silver causes excessive pain, relief may be gained by washing the parts with a solution of common salt. Pieces of caustic have been left in the vagina and urethra without unpleasant consequences resulting. Injections of a solution of common salt are the best means of preventing bad effects.

To diminish the slate-coloured tint of the skin arising from nitrate of silver, acids or the super-salts offer the most probable means of success. The external and internal use of dilute nitric acid, or the internal employment of bitartrate of potash, may be tried: the discolouration is said to have yielded to a steady course of the last-mentioned substance. (*United States Dispensatory*.)

1. LIQUOR ARGENTI NITRATIS, L.; *Solutio Argenti Nitratis*, E. (Nitrate of Silver, ℥j. [grs. 40, E.]; Distilled Water, f℥j. [grs. 1600, E.]) Dissolve the nitrate of silver in the water, and strain; then, the access of light being prevented, keep it in a well-closed vessel.)—This solution is employed as a test of chlorine, chlorides, or hydrochloric acid (see p. 218.)

2. SOLUTIO ARGENTI AMMONIATI, E.; *Solutio of Ammoniaco-Nitrate of Silver; Hume's Test for Arsenious Acid*. (Nitrate of Silver, grs. xlv.; Distilled Water f℥j.; Aqua Ammoniacæ, a sufficiency. Dissolve the salt in the water, and add the aqua ammoniacæ gradually, and towards the end cautiously, till the precipitate at first thrown down is very nearly, but not entirely, redissolved.)—Employed as a very delicate test for arsenious acid (see p. 525.)

α. HAIR DYE.—A solution of nitrate of silver is one of the substances used to dye the hair (see pp. 212 and 575.)

β. INDELIBLE MARKING INK; PERMANENT INK.—A solution of nitrate of silver, coloured by sap-green, and thickened by mucilage, is used as a permanent ink for linen. The cloth is to be moistened with a solution of carbonate of soda, and afterwards dried. The Ink is composed of Nitrate of Silver, ℥v.; Sap-green, ℥j.; Powdered Gum, ℥ij.; Distilled Water, f℥j.—The *Preparing Liquid* consists of Carbonate of Soda, ℥j.; Powdered Gum, ℥ij.; Water, f℥ij. Sometimes a solution of Ammoniated Nitrate of Silver, coloured and thickened as above, is used for the ink. The advantage of it is that it does not require the use of the preparing liquid.

3. ARGENTI CYANIDUM, L.—CYANIDE OF SILVER.

[Argenti Cyanuretum, U. S.—Cyanuret of Silver.]

HISTORY.—This compound, sometimes called *Hydrocyanate*, *Cyanuret*, or *Cyanodide of Silver*, or *Argentum Zootinicum*, has been studied by Scheele, Ittner, and Gay-Lussac.

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

Take of Nitrate of Silver, ℥ij. and ℥ij.; Diluted Hydrocyanic Acid, Distilled Water, each ℔j. Dissolve the Nitrate of Silver in the Water, and add to them the diluted Hydrocyanic Acid, and mix. Wash what is precipitated with distilled water, and dry it.

[Nitrate of Silver, fifteen drachms; Hydrocyanic Acid, Distilled Water, each a pint. U. S.]

In this process one equivalent or 27 parts of hydrocyanic acid react on one equivalent or 170 parts of nitrate of silver; thereby generating one equivalent or 134 parts of cyanide of silver, and one equivalent or 9 parts of water, and setting free one equivalent or 54 parts of nitric acid.

MATERIALS.		PRODUCTS.	
1 eq. Nitrate Silver.. 170	{ 1 eq. Nitric Acid.. 54 1 eq. Oxygen..... 8 1 eq. Silver..... 108	1 eq. Nitric Acid..... 54	1 eq. Water..... 9
1 eq. Hydrocye Acid. 27	{ 1 eq. Hydrogen ... 1 1 eq. Cyanogen.... 26	1 eq. Cyanide Silver . 134	
	197	197	197

PROPERTIES.—When first thrown down it is a curdy precipitate, which by drying becomes pulverulent. It is insipid, insoluble in water, but dissolves in caustic ammonia. It is decomposed by hydrochloric and hydrosulphuric acid, both of which develop with it hydrocyanic acid. It combines with other metallic cyanides to form the *argento-cyanides*. By exposure to the atmosphere and solar rays it assumes a violet tint. It is decomposed by mixture with neutral vegetable substances. (*Journ. de Chim. Méd.* 2^{nde} Série, iii. 407.)

Characteristics.—It is insoluble in cold nitric acid, but soluble in the boiling acid. When carefully dried and then heated in a glass tube it yields cyanogen gas (which is readily known by its combustibility and the bluish-red colour of its flame) and a residuum of metallic silver. The latter is recognised by the before-mentioned tests for this metal.

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

	Atoms.	Eq. Wt.	Per Cent.
Silver	1	108	80.60
Cyanogen	1	26	19.40
Cyanide of Silver	1	134	100.00

PHYSIOLOGICAL EFFECTS AND USES.—I am unacquainted with any experiments made to determine its effects on man and animals. Serre, of Montpellier, (*Medico-Chirurgical Review*, July, 1840.) gave it in syphilitic maladies, in doses of one-tenth and even one-eighth of a grain, without the least inconvenience. It has been introduced into the London Pharmacopœia, at the suggestion of Mr. Everitt, as a source of hydrocyanic acid (*vide* p. 376.)

OTHER COMPOUNDS OF SILVER.

1. **ARGENTI OXYDUM**; *Oxide of Silver*.—This compound is precipitated from a solution of nitrate of silver by lime water or liquor potassæ. Its colour is grayish brown. Its composition is 1 eq. silver 108, and 1 eq. oxygen 8 = 116. It was employed in medicine by Vans Mons and Sementini. More recently it has been used by Mr. Lane. (*British and Foreign Medical Review*, Oct. 1841.) Internally it has been exhibited, in doses of half a grain, in epileptic and gastralgic affections. In the form of ointment, composed of ten grains of oxide to a drachm of lard, it has been applied to venereal sores, and to the urethral membrane, by means of a bougie, in gonorrhœa. It does not possess the powerful chemical action of the nitrate of silver on the animal tissues.

2. **ARGENTI CHLORIDUM**; *Chloride of Silver*.—It is thrown down, in the form of a white curdy precipitate, from a solution of nitrate of silver by hydrochloric acid. Several of its properties have been already described (see p. 218.) It is composed of 1 eq. of Silver 108 and 1 eq. Chloride 36 = 144. This, like the last-mentioned preparation of silver, was formerly used in medicine, but fell into disuse. More recently its medicinal employment has been recommended, by Dr. Perry, (*Ibid.* 2^{nde} Série, iii. 408.) an American physician, in epilepsy, chronic dysentery, and chronic diarrhœa.—Dose, three grains four or five times daily. Thirty grains at one dose caused vomiting. Twelve grains administered daily for three months produced no unpleasant symptoms.

ORDER XXI.—MERCURY AND ITS COMPOUNDS.

1. HYDRARGYRUM, *L. E. D.* (U.S.)—MERCURY OR QUICKSILVER.

HISTORY.—No mention is made of quicksilver in the Old Testament; nor does Herodotus allude to it. From this we might infer that both the ancient Hebrews and Egyptians were unacquainted with it. But we are told on the authority of an Oriental writer, that the Egyptian magicians, in their attempts to imitate the miracles of Moses, employed wands and cords containing mercury, which, under