

**Lectures on the adulteration of food and culinary poisons, the detection of poisons in general, and of adulterations in sundry chemical preparations, &c.; used in medicine and the arts, with the means of discovering them : and rules for determining the purity of substances : delivered in the United States Military Academy / by James Cutbush.**

### **Contributors**

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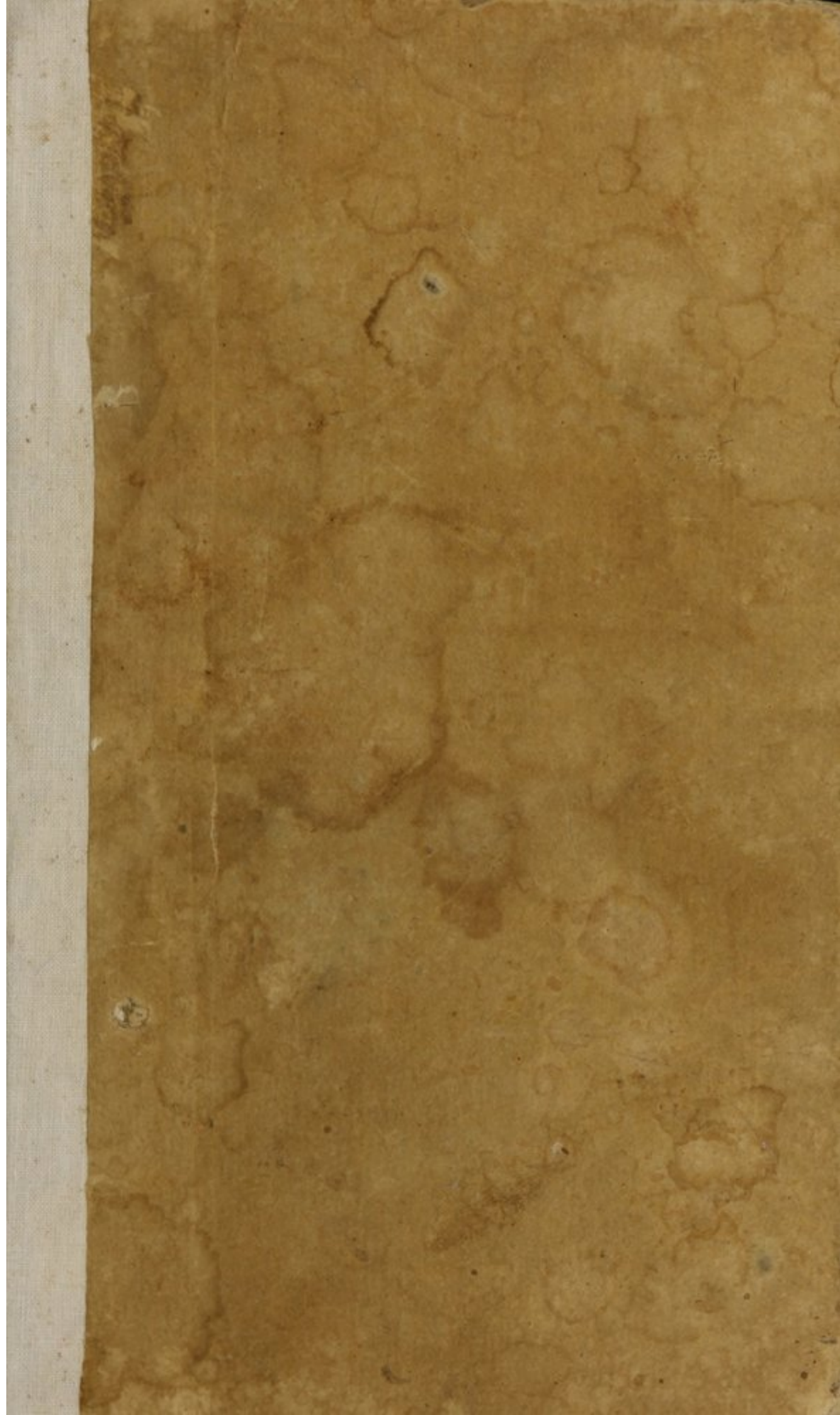
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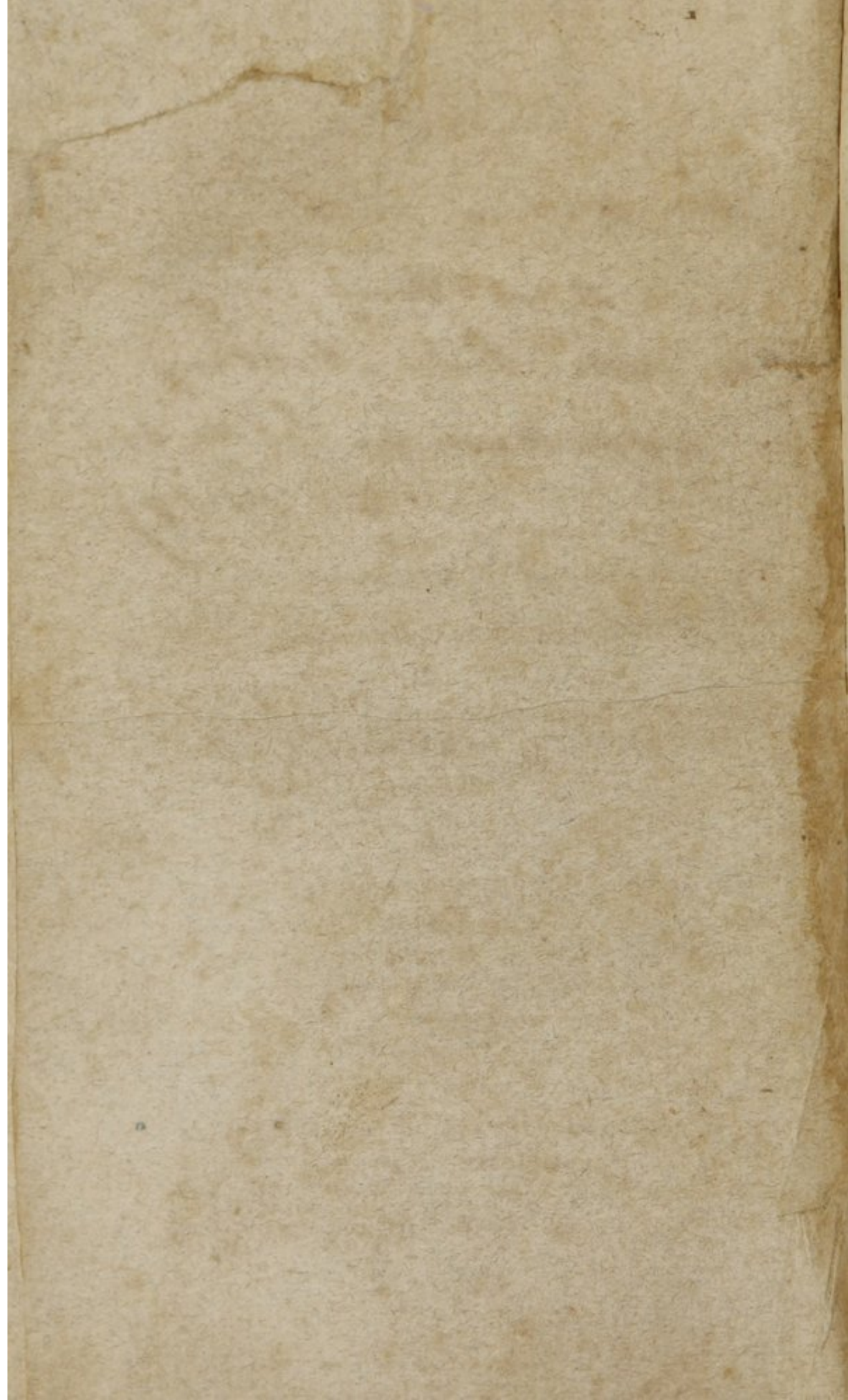
West Point

United States Military

Academy September

3<sup>rd</sup> 1893







*Edward Williams*

LECTURES

ON THE

ADULTERATION OF FOOD AND CULINARY POISONS,

THE DETECTION OF

POISONS IN GENERAL

AND OF

ADULTERATIONS IN SUNDRY CHEMICAL PRE-

PARATIONS, &c. USED IN MEDICINE AND

THE ARTS, WITH THE MEANS OF

DISCOVERING THEM:

AND RULES FOR DETERMINING THE

PURITY OF SUBSTANCES.

DELIVERED IN THE UNITED STATES MILITARY  
ACADEMY.

---

BY JAMES CUTBUSH, A. S. U. S. A.  
*Mem. Am. Phil. Soc. Corresp. Mem. Columb. Instit. &c.  
and acting Professor of Chemistry and Mineralogy  
in the United States Military Academy.*

---

PRINTED BY WARD M. GAZLAY,  
NEWBURGH, N. Y.

1823.



*Southern District of New-York, ss.*

BE IT REMEMBERED, that on the 31st day of May, in the 47th year of the Independence of the United States of America, JAMES CUTBUSH of the said District, hath deposited in this office the title of a book the right whereof he claims as author and proprietor, in the words following, to wit:

"Lectures on the Adulteration of Food and Culinary Poisons, the Detection of Poisons in general, and of Adulterations in sundry chemical preparations, &c. used in medicine and the arts, with the means of discovering them: and Rules for determining the purity of Substances. Delivered in the United States Military Academy. By James Cutbush, A. S. U. S. A. Mem. Am. Phil. Soc., Cor. Mem. Col. Instit. &c., and acting Professor of Chemistry and Mineralogy in the United States Military Academy."

In conformity to the Act of Congress of the United States, entitled "An Act for the encouragement of Learning, by securing the copies of Maps, Charts, and Books, to the authors and proprietors of such copies, during the time therein mentioned." And also to an Act, entitled "an Act, supplementary to an act, entitled an Act for the encouragement of Learning, by securing the copies of Maps, Charts, and Books, to the authors and proprietors of such copies, during the time therein mentioned, and extending the benefits thereof to the arts of designing, engraving, and etching historical and other prints."

JAMES DILL, *Clerk of the*  
*Southern District of New-York.*

HMD

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## PREFACE.

The following lectures, as will be seen from the Table of Contents, embrace a variety of subjects of immediate interest, not only with respect to sundry preparations used in medicine and the arts, culinary articles, &c. but also a collection of facts on adulterations, and the mineral, as well as the, so called, culinary poisons.

Containing a general view of these subjects, it was suggested, that their publication would be useful: at the instance of the senior class, to whom they were delivered, they were, therefore, put to press.

A few remarks concerning the work itself may be premised :

On some occasions I found it necessary to give a comparative view of the most remarkable, and distinguishing chemical properties of bodies, so that the means of detection might be more readily shown, and the presence, or absence of particular substances more correctly determined.

As to the arrangement, we have endeavoured to treat of the substances with some system. Thus, the adulteration of articles, used principally for domestic purposes; the deleterious nature of some



culinary preparations; the enumeration and detection of sundry poisons; poisonous plants; ærial poisons; antidotes, &c. are treated of in a regular order.

With regard to colours or pigments, and the great body of chemical preparations, we have also noticed them in rotation, so far as they were in any manner analogous, or connected with each other. In other instances, this order did not appear particularly necessary.

In naming the preparations, I have generally introduced the synonyma, to render the terms expressing the same substance, more familiar; and have usually preceded the examination of the preparation, by giving an outline of the process. On some occasions, I have added notes, both explanatory and illustrative.

Having added very largely to the list of articles, which are frequently adulterated, and pointed out methods of detecting sundry sophistications, not heretofore noticed; I may be permitted to remark, that, in these respects, I have endeavoured to render the subject more perfect in its several details. How far I have succeeded, the reader will be the better competent to judge.

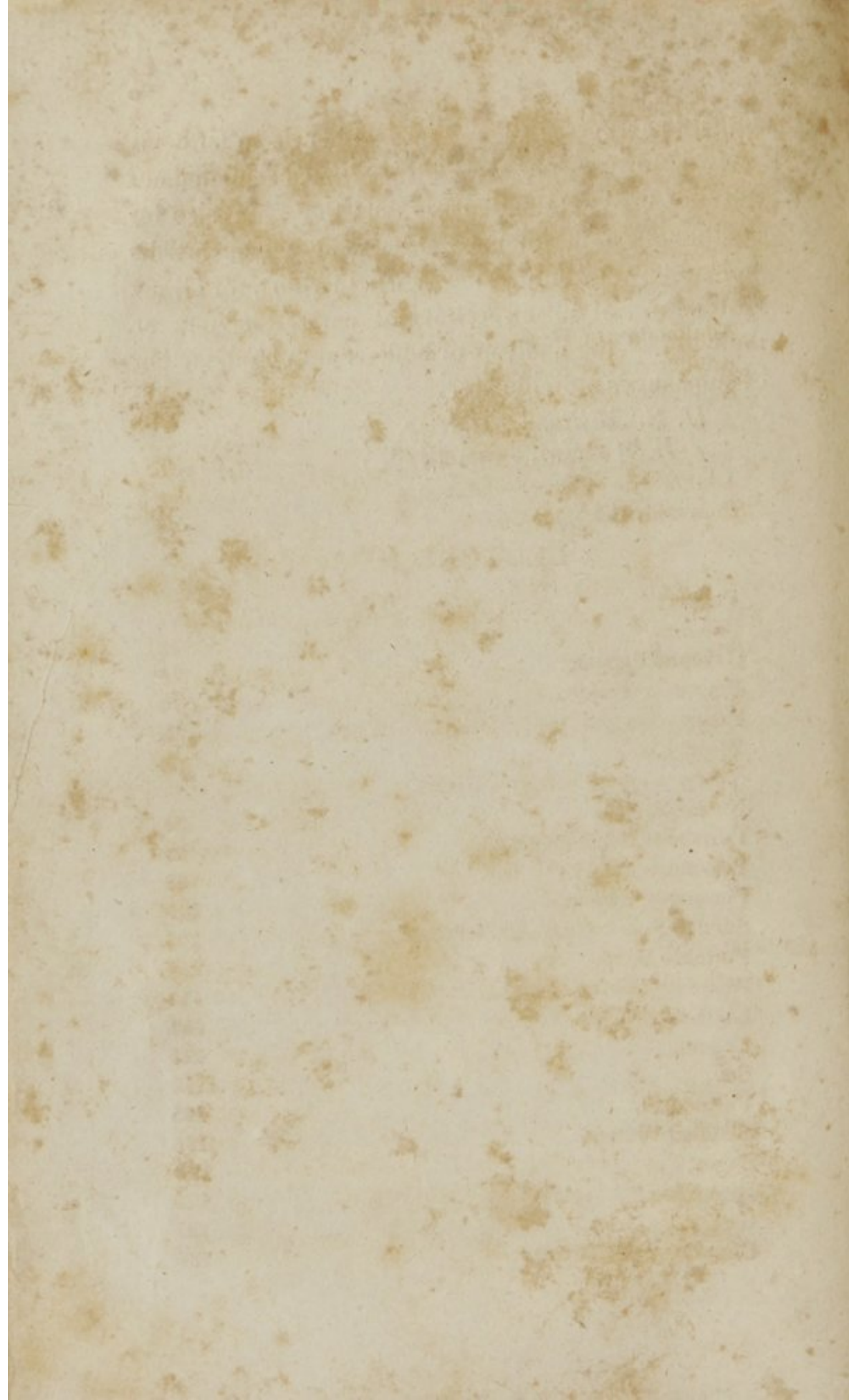
I need hardly remark, that the work itself is adapted to the physician, pharmacist, domestic economist, artist, and manufacturer; in a word, to ALL who are interested in the detection of adulterations, and of poisons.

*Lastly.*—I have added a list of tests, which, generally speaking, will be required for the several exa-

minations referred to. The number is so far complete as to furnish a *chest of chemistry*, calculated not only for the examinations in question, but also for conducting experiments on ores and metals, earths and stones, and mineral waters; in short, for all investigations of an experimental nature, having for their object the analysis of bodies, and the detection of substances individually.

*U. S. Military Academy, }  
West Point, June, 1823. }*







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*TO JOSEPH LOVELL, M. D.*

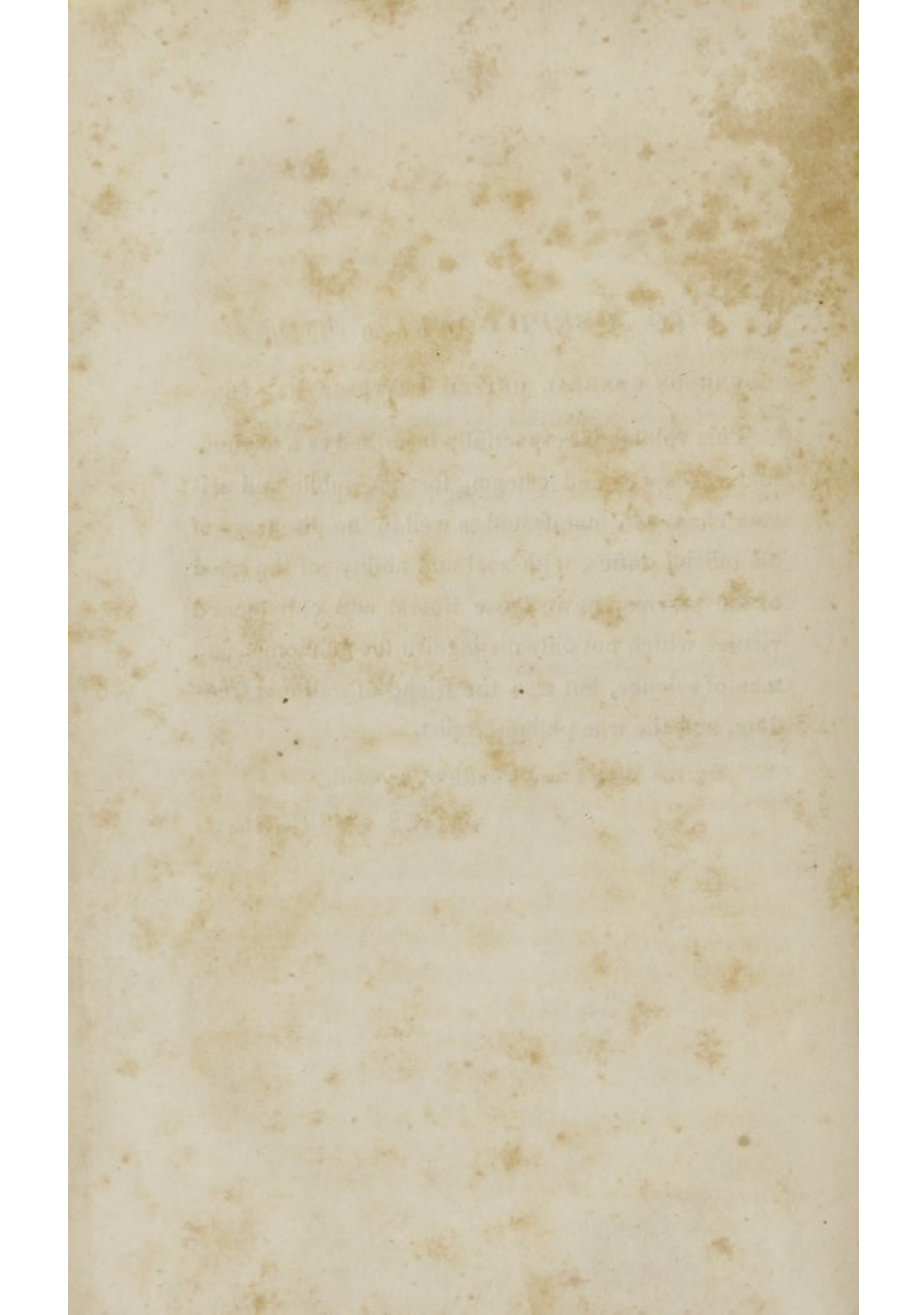
SURGEON-GENERAL UNITED STATES ARMY, &c.

This volume is respectfully inscribed as a testimonial of respect and esteem, for his public and private character, manifested as well in the discharge of his official duties, with zeal and ability for the good of the service, as in those liberal and enlightened virtues, which not only distinguish the gentleman and man of science, but also the friend of rational freedom, and the true philanthropist.

By his friend and obedient servant,

JAMES CUTBUSH.





## LECTURE I.

### ADULTERATION OF FOOD, &c.

IN considering a subject so important and extensive as adulterations, in its various details, and how sundry substances may be, as they frequently are, sophisticated, many of which being used for aliment, we necessarily inquire into the means of detecting them, and the use, as well as the action of re-agents in such cases.

With respect to the adulteration of metallic and earthy preparations, sundry pigments employed by the painter, and substances made use of by the bleacher, dyer, soap-maker, &c. with a long catalogue of articles used in the arts in general; we may remark, that, as they are highly important, a knowledge of their purity must be particularly desirable, and their examination require a minute investigation. We purpose to consider, in the first place, the subject of water, connected with its purity and foreign admixture; and proceed, in order, with the adulterations of wine, and of other substances.

#### WATER.

*Water* was formerly supposed to be a simple body, and was considered one of the four elements. It is now known to be a compound of hydrogen and



oxygen. Two volumes of hydrogen gas, detonated with one of oxygen gas, produces water. Water may be decomposed by galvanism, and its elements separated in a distinct state; by passing its vapour through an ignited gun-barrel, by which the oxygen will be absorbed by the iron, and its hydrogen evolved; by mixing it with sulphuric acid, and pouring the mixture on iron or zinc, hydrogen gas being evolved; and by several other processes unnecessary at this time to enumerate. Water freezes at 32 deg. and boils at 212 deg. Faht. It is the standard of the specific gravity of bodies: its specific gravity being called 1000. It dissolves various substances, and constitutes the water of crystallization of crystallized salts. It unites with the earths and some metallic oxydes, and forms hydrates. It is susceptible of compression, as was first shown by Canton, and more lately by our countryman, Mr. Perkins, who has estimated, in an ingenious series of experiments, the rate of its compression. Mr. Thenard has shown that water may be combined with a considerable excess of oxygen, which has been named the per oxyde of hydrogen. The specific gravity of hydrogen compared with oxygen, is as 1 to 16: and the component parts of water, by weight, are 1 hydrogen, and 8 of oxygen, nine being the representative number of water; or 100 parts of water consist of

88.89 oxygen.

11.11 hydrogen.

---

100.00

---

Oxygen 8  
Hydrogen 1



The division of water into *hard* and *soft* is well known. Soft waters are certainly more wholesome than hard, as the latter contains sundry salts, principally of an earthy nature. Soft water, for very obvious reasons, is preferable to hard for the purpose of brewing; in dyeing, as it does not alter the dye-stuff, or the mordant; in bleaching, as it acts more powerfully on the colouring matter of the vegetable fibre; in the preparation of painter's pigments, as it is known that carmine, madder lake, ultramarine and Indian yellow, cannot be prepared without perfectly pure water; in the steeping of flax, as hard water will not decompose the ligneous matter so effectually; in the culinary art, as in proportion to its purity, it will soften the fibres of animal and vegetable matter more readily than hard; for with the latter *peas*, or any fasinaceous seed, cannot readily be boiled, without the addition of a little potash, which is recommended in every cook book. The effect of hard and soft water may be shown on tea. With soft water, the infusion will have the strongest taste, although possessing less colour than the infusion made with hard water. With sulphate of iron it will strike a more intense black, and will give a more abundant precipitate with gelatin, which shows that it contains more gallic acid and tannin, both of which are contained in tea. But by far the best criterion of the purity of water, as respects its freedom from acids, and earthy and metallic salts, is its effect on soap: with soap it ought to form a clear solution; for, if it become in the least turpid, we may infer the presence of



either one or the other of these substances, as that change is known to arise from the decomposition of the soap, either producing a disengagement of the oily matter, if an acid be present, or the formation of insoluble soaps of the earths or metals, if earthy or metallic salts, at the same time the alkali uniting with the acid of the salts. As a more delicate test, the solution of soap in alcohol is employed, with the effect of which you are well acquainted. Common air and carbonic acid gas, are both contained in water; to these substances the *taste* or liveliness of spring water is owing, and hence the difference in spring and river water. The latter also contains air, but in a smaller quantity; otherwise fish could not live in it. River water contains about 2.25 of carbonic acid, and 1.25 of common air, in 100 cubic inches. Water is rendered pure, or free from foreign matter, by distillation. Hard waters may be corrected by the addition of potash, which in general decomposes the earthy salts, leaving an alkaline salt in solution that does not act on soap. Rain water, next to distilled water, is the purest, which may be readily proved by experiment. Snow water appears to be free from air. It is to snow water that some physicians ascribe certain swellings of the neck, which deform the inhabitants of many of the Alpine vallies.

Common springs, which furnish us with water after having traversed various strata, contain saline substances in consequence of that filtration, as the water dissolves all soluble substances it meets with; and



not unfrequently such springs contain a variety of mineral substances, so highly impregnated as to receive the name of *mineral waters*.\* The most common saline matter in spring water is muriate of soda; but the *hardness* of water depends chiefly, either on the presence of the supercarbonate or sulphate of lime, or sometimes of both. One grain of sulphate of lime in 2000 grains of water, forms the hardest spring water with which we are acquainted.

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\* Mineral Waters have been defined, those waters which, by their peculiar smell, taste, colour, &c. and cannot be applied to domestic purposes, differ from common spring water. According to the peculiar substance which predominates in each, they have been divided into four classes, namely,

- |                |             |
|----------------|-------------|
| 1. Acidulous,  | 3. Hepatic, |
| 2. Chalybeate, | 4. Saline.  |

The acidulous waters contain a considerable proportion of carbonic acid, and have an acid taste. The chalybeate waters contain iron in solution usually dissolved by carbonic acid, which they deposite on boiling in the form of an ochre. The hepatic or sulphurous waters are distinguished by an hepatic smell, resembling the odour of rotten eggs, which is owing to the presence of sulphuretted hydrogen gas, and blacken silver. Saline waters contain only salts in solution, without iron or carbonic acid in excess.

The contents of a mineral water are discovered by analysis. Tests or re-agents determine the presence of certain substances. We may remark here, that, with regard to well water, of which we shall speak hereafter, Solon established a law, predicated on the scarcity of spring and river water. He obliged wells to be dug; and "where there was a common well within a Hippicon, the people should use it; they that lived farther off should procure water of their own, and if, when they have digged ten fathoms deep, they find not any, they might be allowed to fill a pitcher of six gallons, twice a day, at their neighbour's well."—*Hist. Philos.* by Blame.



River water may be considered as merely a collection of spring and rain water. Bergman found the springs about Upsala, which are considered pure, to contain the following substances, viz. oxygen gas, carbonic acid gas, carbonate of lime, silica, common salt, sulphate of potash, carbonate of soda, and muriate of lime. The whole of these ingredients amounted at an average to 0.0004 parts. Having frequently examined spring and mineral waters in this country, we may remark, that we have always detected in the former, the presence of alkaline sulphates and muriates, with frequently lime, and traces of magnesia. With regard to the waters of West Point, the purity of which is proverbial, by experiments made at different times; all these saline substances we found to exist, although in a comparatively small proportion. Well water is essentially the same with spring water, being derived from the same source. It is generally supposed to be less pure than spring water, on account of its stagnation or slow filtration. The well water of cities is excessively impure. A well in Philadelphia was supposed to furnish a *mineral* water, on account of its peculiar *hepatic* smell, as it possessed some of the characters of sulphuretted hepatic water, and was drank by many in consequence of its supposed medicinal properties, when it was finally discovered that the *hepatic* odour did not arise from the decomposition of sulphurets, or other natural cause, but was nothing more than a filtration of water through a neighboring receptacle! The fact, however, was admitted, that the well water



throughout the city was generally very impure; hence the present introduction of Schuylkill water, the numerous advantages of which are now appreciated. Mr. Sennebier has shown, that well water usually contains a greater proportion of carbonic acid gas, than spring or river water.

Lake water is merely a collection of rain water, and is seldom so transparent as river water. It contains frequently decomposed animal and vegetable matter. Marsh water is altogether stagnant, and is largely charged with animal and vegetable remains, to the decomposition of which the noxious miasmata of marshes is attributed. The deleterious effect of marsh air is particularly observable to the south. Rice grounds, which are low wet land, produce an abundance of this miasmata, and extend its fatal influence for many miles. Since the rice culture near Savannah has been abolished, that city enjoys a greater degree of health.

River water is the purest when it runs over a gravelly or rocky bed, and when its course is swift. It is generally soft, and more free from earthy salts than spring water. In the *new river water*, near London, we are informed that a minute portion of muriate of lime, carbonate of lime, and muriate of soda, are contained. Although river water may, in general, be free from saline matter, yet it is often fouled with mud, containing much animal and vegetable matter, which are suspended in it. The water running by cities must be exceedingly impure. The river water of



the Seine,\* near Paris, is foul in consequence of many circumstances. It is drank, however, after passing through the filtering machines, which can only separate the substances that are mechanically, but not chemically combined with it. Mr. Du Commun's filtering apparatus is chiefly used for that purpose.† The water of the river Thames, in the envi-

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\*The quantity of gas obtained from the Seine water, was at an average 0.0275 of its bulk, or not quite 1-36 part; the average quantity of oxygen which this gas contained was 0.310.—Thomson's Chemistry, iv. 612, English edition, 1820.

†Several contrivances for the filtering of water have been made; some of which have been patented. The filtration of river water is sometimes desirable, and, especially at sea, is often indispensable. There does not require any arguments to prove the beneficial effects of pure soft water to the preservation of health. The filtering machine of Mr. J. Peacock, which has been generally in use, consists in causing the fluid to ascend through a medium of fine gravel, of progressive degrees of fineness. It does not require more room than a large drip stone, and yields more than 300 gallons in 24 hours. A filtering apparatus for the use of the navy was invented by Dr. E. Cutbush, and found to answer its highest expectations. A view of the machine may be seen in Cutbush's *Observations on the means of preserving the health of Soldiers and Sailors*. Parrat, of Paris, also invented an apparatus for the same purpose, and so did Mr. Smelt of the same city, which purified water by passing it through sponge, and then through alternate strata of chalk sand, and gravel. Moul's improved method of using the filtering stone, has likewise advantages. But of all that we are acquainted with, none is more portable and complete, and more effectual in its operation, than Mr. Du Commun's. It consists of an earthen jar furnished with a division in the middle, having an aperture of an inch or more in diameter, and a tube for the conveyance of air to the inner, or confined part of the jar. The middle, or confined part is filled with alternate layers of gravel, sand and charcoal, and all the water which passes through the



sons of London, is very impure. No water carried to sea becomes putrid sooner than that water. It undergoes, however, a remarkable change in casks. Iron tanks are used in the British navy in the place of wooden casks, which are said to preserve the water much better. The putrefaction which the Thames, and other water containing animal and vegetable matter undergoes, creates a very unwholesome smell, from the escape of the carburetted and sulphuretted hydrogen gases. During this change the water is *black* and offensive. When racked off, and exposed to the air, it deposits a black slimy mud, and becomes limpid.\* A water, containing animal matter

---

different strata, is first imperfectly filtered through a sponge, placed in the aperture above mentioned, made for that purpose. This is the apparatus so generally in use in the city of Paris, and occasionally in this country, for which Mr. D. has taken out a patent. When the filtering materials have become charged with foul matter, which happens in a greater or less time according as the water which is filtered is impure, they may be renewed without difficulty: but, generally, for ordinary river water, one charge is sufficient for a twelve month.

\*The Rev. Mr. Clarke, in his *Hundred Wonders of the World*, in speaking of the Thames water, says, that it "is justly esteemed exceedingly wholesome and fit for use in the longest voyages *during which it ferments*, and becomes fine and clear!" Why the Thames water should be "exceedingly wholesome," when it is known to be exceedingly impure is rather contradictory, especially when Mr. Clarke observes, that it is fit for use "in the longest voyages, *during which it ferments*," a fact that it is excessively impure? The superiority of English porter, as some give it the preference, is said to be owing to the water, with which it is made, viz. the water of the Thames! All soft water, i. e. water free from saline matter, is known to every brewer will make a better infusion of malt and hops than hard



in solution, will give with nitrate of lead a white precipitate, which is *soluble without effervescence* in nitric acid. This precipitate is a combination of oxyde of lead, and animal matter.

As to the mode of detecting saline matter in water, the usual course of analysis may be resorted to. The foreign salts are generally carbonates or sulphates, and muriates of soda, lime, and magnesia. The distinguishing character of water, into hard and soft, may be determined by a solution of soap. The carbonic acid may be detected by lime or barytic water, the precipitate being soluble with effervescence in acids. Sulphuric acid is known by the addition of any of the soluble salts of barytes, with which it forms a precipitate, insoluble in nitric, or muriatic acid. Muriatic acid is known by nitrate of silver, and the solubility of the precipitate in liquid ammonia. Iron is detected by tincture of galls, or the ferroproussiate of potash. Magnesia is known by adding first, carbonate of ammonia, and then, phosphate of soda. The presence of oxygen may be discovered by the green or protosulphate of iron. We may proceed also, according to well known rules, to determine the proportion of these substances, if it be worth the trouble.

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water ; but it is a question whether animal and vegetable matter, and filth of every description, which exists in the Thames water, will *improve* beer or porter ! We have heard of vessels taking in their water in the Thames, under a belief that it was better than other water, when it is represented to be so very impure, as to require to be *fermented, filtered, &c.* before it can be used.



With respect to the deleterious effects of keeping water in leaden vessels, it seems that the ancients, 2000 years ago, were well acquainted with the injurious effect of lead, and of keeping water in leaden vessels. Although pure water, it is to be observed, does not act on lead, if air be excluded, and therefore can have no effect upon it; the metal is certainly acted upon by the admission of air, a fact abundantly proved by some fatal accidents that have occurred in using water thus kept. The *white line* observed at the surface of the water kept in leaden vessels, is a carbonate of lead. The metal touches the water, and at the same time comes in contact with the air. The ancients condemned leaden pipes in consequence of this circumstance; and persons, according to Sir G. Baker, who have swallowed the sediment of such a water, became affected with bowel complaints. Numerous instances, however, are recorded of fatal consequences; whole families have been poisoned by water which had remained in reservoirs of lead, according to Van Swieten, and others. Hard waters, it is said, will corrode lead more rapidly than soft waters. The following facts stated by Sir G. Baker, are conclusive as to the deleterious effect of lead:—

“ A gentleman was the father of a numerous offspring, having had twenty-one children, of whom eight died young, and thirteen survived their parents. During their infancy, *and indeed until they had quitted the place of their usual residence, they were all remarkably unhealthy*: being particularly subject to disorders of the stomach and bowels. The father, during ma-



ay years was paralytic ; the mother, for a long time, was subject to cholics and bilious obstructions. After the death of the parents, the family sold the house which they had so long inhabited. The purchaser found it necessary to repair the pump. This was made of lead ; which upon examination was so corroded, that several perforations were observed in the cylinder, in which the bucket plays ; and the cistern in the upper part was reduced to the thinness of common brown paper, and was full of holes like a seive." Besides the agency of air and carbonic acid, it is said that vegetable matter, as leaves, falling into a leaden cistern filled with water, imparts to the water a considerable solvent power of action on the lead. The saturnine cholic of Amsterdam, mentioned by Tronchin, originated from such a circumstance, and other instances are mentioned of a similar nature.

To discover the presence of lead in water, the usual tests are : water containing sulphuretted hydrogen gas, the hydrosulphuret and hydroguretted sulphuret of the alkalies, and the celebrated *wine test* of Hahneman, all which produce with the smallest quantity of that metal, a dark brown or black precipitate. One part of acetate of lead may be detected in 2000 grains of water, so delicate is this re-agent.

Other tests are recommended for the same purpose : sulphate of potash, or sulphate of soda, will detect minute portions of lead, as one part of lead in 100.000 parts of water. Dr. Thomson in recommending this test, remarks, that no other precipitate, (sulphate of lead,) can well be confounded with it.



except sulphate of barytes, and there is no probability of barytes existing in common water.

Carbonate of potash, or carbonate of soda, are also highly recommended to discover lead; but the precipitate produced, must not be confounded with the carbonate of lime, or of magnesia, as the salts of these earths may exist in a water, and be decomposed by the alkaline carbonates.

With respect to the preservation of water at sea, several methods have been recommended, but none appear to answer so well as using fresh burnt charcoal, and having the staves of the casks previously charred.

Dr. Butler has found, that four ounces of pearl-ash dissolved in 100 gallons of water, and the cask cleaned in the usual manner, will keep it sweet for eighteen months. Sulphuric acid, in a small portion, has a powerful effect on the preservation of water. Calcined allum and powdered charcoal, mixed together, have been used to restore putrid water; ten grains of the former to a gallon, is the proportion recommended. Mr. Lowitz used 1 1-2 ounces of charcoal in powder, and 24 drops of sulphuric acid, to correct the putrescency of three pints and a half of water. A few grains of lunar caustic to a hogshead of water, will prevent its putrefaction; but putrid water may be restored to its original purity by filtering it through sand and charcoal. In Boerhaave's Chemistry is the process formerly used in the Dutch navy, for the preservation of water. In Lind, on *Hot Climates*, may be found a very economical method



of obtaining *fresh* water from sea water; it consists in an economical arrangement of a simple distillatory apparatus. An economical method of obtaining fresh water from salt water at sea, when a scarcity of the former is experienced, must be highly advantageous to the mariner. In the navy, where the boilers are necessarily large, the supply of water might in this way be considerable; each boiler being furnished with a head, and condensing the aqueous vapour in the usual manner. If we are not mistaken, a plan of this kind is adopted in the British navy. The cooking by *steam* is altogether a saving of fresh water, as sea water can be used with the same advantage, and the salt left in the boilers saved for use. We perceive then, that saline matter when dissolved in water can only be separated, or the water rendered fit for drinking, by distillation; whereas water which is merely fouled, or rendered turbid by earthy matter, as river water, is purified and made transparent by filtration. The common drip stone, or filtering stone used at sea, separates only those substances that occasion the turbidness of the water; but the filtering apparatus of Du Commun has a double advantage, in separating all foul matter, resulting from the putrefaction of animal or vegetable substances, and at the same time all earthy substances in suspension.

### ADULTERATION OF WINE.

Wine is frequently adulterated. To discover the adulteration in every particular, is a difficult and uncertain undertaking.



Allum is used to give young and meagre wine a more lively colour ; Brazil wood, the husks of elder berries, and bilberries, to impart to Port wine a rich purple tint ; gypsum, to render cloudy white wine transparent ; oak wood saw dust, and the husks of filberts, to give additional astringency to red wine ; bitter almonds to communicate a nutty flavour ; tincture of raisin seed to give flavour to factitious port wine ; and sweet briar, oris root, clary, elder flowers, and cherry laurel water, to form the bouquet of high-flavoured wines.

The art of manufacturing spurious wine is a regular trade in London, and, in fact, is largely practised in our own country. Cider is the article used for this purpose ; it is generally poured on the lees of old wine, to give it the flavour and the tartar taste, then mixed with a due quantity of brandy or spirit. The Tatler, (vol. viii. p. 110,) alludes to these wine brewers, who work under ground in holes, caverns, and dark retirements, to conceal their mysteries from the eyes and observations of mankind. "These subterraneous philosophers," says the Tatler, "are daily employed in the transmutation of liquors, and by the power of magical drugs and incantations raising under the streets of London, the choicest products of the hills and vallies of France. They can squeeze Bordeaux out of the sloe, and draw Champagne from an apple. Virgil in that remarkable prophecy

*Incultisque rurens pendebit sentibus uva.*

Virg. Ecl. iv. 29.



The ripening grape shall hang on every thorn:—seems to have hinted at the art, which can turn a plantation of northern hedges into a vineyard.” Various recipes are given for the manufacture of spurious wine. It will be sufficient for our purpose to remark, that in the so called fabricated British port wine, the juice of red beet root, logwood and rhatany are added to cider, with a due quantity of brandy ; and in the British Champagne, white and brown sugar, and lemon acid are used with water, white grape wine and brandy, and suffered to ferment. *Pink Champagne* is made of it by using preserved strawberries and cochineal.

What is called *crusting* in the wine trade, consists in lining the interior surface of empty wine-bottles, in part, with a red crust of supertartrate of potash, by suffering a solution of that salt coloured red with a decoction of Brazil wood to crystallize within them. Staining the lower extremities of bottle corks, with a fine red colour, to appear, on being drawn, as if they had been long in contact with the wine, is also a common practice.

In London, it is the business of the *wine cooper* to prepare the astringent extract, and “genuine old port,” by the admixture of foreign and domestic wine ; and the *refiner of wine* is employed in the mellowing and restoring of spoiled white wines. Sometimes the internal part of a cask is lined with an artificial red tartar.

In this country we have known not only cider converted into *Madeira*, but also red or astringent



Wines manufactured from it. Artificial red wines are usually made of cider, with the addition of spirit, the juice of the sloe, gum kino, or other red astringent colouring matter; and white wines by adding to cider a due quantity of brandy, and digesting the mixture on the lees of wine, and imparting a flavour as occasion requires. A very delicious flavour may be given by pine apple.

The fact is well known, that wine merchants, generally, have been in the habit of purchasing cider. A wine merchant of one of our large cities, who amassed a fortune by the trade, purchased annually some thirty or forty hogsheads, which although not manufactured *under* the street, as in London, was nevertheless converted into Port, Madeira and Champagne; so well did he understand the magical art of *squeezing Bordeaux out of the sloe, and drawing Champagne from an apple!*

Fraudulent adulterations are practised with impunity, and paradoxical as it seems, the practice is justified by not only wine merchants and dealers in liquors, but by many others. The wine merchant will tell you that your wine wants a body, is pricked, &c. and prescribes, *secundem artem*, the addition of brandy, wood ashes, and the like; and that Madeira, in all respects equal to imported, he can imitate without sending all the way to the Madeira Islands; but when you purchase of him, he will sell you his *pure, genuine, unsophisticated* wine at the rate of from three to six or eight dollars *per gallon*, and thus tax your purse for your credulity, and actua-



ally give you his imitative wine! The manufacturer of mustard will justify his foreign admixtures, on the ground that the seed will not grind without them; and the chocolate maker, that his coco lost its oil, and will not pass through the mill without fat or lard! Good cider wine is wholesome. There is nothing particularly injurious in imitative wine made from cider, brandy, and wine lees, with or without the addition of red astringent matter, as the sloe, kino, &c. But what we deprecate is the fraud, the deception actually practised by selling such wine as the imported, and at the same price, with the duties and all included!\*

During the war, impositions of this kind were practised on the Hospital department of the army, some of which we detected.

There is a preparation of cider, made by ferment-

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\* *Cider wine* is prepared by boiling the juice of apples till one half is evaporated, and the remainder is put into a wooden cooler, whence it is barrelled, with the addition of a due proportion of yeast, and fermented in the usual manner. In three or four years it is said to acquire the colour and flavour of Rhenish wine. In the west of England, several hundred hogsheads of cider wine are annually prepared, and the boiling is conducted in copper vessels. Dr. Fothergill was the first who supposed that this wine contained copper. He accordingly made a number of experiments, which proved that cider wine prepared in that manner, *does* contain a minute portion of copper. We do not consider wine prepared by this process as meriting any preference, because the greater part of the juice must be volatilized, and consequently a considerable part of the essential ingredient itself lost. Ciderkin is no other than a preparation from the *lees* of cider, and cider spirit, the cider distilled.



ing honey, which is bottled, and called "American Champagne." When the cork is drawn the quantity of carbonic acid gas that is liberated is so great, as not only to produce a copious *sparkling*, but also a foaming. Cider bottled in this way, partakes more of the nature of hydromel, or mead, a beverage prepared by fermenting honey and water, which contains from two to three times its bulk of carbonic acid.

The "American Champagne," as it has been named, is, therefore, a preparation of cider, the fermentation of which has been renewed by the addition of honey added in a certain proportion. Although cider may be treated in this manner, clarified with isinglass, racked and bottled, and sold as *bottled cider*; the briskness of which is owing not to the original carbonic acid produced by the fermentation of the juice of apples, but to that which is subsequently generated by a new fermentation, and a larger quantity of alcohol is also produced. We consider the addition of honey, under these circumstances, by no means objectionable. Harsh cider is very greatly improved by it. Those who follow the business of preparing bottled cider for the market, frequently avail themselves of the use of honey. Cider which is *pricked*, or has become slightly acescent, is *cured* with a little pearlash; the effect of which is obvious by its neutralizing the acetic acid, thus generated. The acetate of potash formed, is perfectly harmless. A very grateful flavour to cider is imparted by orris root.



To prevent the escape of carbonic acid in the fermentation of the juice of apples, or to retain a sufficiency to give the cider a *brisk* taste, cider makers have adopted several expedients. In the state of Connecticut, where much cider is made, it is a common practice to pour a tumbler full of olive oil into the bung hole of every cask, which is said to *retain* the fixed air, but the fact appears doubtful. We think, however, that as the olive oil prevents the immediate contact of air, it must prevent the acescency of the cider. Dr. Darwin assures us, that on an estate in England, where a considerable quantity of cider was made, the apple juice as soon as it had settled, was put in strong casks, and bunged up close, and that very few casks burst. This cider, we may reasonably suppose, must have been supersaturated with carbonic acid. A handful of powdered clay is said to prevent a succeeding fermentation. To preserve it, apple whiskey is sometimes added.

The "American wine," prepared by Mr. Cooper, of Gloucester county, N. J. according to his mode of preparation, is made by mixing with cider from the press a quantity of the honey comb, and after standing some time honey is added, until the strength of the liquor will bear an egg. After fermentation it is fined with the white of eggs, and a sufficient quantity of common cider spirit added. Wine made in this manner, Mr. Cooper observes, would not cost a quarter of a dollar per gallon!

In the manufacture of artificial wine, the whole art consists in giving the liquor a sufficiency of bran-



dy, and of tartar, and imparting to it the *flavour* of the wine, as, for instance, Madeira; taking care at the same time, that it be neither too weak, nor too strong, and that the quantity of tartar be rightly apportioned. In the preparation of artificial liquors, I mean for domestic consumption, as a mean of economy, various expedients may be used, which will readily occur to those who are acquainted with the nature and properties of liquors.

The expressed juice of grapes, which is a liquid of a sweet taste, called *must*, is composed of water, sugar, mucilage, gluten, and tartaric acid partly saturated with potash, and is decomposed by the vinous fermentation, in which alcohol is generated. If we inquire into the causes of the fermentation, the substances present, the changes which they undergo, and the character and properties of the product, we will then have a knowledge of wine-making. In ordinary cases of fermentation, alcohol is produced in combination with water, mucilage, and probably undecomposed sugar, as in brewing some kinds of beer, as ale, and nothing remarkable is to be observed. But as the fermentation of *must* takes place without adding any ferment, Fabroni attributes it to the presence of gluten, which exists on the membranes of the grapes that separate the cells; whereas the saccharine part resides in the cells of the grapes. The-  
nard has shown, that all other juices that undergo a spontaneous fermentation contains a similar substance; and hence the formation of wine is the ac-



tion of this glutinous matter on the saccharine substance of the juice.

The properties, such as the taste, &c. of wine differ very much; and by the substances pre-existing in the juice, or taken up in fermentation, we determine the character of the wine, inasmuch as it is either red or white, strong or weak, sweet or tart.

Saccharine matter dissolved in water, and mixed with common vegetable gluten, with the addition of tartar, will ferment and produce a fluid analagous to wine; to which colouring matter, and if necessary, astringent matter may be added, and thus give an imitation of red wine. It is then evident, that the alcohol in fermented liquors is variously combined with water, colouring matter, sugar, mucilage, and the vegetable acids; and the art of imitating wines, &c. depends altogether on imparting to the spiritous fluid, the taste, flavour, colour, &c. of the original.

Mr. Brande has shown, that the colouring and acid matter in wines may be, for the most part, separated in a solid form by the action of a solution of acetate of lead, and that alcohol may be then obtained by abstracting the water by means of hydrate of potash, or muriate of lime, without artificial heat. It is true that some colouring matter, and particularly tartaric acid, will combine with oxyde of lead, and form an insoluble precipitate, which may be readily recognized; but when sugar of lead is used to *correct* the acescency of wine, which was formerly the practice, it is prejudicial in the highest degree, and ought to be discarded.



With respect to the use of the sloe, (*prunus spinosa*,) in imitating red wines, a practice hinted at in the Tatler, it is remarked that its juice communicates to them not only a red colour, but an astringent taste. If the juice of the unripe sloe be inspissated, it will have a strong resemblance to the Egyptian acacia, which is furnished by the *mimosa nilotica*. Some of the *lichens* have also been used to impart colour to wine. Thus the calcareous lichen, (*lichen calcareous*,) which is found in limestone rocks, will give a rich colour; and the *orchall*, or dyer's lichen, (*lichen rocella*,) furnishes a rich purple colour. But the substances which may be used as colouring matter, are almost innumerable. The original colouring matter of red wines, it is known, resides in the husks of the grape; and when the *must* is fermented on them, the moment the alcohol is generated, it acts upon and dissolves it. A contrary procedure produces white wine.

A short account of wines may be useful at this time. Several species of the vine are cultivated, but by far the most important of the whole is the common vine, the *vitis vinifera*, of Linneus. It is hardly necessary to add, that the grapes are put in presses similar to our cider presses, or according to the ancient method, by treading them with the feet in order to obtain the juice. The characteristics of the ancient vintage is expressed very strongly in the predictions of Isaiah concerning Moab: "And gladness is taken away, and joy out of the plentiful field; and in the vineyards there shall be no singing, neith-



er shall there be any shouting; the treaders shall tread no wine in their presses; I have made their vintage shouting to cease." Wine, it is known, contains more or less carbonic acid gas, if bottled before the fermentation ceases; and hence it frequently breaks the bottles which contain it. The ancients usually kept their wine in skins, or leathern bags, well secured at the seams. The following passage in Scripture, refers to the effect of carbonic acid in new wine: "Neither do men put *new* wine into *old* bottles, else the bottles break, and the wine runneth out, and the bottles burst; but they put *new* wine into *new* bottles, and both are preserved."

The difference of wine does not depend so much on the species of the grape, as in the quality of fruit, produced by the varieties of soil, cultivation, and climate. The peculiar mode of fermentation, and the state of the grapes at the time, must also influence the quality of the product.

Of Portuguese wines, none are so much in repute as the red port, which takes its name from the city of Oporto, in the neighbourhood of which it is made. There is also the white port and Lisbon.

Of French wines, that usually considered the best is Burgundy, a red wine of very delicate flavour. Claret is the only French red wine in demand. Champagne possesses the most celebrity of the white wines. This is of two kinds, the *sparkling* and the *still*; the former is produced by bottling it before the fermentation ceases, by which an insensible fermentation, more properly speaking, takes



place ; and the latter, or still Champagne, by suffering the wine to go through the whole process of fermentation. Frontignac and Muscadet are also white wines, the production of Languedoc.

Of Spanish wines, is the Sherry, prepared from the grape of Andalusia ; the Rota, in Seville ; the Malaga, prepared in the neighbourhood of Malaga ; some inferior red wines ; the Alicant ; and a sweet red wine called *Tent*.

Of Italian wines, which are now generally thin and bad, notwithstanding the ancient celebrity of many of the wines of Italy, we may mention the red wine called *Lachryma Christi*, prepared in certain vineyards on Mount Vesuvius.

Of German wines, the most celebrated are Tokay, Hock, Rhenish, and Moselle, some of which are highly prized.

Of the Madeira and Teneriffe wines, we may consider them generally as superior. The Madeira is considered by far the most valuable, particularly after it has been ripened by conveyance into a hot climate. The number of pipes of wine annually made in the island of Madeira, is about 30,000. The grapes are put into wooden vessels, and the juice is extracted by persons treading upon them. The Canary Islands furnish rich white wine under the name of Canary sack, but more commonly called Malmsey Madeira. The genuine Malmsey, however, is the produce of Malvesia, one of the Greek islands. Teneriffe wine, when a few years old, has much the flavour of Madeira ; but it then



becomes sweet and mellow, and resembles Malaga. Of Cape wines, produced at the Cape of Good Hope, there are two kinds, peculiarly rich, sweet, and delicate, called red and white Constantia, which are made at a vineyard situated about eight miles from Cape Town. The grapes of this farm, owing to some peculiarity in the soil, are superior to any other in the whole country. The annual produce, however, is small, seldom exceeding sixty pipes of the red, and 100 pipes of the white wine.

In the United States several attempts have been made to cultivate the grape, for the manufacture of wine; some of which proved successful. Wine, on a small scale, has frequently been made in families, who have raised the grape for their own use. I allude, however, in particular to a settlement near Pittsburg, called Harmony; and to another by the same emigrants at Vevay, in Indiana. The quantity now made, I am informed, exceeds all former calculations; but it has not been manufactured in sufficient abundance to become a general article of trade.

That various sections of the United States are well adapted to the cultivation of the grape, I presume is generally admitted. The cultivation of the grape should be encouraged as correct policy in our political economy, since the consumption of wine is so great, and large sums of money are annually expended in the purchase of it. By producing within ourselves a sufficient supply of wine, if even we were to manufacture no other than that recommended by the late Mr. Cooper of Gloucester, New-Jersey, by



using honey and cider, the importation of wine would be rendered unnecessary. Thus we should keep a large amount of capital at home, which now passes into a foreign channel ; for it ought to be remembered, that with wine, as with many other articles we import, the, so called, *balance of trade* is against us. It is true that the tariff exacts one dollar per gallon duty on Madeira wine, which affords a revenue to government of a considerable amount, but this is only an *indirect* tax on the *consumer*, who in every instance, pays indirectly all costs, all duties, both foreign and domestic, on every article imported. If the produce of the farmer were taken in exchange, the *trade* would be equal.

Many sophistications of wine are practised with impunity, and are considered legitimate with those who pride themselves for their skill in the art of *managing*, or, according to the familiar phrase, of *doctoring* wines. When wine is adulterated with substances deleterious to health, they must of course prove fatal. This was the case with several persons who unfortunately drank of them ; a statement of which is given in the British Monthly Magazine. Lead is the most deleterious substance which has been added to wines, and it was usually introduced in the form of sugar of lead. It was supposed to check the acesence of wine, as well as destroy any acid, and to render turbid wines clear. Wine merchants at one time believed, that the lead was perfectly harmless ; and some alleged, that none of the metal remained in the liquor ; both of which are contrary to fact. In what-



ever state lead is received into the stomach, it produces disease; and although wine may contain but a small quantity, like the water in leaden cisterns, yet it acts as a slow and constant poison. Toffania, the celebrated female poisoner, who followed the infamous practice of preparing and vending poisons, could not, perhaps, have prepared a much more fatal slow poison than sugar of lead dissolved in wine. But the action of the lead on the system, it will be observed, is more or less great, according to its quantity and the quantity of wine daily used.

The adulteration of wine with lead was at one time a common practice in Paris.

In Graham's treatise on wine-making, lead is recommended to prevent wine from becoming acid; and to prevent, or *cure its muddiness*, a lump of sugar of lead, of the size of a walnut, and a table spoonful of *sal enixon*, are recommended for 40 gallons of wine! The solution of litharge, or the semivitrified oxyde of lead, in vinegar, (subacetate of lead,) was used to *soften grey wine*. Without understanding its chemical combination, or that it was pernicious, the ancients were acquainted with the fact, that *lead rendered, apparently, harsh wines milder*. When its effects were discovered, they were ascribed to some other cause. When the Greek and Roman wine merchants wished to try whether their wine was spoiled, they immersed in it a plate of lead; if it became *corroded*, they concluded the wine was spoiled.

Besides the fraudulent practice of adulterating



wine with lead, a practice which, happily for mankind, is now abolished to the best of our knowledge, lead may occasionally gain admission into wine, either unsuspectingly or inadvertantly. *Shot*, for instance, which contains both lead and arsenic, is used in cleaning of wine bottles, and by rolling against the sides of the bottle, detaches the supertartrate of potash, and is acted upon. This practice of cleaning bottles has led to serious consequences. A gentleman, whose friend was taken ill by drinking out of a bottle, on examining the dregs that remained, discovered a row of shot wedged forcibly into the angular bent up circumference of it, which, when examined, crumbled into dust, the outer crust (defended by a coat of black lead, with which the shot is glazed,) being left alone, unacted on, whilst the remainder of the metal was dissolved.

The proper counter poison for a dangerous dose of sugar of lead, is a solution of Epsom, or Glauber salts, which forms an inert sulphate of lead.

The Greeks and Romans were accustomed to boil their wine over a slow fire, till a half, third, or fourth part of it remained, and to mix it with bad wine in order to improve it. When by this operation it had lost part of its water, and had been mixed with honey and spices, it acquired several names, such as *mustum*, *mulsum*, *sapa*, *carenum*, &c. Most of those authors who have described this method of boiling wine, expressly say, that *lead* or tin vessels must be employed. The method of improving wine by the use of lime, still practiced in the Island of Zante, in Spain,



and on the coast of Africa, is not to be considered injurious, as nothing but either an acetate or tartrate of lime would result; but with respect to the alcoholic part, it is impossible by this, or any similar process, to re-produce it. The tartrate of lime is insoluble. Calcined shells were in ancient times used instead of lime. They are occasionally used by the moderns.

Potter's earth was also made use of, to clarify wine. The oldest account of the poisonous sweetening of wine, is that which occurs in the French ordinance of 1696. In Germany, an order was issued in 1697, forbidding the use of lead, bismuth, sulphur, &c. under pain of death, and confiscation of property, as well as being declared infamous. One person was detected in using litharge; another, about eight years after, named John Jacob Ehrni, of Eslingin, was also detected and was beheaded. The fumigating of wine with sulphur, performed by kindling rags of linen, dipped in melted sulphur, and suffering the fumes or sulphureous acid gas to enter the cask partly filled with wine, was supposed to stop the fermentation of wine, and prevent it from spoiling.

The acidity of wine may arise either from a superabundance of tartaric acid, or from the presence of acetic acid, the result of the acetous fermentation.—The latter indicates either the want of a sufficient quantity of alcohol, or the existence of more than is usual of mucilaginous matter. To correct the acidity of wine in either case, calcined oyster shells are



generally recommended. As burnt shells are nothing more than lime, a lump of quicklime will answer equally well. In the place of quicklime, common chalk (carbonate of lime,) may be used with more certainty, as no more will be taken up than the acid will combine with. The lime, in both instances, will form with tartaric acid an insoluble tartrate, which will fall to the bottom; and with acetic acid, acetate of lime, a salt of considerable solubility.—Potash will have the same effect. Three methods have been used for the clarification of wine, viz.: the use of isinglass, of skimmed milk, and the white of eggs. The first unites with foreign substances in suspension, or with tannin, if present, and gradually precipitates; the second is decomposed by the acid of the wine, and the curd is separated, which envelopes the foreign matter, and falls with it to the bottom; and the third is coagulated by the alcohol in the wine, and the coagulum is precipitated in a similar manner.

The re-agents for detecting the presence of lead in wine are several. The arsenical liver of sulphur, was formerly a test to discover the presence of lead. The solution was called *liquor probatorius Wurtembergicus*, having been applied for that purpose by a public order of the duchy of Wurtemberg. The *wine test*, as is called, which consists of water, impregnated with sulphuretted hydrogen gas, diluted with muriatic acid, is the most ready re-agent to detect the presence of lead, or any other deleterious metal in wine. The sulphuret, or hydro-sul-



phuret of lead, thus produced, is of a dark brown, or black colour, which when dried and fused before the blow pipe on charcoal, yields a globule of metallic lead. In consequence of the presence of muriatic acid, this test has no effect on iron—a harmless metal. Any of the alkaline hydro-sulphurets, hydroguretted sulphurets, or hepatic gas, may be used for the same purpose. *Hahneman's wine test* is made, by putting a mixture of 36 grains of sulphuret of lime, and 26 grains of supertartrate of potash in an ounce phial, and filling it with boiled water. The liquor after having been repeatedly shaken, and allowed to become clear, may then be placed into another phial, and 20 drops of muriatic acid added. It is sufficient to remark, that in consequence of the decomposition of the water, sulphuretted hydrogen gas is produced, which combines with the water, and at the same time we have a hydroguretted sulphuret of lime, with sulphate of lime. The addition of muriatic acid is to prevent the precipitation of iron. This re-agent produces, both with lead and copper, without enumerating some other metals, a dark brown or black precipitate. Wine, previously acidulated with muriatic acid, if brought in contact with sulphuretted hydrogen gas, will instantly show if it contains lead, and this mode of using the gas is the most active.

Subcarbonate of ammonia, besides carbonate of soda, is considered a very delicate test for lead, which it precipitates in the state of a white carbonate. This carbonate, when washed or digested in water, containing sulphuretted hydrogen gas, will in-



stantly become black. If this precipitate be gently heated, it will become yellow, and, on charcoal before the blow pipe, will yield a globule of lead.—Chromate of potash will throw down from saturnine solutions, a beautiful orange yellow powder, the chromate of lead. It is said, however, that Burgundy wine, and all those that contain tartar, will not retain lead in solution in consequence of the insolubility of the tartrate of lead. The presence of acetic acid, which is frequently the case, will always act on, and dissolve lead.

Mr. Nicholson recommends the evaporation of wine, supposed to contain lead, and exposing the extract with charcoal to the action of heat in a crucible, by which metallic lead will be obtained.

With respect to the extraneous colours in red wine, Mr. Vogel, as well as Mr. Brande, has recommended, as a test, the acetate of lead. The substances usually employed for colouring wine, such as bilberries, elder berries, and Campeachy wood, do not produce a *greenish grey precipitate*, as with genuine red wines. The precipitate, which these substances give, when infused in wine, is of deep blue colour. Brazil wood, red saunders, and red beet, produce a colour which is precipitated red by acetate of lead. Lime water will render wine, coloured by the beet root, colourless; but acids restore the colour. Red wine, prepared from black grapes, produces a greyish green precipitate with acetate of lead; and the same effect takes place when the skins of grape, digested



in alcohol, are mixed in the form of a tincture, with acetate of lead.

In concluding this subject, it may be proper to add, that all wines contain more or less alcohol, which depends on the quantity of saccharine matter contained in the must, previously to the vinous fermentation, and on which the strength of wine depends; that the *sparkling Champagne* owes its particular character to the presence of carbonic acid gas, which is produced by insensitive fermentation after the wine is bottled; that white wines are produced when the must is separated from the husk of the grape, and red wines when it is suffered to ferment on the husks, by which their colouring matter is taken up; that wines by distillation furnish brandy, a liquor composed essentially of alcohol and water; that they contain also a free acid, and hence they turn litmus, or tincture of cabbage red, which acid is naturally the tartaric, and also a small portion of supertartrate potash and extractive matter; and in general, that they differ from each other in flavour, taste, colour, and strength, some containing as low as 12 per cent. as Hermitage, and others on the contrary, as much as 26 per cent. of alcohol, as the Lissa, Raisin, and some of the Madeira wines.

With respect to *home-made wines*, it may be observed, that as the gooseberry, currant, the cherry, &c. furnish vinous liquors by fermentation, the quantity of spirit which they contain must be variable, without considering that which is added in preparing some of them. The acid in home made wine is



principally the malic, while in grape wines it is the tartaric. In consequence of this circumstance, the use of supertartrate of potash is recommended.

The juice of the gooseberry, as it is said to contain some portion of tartaric acid, is the best suited for making good wine. With respect to the sweet mucilaginous domestic wines, usually formed by the addition of a larger quantity of sugar, they are generally too sweet to be palatable to most persons; and besides, there is a deficiency of alcohol, on account of which, they are apt to grow vapid. This deficiency, however, is usually remedied by the addition of brandy, or more commonly ordinary whiskey. The addition of tartar, we are of opinion, would considerably improve such domestic wines.

### ADULTERATION OF BREAD.

Bread is that substance which is prepared from certain grains, as wheat, or rye, previously ground by a mill into flour. The difference between leavened and unleavened bread, is, that the first is prepared with leaven, or a dry ferment, a practice which is ancient, and the latter without the use of fermentable substances. The unleavened bread is also very ancient, and is frequently spoken of in scripture, especially in the pentateuch. Biscuit may be considered as unleavened bread. The presence of gluten is essential in making *raised* bread; hence wheat, rye, &c. as they contain it, along with starch and saccharine matter, makes the most perfect bread. Certain substances, as potatoes, rice, &c. although



they contain an abundance of starch, will not make bread without the addition of gluten; hence they require wheat or rye flour. The theory of bread-making, or panification, is no other than, by the yeast which is added to cause the fermentation, the combined effect of the vinous and acetous fermentation; the carbonic acid being prevented from escaping by the gluten which suffers expansion. The baking puts a stop to the fermentation.

Allum is often used in bread-making, which is said to impart a degree of whiteness, that common flour will not receive in panification. This process is called the *bleaching* of flour. It is, however, injurious, and the best superfine flour, needs no addition of the sort. The smallest quantity used, to produce a white, light, and porous bread, is 4 ounce to 240 pounds of flour. It is mixed with it either in the state of powder, or in solution. Another substance used by bakers, is subcarbonate of ammonia, with which they produce a light and porous bread, from spoiled, or what is called *sour flour*. This salt causes the dough to swell into air bubbles, which carry before them the stiff dough, and thus it renders the dough porous. None of the carbonate, however, remains, as it is volatilised by the heat.—Potatoes, in bread-making, are frequently mixed with flour; but they will not make good *raised* bread without gluten, as before noticed. Gypsum,\* chalk,

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\* History has recorded the treachery of one of the Bizantine emperors, who, it is said, mixed powdered gypsum with the meal designed for the army of Conrad III, by which the greater part is said to have been destroyed. It is a fact, however, that



and pipe clay, have also been used in the sophistication of flour, or the making of bread. Carbonate of magnesia has been recommended by Mr. E. Davy, who observes, that when mixed with flour, in the proportion of from 20 to 40 grains to a pound of flour, materially improves it for the purpose of making bread, and that it is superior to carbonate of potash, especially with new flour. One pound of carbonate of magnesia is sufficient to mix with 256 pounds of new flour, or at the rate of 30 grains to the pound. When the flour is of the worst kind, forty grains to a pound are the proportion recommended. Mr. Davy conceives that not the slightest danger can be apprehended from the use of so innocent a substance, especially in such small proportions. Carbonate of magnesia is used in the preparation of some particular kinds of biscuit. The *Boston crackers*, for instance, are said to be made with it. Aerated soda water added to flour, we have been credibly informed, makes a light bread. But to produce good bread, a regular fermentation (the *vinous* and *acetous*,) is required.—

The detection of allum in bread may be effected in an easy manner. If some of the suspected bread be digested in water, and the solution concentrated by boiling, and then muriate of barytes added, if allum or sulphuric acid be present, a copious *white* precipitate will ensue, which will not disappear by

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gypsum, in common life, is neither dangerous nor fatal. When found in water, the only effect it has, when the water is drank, is to produce a constipation. Lime-stone waters, however, operate usually in a contrary manner.



the addition of *pure* nitric acid. Bread, made without allum, treated in the same manner, produces merely a slight precipitate, which is occasioned by a minute portion of sulphate of magnesia contained in the common salt used in the seasoning of the bread. Muriate of barytes, it is obvious, is calculated merely to discover the presence of sulphuric acid; but to detect all the constituent parts of allum, viz. the sulphuric acid, alumina, and potash, so as to determine its existence, we must proceed in a different manner. Having decomposed the vegetable matter of the bread, by the action of chlorate of potash, by exposing a mixture of the two to a red heat in a platinum crucible, the residuary mass will consist of allum.

It may be examined by muriate of barytes, for sulphuric acid; by ammonia, for alumina; and by muriate of platinum, for potash. The earthy adulterations are easily detected by incinerating the bread at a red heat in a shallow vessel, and heating the residuary ashes with a little nitrate of ammonia.—The earths themselves will then remain, characterised by their whiteness and insolubility. Lime may be detected by solution in nitric or muriatic acid, and the addition of oxalate of ammonia; magnesia, by adding to the solution, first, carbonate of ammonia, and then phosphate of soda, or by a copious precipitation on the addition of potash. The goodness of flour depends on the due proportion of gluten, as well as of starch; and as flour makes good fermentable bread in consequence of the gluten, its quantity is



determined, as well as the quality of the flour, by kneading it in water. The best kind of wheat flour assumes by the addition of water a very gluy, ductile, and elastic paste. Flour, it will be seen, consists essentially of starch and gluten; and no farinaceous substance will make *raised* bread, whatever may be the proportion of fecula, unless it contains a due quantity of gluten.

### ADULTERATION OF BEER.

Malt liquors, of all kinds, have been more or less adulterated; and fraudulent brewers and others have been convicted of preparing and using a variety of deleterious substances, among which we may mention *coccus indicus*, and *nux vomica*. Sundry colouring substances have also been employed. Thus, burnt sugar, or sugar colouring, has been added to porter; and to communicate a more bitter taste, quassia wood and wormwood have either been used with, or substituted for, hops. This practice is the same for all beer brewing. Nothing, however, according to British statutes, is allowed to enter into the composition of beer, but malt and hops.\* Quassia gives a very good bitter, but the

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\* Malt is barley which has been partially germinated, then torrefied, and ground in a mill. By the operation of malting, the grain develops certain principles; first, that which is antecedent to the growth of grain, and which is shown by pushing forth its radicle, the consequent effect of a change in the fecula, and gluten in particular; secondly, the change which these principles undergo by drying and torrefication, as they undoubtedly



nops possess a more agreeable aromatic flavour, besides partaking in an eminent degree of the bitter and

ly give colour to the malt liquor, in proportion to the degree of kilndrying. This colour is owing more to the saccharine matter than anything else; which undergoes an analogous change in the preparation of the liquor colouring. At the time of the ripening of grain, the saccharine matter it contains, as well as that carried by the sap vessels, coagulates and forms the fecula or starch; but in malting, the starch of the grain is converted into sugar, in all probability by losing a little carbon, because there is a small absorption of oxygen, and consequent formation of carbonic acid. What other immediate changes take place, in the proximate principles, are of little moment. Starch, however, is convertible into sugar, by means of dilute sulphuric acid; and the acid is afterwards removed by using plentifully of lime water.

It is therefore evident that the process of malting is no other than artificial germination; that the starch of the cotyledon is changed into sugar, which sugar, is afterwards, by fermentation, converted into spirit, and that the process should be carried on no farther than to produce the sprouting of the radicle, which should be checked as soon as this has made its distinct appearance. If carried too far, so as to occasion the perfect development of the radicle and the plume, a considerable quantity of saccharine matter must necessarily be consumed in their expansion, and hence barley, malted to that degree, will produce less spirit by fermentation.

Brewers have a method of discovering whether malt has been made with mixed or unripe barley, by throwing a handful into a bowl of water; when the grains that have not been malted will sink, the half malted grains will have one end sunk, and swim in a perpendicular position, and those that are perfectly malted, will swim.

Beet roots have been substituted for malt, when deprived of their juice by pressure, and dried, and the beer is said to be little inferior to that prepared from malt. In some parts of Ireland, parsnips are also used in lieu of malt, in brewing. The young



narcotic principle. Beer, rendered bitter by quassia, will not preserve as well as the ordinary hop beer. The fine *frothy head*, characteristic of good beer, called the *cauliflower head*, is said to be imparted by a mixture of green vitriol, allum and salt; but this addition is generally made by the publicans. The sulphate of iron, alum, and common salt, may be readily discovered in the usual manner. It is said, however, that the sulphate of iron, added for that purpose, does not possess the power ascribed to it. After fining a butt of beer, the publicans frequently adulterate the porter with table beer, and a small quantity of molasses, and sometimes with a small portion of the extract of gentian root, to preserve the bitter of the porter. Those who make it a business to bottle porter from the cask, are very often addicted to these practices. I have known a *bottler* who put up porter, that when he purchased his butts of porter from the brewer to sophisticate it; not that the porter required any addition, but for the purpose of *improving* it, *secundem artem*; i. e. by mixing it with stale porter, molasses and water, re-fermenting, and adding, occasionally, some bitter extract, either of quassia or gentian. This *species* of brewing, like many other frauds we shall have occasion to notice in our remarks, is calculated, of course, to *increase* the quantity of porter, and also the profits.

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tops of the common heath, or ling, with half their quantity of malt, forms a very good beer to the inhabitants of Islay, one of the islands of Scotland.



To recover sour beer, in which acetic acid is formed, it is not an uncommon practice to add calcined oyster shells; and for the same purpose, to restore *pricked* or stale beer, carbonate of potash is used, or in lieu thereof, some wood ashes put into a little bag, and thrown into the cask. In either case, the acetic acid will be absorbed, but the acetate of lime or of potash, will remain in solution. To impart a pungent taste to insipid beer, both capsicum or red pepper, and grains of paradise are employed. In some parts of Sweden, buck bean (*menyanthes trifoliata*,) are employed in brewing, in the place of hops; two ounces of which being considered equal in strength to a pound of hops.

Ginger root, coriander seed, and orange peel, are also employed to give a particular flavour. The intoxicating quality of beer is increased by cocculus indicus, and an extract prepared from it, called *hard mulsum*; and, in addition, to produce a narcotic effect, opium, tobacco, nux vomica, and extract of poppies.\*

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\* Cocculus indicus, or fruit of the *menispermum cocculus*, has been long in use in brewing. The bitter principle of the cocculus is called the *picrotoxin*, and when swallowed it intoxicates and acts as a poison. For the purpose of producing a temporary effect on fish, with the view of taking them, cocculus indicus has been used. A paste is made of cocculus, cummin seed, fenugreek seed, and coriander seed, equal parts, and made into balls of the size of peas, and thrown into ponds or creeks. The fish eat of it, rise to the surface of the water almost motionless, and become an easy prey to the fisherman. Before fish, caught in that manner, are eaten, it is necessary to put them in water for some time, until they entirely recover.



The detection of deleterious vegetable substances, so complicated in their nature as they are, although many of the proximate principles are characterised by certain distinguishing properties, is extremely difficult; and, in fact, when combined with each other, beyond the reach of chemical analysis.

Beer which contains sulphate of iron, may be tested with muriate of barytes; and the precipitate, if any, collected, dried and ignited, and, if insoluble in nitric acid, the presence of sulphuric acid is inferred.

Tincture of galls, strikes a black in beer which contains iron. Genuine old beer may produce a precipitate with muriate of barytes, but the precipitate in that case *is soluble* in nitric or muriatic acid.

If beer, containing sulphate of iron, is evaporated to dryness, and the vegetable matter burnt away in a crucible by the action of chlorate of potash, the residue will consist of sulphate of iron, which, when dissolved in water, may be readily recognised by the usual tests for sulphuric acid and iron.

The quantity of spirit contained in malt liquors, is readily known by distillation. The specific gravity of beer *may* point out the presence of some adulterations. The bitter principle of hops, quassia, &c. in beer, is shown by a precipitation with acetate of lead.

### COUNTERFEIT TEA LEAVES.

*Tea* has been counterfeited in several ways. The



leaves of the sloe, elder, ash, and of other vegetables have been used for the purpose, and persons have been convicted for employing them in London.— Other persons have also been convicted of using sundry leaves, and converting them into a spurious article, resembling *black tea*. The leaves were first boiled, then baked upon an iron plate, and, when dry, rubbed with the hand in order to form the curl, which the genuine tea had. The colour, which was afterwards given, was imparted by logwood. The manufacture of green tea they conducted by laying the leaves on copper plates, and adding Dutch pink and verdigrease. The presence of the latter is known by the well known blue colour it forms with ammonia. In forming black tea, sometimes a little verdigrease was added in the boiling, along with the logwood.

We may distinguish the genuine tea leaf from the sloe, by comparing the botanical characters of the two leaves; but these characters can only be determined when the leaves have been macerated, and unfolded. Spurious black tea, when moistened, gives a bluish black stain to paper, and in cold water affords a bluish black infusion, which changes to red by a drop or two of sulphuric acid.

Genuine tea produces an amber coloured infusion, which does not become reddened by sulphuric acid. The reason the acid produces a red colour with the spurious tea, is evident from the separation of the colouring matter of the logwood, used in giving the black colour to the tea. Mr. Accum assures us, that



all the samples of spurious tea, which he examined, were coloured with carbonate of copper, and not by means of verdigrease. Tea containing copper, if shook up in a phial with ammonia, will impart a fine blue tinge; and if thrown into water containing sulphuretted hydrogen gas, it will acquire a black colour. Neither of these appearances take place with genuine tea. If tea coloured by copper be burnt with chlorate of potash, and the residue dissolved in nitric acid, the solution will be affected by ammonia as before noticed.

It may be useful, perhaps, to notice, that the dried leaves of an evergreen shrub, the *thea bohea* and *thea vicides*, of Linnæus, furnishes both the black and green tea. Of black teas, is the *bohea* or *vooyee*, so called from the country in which it is produced, and is collected sometimes at four gatherings. After the leaves have been partly dried, by exposure to the air or sun, they are thrown by small quantities at a time, into a flat cast iron pan, which is made very hot; they are stirred quick with the hand, then taken out, and rubbed between men's hands to roll them, and are again roasted over a slow fire, which is usually made of charcoal. The characters of the best bohea are, that it is a small blackish leaf, is dusty, and has a rough somewhat harsh taste.

*Congoo* or *cong-foo* is also a black tea, derived from a word which implies much care and trouble. It is a superior kind of bohea, less dusty, with larger leaves. *Souchong* belongs to the same class. It is a Chinese word said to signify a small good thing.



It is made from the leaves of trees three years old. The true souchong is scarce. That which is sold in China, is the finest kind of congo; and ordinary congo, which is purchased, is but the best sort of bohea. Upon a hill planted with tea trees, there may be only a single tree the leaves of which are sufficiently good to be called souchong. The others make congos of different kinds, and bohea. The *Pekoe* is likewise a black tea, but distinguished by having the small white flowers of the tree intermixed with it. It is usually made from the tenderest leaves of trees three years old, gathered just after they have been in bloom.

With respect to green teas, the opinion which has been given, that their colour is owing to a process of drying them on copper plates, is altogether erroneous. When gathered they are roasted, or tached, as it is called, upon cast iron plates, and rubbed between men's hands, to roll them. They are again roasted, &c. before they are packed. There are a variety of green teas, but the principal are singlo, hyson, and gunpowder.

Of the *singlo* or *songlo*, so named from the place where it is chiefly cultivated, there are three principal sorts; but the leaves of the best are large, fine, flat, and clean. It always gives an infusion of a pale amber colour.

*Hyson* or *hee-chun*, is a name derived from an Indian merchant, who first sold it. There are two gatherings of hyson. The characters of this tea should be,—a fine blooming appearance, of a full sized



grain, very dry and crisp, and with a slight pressure crumble to dust; and when infused in water the leaf should appear open, clear and smooth, and should tinge the water a light green colour. The infusion ought to possess an aromatic smell, and a strong pungent taste. The *imperial* or *bloom tea*, which is the first gathering, has a large loose leaf, and a light green colour.

*Gunpowder tea*, which is in small grains somewhat resembling small shot, is a superior kind of tea, gathered and dried with peculiar care. This tea is frequently adulterated; an inferior kind being dried and glazed in such manner as to resemble it; but on infusion this is found in every respect inferior.

Fresh tea leaves, if used as tea, produce giddiness and stupefaction, but these noxious properties are dissipated by the process of roasting. We do not know of any regular set of experiments on tea, although some few of the leaves of vegetables have been examined.

The leaves of plants bear a great resemblance to each other. They are covered only with an epidermis, below which is a pulpy matter, usually green, which contains a resinous substance, and a portion of tannin, gallic acid, and gluten. Below this is the fibrous matter, or vessels that constitute the outline of the leaf. Leaves, however, differ in their proximate principles and properties. Thus, the leaves of weld (*reseda luteola*,) impart a fine yellow colour in dyeing, the leaves of senna (*cassia senna*,) are strongly cathartec, the leaves of wormwood (*artemisia absyn-*



*thium*,) are intensely bitter, and the leaves of tobacco (*nicotiana tabacum*,) possess an acrid taste, and the infusion when taken in sufficient quantity, acts powerfully on the system; and others again are decidedly poisonous, whereas other leaves possess mild and inoffensive properties, many of which have been recommended as substitutes for the tea of China.—Hence, what is called the *British substitute for foreign tea*, is betony, gathered when just going to flower; also, the young and tender leaves of the sloe, (*prunus spinosa*,) which, by the way, are unwholesome; the leaves of wild briar, (*rosa canina*,) and many others unnecessary to enumerate. The New-Jersey tea, (*ceanothus Americanus*,) is also used for the same purpose.

Dr. Parr assures us, that of all the substitutes for tea, the male speedwell is the most celebrated. His observations on tea may be useful. He remarks, that the green tea, should be chosen fresh, of a bright green, not inclining to a yellow or brown. It should be rolled in round cylinders, consist of entire leaves, be thoroughly dry, of a bitterish subastringent taste, but not ungrateful, and of a pleasant smell; the *fresh-er* the tea, the *greener* the infusion. Its prevailing smell is that of violets or new hay; but if this be strong it is the effect of art. Bohea tea is of a blackish brown colour, gives a brown infusion to water, and smells of roses. The more highly flavoured teas have apparently an admixture of some other leaves, it is said of a species of olea; but this is denied by the Chinese brokers. The whole mystery appa-



rently consists in the process of drying, by which its latent narcotic powers are most successfully elicited or preserved ; for the most highly flavoured teas are undoubtedly the most injurious.

## ADULTERATION OF CHOCOLATE.

*Pure* chocolate is, or ought to be prepared from the cocoa, without any additions. The nut is first roasted, in the same manner as coffee, but usually in large cylinders of sheet iron which turn on their axis over the fire. When this operation is finished, it is taken to the mill, and ground between stones, the lower one of which is moderately heated by a fire put underneath. The nut is thus ground up in its *own oil*, and when put into moulds, which are of tin, it cools, and is fit for use. But the chocolate, even no. 1, contains foreign admixture. Thus the oily, or greasy portion of chocolate is increased by grinding with the nut a due quantity of butter, but more generally of lard. To increase the quantity in another respect, chocolate-makers add flour, mostly of rye or Indian corn. Other substances are occasionally added. If chocolate be required pure, the best mode is to buy the nut, and have it roasted and ground within one's self.

The chocolate nut, coco, or cocoa, is the produce of the cocoa tree, (*theobroma cacao*,) and is contained in pods. The nuts are first in a pulpy state, and are laid in skins or on leaves to be dried. In the West Indies and South America, chocolate is made



by roasting the nuts over the fire in an iron vessel, and pounding them in a mortar, and subsequently grinding them to a fine paste on a smooth warm stone. Sometimes they add annatto, which they say improves its flavour. In Spain, other additions are made: thus, the sweet chocolate is a mixture of chocolate and sugar; and they add according to taste and fancy, cinnamon, long pepper, vanilla, cloves, almonds, and other ingredients. Mr. Edwards, who wrote on the West Indies, is of opinion, that the cakes of chocolate, especially those used in England, were made of about one half genuine cocoa, and the remainder of flour or castile soap.

The Mexicans now mix with the cocoa nuts a portion of Indian corn, a few seeds of cocoa, and a little vermillion. The French mix with the chocolate a little cinnamon, vanilla seeds, and fine sugar. In Paris, they make the chocolate for sale as follows: take of chocolate nuts, freed from their husks, and fine sugar, of each a pound; of cinnamon, finely pounded, two drachms; and of vanillas, half a drachm; heat them well together, and form them into cakes or rolls. "The chocolate of health," contains, however, only canella; and the chocolate of one, two, or three vanillas, is denominated from the proportion of this condiment. The proportions, &c. given by Dr. Parr, for making Spanish chocolate, are six pounds of cocoa nut, three pounds and a half of sugar, seven vanilla pods, a pound and a half of maize, half a pound of cinnamon, and six cloves, with a drachm of capsicum. The whole is scented with musk, and coloured with rocou.



Besides the adulterations already noticed, Mr. Parmentier observes, that some manufacturers purchase at a low price the residuum of the cocoa nut, from which the oil has been expressed, and to supply the latter by animal fats and yolks of eggs.—Others add roasted almonds and gum arabic. Dr. Parr remarks, that it is not an uncommon practice in England, to purchase the unripe fruit, and lower its sharp bitter taste with a large proportion of sugar, which is the cheapest ingredient.

*Artificial chocolate*, as it is called, is made of sweet and bitter almonds roasted together, then ground in a mortar, and mixed with warm milk, some eggs and sugar, with spices.

It is remarked, that chocolate without any bad intention, is sometimes injured in the preparation. If the nut is not sufficiently roasted, the taste is disagreeable; if burnt, bitter; and the chocolate is black, without the soft unctuous taste natural to it. If the germ is not separated from the two lobes of the seed, it is found in the chocolate, since it resists the weight of the grinding stone. The following receipt for making chocolate, is from Baume's Elements of Pharmacy: Take of Carraccas cocoa nuts five pounds; of the island's nut, one pound; sugar, five pounds; fine canella, an ounce and a half; cloves, twelve in number.

It remains now to speak of the characters of good chocolate, and of the adulterated, or otherwise bad chocolate.

Good chocolate, when broken, should have a uniform aspect, without a granular surface. It should ap-



pear, on its surface, of a brownish white colour, which when removed by the finger, (having at the same time an oily feel, and an agreeable smell,) the chocolate appears of its usual colour. Some chocolate has not this external appearance, nor is it an essential character of its purity, since it is owing to the *presence* of the oil of the cocoa, and some cocoa contains more than others, as the cocoa of the Islands. It indicates, however, a peculiar richness.

Good chocolate should melt in the mouth, leaving a kind of freshness; and when boiled in water, or milk, its consistence should be moderate. The smell of cheese shows that animal fat has been added; rancidity discovers mucilaginous seeds; and a bitter or musty taste, that the nut is unripe or too much roasted. In boiling, if little grains are deposited, it is usually an indication, if sugar had been used, that it was of a very inferior kind. When chocolate tastes in the mouth like paste, when on its first boiling it exhales the smell of glue, or in cooling becomes a jelly, it has been adulterated with farinaceous substances.

### SPURIOUS, OR COUNTERFEIT, COFFEE.

The true coffee, is the produce of the *coffea Arabica*, of Linneus, called also the *jasminum Arabicum*, or coffee tree bush. Coffee berries have a farinaceous, somewhat unctuous, bitterish taste, and little or no smell.

Coffee when roasted, changes its properties, and



developes a peculiar principle, which is recognised in the smell of burnt coffee. Caffein, a bitter principle obtained from an infusion of unroasted coffee by Mr. Cheveix, is peculiar to coffee, and possesses characters of a different nature from other vegetable principles.\* Many seeds by roasting, acquire the flavour for which coffee is admired. Dillenius has enumerated in the *Ephemerides Naturæ Curiosum*, the substances which in smell and taste resemble coffee; and finds that roasted rye, with a few roasted almonds to furnish the necessary proportion of oil, comes the nearest to it. It is a fact well known, that a peculiar principle similar to that of coffee, is developed by the roasting of barley, rye, peas, beans, chesnuts, &c. which has led to their use as substitutes for coffee. Roasted coffee keeps very well; and, to recover its flavour, lay it before the fire a few minutes, and when warm, it may be ground for use. This is said to improve it.

Coffee, although of a late introduction in Europe, (in 1652,) has been long known in the east. The

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\*Bouillon la Grange, from some experiments he made, is of opinion, that a similar substance to this species of bitter principle exists in the flowers of the mountain arnice, (*arnica montana*,) and it is also remarked, that the same species of bitter principle is found in wormwood, (*absinthium vulgare*,) sabine, (*juniperus sabinus*,) chamomile, (*anthemis nobilis*,) rue, (*ruta graveolens*,) and milfoil, (*achillea millefolium*,)

By the roasting of coffee, it undergoes a peculiar change of composition, attended by the formation of tan, and a volatile, fragrant, and aromatic principle. In this state it has not been examined with precision.



Persians say it was revealed by the angel Gabriel to relieve Mahomet after his fatigues.

Beans, peas, rye, &c. are employed for the purpose of counterfeiting coffee, when roasted and ground. It is called "*sham coffee*," by British grocers. In England the penalties are very severe for practising this deception. It appears that roasted beans and peas, are the principal ingredients in spurious coffee, manufactured by British wholesale dealers. The ground coffee, prepared and sold in our cities, is a similar preparation. Rye, however, when *washed, gently boiled*, then dried, and roasted, forms a good *substitute* for coffee, and makes a wholesome beverage. Among other substances, which have been used for the same purpose, may be mentioned a mixture of rye flour and sweet potatoes, the seeds of the common water flag, the seeds of grapes, wild chicory, acorns, chesnuts, beets, and parsnips, which are first roasted before they are used.

A writer in Cooper's *Emporium of Arts and Sciences*, on cookery, observes, that to a poor family, three pounds of dried succory, (chicory, *chicorium intubus*,) and one pound of coffee, are of 20 *per cent.* more value, than four pounds of coffee, and nearly equal in flavour; and if sweetened with molasses made of an inspissated infusion of good malt, it will constitute a considerable saving. He also remarks, that in Northumberland, Pa. the poorer people will gladly exchange coffee for dried chicory, weight for weight. The German or Westphalia coffee, is manufactured from the succory. It is said, however,



to want the flavour, &c. of genuine coffee, but will make a healthy beverage; hence some prefer it to rye, believing that the latter is unwholesome. I saw a paragraph lately in a newspaper, in which Dr. W. P. C. Barton prefers it to rye, which, in his opinion, is hurtful to most constitutions. Pure rye, and rye which is mixed with *ergot*, ought not to be confounded; but if rye contains *ergot*, in that case the doctor's opinion would have been fully correct. I have seen rye used in families for years, as a substitute for coffee, without producing disease or any inconvenience, as many families in *Philadelphia* can attest, and, in short, have enjoyed better health than when they made use of coffee. There are a number of vegetable substances, which may be used as substitutes for coffee, that are perfectly harmless; but if *ergot* were introduced, or sundry *bitter* kernels which furnish hydrocyanic acid, rye might be considered, at once, as poisonous! But what deleterious principle is there in rye, or what deleterious principle is evolved in the *roasting* of it; a grain which is composed essentially of starch and gluten? Rye is undoubtedly as wholesome as succory.

Coffee when adulterated with those substances, is beyond the reach of analysis: The sure way of avoiding the evil of purchasing spurious ground coffee, is undoubtedly that of buying coffee in its *unground state*.



## ADULTERATION OF SUNDRY SPIRIT- OUS LIQUORS.

Spiritous liquors are compounds of alcohol, and water, in various proportions, and are the result of the vinous fermentation. Some are coloured, and some have a peculiar flavour. But the *strength* of liquors depends on the quantity of alcohol, which is determined by the hydrometer.

The spirits obtained by the distillation of several fermented liquors, it is well known, differ in their taste and flavour. The latter is owing to peculiar odoriferous matter, or volatile oil, which rise in distillation. Malt spirit has usually an empyreumatic taste, like that of the oil formed by the distillation of vegetable substances. Rum derives its characteristic taste from a principle in sugar, as it is obtained from the fermented juice of the sugar cane; or, if domestic, from molasses, which undergoes the same change before distillation. Gin is recognised and known from all other liquors, by its peculiar taste and flavour, which are imparted by the juniper berry, assisted by age. All the common liquors, such as rye, apple, and other whiskey, which partake of a *firey* taste, and unpleasant empyreumatic odour, especially when new, may be rendered mild, and their peculiar taste and smell removed, by using fresh made charcoal. Distillation from charcoal and lime, was formerly resorted to; but we have seen the purification effected by merely passing the liquor through a flannel filter, in which was put a quantity of coarse



ly pulverised charcoal. The best brandies seem to owe their flavour to a peculiarly oily matter, supposed to be formed by the action of the tartaric acid on alcohol.

Mr. Davy assures us, that cogniac brandies contain vegetable prussic acid; and on this supposition, recommends, for their imitation, besides a few drops of the ethereal oil of wine, produced during the formation of æther, a similar quantity of prussic acid, procured from laurel leaves, or any bitter kernels. The prussic acid, however deleterious, is actually communicated to imitative brandy, in England, by using the *cherry laurel water*. The leaves of the black currant, which are fragrant, are also used to give the brandy taste. If a liquor of a certain strength is sold, its strength is usually determined by the hydrometer, which will indicate *above or under proof*, according to the respective proportions of alcohol and water. The specific gravity of proof spirit should be 0.916, temperature 60 deg., which corresponds with a mixture of equal parts of alcohol and water. There is, however, a difference of opinion on this subject.

It may be proper to notice, that besides the use of the hydrometer, there are other methods of judging of the strength of spiritous liquors, which, however, cannot be depended upon for accuracy; viz. the taste; the size and appearance of the bubbles produced by shaking; the sinking or floating of olive oil when poured in it, and the appearance that it exhi-



bits when inflamed. If it inflames gun powder when a portion of it is put in a cup and the liquor poured on, and set on fire; or if it burn away to dryness, or inflame cotton immersed in it, in either case it is considered as alcohol. The different spiritous liquors, when burnt in a graduated vessel, leave variable proportions of water. Pure alcohol burns with a pale blue flame, scarcely visible in bright day light, and produces no fuliginous deposit, but merely aqueous vapour and carbonic acid, in consequence of the union of its constituents, hydrogen and carbon, with the oxygen of the air. One hundred parts of alcohol have been known, to produce in this manner, one hundred and thirty-six parts of water. The flame of alcohol is coloured in a very remarkable manner, by the presence of certain substances; thus, from boracic acid, it acquires a greenish yellow tint; nitre, and the soluble salts of barytes, produce a yellow flame; those of strontion, a beautiful rose red colour; and cupreous salts, a fine green tinge.

With respect to the different modes of ascertaining the strength and quality of liquors, that by the taste is very uncertain.

Sometimes a false strength is given by infusing in the liquor acrid vegetable substances, or by adding a tincture prepared with the grains of paradise and Guinea pepper. Brandy is often coloured with burnt sugar. The flavour of French brandy, in our opinion, is owing to a peculiar oil, and is often communicated to rum or whiskey by distilling it over wine



tees, the spirit having been previously filtered through charcoal, or rectified over fresh burnt charcoal and quicklime. French brandies acquire by age a great degree of softness. Oak saw dust and a tincture from raisins' stones, impart to new brandy and rum a *ripe taste*. Burnt sugar and molasses communicate to factitious brandy, a luscious taste, and a degree of fulness. Imitative brandy is usually made in England, by adding to ten puncheons of brandy, 118 gallons of flavoured raisin spirit, 4 gallons of the tincture of the grains of paradise, 2 gallons of the cherry laurel water, and two gallons of the spirit of almond cakes, to which are added 10 handfuls of oak saw dust, and a sufficient quantity of burnt sugar, to give it, in the language of the trade, a *complexion*.

The best brandy flavour, however, is the spirit of nitrous æther, or sweet spirit of nitre; even nitric acid added to liquor, will impart that flavour, in consequence of the gradual formation of the same.—Ground rice and charcoal, it is said, will make a brandy flavour.

By diluting spirit or brandy, the acrimony of capicum and grains of paradise, if it contain them, will then be readily discovered by the taste. Brandy that contains molasses spirit, or New England rum, is known by rubbing it between the palms of the hands; or, if a portion be heated in a spoon over a candle, and inflamed, the residue after combustion, if from genuine brandy, will possess the vinous odour peculiar to that liquor, but if otherwise, will have a disagreeable smell, resembling gin or common whiskey.



Arrack is imitated by adding to rum some pyroligneous and benzoic acid.

The *neutral liquor*, as it is called, which is largely manufactured by the distillers in this state, is made of rye, but deprived of its usual taste and flavour; hence its name. This liquor is no other than whiskey filtered through charcoal in a flannel filter. It is well adapted to receive the flavour, &c. of either rum or brandy, but is more frequently used in adulterating them.

For the purpose of improving the flavour of sundry liquors, and of communicating flavour to others, there is a method made use of, which we have not mentioned.

We are informed by a gentleman, on whose veracity we can rely, that there is nothing which imparts a more grateful taste and flavour to liquor, either for improving that of rum, or communicating a more agreeable flavour to brandy, than the *pine apple*.—He has used it himself, and assures us, that, although a very expensive addition, the liquor is rendered very superior both in taste and flavour. Along with the pine apple, souchong has been added, which is said even to improve the taste and flavour. In order to preserve as well as improve the flavour of rum, twelve or fourteen pine apples are used for four hundred gallons of liquor.

Liquors sometimes become *milky* or turbid when mixed with water. This effect is owing to the separation of some volatile oil or resin, which was dissolved in the spirit; for a mixture of spirit and wa-



ter will not dissolve an essential oil, as its solution depends on the alcohol. Very frequently brandy becomes nearly black, altogether by accident. This is attributed to nails or iron getting into the cask.—The cask, which is usually made of oak, is acted upon by the liquor, and the tannin and gallic acid of the wood is taken up, which, by their union with the iron, produces the tanno-gallate of that metal.—There is no other way of getting rid of this colour, but by distillation; acids, indeed, would decompose the tanno-gallate, but then their presence would injure materially the liquor. If even an alkali were added to saturate the acid, it would be equally injurious, as it would cause the re-production of the tanno-gallate of iron, and consequently, the black colour.

Gin is a liquor of a peculiar taste and flavour. It is a preparation of malt spirit, and is usually imported from Holland. Holland gin is considered the best, although domestic gin, especially that which bears the name of *Pierpont*, is now made nearly, if not of an equal quality to, and will bear comparison with, the imported. Age, and especially a sea voyage, improves gin; hence, perhaps, why Holland gin has the preference. This liquor is characterised by the peculiar flavour of juniper berries, from which the raw spirit is distilled. Spirit of turpentine, however, is too frequently added. Common gin appears to be flavoured more with turpentine. Sugar is sometimes mixed with this liquor, especially when diluted. Evaporating a portion of it in a spoon, will show it by leaving a residue of a saccharine taste.



For the clarification of sundry mixtures forming fraudulent gin, alum and potash are usually added in succession, so that the alumina may be separated, and carry down with it the turbid matter. Alum is sometimes used alone.

Shannon, on *Brewing and Distilling*, gives a process "to prepare and sweeten British gin," which consists in using oil of turpentine, oil of juniper berries, alcohol, alum, &c. Some of these substances are intended to impart the flavour, as the turpentine and juniper, and others again, to clarify the liquor when prepared, such as the alum. A method of fining with sugar of lead has been practised, which undoubtedly is highly reprehensible, notwithstanding a solution of alum is afterwards added; by which, some would believe, the whole of the lead is separated in the state of a sulphate. This is too precarious an experiment, where *health* is concerned, as the separation of the *whole* of the lead must depend on circumstances. The presence of lead in distilled malt liquors, may be detected by the re-agents before mentioned.

Sundry substances have been used to give what is called a *bead* to spiritous liquors: such substances are chiefly of an oleaginous, resinous, and soapy nature. Thus, common soap has been added in a smaller quantity; but the fraud may be immediately discovered by adding a few drops of sulphuric acid, or in preference a solution of allum. Either will produce a *milkiness*. If the cause of the size, &c. of the bead should be attributed to an oil, or a resin,



the fact may be verified by the addition of water, which will produce a milkiness, the intensity of which will be according to its quantity.

## POISONOUS AND OTHER CHEESE.

Several instances have occurred in which cheese has been found contaminated with red lead, which was inadvertently introduced in it by the impure *annatto*, employed for colouring it. Annotta, in consequence of its frequent scarcity, is adulterated with sundry substances, and its color heightened either by red lead or vermilion; and, therefore, when employed in the process of cheese-making, as a colouring ingredient, must prove injurious. One instance is stated, that the vermilion used in the adulteration, was found itself to be impure, being composed of a mixture of the real vermilion with red lead.

If cheese is suspected to contain lead, the fact may be ascertained by macerating a portion of it in water containing sulphuretted hydrogen gas in solution, which will give to it a dark brown colour.

When milk is turned by a mixture of rennet, which is prepared by digesting the inner coat of the stomach of young animals, especially that of the calf, the curd is separated into an apparently solid mass. This caseous part when pressed in the usual manner, constitutes cheese. In this operation, for a particular reason, some cheese-makers cut the curd from time to time, and with a *brass knife*, for iron is supposed by many to give a bad flavour. This is the usual



practice in some *British* dairies, according to Mr. Nicholson. This practice of using brass, which is an alloy of copper and zinc, may in particular instances be objectionable. If the milk becomes aced, which is often the case after the spontaneous separation of the cream, this acidity being in consequence of the formation of lactic acid from the whey, and which in fact produces the spontaneous coagulation, and separation of caseous matter; there can be no question, if there is the slightest acidity in the curd, that some of the metal will be dissolved and contaminate the cheese.

Cheese, if thus contaminated, may be tested with ammonia. In this country, however, *brass knives* are not in use in cheese-making.

In the manufacture of cheese, a very agreeable flavour is often imparted to cheese, especially the kind called *Stilton*, by preparing the rennet in an infusion of sweet briar, rose leaves and flowers, cinnamon, mace, cloves, and, in short, almost every kind of spice and aromatic that can be procured. In Cheshire cheese, if it is intended to be coloured, annatto, or an infusion of marigolds, or carrots, is mixed along with the rennet. In the Hafod cheese, marigold, cloves, and mace are added. The Parmesan cheese is prepared of milk gradually heated in a *copper cauldron*, and afterwards coagulated; and when pressed, the outer crust is pared off, the fresh surface is varnished with linseed oil, and the convex side coloured red. The green Swiss cheese, usually called "*sap-sago cheese*," derives its flavour from



the *metilot* plant, (*Trifolium melilotus officin.*) In the preparation of Dutch cheese, the curd is separated from the whey by muriatic acid, which may be detected in it. It has a sharp saline taste.

In Westphalia cheese, in the operation of *mellowing*, which is a kind of putrefactive fermentation, caraway seed, pepper, and cloves are also used; and finally, to suit the palate of epicures, the cheese is well smoked in a chimney, as it seems, an its impregnation with pyroligneous acid, is considered by them an improvement!

With cheese in general, it is given as an opinion, that the rank and putrid taste, of which they frequently partake, is owing to a putridity in the rennet.

Where sundry plants or flowers are introduced into cheese, by infusing them previously with the rennet and water, either with the intention of communicating a flavour or colour, there can be no doubt of the introduction of deleterious vegetable substances through mistake; and although such accidents may but seldom occur, yet it is necessary for cheese-makers to guard against them. We have heard of a number of persons, who were affected with a pain in the stomach, by eating of *coloured* cheese, and the sickness was only removed by ejecting it.

It is well known to cheese-makers, that the goodness of cheese depends in a great measure on the manner of separating the whey from the curd. The practice followed in many parts of Scotland of heating the milk too much, breaking the coagulum in pieces, and forcibly separating the whey, is highly



reprehensible, as the cheese is scarcely good for any thing. This whey, however, is delicious, especially that which is the last squeezed out, a proof that nearly the whole of the creamy part of the milk has been separated with the whey. On the contrary, if the milk be not too much heated, (about 100 deg. is sufficient,) the coagulum allowed to remain unbroken, and the whey separated by very slow and gentle pressure, the cheese is good, but the whey is nearly transparent and colourless.

*Bad cheese*, or that which has not been properly made, when exposed to heat, dries, curls, and exhibits all the phenomena of burning horn; whereas *good cheese*, or that which has been made according to the above principles, melts at a moderate heat; a fact that it contains a quantity of the peculiar oil, which constitutes the distinguishing character of cream.

The *oxygala* of the ancients, which occurs in the writings of Pliny, was a kind of cheese, the preparation of which was described by Columella. In order to make it, sweet milk was commonly rendered sour, and the scum was always separated from it. Pliny mentions another kind of ancient cheese, which went under the name of *caseus oxygalactium*, formed from the caseous part of buttermilk, by the addition of some acid, and mixed and prepared in several ways.



## LECTURE II.

### PEPPER.

This article is subject to counterfeit. A spurious pepper is made of oil cakes, (the residue of linseed after expression,) common clay, and a portion of cayenne pepper. These are formed into a mass, granulated by means of sieves, and then rolled in a cask. But these artificial pepper corns, the moment water is poured upon them, fall to pieces, whereas the genuine pepper remains whole.

White pepper is prepared from the black pepper. The process consists merely in removing the rind, or outer bark. This is performed by steeping it in sea water or brine, till the rind softens, which is then detached by rubbing it with the hand. White pepper does not communicate any colour to water, but black pepper infused in water gives it a brown colour, which reddens vegetable blues, and has the odour and taste of pepper. Alcohol, when digested on it, acquires a light yellow green colour. By distillation it furnishes an essential oil, which is soluble in alco-



hol, and when the solution is diluted, is extremely pleasant. A decoction of pepper treated with an infusion of nut-galls, gives a precipitate, which dissolves at 120 deg. Hence pepper contains fecula, as well as essential oil, and extractive matter.

## PIMENTO.

Allspice, or pimento, is the berry of the Jamaica pepper tree, (*myrtus pimento*.) They are gathered at a certain season, and dried, and put into bags for exportation. Some planters kiln-dry them. The pimento which grows in the Spanish dominions, is inferior to the Jamaica; the berry is larger, and possesses a weaker aromatic flavour. Allspice is so called from its resemblance in smell and taste to cloves, juniper berries, cinnamon, and pepper.

As there is so great an affinity between this and the true clove, it has been proposed as worthy of trial, if the fruit, when first ripe, or the flowers picked off the tree, and dried, might not answer the same purpose as the Asiatic.

Allspice should yield on distillation, an aromatic oil, and when digested in alcohol afford a pungent tincture.

If counterfeited by oil cake, &c. as the black pepper, the fraud may be discovered in the same manner.



## CAYENNE PEPPER.

Many species of the capsicum are used for Cayenne pepper. The pods, when dry, are pulverised. It is sometimes adulterated with the red oxyde of lead, which may be known by treating the powder with sulphuretted hepatic water, as already described. If one part of the suspected pepper, and three parts of nitrate of potash, are projected into a red-hot crucible, in small quantities at a time, the vegetable part will be entirely destroyed; and the residue, when dissolved in nitric or acetic acid, may be examined for lead in the usual manner. Red saunders are also used to increase its quantity.

The *capsicum frutescens*, commonly called Barbary pepper, is used for making, what the author of the *Dictionary of Merchandise* calls, "pepper pots." We do not know of any particular advantage in preparing the capsicum in the manner mentioned by him; but as it may be useful to some persons, we here introduce it. (*Dictionary of Merchandise*, p. 163.)

"Take the ripe seeds of this sort of capsicum, and dry them well in the sun, then put them into an earthen or stone pot, mixing flour between every stratum of pods, and put them into an oven after the baking of bread, that they may be thoroughly dried; after which they must be well cleansed from the flour, and reduced to a fine powder: to every ounce of this add a pound of wheat flour, and as much leaven as is sufficient for the quantity intended. After this has been properly mixed and wrought, it



should be made into small cakes, and baked, then cut into small parts, and baked again, that they may be as hard and as dry as biscuits, which being powdered and sifted, is to be kept for use. The spice is prodigiously hot and acrimonious, setting the mouth as it were on fire.

### POISONOUS PICKLES.

A variety of vegetable substances are pickled, as gerkins, beans, samphire (both the *crithmum maritimum* and *salicornia*,) the green pods of capsicum, &c. besides the cucumber.

In consequence of the different directions for the preparation of pickles, especially for communicating a lively green colour, they differ very considerably in taste and appearance.

The use of copper, or of copper kettles, is highly pernicious. Copper or brazen vessels are usually employed for the *scalding* of vinegar, as it is called, previously to its being poured on the cucumber, or other vegetable intended to be pickled.

Books on cooking recommend certain formulæ, in which copper is used in some shape as the *colouring* ingredient ; as, for instance, boiling the pickles or the vinegar with copper coin, or suffering them to remain a given time in brazen vessels.

There are cases recorded of serious accidents having occurred by eating of pickles *greened* with copper. A young lady, while dressing her hair, amused herself by eating a samphire pickle prepared in that



manner; she suffered most excruciating pain, lingered a few days and expired!

There are two recipes in particular, which we shall notice, for greenening with copper. One is in the *Modern Cookery*, which is a solution of verdigrise in vingar; the other is in the *English Housekeeper*, by boiling the pickles with half pence.

It is now, however, generally known and admitted, that copper is decidedly poisonous, and hence these recipes are not used. But the practice of boiling or scalding vinegar in brass kettles, and then pouring it on the cucumbers, previously soaked in a solution of common salt, is still pursued in many families. We will here remark, that in all these instances, the *green* colour is imparted by acetate of copper, which is formed.

Wholesome pickles may be made by soaking the cucumbers first in salt and water, and putting them with cider vinegar and cabbage leaves into stone ware jars, which have not been glazed with lead.—The cabbage furnishes the green vegetable matter, which, with the acid, is absorbed by the pickles.—The jars ought to be kept in a moderate temperature. Pickles made in this manner, neither contain lead nor copper. A *small* portion of alum will not injure the pickles; but, on the contrary, make them more firm.

The addition of alum it is known increases the acidity of vinegar, and is frequently added by fraudulent vinegar-makers. But its detection is easy, as will be shown in the following article. Alum contains



nothing deleterious; and, therefore, in the preparation of pickles, for the reason already given, a small portion may be added with advantage.

The detection of copper in pickles may be accomplished by mincing a piece, and putting it into a phial with diluted water of ammonia; if the minutest quantity of copper be present, the ammonia will assume a blue colour. If a portion of this blue solution (*ammoniacet of copper*,) be mixed with a solution of arsenious acid, a yellowish green arsenite of copper (*Scheele's green*,) will be precipitated. If lead be suspected, the pickle may be macerated in aqueous sulphuretted hydrogen.

## PREPARATION AND ADULTERATION OF VINEGAR.

Vinegar is the product of the acetous fermentation,\* and is composed of acetic acid, water, and

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\* Notwithstanding vinegar is the product of the acetous fermentation, there is one remarkable exception, which is mentioned by Fourcroy and Vauquelin, namely, that when the gluten of wheat is fermented and mixed with sugar, the liquor is converted into vinegar without fermentation, without effervescence, and without the contact of air. This phenomena has not been explained. We may remark here, that acetic acid is developed with other substances by the spontaneous decomposition of perine, and by the action of concentrated sulphuric acid on vegetable substances. The destructive distillation of sugar, gum, wood, &c. also produces it, and, as it is generated by fire, more or less empyreumatic, &c. it was distinguished by the names of pyromucous and pyroligneous acids. See *Wood Vinegar*.



more or less mucilaginous and colouring matter, from which it is separated by distillation. The distillation should be conducted in glass retorts, if we wish to have the distilled vinegar pure; because, if we employ a common still, with a pewter worm, it is apt to contract some of the lead, as the pewter of which it is made (ley-pewter) contains more than a fifth part of its weight of lead.

When vinegar is distilled, the temperature ought not to exceed that of boiling water, and two thirds or five sixths at most, drawn off. The residuum is still an acid liquid. The product is acetic acid diluted with water. Mr. Chenevix has shown, that it still contains a peculiar mucilaginous and extractive matter, and traces of a spiritous liquor.

The specific quantity of vinegar varies from 1. 0135 to 1. 0251.

The strength of vinegar, whether cider, wine, or malt vinegar, depends entirely on the quantity of acetic acid it contains; and may be ascertained by knowing the quantity of alkali or earth, a fluid ounce, or any given quantity, will saturate. This will form a standard of comparison.

One ounce, by measure, should dissolve at least 13 grains of white marble.

Mr. Phillips, (*Pharm. Lond.* p. 7,) states, that English malt vinegar, sp. gr. 1.0204, when distilled, should dissolve carbonate of lime as follows: a fluid ounce (1.8047 cub. in.) of the first eighth which comes over, sp. gr. 0.99712, from 4.5 to 5 grains; the next six eighths, sp. gr. 1.0023, should dissolve



8.12 grains of the precipitated carbonate of lime ; and fluid ounce of acid, sp. gr. 1.007 dissolve from 15 to 16 grains precipitated carbonate of lime, or 13.8 grains of marble.

The purified wood vinegar, which is also used for culinary purposes, has usually a specific gravity of about 1.009, which is said to be equivalent to good wine or malt vinegar of 1.014. It contains 19-20ths of water, and 1-20th of absolute acetic acid. In England a duty of 4d. is levied on every gallon of vinegar of the above strength. The acetometer, a kind of hydrometer, is used for the purpose.

In a large manufactory of malt vinegar, a considerable revenue is derived from the sale of yeast.

Dr. Thatcher, in his *Dispensatory*, observes, that “besides pure acetous acid, vinegar contains tartareous acid, tartrate of potash, mucilaginous matter, and sometimes phosphoric acid.”

The existence of the tartareous acid, and of tartrite potash, in *some* vinegar, may be detected, as in the wine and gooseberry vinegar ; but they do not constitute essentially a part of vinegar, neither are they found in cider or malt vinegar. Vinegar, however, is liable to decomposition ; but Scheele found that if it be boiled for a few minutes, it may be kept a long time without alteration ; hence it is usually boiled, filtered, and bottled for preservation. In consequence of its antiquity, as it is mentioned by Moses, and was in common use among the eastern nations, the art of preparing it was known at an early period.

Vinegar is the result of the acetous fermentation ; the conditions necessary for which, are saccharine



and mucilaginous matter, with perhaps gluten, a due degree of heat, and exposure of the fluid to air.— Thus beer, ale, &c. undergo this change, and form vinegar. Cider, which furnishes the best, is also subject to it; and wine, it is known, produces a colourless vinegar.

The vinous fermentation usually precedes the acetous; and the latter invariably follows when the quantity of alcohol is small, and the proportion of mucilage and extractive matter considerable.— The principal object of using hops, besides imparting a bitter taste to beer, is to preserve it from the acetous fermentation; and the quantity of hops, for that reason, is increased for summer ale or beer. In the vinous fermentation there is a large quantity of carbonic acid gas generated, during the formation of alcohol; in the acetous, oxygen is absorbed, which combines with carbon and hydrogen in due proportions, and forms acetic acid. This acid, thus generated, is diluted with water, and mixed with redundant mucilaginous and other substances.

According to Cadet, if 1 part of sugar be dissolved in 7 parts of water, and fermented with yeast in a proper temperature, an excellent vinegar will be formed; but if the sugar exceed an eighth part, the whole is not decomposed.

Before we notice the adulteration of vinegar, some remarks concerning some of its preparations may be important. There is a very useful preparation of vinegar, which is very agreeable as a beverage in the summer season, by mixing an ounce or two of it with a glass of water. This preparation is the sirup



of vinegar. It is made by boiling two pounds of sugar in four or five quarts of vinegar down to a sirup. It is nearly equal to the sirup of lime juice, and, in point of cheapness, is recommended as an economical, and at the same time a healthy drink. With a portion of brandy, it makes a punch little inferior to that prepared with lemon juice or sirup. In garrisons and on board of ships, sirup of vinegar should always be kept. A preparation of vinegar, called aromatic spirit of vinegar, was invented by Mr. Henry, of Manchester, England. The pungent smelling salt is of a similar nature. It is not the sal volatile ammonia, usually called smelling salts, but merely sulphate of potash impregnated with acetic acid or radical vinegar. The acetic acid of the apothecaries, which contains a little camphor, or fragrant essential oil, and composed fully of one of part of water and two parts of crystallized acid, has a specific gravity of about 1.070. The aromatic vinegar of Henry, is nothing more than concentrated vinegar combined with aromatics. Many attempts, it appears, have been made to imitate this vinegar. In the *London Monthly Magazine*, 1812, the following methods are given: Put acetate of copper (distilled verdigrease) into a retort, pour sulphuric acid upon it, apply heat, and collect the acetic acid. When scented with an aromatic oil, it furnishes the preparation of Henry.—Acetic acid may also be formed by distilling acetate of lead with sulphuric acid, in the same manner. But the author of the communication in the *Magazine*, assures us, that he has formed it extemporaneously



by putting a portion of acetate of potash (*sal diureticus*,) into a smelling bottle, adding gradually half its weight of sulphuric acid, and afterwards a drop or two of the essence of bergamot, or oil of lavender. This aromatic vinegar is said, by its pungent odour, to afford relief in head aches and faintings; and is peculiarly grateful and refreshing in crowded rooms, and in the apartments of the sick. We may remark, also, that there is another preparation called the vinegar of the four thieves, which is made by infusing sundry aromatic herbs in vinegar; it was used to prevent the effects of contagion.

Vinegar may be considerably concentrated by freezing it; the watery part will congeal, and leave the stronger acid. If perfectly dry charcoal be saturated with common vinegar, and distilled, water will first come over, which is to be thrown away, and by increasing the heat a very concentrated acid will be obtained.

Among the remarkable properties of charcoal, that of producing the discolouration of vinegar may be mentioned. It is found, that if an ounce and a half of charcoal be mixed with a quart of common vinegar, a thick froth will rise to the surface, and in twenty-four hours, it will begin to lose its colour; and in three or four days it will be found, after filtration, to be quite clear and colourless. This process may be advantageously used in the purification of vinegar upon a large scale. Vinegar treated in this manner, will certainly keep longer, without becoming mouldy and vapid.



Acrid vegetables are sometimes infused in vinegar, with the intention of making it appear stronger; but the pungency and taste of vinegar, thus treated, will be found to depend on acrimony more than acidity.

But with the view of giving it more acidity, in a cheap manner, some vinegar makers and retailers have been in the practice of adding sulphuric acid, or a solution of the supersulphate of alumina and potash. This fraud may be discovered by the soluble salts of barytes. If we pour some of the acetate of barytes into vinegar, thus adulterated, it will produce a white precipitate of sulphate of barytes; which, after being made red hot, will be insoluble in nitric acid. The detection of alumina and potash, if alum had been used, is effected by adding ammonia, which will throw down the alumina; and, to another portion, muriate of platinum, which will also produce a precipitate,—thus indicating the existence of that alkali.

Muriatic acid may be known by acetate of silver, producing a precipitate of muriate of silver.

If nitric acid is used for the purpose, the detection is not so easy, as we have no immediate re-agent or precipitant, by which it can be identified. Nevertheless, it may be detected by saturating the vinegar with potash, and evaporating it to dryness, and exposing the mass to the action of heat with a portion of sulphuric acid, when the well known fumes of nitric acid will be disengaged, recognised by their colour and smell. Acetic acid, or pyroacetic acid will also be disengaged. A small portion of the dry mass,



consisting of nitrate and acetate of potash, if thrown on ignited coals will deflagrate like salt petre. Acetate of potash would not produce a detonation, neither would muriate or sulphate of potash, salts that are also formed if the muriatic or sulphuric acid is present; but, on the contrary, a decripitation would be the consequence.

In a word, vinegar should neither precipitate acetate of barytes, nor acetate of silver; neither water impregnated with sulphuretted hydrogen gas, nor liquid ammonia; but should saturate a given quantity of carbonate of lime, as a criterion of the proportion of acetic acid which it ought to contain.

### WOOD VINEGAR.

Although vinegar is the result of the acetous fermentation, a process which generally follows the vinous, and is usually made by exposing certain fluids, as cider, to the action of air under an increased temperature, yet a crude vinegar has long been prepared for dyers and calico printers, by the destructive distillation of wood in iron retorts. In the charring of wood in iron cylinders, a practice more generally adopted by gun powder makers, in order to prepare a more pure and perfect coal, a large quantity of wood vinegar or pyroligneous acid is formed, which is now collected, and purified for use. The manufacture of wood vinegar is a regular business in Europe; and to no person are we more indebted than to the late Dr. Bollman for the process of freeing it from tar, and em-



pyreumatic oil, and rendering it fit for all the purposes of common vinegar. It is purified by distillation, combining it with lime, and torrifying the acetate of lime, and lastly, decomposing the calcareous salt (acetate of lime,) by sulphuric acid. A better mode consists in decomposing the acetate of lime by sulphate of soda, separating the sulphate of lime thus formed by filtration, and after evaporating the acetate of soda to dryness, distilling it with sulphuric acid. The acetic acid may be diluted with water, and reduced to any required strength. Fourcroy and Vauquelin having shown, that this acid is merely the acetic, contaminated with empyreumatic oil and tar, it is obvious that its purification depends on the separation of these substances, when it approaches to ordinary vinegar. Wood vinegar possesses many advantages over the ordinary kind. It may be kept in a more concentrated state, and diluted as occasion requires. It possesses a property which is peculiar to it, namely, that of preventing the putrifaction of animal substances, a property discovered by Mr. Monge. It is hardly necessary to mention, that, for the preservation of meat, it has already been extensively used. It is sufficient to plunge meat for a few moments into this acid, even slightly empyreumatic, to preserve it for any length of time. This effect is attributed to the presence of empyreumatic oil; and the preservation of meat, fish, &c. by smoking, is on the same principle.

The presence of sulphuric acid, alum, &c. may be detected in the same manner as in common vine-



gar. Concentrated wood vinegar is particularly calculated to take to sea. In consequence of its concentration, it is more portable, and may be diluted when required. Parry, in his voyage to the north pole, found it particularly useful.

Although wood vinegar is considered a recent discovery, yet it appears (*Jour. Royal Instit.* no. 16,) that it was known as early as 1661, and its property of converting minium into sugar of lead.

On the principle that meat is cured by smoking, which depends on the action of pyroligneous acid, which is disengaged by the slow and imperfect combustion of the fuel; we are informed (*Bul. d'Encour.* Aug. 1821,) that meat, after it has been salted, may be preserved by dipping it into an aqueous infusion of wood soot. Three pounds of beef require a pound of soot. This quantity is put into half a gallon of water, and macerated for 24 hours. It is then decanted. In this infusion the meat remains half an hour, and is then removed, and dried in the air. It is found that a pound of soot will strongly impregnate two quarts of water, and that the water is charged with 1-25th of its weight of acid, of the soot.

## ADULTERATION OF MILK AND CREAM.

Cream, we are told, is frequently adulterated with rice powder, or arrow root. The latter when boiled with milk, and the compound added to cream dilut-



ed with milk, is said to impart a richness without materially impairing the taste of the cream.

Two hundred and twenty to two hundred and thirty grains of arrow root, when mixed with one pint of milk in this manner, and the *solution* added to three times its quantity of cream, will produce a compound which many prefer to cream alone. But the fraud, when it is used as such, may be detected by adding a solution of iodine to a portion of the suspected cream; if it contain that fecula, it will produce a dark blue colour.\* The presence of chalk in milk may be discovered by the tests for lime and carbonic acid: chalk, however, will not be held in solution, but merely suspended.

Adding water to milk is a common practice with the dealers in that article, the detection of which is difficult. The quantity of curd furnished respectively by pure milk, and watered milk, may indicate the proportion of water; for the diminution in the proportion of curd in the latter instance, will be according to the degree of dilution, admitting that milk is uniform in the quantity of curd it contains. The instrument called the *lactometer*, we are told, is calculated to determine the proportion of curd and whey in milk; but we have not seen the instrument, and therefore can say nothing as to the fact. The detec-

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\*Iodine and starch are tests for each other. Iodine produces with it an ioduret, or iodide of starch. Water containing merely one grain of iodine to the quart, will *instantly* acquire a blue colour by the addition of a small portion of starch paste. Starch will thus indicate 1-450,000th part of iodine.



tion of water in milk has been attempted by freezing it, a method lately recommended in a newspaper ; and some have advised the use of the hydrometer, believing that pure milk is much heavier than diluted or watered milk. Neither of these trials can be depended upon, for the following reason: the boiling and freezing points of milk are nearly the same as those of water, but they vary a few degrees in different milks, and although milk is specifically heavier than water, the precise degree cannot be ascertained, as it seems from some experiments that every particular milk has a specific gravity peculiar to itself.

Pure cream is of a yellow colour, and its consistence increases by exposure to the atmosphere. If the exposure is for any considerable time, it will have no longer the flavour of cream, but of very fat cheese ; it is then in fact, *cream cheese*.

Cream possesses many of the properties of an oil. It is specifically lighter than water, has an unctious feel, and stains clothes precisely in the same manner as oil. It is neither soluble in alcohol nor oils. It is composed of a peculiar oil, curd, and serum; the first is well known by the name of *butter*, which is separated by the operation of churning.

It is said that cream may be preserved for many months by boiling it with sugar, in the proportion of one pint to an ounce, keeping it at the same time secluded from the air.

The Corstorphon cream, so called by the inhabitants of Mid-Lothian, from a village of that name, is said to be an agreeable preparation of cream, and



sold in Edinburgh by the name of sweet cream. The process is as follows :—

Take skimmed milk that has only acquired a moderately acid taste ; put it in an upright wooden vessel, (an upright churn is commonly used) having a spicket and fosset at the bottom : place that in a tub, and pour hot water into the tub till it rises nearly as high as the milk in the containing vessel. Cover the whole with a cloth to keep in the heat. In a few hours the milk separates into two parts ; the upper part assuming the consistence of thick cream, that has very much the appearance of good cream, only moderately acid ; the other portion that remains is a thin watery liquid, which is of a pungent acid taste, and may be easily let off by means of a spicket ; this liquid is called wigg. The cream is then fit for use.

Speaking of this preparation, Dr. Mease, (*Archives of Discoveries*, vol. iii. p. 269,) remarks that, “ No one would believe that it did not consist wholly of real cream that had stood till it became acid. Much of the goodness of this, however, depends upon the skill of the maker ; as it is greatly affected by various circumstances, particularly the degree of heat to which it is subjected, and the acidity of the milk. It is eaten with sugar as a great delicacy.”

## HONEY.

The most anciently used and one of the most grateful of all the saccharine juices, is a natural compound, according to Mr. Cavezzali, of sugar, mucic-



lage, and an acid. The sugar may be obtained by melting the honey, adding carbonate of lime in powder as long as any effervescence appears, and scumming the solution while hot. The liquid on standing will gradually deposite crystals of sugar. It is said the sugar is analogous to that of grapes. Mr. Proust observes, that there are two kinds of honey; one always liquid, and the other solid, and not deliquescent. They may be separated he says, by means of alcohol. If Mr. Seguin's experiments are correct, honey must also contain albumen, since substances, which are susceptible of fermentation without yeast, seem, in his opinion, to owe it to their albumen. The clarified honey is nothing more than honey liquified, and separated from its serum.

Aristæus, a pupil of Chiron, is said to have first gathered this vegetable juice collected by the bee from various plants, and deposited in the cells of its comb. The honey bee is the *apis mellifica* of Linnæus. The honey which separates without expression, contains a less proportion of wax, and is of a thick consistence, a white colour, and of a more pleasant taste. The colour and flavour of honey, however, depends on the plants which the bees prefer. The honey of young bees, when obtained without expression, is called virgin honey; but the honey of old bees pressed from the wax is yellow.\*

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\*The best sort of French virgin honey, is that of Languedoc, called honey of Narbonne. It should be thick, granulated, of a clear transparent white colour, of a soft somewhat aromatic smell, and of a sweet and lively taste. If it is very pure, and ab-



Several circumstances contribute to the goodness of honey. Where the bee hives are fixed, aromatic plants, particularly thyme, lavender, violets, primroses, baum, sage, and borage should abound. It ought to be observed, that all honey is not wholesome. Bees indiscriminately sip the flowers of *all* plants which abound with *sweet* matter, whether it be from innocent flowers, or those actually noxious. As some of these plants are of a poisonous nature, it follows that the honey must partake of their injurious qualities. The late professor *Barton* has written an excellent paper on the subject, in the *Transactions of the American Philosophical Society*, vol. v. Poisonous honey is very common in the West Indies ; but we seldom find our honey of this quality.

The plants affording this poisonous honey, are the dwarf laurel, (*kalmia angustifolia*,) the great laurel, (*kalmia latifolia*,) the broad leaved moor wort, (*andromeda marina*,) and the *kal hisuta*, a little shrub

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most as hard as sugar-candy ; and what renders it so superior, are the many aromatic flowers which grow in those parts, and from which the bees gather their honey. It is observed that honey made in mountainous countries is more highly flavoured than that of low grounds.

Vanden Heuvel, (*Silliman's Journal*, III. 34,) speaks of the South American and West Indian honey ; and of the " ardent sun of the tropics, which generates in all vegetable bodies an increased portion of saccharine matter, which decks the woods and groves with an endless display of blossoms and flowers, of aromatic and nectareous fragrance, and distils from the trees of the forest in luxious streams those balmy juices with which it surcharges them, furnishes a region where bees may luxuriate in a wilderness of sweets !"



of the southern states. Dr. Barton is of opinion, that it will be found that other plants yield unwholesome honey ; such as the Pennsylvania mountain laurel, (*Rhododendron maximum*,) the wild honey suckle, (*azalea nudiflora*,) and the common James-stown weed, (*datura stramonium*.) The four first plants ought to be extirpated in the neighbourhood of the bee hives ; and the honey procured from the three enumerated in the second place as suspicious, should be carefully examined, to determine the fact with regard to them.

The goodness of honey for culinary purposes is generally determined by the delicacy of flavour, but the comparative quantities of sugar, and other chemical differences have not been much examined.

Owing to the abundant quantity of sugar and mucilage, in the composition of honey, added to the presence of albumen, according to Seguin ; when honey is mixed with water, it readily undergoes the vinous fermentation, and produces the well known beverage called hydromel, or mead. Thirty-six ounces of honey, and four quarts of warm water, produced a mead by fermentation, which gave Newman 8 ounces of strong alcohol. On this principle honey improves cider.

Several experiments have been made on the clarification &c. of honey, by Mr. Lowitz and others, which cannot be interesting to us at this time ; but with regard to the acetification of honey, or converting it into vinegar, it may be useful, perhaps, to add, that by making a mixture of honey and water, in the



proportion of about one part of the former to eight of the latter, and allowing it to pass through the acetic fermentation, a white vinegar will be formed, which in many respects is superior to the ordinary vinegar.

Honey is often adulterated with *flour*, which may be detected by diffusing it in blood warm water, by which all the honey will be dissolved, and the flour remain nearly unaltered, and a subsequent boiling of the residue will convert the flour into thick paste.

Good honey has usually a solid, or a soft, consistence, and is of a pale yellow colour, with an agreeable aromatic flavour.

We may observe, that the ancients applied honey to various uses. The most celebrated was the honey of Hybla. They used this honey as a delicacy, although sometimes they fermented it for beverage. Hydromel, or mead, appears to have been a very ancient drink; and if well prepared, is undoubtedly pleasant and wholesome, and in summer, particularly grateful, owing to the large quantity of carbonic acid gas, which it contains. This, however, depends on the *time* of bottling, and some other minutæ, which can only be acquired by practice.

Professor Beckman, (*History of Inventions*, vol. ii, p. 49,) observes, that the practice of putting dead bodies in honey, for the purpose of securing them from putrefaction, is very ancient, and was used at an early period by the Assyrians. The body of Agesipolis, king of Sparta, who died in Macedonia, was sent home in honey, as were also the bodies of



Agesilaus, and Aristobulus. The faithless Cleomenes caused the head of Archonides to be put in honey, and had it always placed near him when he was deliberating upon any affair of great importance, in order to fulfil the oaths he had made to undertake nothing without consulting his head. According to some authors, the body of Alexander the Great, was deposited in honey, though it is generally believed it was embalmed according to the manner of the Egyptians. The body of the emperor Justin ii, was placed in honey mixed with spices. Democritus desired to be buried in honey. Besides the use of honey in this manner, it was often applied in ancient times to purposes for which we use sugar; and also, for the preservation of fruit, the celebrated purple dye, sundry worms and insects, and other natural curiosities, such as the *hippocentaur*. In later times it has also been employed for the same purpose, as is proved, in the opinion of Beckman, by the account given by *Alexander ab Alexandro*, respecting the supposed *mermen*.

It may appear remarkable, that so long ago as the time of Solon, *bee-hives* were regulated by certain laws. Solon made a law, that "whosoever placeth a hive of bees, should observe the distance of thirty feet from those that were before placed by his neighbour."

### NUTMEGS.

Nutmeg is the produce of the *myristica officinalis*, or *moschata*. It is said to have been known to the



ancients, and to have been the *comacum* of Theophrastus. Nutmegs, preserved entire, are introduced in India with tea, but the mace and pulp are only eaten : the nut is thrown away. Newman procured from 1920 parts, 480 of spiritous, and 280 of watery extract, with 320 of oil. The last two were insipid. By distillation with water, nutmegs yield nearly one tenth of their weight of a limpid essential oil. On the surface of the remaining liquor an unctuous concrete, like tallow, swims, of a white colour, nearly insipid, but used as a basis for odoriferous balsams. Alcohol takes up the whole smell and taste, and assumes a bright yellow colour. When the *genuine* nutmeg is heated, and strongly pressed, it gives out a fluid yellow oil, which concretes on growing cold. A counterfeit nutmeg has been prepared, composed of oil cake and oil of mace, made into the shape, &c. of the real. But the fraud is readily detected by merely cutting it, as the difference in appearance will be at once obvious. It may be also examined by boiling it; it will fall to pieces, whereas the genuine will remain whole. We have heard, indeed, of counterfeit *wooden* nutmegs, made so artfully out of solid wood, coloured and scented, as to defy detection by the eye; but the labour and pains required in cutting the wood, would not, it appears to me, recompense the counterfeiter!

Mace, which constitutes one of the coverings of the nutmeg, furnishes an oil. Nutmegs, we remarked, heated and strongly pressed, will give out a fluid oil, which concretes into a sebaceous



consistence; this is the *genuine* oil of mace; but in the shops, there are generally three sorts.—The best, brought from the East Indies in stonejars, is softish, of a yellowish colour, an agreeable fragrance, greatly resembling that of the nutmeg itself, but of the colour of mace. The next, from Holland, in solid masses, of a paler colour, having a weaker smell, and inferior to that of India. The last is altogether an adulteration, or rather, counterfeit; composed of suet or palm oil, flavoured with a little of the genuine oil of nutmeg.

The expressed oil contains both the solid and volatile oil of the nutmeg.

### POISONOUS CONFECTIONARY.

The art of the confectioner is employed in many different operations. Although in the preparation of cake, creams, jellys, &c. we have little reason to expect fraudulent adulterations, and especially the addition of deleterious substances, knowing them to be such; yet instances have occurred, through negligence, where copper has gained admission, in consequence, no doubt, of the vessels made use of not having been properly cleansed. All acid fruits, as well as sebaceous substances, should never be prepared in copper vessels; pies, for instance, made with crust containing a large quantity of butter, as equal parts of flour and butter, a proportion frequently used for *short* crust, when baked in pans of that description, must contract a portion of metal.—



Cranberry, and other acid fruit, stewed in copper pans, have been known to produce colics, &c.

The use of sundry colouring substances for cakes, plums, &c. is common. It is observed, that sugar plums, which consist entirely of sugar and starch, are frequently adulterated in England with pipe clay; a fraud which may be readily detected, by dissolving them in water. This addition is harmless, although it is a foreign ingredient in the composition.

Red sugar plums are usually coloured with vermillion, which is frequently adulterated with red lead; the blue iceings are generally coloured with Prussian blue; the green, by employing the juice of the buckthorn berry, which forms the sap green; the yellow, by using infusions of saffron and turmeric; and, in short, a variety of vegetable and mineral colours are employed.

Certain vegetable colours are inert. This is the case with turmeric, saffron, and red-wood, and with the insect called cochineal. But sap green, as well as Prussian blue, are frequently adulterated; the former with some preparation of copper, and the latter, sometimes with indigo. Foreign conserves, such as limes, citrons, plums, &c. are frequently impregnated with copper.

The art of *increasing* the quantity of ice cream, from a given quantity of cream, or the particular mode of preparing milk in lieu of cream, and of augmenting the quantity of jelly from calves' feet by the use of inferior fish glue, &c. is known to, and frequently practised by, the confectioner. Thus, by



using boiled milk, with occasionally the addition of sugar, a rich milk is formed, which, when frozen, has all the characters of the genuine ice cream. The different kinds of cream, as the vanilla, lemon, strawberry, &c. are formed by extracting from these substances the flavour, colour, &c. either by previous digestion, or expression, according to circumstances. The freezing of the cream depends on a well known principle, that of the abstraction of free caloric by means of ice and common salt, a freezing mixture used in such cases.

Although, as we remarked, few instances have occurred of the wilful introduction of deleterious substances into pies or pastry, yet instances are recorded in which arsenic itself was sprinkled over desserts.

Morgagne informs us, that an Italian feast the dessert was purposely sprinkled over with arsenic instead of flour. Those of the guests who had previously ate and drank little speedily perished; those who had their stomachs *well filled*, were saved by vomiting. He also mentions the case of three children, who ate a vegetable soup poisoned with arsenic.

The detection of arsenic will be considered when we treat of mineral poisons.

Secret poisons were frequently given to *guests* even at private entertainments. Beckman, in his *History of Inventions*, says, "that Pope Alexander VI, died in the year 1503, and Cæsar Borgia recovered without any loss of health, though, by the bottle's be-



ing changed by mistake, he drank of the poison that had been prepared for the other guests alone."

## POISONOUS FISH.

Very frequently fish partake of a poisonous quality, and with some constitutions what is inoffensive, is to others decidedly deleterious. In warm climates we meet with fish possessed of the most deleterious quality. The barracuda, (*perea major*,) king fish, (*xiphias*,) cavallee, (*scamber*,) rock fish, (*perca marina*,) smooth bottle fish, (*ostracion glabellum*,) and yellow sprat, are the fish most to be apprehended. The poisonous virus is so great in the latter, that it has been known in several instances to destroy life in half an hour, by exciting dreadful convulsions.—The Conger eel and some other fish, particularly of the shell kind, that feed on the leaves of the machine-eel-tree, are also frequently poisonous, and productive of violent cholera.

The cause of the deleterious quality of fish, in all cases, is uncertain; some suppose the fish even to be a different species; others, that it is owing to their food; and some, again, attribute the poison to the existence of *copper banks*, on which they feed. It is supposed that the poison lies in the intestinal tube of the fish, and is assimilated with its food, and circulates without any detriment to the fish. Certain and rapid death has been produced by eating the *yellow bill sprat*. It is necessary at all times to relieve the patient by an emetic, either of tartar emetic



or sulphate of zinc, using copious diluent draughts, and spiritous cordials, or even brandy and water. It has been observed, that those who have taken a quantity of rum or brandy after eating fish of this nature, have suffered considerably less than those who neglected that precaution.

Fish forms a great part of the diet of the inhabitants of the West Indies, where they are most frequently deleterious. To be able to distinguish those of a poisonous nature from such as are wholesome, the surest criterion is to give the entrails to a dog or cat, and if after an hour or two no disorder arises, the fish may be eaten with safety. A method much practised is, to put a silver spoon sometime into the water in which the fish is boiling, and if, upon taking out the spoon it appears unsullied, the fish is supposed to be safe; but if the colour be at all changed, it is then judged unwholesome. This test, it is very justly remarked, should never be depended upon.—Fishermen assure us, that fish that have no scales are most apt to prove poisonous. The *mytilus edulis* or muscle, is said to feed occasionally on a deleterious insect. The *conger-eel*, &c, are deprived of their rankness by washing and salting.

The poisonous effects of muscles, lobsters, &c. may be obviated by taking a smart emetic, which should be administered as quickly as possible, and afterwards the patient may take the acetous acid, and also milk. The subject of antidotes, in connection with that of poisons, we purpose to consider in our lecture on the detection of mineral poisons.



## POISONOUS CATSUP.

Catsup, from the manner it is frequently prepared, is often contaminated with copper. In London, Mr. Accum assures us, that catsup is often nothing else than the residue left after the distillation of vinegar, mixed with a decoction of the outer green husk of the walnut, and seasoned with allspice, &c.

The presence of copper may be detected by adding to a portion of the catsup some liquid ammonia.

We will have occasion to mention hereafter mushroom catsup. In the mean time it may not be amiss to remark, that we consider the *tumatos* catsup, if properly made, as equal to the mushroom; and there is less liability to accidents in making it with the *tumatos*, than with mushrooms, which may have been very old, and probably the introduction of poisonous fungus by mistake. The *tumatos* catsup is usually prepared by mashing them, and digesting them with salt for some hours; then straining the fluid, and boiling it with sundry aromatics, as allspice, cloves, and cinnamon, with or without the addition of vinegar, according to taste or fancy. As a condiment, this catsup possesses all the qualities of the mushroom or walnut.

## SUNDRY OTHER POISONS AND ADULTERATIONS.

The leaves of the cherry laurel, *prunus lauro-cerasus*, a poisonous plant, which have the flavour of



peach stones or bitter almonds, have been used in cooking, on account of their flavour.\* Custards, puddings, creams, *blanc-mange*, &c. frequently receive their flavour from these leaves.

Families have been dangerously poisoned by using the cherry laurel. When the leaves of this plant are distilled with water, they form the cherry laurel water, which is frequently mixed with brandy and other spiritous liquors, to imitate or impart the flavour of *noyau*. Cordials are indeed sometimes poisonous. *Noyeau* especially, which contains the flavour of the peach stone and bitter almond, with that of the cherry laurel, and is formed by distilling "*a spirit*," from these substances, is impregnated with the hydrocyanic or prussic acid, which exists abundantly in the leaves of several plants, and in the bitter kernels of some fruits. Instant death has followed the drinking a single glass of *noyau*, supposed to have contained a large quantity of prussic acid. The leaves of the peach (*amygdalus persica*,) occasionally employed in cooking, ought to be used with great caution.

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\*The truth is, the *prunus lauro-cerasus*, in consequence of containing prussic acid, has been used in the place of the latter in some cases of *phthisis pulmonalis*. Dr. Oliver, in *Silliman's Journal*, iii p. 184, remarks, that he used the laurel water with success; but being exhausted of the water, he procured some of the leaves of the *lauro-cerasus*, and made a tincture, which had the same effect as the water; and finally, wishing to use the *efficient principle* of the *lauro-cerasus*, he procured the prussic acid.



*Anchovy sauce* has been found contaminated with lead. This has occurred in consequence of employing venetian red, as a colouring, which was adulterated with orange red, a preparation of lead. Armenian bole, an innocent earth, is however more generally used than venetian red.

*Lozenges, comfits, ginger pearls*, and other articles of this nature, are often adulterated with pipe clay, which may be detected by simply dissolving them in a large quantity of boiling water. The clay will afterwards subside, and may be known by its becoming hard like brick when burnt.

*Olive oil* is frequently deleterious, by being contaminated with lead, in consequence of the oil having been expressed from the olive between leaden plates, or by allowing it to clear in leaden cisterns. The French and Italian olive oil, it is observed, is free from this impregnation. Olive oil is said to be often adulterated with the oil of poppy-seeds, in order to preserve it from rancidity. The method recommended for its detection, is by submitting the oil to the freezing temperature, which will freeze the *olive oil*, and leave that of the poppy-seeds in a fluid state. The presence of lead may be shown by mixing the suspected oil with water impregnated with sulphuretted hydrogen gas, which will cause the well known brown colour. See Lecture VI.

*Mustard* when bought in the state of flour, is frequently sophisticated, and this is known to be particularly the case with the imported Durham mustard.



The adulteration, however, is by no means injurious. The Durham mustard is usually a mixture of mustard and common wheat flour, with a portion of cayenne pepper. The fine yellow is given to mustard seed by grinding it with turmeric. Turmeric may be detected by adding to the mustard a few drops of a solution of potash, which will change the bright yellow to a brown. The mustard, which is sold in pots, is made of the same materials as the Durham, with the addition of bay salt. We do not know of a single exception to the *adulteration* of mustard; when ground into flour, it is *always* mixed with corn, rye, &c. and coloured with turmeric, or some other substance. The plea of excuse is, that the mustard seed will not *grind* without some addition, either of corn or rye, owing to the oil it contains.\*

*Lemon or citric acid* is frequently adulterated; and sometimes tartaric acid is sold in its place. Lemon acid is frequently used for domestic purposes. The presence of tartaric acid may be known by adding a solution of muriate of potash; if it produce a precipitate, (the supertartrate of potash,) its pres-

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\* An acrid property or principle is to be found in many vegetables. We are unacquainted with the chemical properties and nature, of many of these vegetables, or their products, although it is admitted that *some* peculiar principle, which has not been examined, is the cause of their acridity. Most of the *ranunculi*, the *polygonum hydropiper*, *mustard*, &c. are well known instances. This fact has been remarked, that, on drying, some of them loose their acridity, while in others, as mustard, it remains. Water extracts it from the *ranunculi*; while in mustard, it dissolves only a very small part, and acquires the taste of garlic.



ence is shown, if not, the citric acid may be judged pure. A solution of tartrate of potash will produce a precipitate in the same manner, with tartaric acid. There is a supersulphate of potash, flavoured with the oil of lemon, that is sold as *concrete lemon acid*, which is evidently a fraud. If such articles were sold as *substitutes*, persons would know what they purchased. Coxwell's concrete salt of lemons is pure citric acid.

The preparation of the essential salt of lemon, or citric acid, is certainly advantageous. Lime or lemon juice, which contains citric acid united with water, and mucilaginous matter, is very apt to grow mouldy, and spoil in a short time. Several methods have been recommended for preserving the juice; as straining it, then boiling and bottling it, or putting the juice and pulp into bottles, and covering the top with olive oil. The juice is supposed to *feed* upon the pulp. The oil is removed by means of cotton before it is used. Heretofore lime juice put in casks was exported to Europe from the West Indies, but now at the suggestion of Mr. Coxwell, the principal maker of citric acid in London, it is saturated with carbonate of lime, and the citrate of lime in a dry state is only sent. This citrate of lime, when treated with sulphuric acid, furnishes pure citric acid, which is entirely different from that preparation sold in our shops as *concrete lemon acid*. We must not confound this acid with a preparation, usually sold in small boxes, and chiefly employed for the removal of ink stains, and iron moulds, called the *essential*



*salt of lemons*, which is nothing more than the salt of sorrel, or superoxalate of potash in a pulverized form. We may remark, that citric acid has been found unmixed with other acids in the following vegetable substances: the juice of oranges and lemons, the berries of the cranberry, the red whortle berry, the bird cherry, the nightshade, and the hip, and in union with lime in the onion. The proportion of citric acid in the cranberry is considerable. Although it is said to be unmixed, yet some experiments have detected the tartaric acid, but in a very small proportion. It has frequently occurred to me, that as the cranberry grows very abundantly in different parts of the United States, it would be an object to prepare the citric acid from it. It is only necessary to separate the juice by pressure, and treat it in the same manner as lemon juice, first with carbonate of lime, to obtain a citrate of lime, then with sulphuric acid to disengage the citric acid.

*Poisonous mushrooms* have frequently proved fatal. There are several species of these *fungi*, which are decided deleterious in their effects, and, in general, it requires some knowledge to distinguish them apart. In preparing catsup from mushrooms, the same care is necessary in selecting them.

The morell, (*phallus esculentus*,) which is a kind of fungus, is employed for thickening and heightening the flavour of sauces and soups. It differs from the common fungus in its figure and structure, but if gathered after having been exposed for some days to wet weather, they are extremely pernicious. The



truffle, (*tuber cibarium*) is a watery fungus, without root, found in hilly woods and pastures, which have a sandy and clayey bottom. In England, they are discovered by means of dogs, which are taught to hunt for them by their scent. They are internally of a white colour, and have somewhat the odour of garlic. The common mushroom (*agaricus campestris*,) is in the most common demand. It is a fungus which consists of a white cylindrical stalk, and a convex cover of white or brownish colour, which has beneath an irregular arrangement of gills, pinky when young, but afterwards of a dark liver colour. When it first appears it is smooth and nearly globular, and in this state is called a button. As an article of food, mushrooms, we are of opinion, are by no means wholesome. The *agaricus georgii*, the *agaricus procerus*, and the *agaricus orcadæ*, or the *cham-pignons* of the French cooks, have been used for the same purpose as the common mushroom.

*Ærated soda water*, which remains any length of time in the coppers either contracts lead or copper. The former from the *tinning*, as tin is often adulterated with lead, and the latter from the copper, where the tinning has either been imperfect or worn off. Such waters never fail to produce sickness, and pain in the stomach and bowels. The instances, however, have been few. Both lead and copper may be detected by the well known reagents. *Food* has also been poisoned by employing copper and leaden vessels. These metals may gain admission into food, either in consequence of the action of acids, or of



sebaceous substances employed in culinary preparations.\*

Food cooked in an unclean copper vessel is extremely pernicious. One instance is recorded of three men having been poisoned, and afterwards thirty more became ill from the same source, on board the British frigate *Cyclops*. Another instance is stated where *cider* and honey were boiled in a brewing vessel, the rim of which was capped with lead. All who drank of the cider afterwards were seized with a bowel complaint, and some lingered a few years and died. Sundry acid and sebaceous substances should never be kept in earthen ware vessels, which have been glazed with lead. Such glazing is

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\* With regard to the use of tin vessels in culinary concerns, some interesting remarks have been made by Vauquelin, (*Ann. de Chim.* xxxii, 243,) concerning the action of vinegar on tin. It is known that tin, or the tinning, contains a little lead, and it was of importance to determine whether the vinegar acted upon the tin, and, if it did, whether its action was confined to the tin, or extended to the lead.

The result was, that a small portion of tin is dissolved by vinegar, and that when the quantity of lead exceeded the sixth part of the tin, a small portion of the lead was taken up, but only in that part of the vessel in contact both with the vinegar and air; so that the presence of air to supply the oxygen, for the oxydizement of the metal previously to its solution, appears to be necessary. It is worthy of remark, that the English *block tin*, generally speaking, is very pure, and consequently the tin plate, (formed by dipping sheets of iron into melted tin,) must be free of lead, or if it exist at all, the quantity must be exceedingly small. But the tin met with on the continent, is so much debased or adulterated by dealers in that article, especially the Dutch, that pewter and tin are considered the same substance.



usually made by the vitrification of oxyde of lead in contact with siliceous substances.

*Mint Sallad*, as it is called, is prepared in some parts of England, by bruising the mint with large leaden balls; the consequence of which is, that portions of the lead are worn off, and mixes with the mint.

*Leaden milk pans* have been made use of in the place of earthen ware, as it is said they will throw up more cream. This practice is certainly injurious. I have heard, indeed, that *pewter* pans were used in this country for the same purpose; and a gentleman in the neighborhood of Washington city informed me, that he found a greater increase of cream by using a pan or pot made of zinc, and supposes that it was in consequence of a galvanic effect. Vessels of earthen ware, glazed with lead, are extremely improper for the holding of pickles. For that purpose, in particular, stone ware jars, which have been glazed *with salt*, are perfectly safe.

Lead is frequently introduced into *cider*, by the custom in some countries of lining the beds of the cider presses with lead. When lead is combined with tin, it is not acted upon by acid so readily as when this alloy is not formed; and some even assert, that tin, in such cases, prevents the oxydizement and consequent solution of the lead.\* The *water* ob-

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\* We mentioned in lecture 1st, that, in the preparation of cider wine, by boiling the apple juice in copper vessels, a practice in the west of England, a portion of copper was taken up. Dr. Fothergill detected it, and made the fact known. We have



tained from the distillation of bitter almonds, as well as cherry stones, and peach and laurel leaves, is strongly impregnated with the noxious matter, which gives them their taste and flavour. This water, we remarked, contains *prussic acid*, which is readily recognized. Bitter almonds, peach kernels, &c. should be used with caution. *Arrowroot*, a *fecula* or starch prepared from the *maranta arundinacea*, which is used as a nutritious aliment, is frequently adulterated with starch, particularly that obtained from the *solanum tuberosum*, and sometimes with powdered rice. It is difficult to detect these substances, as the chemical characters of *fecula*, (and rice contains as much as seven eighths,) are the same. They are merely adulterations, and partake of nothing of a deleterious nature.\*

remarked in the *Artist's Manuel*, article *cider*, that although *cider* is a cooling, pleasant, and wholesome liquor, during the heat of summer, yet when it is new and tart, and kept in leaden vessels, or passed through leaden pipes, some lead will be taken up, and render it unwholesome; and that such *cider* cannot fail sooner or later, to produce painful and dangerous colics, and a train of evils, which we have already noticed in treating of water kept in leaden cisterns, and of wine adulterated with sugar of lead, as the effect alluded to, is owing to the presence of the same metal.

\*Potatoe starch, which is prepared by pouring cold water on potatoes grated down to a pulp, and placed in a fine searce, possesses all the essential characters of starch. It is said, however, to go much farther than common starch, and possesses a very perceptible crystallised appearance; it is also heavier. It cannot be employed with the same advantage for hair powder.—See *Hair powder*.

According to *Einhof*, the potatoe, or root of the *solanum tu-*



*Artificial asses milk* is used for similar purposes as the foregoing. It is prepared of eryngo root and liquorice root boiled in water, to which new milk is added, and the whole boiled and strained. The fecula obtained from the *Palma Japonica* or the Indian bread tree, called *sago*, is a nutritive and light aliment; potatoe starch has frequently been mixed, and granulated with it. The root of the *bitter cassada* is poisonous when raw, but when deprived of its noxious qualities, which resides in the juice, by heat, forms a wholesome and nutritive bread. This bread is also made from the sweet cassada. Cassada when fermented with molasses and potatoes, is said to form a strong intoxicating liquor, called *ouycou*. The fluid expressed from this root contains a very fine fecula or starch, which is used in the preparation of the delicate dishes. The *tapioca*, another substance of a very nourishing character, is said to be made from the cassada by heating it over the fire, to separate the poisonous principle, and treating it afterwards in the usual manner for separating fecula.

*Sundry marmalades*, we may observe, frequently contain slight impregnation of copper and lead from

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*berosum*, when dried by a moderate heat, will be reduced to 1-4th of its original weight, and yields in every hundred parts 15 of starch, with seven of fibrous starchy matter. Potatoes loose by boiling 1 to 1 1-2 *per cent.* of their weight; and it is found, that, by boiling, the albumen, fibrous matter, and starch, unite together, and form an insoluble compound.

Potatoes contain no gluten, in which respect they differ from sundry grains, as wheat, &c. and hence will not make *raised* bread without the addition of wheat or rye, which imparts it.



the vessels in which they are made. Thus the fruit of the *mammæa Americane*, or Toddy tree, is prepared into a marmalade with sugar and spices, and is an article of that kind.

### PORTABLE SOUP.

Portable soup is frequently adulterated, that is to say, instead of forming it altogether of the gelatinous parts of mutton, veal, and beef; fish glue, and even beef glue, are added to it. The fraud cannot well be detected, because the chemical properties of gelatin, no matter from what animal substance it is obtained, are the same. Portable soup is a dry substance, prepared by boiling calves' feet, legs of beef, knuckles of veal, and legs of mutton, in certain proportions, separating the fatty matter which rises; and after clarifying it with the white of eggs, (adding salt, &c. as seasoning,) boiling the whole to the consistence of very thick paste, which is then poured out to cool, and becomes solid. Half an ounce will make a pint of liquid soup.

A process for extracting gelatin from bones, as practised in Paris, which is said to be very economical, is given in the *American Journal of Science* i, p. 170. The head, legs, ribs, &c. are first broken, but kept as compact as possible, and put to soak in a mixture of muriatic acid and water. The muriatic acid used, bears about 23 deg. of the *aerometer*, and is diluted by water to about 6 deg. Four parts of the liquor are used to one part of bones. The bones are



suffered to digest for six or eight days; the phosphate of lime is taken up, and the gelatinous part remains. This, having the original shape of the bone, is then taken out and drained, and immersed a short time in boiling water, to separate any fat and acid which might remain. It is then wiped, and afterwards washed in copious streams of warm water, to whiten it, and render it more transparent. It is then dried in the shade.

The author of the communication states, that 2 ounces of this gelatin are equal to 3 lbs. of beef, in making soup, and of as good a quality as six pounds of beef. It is constantly used in some of the hospitals of Paris.

Soup of any kind should never be boiled in copper vessels, for the obvious reason, that the fatty matter, which it contains, will act upon, and take up a portion of the copper. An additional quantity of nutriment may be imparted, by boiling with the soup beef bones, previously bruised. They contain a large quantity of gelatin. A very cheap and economical soup is prepared with bones. By digesting them first in a Papin's digester, mixing them with ordinary soup, and boiling them together, a large quantity of gelatin is imparted, and the soup rendered remarkably rich. If this practice were adopted at our public soup houses, the economy would be great, and the soup in every respect improved.

Proust obtained from powdered bones, about 1-16th of their weight of gelatin. The remarks of this eminent chemist concerning the advantage of



powdered bones in the preparation of soup, are conclusive.

Cadet de Vaux has shown, that from bones thus powdered, as much good soup may be obtained, as from five times their weight of meat. But this is supposed to be exaggerated, since Dr. Young repeated the experiment without the same success.

The component parts of bones are chiefly four; viz. earthy salts, principally phosphate of lime, fat, gelatin, and cartilage. The proportion of the first, and also of the fat, is variable; but Mr. Proust obtained in one experiment, one fourth of the weight of fat of the bones employed. The cartilage, or soft white elastic substance, remains after the bones are deprived of their fat and gelatin by boiling, and of their earthy salts, by digesting them in diluted acids. It retains the figure of the bones. Hatchett observes, that it has the properties of coagulated albumen.—The cartilage, it will be observed, is the portion of the bone first formed, and the requisite degree of hardness is afterwards given by phosphate of lime; but the gelatin and fat, particularly the first, give the requisite degree of toughness and strength. Bone, deprived of them, becomes brittle.

Potatoes, when steamed and dried, have been used in France in the preparation of soup, under the name of *polenta*. At Manlius, 550 persons reduced to want, were fed during 18 months, at the rate of two centimes and a half (about 1-40th of a cent,) per day, with a soup prepared entirely of this substance. Suppose this *polenta* were joined with the gelatin of

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bones, would not the aliment thus produced be worthy of public attention, since so many indigent families may be supplied at so comparatively trifling an expense? The establishment of soup houses are eminently useful.

Dr. Lind, in his Treatise to prevent the want of provisions at sea, a circumstance highly necessary to be attended to, assures us, that two pounds of portable soup, and the same of salep, will afford a wholesome diet for a person for a month. Salep is powdered orchis root. The flour of sweet potatoes, or of the common potatoe, or the latter root, sliced and thoroughly baked, similar to the French polenta, would answer as well.

The animal substance peculiar to muscular flesh, which gives odour and flavour to soup or broth, is called by Mr. Tenard, *osmazome*. Whether it is in reality a distinct substance, or merely fibrin, is not as yet determined; it differs, however, from gelatin. Its proportion to the latter, in flesh, is about one to five. Four pounds of muscular flesh, bruised and washed with cold water, produces nearly six drachms of this substance. It has a brownish yellow colour. It is soluble both in water and alcohol. The aqueous solution does not gelatinize; but when evaporated, leaves the osmazome in the state of a brown matter.

It is supposed that osmazome is nothing more than fibrin, slightly altered by being boiled in water, and dissolved in that liquid. Its identity with fibrin, however, is not established.



## WHITE BUTTER. CASEOUS BUTTER.

It is a fact but little known, or attended to, that caseous butter is often imposed upon buyers, as pure butter; alledging that its whiteness is owing to the cream of which it is made. Butter, it is true, is not always of that delicate yellow colour, which frequently depends on the food, fodder, or pasturage of cows; but the introduction of curd into butter, in preparing it for the market, is a practice which has been followed by *butter-hucksters* in our large cities, for the purpose of increasing its quantity. Butter of this description, has neither the taste, flavour, nor colour of good butter. It is usually white, and has a cheesy taste. It appears more or less *milky*; indicating that it has not been *worked* in the same manner as pure butter. The “working over” of butter, especially if rancid, by churning it with cream, is nevertheless a frequent, and necessary operation. It renders it sweet, and at the same time increases its quantity. In order, however, to increase the quantity of butter, we have seen it recommended, to add to the cream, in the act of churning, a portion of alum dissolved in water; the acid of which, it is apparent, separates the curd along with the butter. Butter, thus prepared, cannot be pure. The fraudulent practice of sophisticating butter with curd is performed by merely mixing it with the butter. The curd is obtained from milk in the usual manner by rennet. The deception may be detected by merely melting the butter. Pure butter will melt, and flow like oil;



and sophisticated butter will become milky and turbid.

When butter is melted, which contains curd, the latter will gradually precipitate; whereas the pure butter will remain fluid. The mixture, however, will assume a milky appearance. The curd may be separated by a fine flannel filter, and even its quantity ascertained.\*

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\* Lagrange (*Chemistry* ii, 383,) observes, that if butter be put into a glass, and then exposed to heat, three parts are separated from it; one butyraceous and yellow, one serous, and one caseous. The presence of the two last, however, depends entirely upon circumstances. If the butter is imperfectly *worked*, caseous and serous substances may be found in it; but when butter is thoroughly worked, and prepared from sweet cream, and without the addition of acid, no indications of caseous matter, or at least in a very small degree, will be observed. The water, however, usually found in butter, is not to be confounded altogether, with serum. It is a fact, nevertheless, that but little butter is so perfectly made as to be entirely free from some cheesy matter, by reason of the cream becoming slightly aced, or the presence of acid in the act of churning, which separates in the same manner as rennet the caseous matter or curd.

As milk is separated into three substances, cream, curd, and whey; the first differs from the second and third in containing a peculiar oil, or butter, but combined with curd and some serum, which in the operation of churning separates into two portions, one of which is fluid, and takes the name of butter-milk, and, from the experiments of Parmentier and Deyeux, possesses the properties of milk deprived of cream; the second, or curd differs essentially from butter and whey, and according to Berzelius, constitutes but 3 1-2 per cent. of cream, and is used in the making of cheese; the third, or whey, according to the same chemist, constitutes 92 per cent. of cream, and is very com-



The caseous part of milk and cream, possesses characters entirely distinct from those of butter, or whey. It has many of the properties of coagulated albumen. In a dry state, when all the moisture is squeezed out, it possesses a considerable degree of brittleness.

When curd is precipitated by rennet, or by acid, as the muriatic or sulphuric, it is found to be combined with a portion of the acid. In the Dutch cheese, for instance, where the curd has been separated by *spirit of sea salt*, (*muriatic acid*,) the acid communicates a sharp taste. If the precipitate obtained by the addition of acid be digested over carbonate of lime, it will be decomposed; the acid will unite with the lime, and the curd will be dissolved in the water. In this manner an aqueous solution of curd, having a yellow colour, and resembling a solution of gum, may be obtained. The mineral acids form with curd analogous compounds to albumen and fibrin. These remarks, however, are intended to show, that, after we separate the curd from the butter, with which it is fraudulently contamina-

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pound in its nature, consisting of lactic acid, sugar of milk, and saline matter, chiefly phosphates. For remarks concerning curd, see the article on *Cheese*.

Whatever opinion may be given on the constitution of butter; viz. that it contains curd and serum in variable proportions, it is a fact that those who understand the *making* of butter, prepare it free from these substances, or, if they exist at all, they are, as were marked, in a comparatively small proportion. Any one may satisfy himself of this fact by submitting the butter to fusion, and comparing various specimens in that way.



ted, we may identify, by experiment, the existence of that substance.

In many parts of England, they colour their butter in winter, to make it appear like May butter.—The best English butter is made in the county of Essex, known by the name of Epping butter.

Sometimes butter is adulterated with lard, but this sophistication is readily discoverable by the taste. By saponifying it, however, with potash, we might detect both the margaric and oleic acids, which are known to exist in lard, or to be formed in the act of saponification.

It may not be improper to offer some general remarks respecting the preservation of butter.

The common mode of preserving butter is by the addition of salt; but the most effectual method, in the opinion of Dr. Parr, is to use two drachms of sugar, as much salt petre, with half an ounce of salt to every pound. Dr. Anderson recommends a similar mixture; viz. one part of sugar, one of salt petre, two of common salt; which is to be mixed thoroughly with the butter, after it is freed from the milk, in the proportion of one ounce to sixteen. The butter is to be pressed tight. The taste of butter, thus prepared, is said at first to be unpleasant; but in a fortnight, it becomes of a rich flavour.

Mr. Eaton, (*Survey of the Turkish Empire*,) assures us, that most of the butter used at Constantinople, is kept sweet by melting it while fresh over a very slow fire, and removing the scum as it forms. This effect depends also upon the separation of the



caseous matter; for Mr. Thenard approves of the method, and observes, that the melting should be done on a water bath, or at a heat not exceeding 180 deg. F. and be continued till all the caseous matter has subsided to the bottom, which is to be separated by a strainer. He recommends also cooling it, by immersing the vessel containing it in a mixture of pounded ice and salt, or very cold spring water, otherwise it will become lumpy, and not resist the action of air so effectually. If kept in a close vessel, and in a cool place, it will keep a length of time.

How far Mr. Thenard's conclusion is correct, as to the quantity of cheesy matter in fresh butter, is doubtful; for, he remarks, that if this preserved butter be beaten up with *one sixth* of its weight of cheesy matter when used, it will resemble fresh butter. In France, the proportion of caseous matter in butter, from their mode of preparation, may be a sixth part of the whole butter; but this proportion, admitting the fact, is far too great for our best butter. No finer butter is made than in this county, (Orange,) and in Goshen; it melts and flows like oil, without giving hardly any signs of curd; and none, generally speaking, is so free of rancidity. This is, likewise, the character of the best Pennsylvania butter; but the butter of the south, from some cause or other, is usually white, has little or no flavour, and contains, we would judge, an undue proportion of caseous matter.

The taste of rancid butter may be much corrected



by melting and cooling it. Mr. Eaton further remarks, that, by melting butter in the Tartarian method, and salting it after the English custom, he kept it good and fine tasted for two years, without impairing its taste and colour.

That the *rancidity* of butter depends, in a great measure, upon its retaining some whey and caseous matter, there can be no doubt; and that butter *keeps* in proportion as it is free from them, either by working it, in the usual way, or melting it as before stated, appears to be the fact. To prevent the actual decomposition of the caseous and fluid part, in the imperfectly made butter, and also any change which the butter itself might undergo, in causing rancidity, the use of sugar, nitre, salt, &c. seems to be predicated.

Fourcroy is of opinion, that, whatever pains be taken, the butter will still retain a portion of curd; and we are told, that to *melt* butter without granulations, flour is added to prevent the cheesy portion falling to the bottom. This effect takes place only with caseous butter.

With respect to the colour, Parmentier and Deyeux have remarked, that different colours may be imparted to butter, by the juice of carrots, alkanet root, violets, &c. The May butter, rose butter, &c. are imitated by artificial colouring matter.

### LARD AND TALLOW.

Tallow, or suet, differs from hog's lard in consistence; the former is brittle, and the latter is soft



and sometimes semi-fluid. They are acted upon by the strong acids, which gradually decompose them. When nitric acid is digested on fat, the acid parts with some of its oxygen, and according to Foureroy, produces an oxyde of fat of a yellow colour.

At 400 deg. fat begins to emit a smoke ; then, as the heat increases, it becomes blackish ; and, finally, an abundance of carburetted hydrogen and carbonic acid passes off. Without noticing at this time, the substances found in fat, viz. *stearin* and *elain*, which by saponification, are converted into the two acids just mentioned, the *margaric* and *oleic*, it will be sufficient to observe, that the presence of suet or tallow in hog's lard, an adulteration often met with, is readily recognised by the physical character of the lard : if it is pure, it will have a soft feel, and in summer a semi-fluid appearance, more or less translucent, and devoid of a yellow tinge ; but if mixed with tallow, it will be more hard, and have an *opaque* look, and generally a yellow tinge.

### CAPERS.

Capers are the unopened flower buds of a low shrub, the *capparis spinosa*, which grows from the crevices of rocks and walls, and among rubbish, in the southern parts of France and Italy, and the Levant. The buds are picked, and put into vinegar and salt. When a sufficient quantity of them is collected, they are distributed according to their size, into different vessels, again put into vinegar, and then



packed up for exportation. If they are suspected to be *greened* by copper, macerating them in liquid ammonia will determine it, by producing a blue colour.

The flower buds of the marsh marigold, (*caltha palustris*,) and nasturtiums, are frequently pickled, and eaten as a substitute for capers.

### SOY.

This is a kind of sauce prepared from the *dolichos soyæ* or *soja*, by allowing it to undergo a spontaneous fermentation. In the memoirs of the Swedish academy, its preparation is particularly described. The proportions are fifty pounds of the bean, fifty pounds of salt, sixty pounds of wheat flour, and two hundred and fifty pounds of water. We gave an account of this substance in the *Artist's Manual*, from which we make the following extracts :

After having well washed the beans, they are boiled in well water in an open vessel for some hours, or until they have become soft, as to be worked between the fingers. They are then taken out, and put into large shallow wooden vessels. In these they are spread out to the depth of two inches, and when they are cold, the wheat flour is gradually thrown in, and mixed with the beans.

The whole being well mixed, the mass is spread abroad in the vessels beforementioned. When it begins to grow mouldy, and heat is disengaged, which happens after two or three days, the cover is raised, in order that the air may have free access.



During this time a rancid odour exhales : and if the mass become green, it is a sign that the whole goes on properly ; but if it begins to be black, which must be carefully noticed, the lid must be raised higher. If it once becomes black, the whole is spoiled.

As soon as all the surface is covered with green mouldiness, which usually happens in eight or ten days, the cover is taken off, and the compound is exposed to the sun and air for several days. When it has become hard, it is cut into small fragments, which are thrown into an earthen vessel, upon which the water, having the salt first dissolved in it, is poured.

The vessel thus filled is placed in the sun, and its contents stirred up regularly every morning and evening ; and a cover is put on at night to defend it from the cold, as well as to prevent any rain from finding entrance. The hotter the sun, the sooner will the soy be completed.

As the mass diminishes by evaporation, well water is added ; and this digestion is continued, till the salt water has entirely dissolved the flour and the beans. The vessel is still left for some days in the sun, in order to complete the solution still more effectually, as the good quality of the soy depends upon this circumstance ; and the daily stirring or agitation is continued.

When at length the mass has become very succulent and oily, the whole as well the thick as the more fluid portions, is poured into bags, through which the soy is pressed, and is then clear and ready for use.



It is to be kept in bottles well corked. The Chinese, who deal in this article, keep it in large pitchers well closed. Before it is strained in the press, the soy is of a deep brown colour, but afterwards it becomes black.

The Chinese also prepare two kinds of soy from the dregs which remain. For the first kind they add one hundred and fifty pounds, and thirty pounds of salt, and after having pressed the mass, they again add one hundred pounds of water, and twenty pounds of salt, always proceeding as before described.

The two last kinds of soy are not strong, but very salt, more especially the latter, which is also lighter coloured. These two kinds are the most common in China, and are used both by natives and Europeans. The differences of price are as 8, 4 and 1.

The soy prepared, as we have mentioned, is succulent, oily, moderately soft, and entirely different from the spurious kind usually sold in Europe. As to taste it is equal to that of Japan, which is generally considered the best. Mr. Ekeberg asserts that the soy is boiled, and sugar, ginger and other spices are added; but this is an error, since soy has no taste either of sugar or spices, for the prevailing taste is that of salt.

Dr. Mease (*Archives of Useful Knowledge*, vol. 1. p. 219,) assures us, that the bean, *dolichos soya*, bears the climate of Pennsylvania well: "there is therefore nothing" he adds, "to prevent our enjoying the agreeable condiment, of which it is the basis, except our own indifference." Why has it not been cultivated?



We have been particular in noticing the Chinese method of preparing soy, a sauce much used in Europe, as well as in the East Indies; and although we have given it more attention than at first view its importance would seem to require, yet as its mode of preparation is but little known, these remarks may not be altogether unacceptable.

It is obvious that the goodness of soy depends on the fermentation of the bean assisted by the flour; that the salt water combines with the flour and beans, although altered by fermentation; that the heat of the sun assists the solution, and the mass becomes succulent and oily before it is finished; and that the perfection of the sauce depends on the complete combination of the whole materials.

The colour of soy is first brown, but becomes black by age.

The presence of deleterious substances, if suspected, such as copper, lead, &c. may be known by the usual reagents. It should have nothing of a rank putrescent taste, and when thrown on burning coals give no decided smell similar to burning bones; if so, gelatin, in all probability, has been added to it.

### VERMACELLI.

There is a farinaceous preparation sold by confectioners, called Vermacelli, which, although not adulterated to the best of our knowledge, is nevertheless liable to contain copper from the copper vessels, &c. which are sometimes used in its manufacture.



Vermacelli is used in soup. It is composed, or ought to be, of flour, cheese, yolk of egg, and sugar, coloured yellow either by turmeric root or saffron.

Vermacelli, in appearance, resembles a congeries of worms; hence its name. It is also made into slender pieces, or cylindrical bits. This shape is given to the composition by forcing it with a piston through a number of holes, the diameter of which corresponds therewith. It is an elegant addition to a family soup. The detection of copper, if it be suspected, (and this indeed may very seldom be the case,) may be effected by dissolving it in water and adding liquid ammonia, or by putting some of it in a phial and pouring liquid ammonia upon it.

Besides Vermacelli, there is a preparation of flour and eggs, called *macaroni*, which is used in soups. It is chiefly imported from Italy. Its name implies *cut-paste*. If blanched almonds are used in the preparation of macaroni, care ought to be taken to employ the freshest. The bitter almonds should be avoided.

## DISTILLED WATERS.

Distilled waters are sometimes liable to adulteration. These waters are prepared by distilling plants, or certain parts of plants, with water; they communicate an aromatic flavour, in consequence of their essential oil. Sundry waters are now prepared more expeditiously, by combining the essential oil with water. This is effected by the intervention of sugar



and alcohol. Thus, a few drops of the oil of mint may be united with, and make a pint or more of mint water.

The distillers make use of blossoms or flowers for two reasons; *viz.* either to obtain colouring matter, as from violets, or aromatic oil, as from mint, rosemary, lavender, &c.

Sundry fruits are also used by the distiller. Thus quinces, when fermented and distilled, produces a spiritous water, frequently made use of for ratifia; and cherries, plums, apricots, kernels of nuts, &c. are employed for the same purpose. Some of which we shall show are decidedly deleterious.

The most common waters are those of mint and peppermint, clove, lemon, citron, orange flower, rose, lavender, cinnamon, pennyroyal, &c. Water which has been made by distillation, and which consists of nothing more than an impregnation of the essential oil, may be distinguished from the water prepared by using sugar and alcohol, or spirit, with essential oil, by submitting it to evaporation. It will evaporate entirely, without leaving a residue; in the other case, owing to the sugar, a residue will be left of a sirupy consistence and taste.

The only deleterious waters to be apprehended, are those obtained by the distillation of the peach blossoms, lauro-cerasus, and bitter kernels, which, we have said, contain prussic acid, and impart it to water by distillation. Since Mr. Scheele pointed out the method of obtaining hydrocyanic acid in a separate state, the similarity between its smell and the



odour of bitter almonds, peach blossoms, and other vegetable substances, did not fail to be remarked.— In 1802, Bohn mixed the *distilled water of bitter almonds* with potash, and added it to a solution of iron, which gave a blue precipitate, a fact conclusive of the existence of prussic acid. *The distilled water of peach blossom*, and of *lauro-cerasus*, treated in the same manner, or mixed with lime water, and then with a solution of sulphate of iron, gave Mr. Schroder the same indications of prussic acid.

These facts were confirmed by the experiments of Gehlen, Bucholz, and Vauquelin. Bucholz found it in the essential oil of bitter almonds, and Vauquelin in the distilled water of the kernels of apricots, and it has since been discovered in the flowers of the sloe, (*prunus spinosa*,) and the leaves of the bay leaved willow, (*salix pentandra*.) It cannot be doubted that almost all the bitter tasted kernels contain this acid. See *Hydrocyanic acid*. If, however, it be suspected in the distilled water of vegetables, especially of such leaves as have a peculiar sweet smell, or of kernels, the fact may be known by mixing it with some lime water, or weak solution of potash, and adding to the mixture a solution of iron.

Hydrocyanic acid is incompatible with some of the proximate principles of vegetables; and hence we do not find it in a number of essential oils in daily use. The rose leaf contains no traces of it. We shall have occasion to observe, hereafter, when we speak of certain active poisons, that too much care cannot be used in preventing the accidental admixture of leaves, &c. containing this acid.



It is a fact that almost every plant, distinguished by a peculiar odour, contains a volatile oil, to which it is indebted for that odour. Fixed oils are only found in the seeds of plants, and are almost entirely confined to those which have two cotyledons; as almonds, linseed, poppy seed, &c. whereas volatile oils are discovered in every part of plants except the cotyledons of the seeds, where they never occur.— Besides the leaves and flower, it is, therefore, to be found in the root, stem, and rind or pulp of the fruit.

Distillation is the usual process for extracting essential oils, but they may be obtained in some instances, like fixed oils, by expression.

Water, when distilled from an aromatic or odoriferous plant or flower, contains a mere impregnation of the essential oil or aroma, and that which is found floating on the surface is always removed for use.— The water itself has neither a turbid, nor milky appearance, which is the case with the extemporaneous preparation to which we have alluded. This turbidness, however, may be removed by filtration.

### SUGAR.\*

The refining of sugar by using lime water, bullock's blood, or eggs, and *claying* in the usual man-

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\* Sugar possesses some remarkable chemical properties. It is capable of combining with, and neutralizing both acids and alkaline bodies. It is decomposed by sulphuric and muriatic acid, and nitric acid converts it into oxalic and malic acids.— One hundred parts of sugar, will yield fifty-eight parts of oxalic



ner, purifies it from all extraneous matter. A small portion of lime, of acetate of lime, and of alumina, derived from the clay, may occasionally be found in it. According to a more modern process, sulphate of zinc is also used, four ounces of which are added to every hundred lbs. of sugar. The lime water decom-

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acid. Chlorine converts it into malic acid, and changes, at the same time, into muriatic acid. Sugar increases the solubility of lime and strontion, and forms a combination with them.—The fixed alkalies, also, combine with sugar, but the saccharine taste is destroyed. It may be restored, however, by the addition of sulphuric acid, which unites with the alkali. The sulphate of potash, or soda, thus formed, may be separated by alcohol.

If lime has a tendency, like potash or soda, to destroy the sweet principle of sugar, might not sulphuric acid be employed with advantage in restoring it? The union of sugar with metallic oxydes, &c. forms saccharates. Thus we have the saccharate of lead, formed by digesting oxyde of lead in a solution of sugar. The juice of the sugar cane, it will be recollected, has been recommended as an antidote to arsenic; and sugar, in substance, has been used with decided success, as an antidote against the poisonous effects of copper. No doubt, in both instances, the effect is owing to a combination of the sugar with the metallic oxydes, neutralising them so as to become harmless, especially with the oxyde of copper.

These are the principal properties of sugar.

Sugar is obtained in the West Indies, and some parts of the United States, from the *arundo saccharifera* or sugar cane. It is also plentifully obtained from the sap or juice of a tree very common in this country, the *acer saccharinum* or sugar maple. It has been extracted, also, from the beet. There are different species of sugar, designated by the name of sugar of figs, sugar of grapes, starch sugar, Botany bay sugar, mushroom sugar, manna, &c.

A variety of plants are found to contain sugar.



poses the sulphate of zinc, and forms sulphate of lime, and the oxyde of zinc combines with the extractive matter, tannin, and galic acid. These new compounds are insoluble, and are separated by filtration. If the quantity of sulphate of zinc should be too great, and not be decomposed, it will remain in, and mix with, the sugar. In that case, it may be detected by dissolving the sugar in the water, and using the tests for sulphuric acid and zinc. When the sugar is dissolved, the alumina will separate.

Grocers have been known to mix different substances with brown sugar, for the purpose of increasing its weight. Sand, dried clay, powdered gypsum, Indian meal, &c. have been used for that purpose. But these sophistications are readily known by the appearance of the sugar, and its solution in water. Pure sugar should dissolve wholly in water, and form a clear solution, without leaving any sediment, the nature of which, if any, may be determined by experiment.\* The quantity of water added to sugar, with the same view of increasing its weight, may be shown, by exposing a certain portion to the ac-

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\* Sugar is very soluble in water. According to Wenzel, water, at the temperature of 48 deg. dissolves its own weight of sugar. When nearly at the boiling point, water will dissolve any quantity of sugar, and form a sirup. When this sirup is boiled down, and poured into pans, it will gradually crystallize, usually in four or six sided prisms, terminated by two sided, and sometimes by three sided summits. They are composed of real sugar 100, and water, 5.6, in 105.6 parts.



tion of a moderate heat. The same experiment may be repeated with other samples of sugar. The decrease of weight will determine that point.

There is nothing of a saccharine nature that can be added to sugar, except sugar of an inferior quality, to adulterate it. *Mixing* of sugars is a common practice with grocers, but it is chiefly intended to produce different qualities at different prices.

It would be well to observe the quantity of insoluble matter, in different samples of the same sugar, as *Muscovado*; by which a knowledge of the quantity of real sugar, in those samples may be attained. If lime in the state of a soluble salt, should exist in sugar, which may be the fact from the use of the lime water in sugar-making, the addition of oxalate of ammonia will detect it.\* The absolute quantity of sugar contained in unrefined sugar may be learnt by experiment. Weighing a given quantity before and after refining, and determining the loss sustained; or by crystallizing a certain portion, and noting the quantity of *candied sugar*, making a due allowance for the water, would in either case afford tolerably satisfactory results.

The proportion of molasses contained in brown

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\* Mr. Daniell, (*Quarterly Jour.* vi. 32,) is of opinion that lime has a tendency to convert sugar into gum. He remarks, that when raw sugar from the West Indies is kept for some time, it is apt to assume a clamminess with the soft feel of flour. In this state it is called weak sugar. This change he supposes is owing to the action of the lime (always present in raw sugar) upon the sugar.



sugar, the existence of which is generally apparent, may be estimated sufficiently accurate by submitting it to pressure. Sugar which has been well drained of its molasses, or saccharine feces, will be found to yield by this operation very little, if any. A solution of sugar, which has been mixed with molasses, will present certain obvious and physical characters that the unmixed does not; and if necessary, may be chemically examined. A saccharine substance has lately been made by the direct action of sulphuric acid, in a sufficiently diluted state on starch. This sugar, we may remark, possesses all the essential properties of that substance. Sugar, thus made, should be entirely free from sulphuric acid, or of sulphate of lime, which is formed in the process. The former is detected by muriate of barytes; and a hot solution treated with oxalate of ammonia, will show the presence of lime, and by both reagents that of sulphate of lime.

It has occurred to me, that as rice consists for the greater part of fecula or starch, and is raised as a staple article in the southern states, its conversion into sugar by the process mentioned, might be advantageous to the planter. There is no question as to the identity of the sugar; and if the process is well conducted, the sugar would bear comparison with that of the West Indies, or of Orleans. The starch from any vegetable, as from the potatoe, is convertible into sugar by the same treatment.



## RICE FLOUR.

Rice is the seeds of the *oryza sativa*. Branconnet analyzed two specimens; one from Carolina, another from Piedmont. Without stating all its constituents, he found the Carolina rice to contain 85 *per cent.* of starch, and the Piedmont 83. Upwards of 90 *per cent.* however, has been obtained. In the East Indies rice flour is employed for making a peculiar kind of paste, and for the imitation of mother-of-pearl. When the paste is very thick and uniform, they press it in moulds, and suffer it to dry. It becomes remarkably hard, and exhibits all the external appearance of the real mother-of-pearl, which they frequently impose on their customers. The mode of detecting this fraud is very easy. The true mother-of-pearl will effervesce with acids. Rice is sold in the form of flour for sundry culinary purposes; and, in short, is a most excellent substitute for the arrow root prepared from the *maranta arundinacea*. It is frequently adulterated with wheat flour. It is with rice, as with potatoes, and other substances which contain starch, and little or no gluten, that in order to make bread, gluten must be added, which is furnished in that case by wheat or rye, a due quantity of which must be used.

Rice flour in *cold* water is insoluble, and will not combine with the water; hence it resembles starch. But in hot water it will unite, and if suffered to grow cold will assume in a measure the tremulous and gelatinous character of starch. If adulterated with



wheat flour, it would form with cold water a gummy adhesive paste ; and if worked in cold water with the hand, using a large quantity of water, the fecula will entirely separate, and gradually subside, leaving the gluten in a cohesive mass. Thus the presence of gluten, and consequently of wheat or rye, may be detected.

Another fact in relation to wheat or rye flour may be noticed, *viz.* that the mixture made with boiling water, would have more the usual appearance of paste, than the gelatinous character of starch, and its adhesiveness generally speaking would be augmented. The Chinese rice paste, prepared with boiling water, we may remark, possesses very considerable adhesive properties. They consider it, for many purposes, as the joining of paper and the like, superior to the ordinary paste. It wants, however, the gluten, which characterises good farinaceous paste.

## GINGER.

Ginger is the root of a plant which grows spontaneously in both the Indies, &c. known in botany by the name of *amomum zingiber*. It is brought to us in knotty, branched, flattish pieces, freed from the outer bark, of a pale colour and fibrous texture, and distinguished into white and brown. The former is the root cleaned and dried; the latter is scalded, more shrivelled, and less aromatic. That which is the least fibrous is reckoned the best. Candied ginger



is prepared in India, from the young and succulent roots. It is almost transparent.

Ginger yields all its virtues to alcohol, and the greatest part of them to water. In distillation water contracts its whole flavour, but spirit leaves nearly the whole behind. A pound will produce only a drachm of essential oil, which retains the smell, but not the pungency of ginger. The watery infusion is at first acrid, and in smell resembles the root. The extract is about one-fourth; the spiritous extract one-sixteenth: each retains the taste only of the ginger.

Ginger when ground for sale is generally adulterated with wheat or rye flour, but most commonly with Indian meal. The detection is easy, as the pure ginger when boiled in water will not form a paste, neither will it produce either fecula or gluten when worked in cold water, which would be the case if these grains were mixed with it. Its taste and pungency are also diminished by these additions.

## CINNAMON AND CLOVES.

Cinnamon and cloves should possess their full degree of pungency; but they have often been sold after being submitted to distillation, either for the purpose of obtaining their essential oil, in which their taste, fragrance and pungency resides, or for obtaining a spirit for the preparation of cordials. They furnish by distillation the essential oils, which are sold in the shops. The fact, however, of their having been submitted to distillation, may be known by



their feeble taste, or by second distillation, as no oil or spirit will be obtained.

The true cinnamon is the under bark of the branches of the *laurus cinnamomum*, which is chiefly obtained from the island of Ceylon. Cinnamon is examined and arranged according to its quality. Persons appointed for the purpose, are obliged to taste and chew it. The oil extracted from cinnamon is heavier than water. This is prepared in Ceylon, and almost wholly from the small and broken pieces. The oil of cassia is generally substituted for it. The virtues of cinnamon are not confined to the bark. The leaves, the fruit, and the root, all furnish the oil. The wild cinnamon, or cassia, or the bark of the *laurus cassia*, is often substituted for cinnamon, to which it has a considerable resemblance. Its taste is much weaker, and is immediately distinguishable by its slimy taste. It is thicker and more course than cinnamon. The buds, as well as the bark of this tree, are used in culinary preparations. Cassia yields more viscid mucilaginous matter than cinnamon. The tincture is also different.

Cloves, which are the unexpanded flower buds of an East Indian tree, *caryophyllus aromaticus*, when first gathered, are of a reddish colour, but by drying they assume a deep brown cast. When fresh gathered, they yield on pressure a fragrant, thick and reddish oil; and by distillation a limpid essential oil. The latter is frequently adulterated sometimes to the amount of half its weight. Like other essential oils, if it is sophisticated with a fixed oil, as the olive oil,



it may be discovered by heating it, when the oil of cloves will evaporate and leave the fixed oils ; or by alcohol, which will take up the essential oil. If sophisticated with turpentine, the smell will readily detect it ; and if with alcohol, the addition of water will discover it, by causing an immediate *milkiness*.



## LECTURE III.

### DETECTION OF POISON, &c.

In considering a subject so extensive and important as the detection of poisons, and of adulterations in preparations employed in medicine, and the arts, and for domestic purposes ; a subject eminently useful in all the walks of life, we shall be obliged to be as brief as the enquiry will admit, so as to present in as few lectures as possible, all the facts on this interesting subject.

A body of facts, thus presented in detail, will develop to our view a knowledge of what are poisons, and the best antidotes to be administered, with the means which chemistry presents for their detection ; what are the adulterations most likely to be met with in various preparations used in medicine, and the arts, and how they may be discovered ; and what rules are, or may be, established for determining the purity and quality of sundry articles.

This subject, therefore, viewed in relation to the adulteration of food, and of culinary poisons, of which we have treated in our preceding lectures, cannot fail, we apprehend, to claim your undivided attention.



## POISONS.

The subject of *Toxicology*, which considers the nature and operation of poison, and of antidotes, comprehends a great number of substances of the animal, vegetable, and mineral kingdom, which have a particular action on living bodies. This action is not mechanical. It deranges the vital functions, in a greater or less degree according to the virulence of the poison, and the quantity taken, and not unfrequently produces death. Antitodes are counter-poisons; a knowledge of which, we are of opinion, is highly important. It will be sufficient for our purpose, previously to the consideration of this class of bodies, and as a preliminary to the remarks we intend to offer, to mention, briefly, that poisons have been divided into six classes; viz, *corrosive* and *escharotic*, as mercurial, arsenical, antimonial, and cupreous preparations, and concentrated acids, corrosive alkalies, and some of the earths and earthy salts; *astringent*, as the preparations of lead; *acrid*, as some of the vegetable substances and their products, and a few of the gases; *narcotic and stupifying*, in which are embraced some vegetable products, and some of the gases; and *narcotico-acrid, and septic and putrescent* poisons.

These classes comprehend a great variety of substances, the effects of which are various, and would require a copious detail. Our object, in particular, is to consider the most active. But before we proceed to notice them individually, with their chemi-



al and other properties, an historical outline of the poisons employed by the ancients, as far as we are acquainted with them, may be interesting, which will give us some general ideas of the nature of the poisons they used, and the corrupt state of society at those periods.

Theophrastus speaks of a poison prepared from the *aconitum*, which formed the basis of a secret poison, and that Thrasyas pointed out the mode of using it. This poison was much used at Rome about 200 years before the Christian era. Several persons of distinction died the same year at that period. An enquiry being made into the cause, a maid servant gave evidence against some ladies of the first families, who, she said, prepared and distributed poison, and above one hundred and fifty of them were convicted and punished.

Sejanus caused such a secret poison to be administered to Drusus. Numerous instances of a similar kind are recorded: Agrippina being desirous of getting rid of Claudius, had prepared by Locusta, an expert poisoner, who had been condemned to death for her infamous practices, and was saved that she might be employed as a state-engine,—a poison, which was given to the emperor in a dish of mushrooms. Nero dispatched Britannicus, the son Agrippina, with a poison prepared by the same person, for which she was liberally rewarded!! These preparations were principally of a vegetable nature. Some animal substances were also used. Thus Philostratus says that Titus was destroyed by Domini-



tan, by a poison obtained from the *sea-hare*, or *lepus marinus*, which appears to have been known by Aristotle.

History, in fact, gives us a variety of facts concerning poisons. Thus aconitum, of which we have spoken, was on one occasion given to Orodes by his son Phraates, with a design to poison him ; but, contrary to expectation, it cured his dropsy, having been afflicted with that complaint. Alexander, it is supposed, was poisoned by Antipater, at the instance of Aristotle, but the account of his death is contradictory. Plutarch remarks, v. 288, that the "poison was of a cold and deadly nature, which distils from a rock in the territory of Nonacris," and hence was called the *Stygian-water*. There was no suspicion he was poisoned, till many years after his death.—Ariston, tyrant of Athens, was poisoned by Syllasor-der. Belitaras is said to have prepared the poison for Statira, the wife of Artexerxes. Berenice, one of the wives of Mithridates, took poison, but not enough to destroy her ; and Mithridates, king of Pontus, gave poison to each of his friends. Gelon persuaded Myrtidus, cup-bearer to Pyrrhus, to poison his master ; and Neoptolemus, who was afterwards killed by Pyrrhus, agreed to the poisoning of him.—Themistocles, it is said, drank warm *bullock's blood*, after the sacrifice, with the same view ; which, according to Pliny, but without truth, as it respects its deleterious qualities, is "*mortal*." The coagulation of the blood in the stomach is advanced as a reason. Phila, the wife of Demetrius, in conse-



quence of the adversity of her husband, killed herself by poison. Other instances are recorded, which, if time permitted, we might mention.

Plutarch informs us, that Cleopatra made a selection of poisonous drugs, and wishing to ascertain which was the least powerful, she tried them upon capital convicts. Such poisons as were quick in their operation, she found to be attended with violent convulsions; such as were milder, were slow in their effects. She, therefore, undertook the examination of venomous creatures, and caused different kinds of them to be applied to different persons under her inspection. These experiments she repeated daily, and at length she discovered that the bite of the *asp* (*aspis somniculosa*,) was the most *eligible* kind of death, as it brought on a gradual kind of lethargy, and the senses sunk easily into stupification, &c.

Cleopatra thus amused herself with experiments little to her credit, and illy suited to the female character; but Attalus passed his time in cultivating poisonous plants, which, as Plutarch informs us, were henbane, hellebore, aconitum, and the dorycnium, a very common poisonous plant, as Pliny tells us, besides learning their effects. These he planted in the royal gardens.

The laws of Persia for the punishment of poisoners were severe: "their heads were placed on a broad stone, and then bruised and crushed with another till nothing of the figure remains."

With our modern, and more powerful metallic poi-



sons, the ancients were not acquainted. Tophania, who resided at Palermo, prepared drops called *aqua Tophania*, which, it seems, were remarkably powerful. She distributed her poison, according to Labat, (*Travels through Italy*, iv, 33,) in small glass phials, with this inscription; "*Manna of St. Nicholas of Bare*," and ornamented with the image of the saint. In 1659, at Rome, secret poisons were greatly in use, and in 1670, in France, the subject excited more than usual attention. It appears a young man by the name of Godin de Sainte Croix, had acquired the secret while in prison, from Exili, an Italian, and had communicated it to the Marchioness de Brinvillier; of whom it was said, that she filled the church yards more rapidly than by the usual course of disease!

There is no doubt that the poison employed by the Marchioness, was of a metallic nature; for, if we mistake not, in the casket which was found, and opened, both corrosive sublimate and arsenic were discovered.

The water hemlock (*cicuta aquatica*,) is the plant which was chiefly used in ancient Greece, to destroy the lives of all who were condemned to death. It is said to have been an ingredient in the medicine of Thrasyas of Mantinea, and combined with the juice of poppies, which killed without pain.\*

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\* Mr. Wilmer, in his *Observations on Poisonous Vegetables*, has noticed the effect of the aquatic hemlock. He considers it one of the most active of the vegetables poisons. Early in the



Under the name of *secret poisons*, all those poisons were considered, which, while they were administered imperceptibly, gradually shortened life like a lingering disease. The Greeks and Romans were celebrated for such poisons. According to Plutarch, Quintilian, and other respectable authorities, a *slow* poison was administered to Aratus of Sicyon. At one time, when Aratus spit up blood, he exclaimed, "This is the effect of royal friendship!" These poisons, however, were of the vegetable kind. Such were the infamous practices of those days!

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spring, when it grows in the water, cows often eat of it, and are killed by it.

Mr. Wilmer observes, that the poison produces epileptic symptoms. Dr. Parr, quoting Wepfer as authority, observes, that some children, who, on eating the roots of this plant, were seized with pains in the precordia, loss of speech, abolition of the senses, and terrible convulsions; the jaws were locked, blood started from the ears, the eyes were distorted, and some of them died in half an hour. Others have observed that the old roots are a more active and sudden poison than arsenic or corrosive sublimate.

We do not know the precise nature of the vegetable poisons; but, from some late experiments of Dr. Brande, it would appear they existed in an alkali of a distinct kind. The poison of the deadly nightshade, however, is supposed to reside in an oil. The new vegetable alkali obtained from the henbane, called by the doctor, *hyosciami*, which possesses the characteristic properties of alkali, is to be used with caution; for Dr. Ure, in his edition of Nicholson's *Chemical Dictionary*, observes, that "the examination of the *alkaline* constituents of *narcotic* plants, demands great circumspection, because in them the whole poisonous properties of the plant are concentrated.—The vapour is particularly prejudicial to the eyes. The smallest morsel put upon the tongue, is very dangerous."



The Upas, the celebrated poison tree of Java, is now known to be fabulous; and, according to Fontana, the *ticuna* is much less virulent than it has been represented.\*

Poisons operate differently, with greater or less energy, on different constitutions. Like the tyrant of antiquity, who used himself to all kinds of poisons that he might be proof against their attack, some may feed on what would be destructive to others; hence the old proverb, "*what is one's meat is another's poison.*"

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\* Dr. Horsfield who wrote, in the *Batavian Transactions*, on the Upas, observes, that the account published by Foersch respecting the situation of the poison tree, its effect on the surrounding country, &c. is an extravagant forgery. The existence of a tree in Java, from the sap of which, a poison, equal in fatality, when thown into the circulation, to the strongest poisons heretofore known, is confirmed by the doctor. The tree, however, which produces this poison is the *anchar*, and grows in the eastern extremity of the island. Rhumphius gives a long account of the *Upas*, under the name of *arbor toxicaria*. "Besides the true poison tree," says the Rev. Mr. Clarke, "the Upas of the Eastern Islands, and the *anchar* of the Javans, this island produces a shrub, which, as far as observations have hitherto been made, is peculiar to the same, and, by a different mode of preparation, furnishes a poison far exceeding the Upas in violence. Its name is chetik, &c."

The *anchar* is one of the largest trees in the forests of Java, and furnishes a milky juice from which the celebrated poison is prepared. The bark is said to possess singular properties, which is prepared also in a particular manner. But the juice, from which the Javans prepare the poison, produces a mortal effect when introduced into the body by pointed weapons. Its preparation is an exclusive art of the inhabitants of the eastern extremity of the island.



This immunity is, however, limited. No constitution can be proof against the *effect* of poison. By tracing their symptoms, and their progress, and by even detecting the poison in the stomach of the victims, *no poisoner can now escape with impunity.*

It may be interesting, and perhaps useful to you to be informed, that animals, in many respects, are singularly exempt from the effect of a number of substances decidedly deleterious to man. We do not vouch for the truth, but we are informed by some writers, (Parr, *Med. Dic.*) that a horse can take a drachm of arsenic daily; and improve in his coat and condition.

Nux vomica is not peculiarly dangerous to man, except in considerable doses, though it soon destroys brutes. The aloes is a poison to dogs and foxes. The cocculus indicus is deleterious to fish, and yet is an ingredient in British porter. The *phellandrium aquaticum* is fatal to horses, and innoxious to oxen. The dornicum fattens antelopes, thrushes, and swallows, but is fatal to dogs. Pepper is injurious to swine, and parsley seeds to birds. Bitter almonds destroy foxes, cats, and chickens.—Various poisonous berries are eaten by certain birds, which, although innoxious to them, render their flesh poisonous, and unfit to be eaten. This happens at certain seasons, and mostly with the pheasant kind. The seeds of hemlock are eaten without injury by some birds, of stramonium by pheasants, of the *Coltium temulentum* by jays, and the roots of henbane by pigs.



Thus again, to insects of every kind, except the *tineæ*, camphor is fatal; frogs inclosed in a vessel with camphor, experience strong convulsions; and with sparrows and other birds, according to Menghini and Carminati, the effects are variable; while a few grains would be fatal to birds; cats, and other small quadrupeds, were seldom killed by less than a scruple. Dogs appear hydrophobic with less than two drachms. For the destruction of moths in woolen cloths, fur, &c. camphor has been used with success, and especially when joined with tobacco leaves.

Antimony was at one time considered innocent to brutes, but fatal to man. Basil Valentine, who was at the head of a college of monks, having observed that this mineral fattened *pigs*, imagined it would have the same effect on the holy brotherhood; but the case was seriously different. The unfortunate fathers, who made use of it, died in a very short time, and the mineral was pronounced a poison. Hence the origin of its name, *antimoine*,—against monks.

The opinion that antimony was a poison was entertained many years, until experience taught the contrary; in fact, it gave rise to much discussion among medical men, especially in France. The antimony, however, which the unfortunate Valentine gave to his brotherhood, must, we apprehend, have contained arsenic, although in too small a quantity to have any effect on swine.

The common antimony sold in the shops, which is used as a medicine for beasts, and particularly for



horses in the composition called *horse-powder*, it may be proper to remark, is a sulphuret of that metal; but when antimony is oxydized, in that state it is more or less pernicious, and when the oxyde is combined with tartaric acid and tartrate of potash, it constitutes the salt called *tartar emetic*.

It is with mercury, and many other metals as with antimony; in its metallic state, it is perfectly inert, but when oxydized, is corrosive and escharotic in the highest degree. If the per oxyde of mercury be combined with chlorine, a very virulent poison (corrosive sublimate,) will be formed.

Dr. Parr (*Lond. Med. Dic. art. Medicina forensis et politica*,) has given some useful remarks on this subject. He considers that poisons may be accidental or designed. After mentioning the symptoms when poison has been administered, he observes, that they are violent, inflammatory, stimulants, or sedatives. The pungent stimulants he ranks among the accidental poisons, the symptoms of which are pain in swallowing, and the inflammation of the fauces.—The power of arsenic is shown by violent inflammation and gangrene in the stomach. When the stimulant poisons have been the cause of death, the abdomen is greatly inflated, becomes rapidly putrid, dark spots appear on the body, erosion, inflammation, and gangrene are found in the fauces and stomach, the blood is black, and collected in the veins; above all, the villous coat of the stomach is destroyed. It is also remarked, that if gangrenous spots should appear in the stomach, after the body has been long buried,



and these spots surrounded by a reddish circle, these were the effects of changes during life. Should the colour of the whole be uniform, the putrefaction took place after death.

The Spanish flye (*meloe vesicat.*) kills by partial stimulus. It produces inflammation, then gangrene.

With respect to accidental poisons, they are of two kinds; those received in the food, or swallowed by mistake instead of a medicine. The first are chiefly copper, arsenic, and lead; the latter, nitre, camphor, corrosive alkalies, or the mineral acids.

### ARSENIC.

Arsenic, or ratsbane, as it is commonly called, is by far the most fatal poison, with which we are acquainted. That which is sold is the white arsenic, called also the white oxyde of arsenic, but more correctly the arsenious acid. Although arsenious acid is considered an active poison, yet the arsenic acid is accounted the most violent of the two, occasioning death as well as the arsenious acid, according to Mr. Brodie, by acting on the brain and the heart.

With regard to the reagents for the detection of arsenic, they are numerous; and methods have been devised to determine the existence of arsenic in the dry way.

Arsenious acid is soluble in water, and its degree of solubility is according to the temperature of the water. This solution is acid, as is shown by its effect on certain vegetable blues. With lime water it



produces an arsenite of lime, soluble in an excess of the solution. With sulphuretted hydrogen gas, and hydrosulphuretted water, a golden yellow sulphuret of arsenic is precipitated. This is so delicate a test, that it will detect 1.100000th of arsenious acid in water. The sulphuret of ammonia, and the hydrosulphuret and dydroguretted sulphurte of potash, have a similar effect if a drop or two of nitric acid be used; but they should be employed in connection with other reagents. The observations of Dr. Bostock on the precipitations produced by these tests, are just;—that they produce with tartarised antimony (tartrate of potash and antimony,) and with acids, precipitates of a similar colour, but this fact can be determined by examining the precipitates. It is readily discovered whether the precipitate be one of arsenic, one of antimony, or one of sulphur, by merely subjecting it to the action of heat, and recognising the arsenic by its well known garlic smell.

If the precipitate or sulphuret of arsenic be dried on a filter, and heated with a portion of caustic potash, a sulphuret of potash will be formed, and at the same time the arsenic will be sublimed in a metallic state, coating the sides of the tube.

When arsenious acid is combined with potash, that is to say, a solution of potash added to arsenious acid, an arsenite of potash will result, which will produce with a solution of sulphate of copper, a yellowish green precipitate, called Scheele's green.

The proportions best suited to produce the arsenite of copper, according to Dr. Bostock, are one of



arsenious acid, three of potash, and five of sulphate of copper.

Nitrate of silver is also a test for arsenious acid, with which it forms an arsenite of silver, of a yellow colour, which is soluble in an excess of nitric acid. The best mode of applying this test, as it is regarded one of the best, is by first adding water of ammonia, and plunging the end of a glass rod in it, and then in the supposed arsenious solution; after which we dip another rod into a solution of pure nitrate of silver, and transfer it into an arsenious solution. A fine yellow cloud will be formed, where they come in contact, being the arsenite of silver, and a slight milkiness will also be perceptible. This mode of using the nitrate of silver was recommended by Dr. Marcet. Mr. Hume employs the nitrate of silver differently. He dissolves about ten grains of lunar caustic in nine or ten times its weight of distilled water, and precipitates the solution by liquid ammonia; and redissolving the precipitate (oxyde of silver,) by an excess of ammonia, he forms a solution of the oxyde of silver in ammonia, with nitrate of ammonia. A rod dipped in it, and applied to a fluid supposed to contain arsenic, will produce a yellow precipitate if it is present.

President Cooper, of South Carolina College, recommends chromic acid as a test for arsenic; the delicacy of which is so great, that 1.50th part of a grain of arsenic put on a piece of glass, will become decidedly green in three hours with a single drop of a strong solution of chromate of potash. The arse-



nic is said to unite with a part of the oxygen of the chromic acid, and the arseniate of potash thus produced, envelopes the green oxyde of chrome. Chromate of potash with the arsenical ague drop, produces in a few hours a green colour; with a solution of corrosive sublimate (per chloride of mercury,) an orange colour, and with solutions of copper a bright brown colour.

Of the cupreous tests, the ammoniaco-sulphate of copper, (ammonia ret of copper,) appears to be preferable. It forms instantly a grass green precipitate, the arsenite of copper, (Scheele's green,) which becomes *brown* with sulphuretted hydrogen gas. This is also the case with the precipitate produced with the sulphate of copper. Either the ammoniaco-sulphate, or the ammoniaco-acetate of copper will detect 1.110000 of the weight of the arsenic in water.

A fact is mentioned in the *American Journal of Science* iii, 354, by Dr. Porter, that the onion juice with the solution of sulphate of copper, but *without* carbonate of potash, produces, in a weak arsenical solution, a *shade* like Scheele's green; but, if carbonate of potash be added, the effect is completely different. He mentions also the effect of chromate of potash on sulphate of copper; for, in the production of Scheele's green by arsenic, sulphate of copper and carbonate of potash, chromate of potash, he observes, might be substituted for the arsenic; and that it produced a precipitate not to be distinguished, by the eye, from Scheele's green!

Professor, now President, Cooper, however, in an



article in the same *Journal* vol. iv, p. 155, replies to the observations of Dr. Porter, with his usual perspicuity. He remarks, "that although a greenish colour may be produced by onion juice, and by coffee, with a solution of sulphate of copper, it is so *dingy* and so different from Scheele's green, that the most inexperienced eye need be under no mistake," and "that it is utterly impossible for any chemist to be led away by the ambiguity of colour produced by Dr. Porter's reagents, as a single drop of ammonia will instantaneously detect the copper in all these experiments."

The professor also remarks, that Dr. Porter's summary is not accurate as a matter of fact. "Take sulphate of copper," says he, "precipitated by carbonate of potash, add chromate of potash in the way you cite the experiment; a green colour will be produced exactly like Scheele's green: so it will if you add infusion of turmeric, gamboge, or saffron, and any other liquor equally yellow with the chromate of potash: but this superinduced yellow colour can be washed away completely, and the carbonate of copper will resume its original blue tint; no chromate of copper is found, no chemical action has taken place; the colour is a mere optical deception that can impose upon no chemist. *But*, if to a strong solution of sulphate of copper, you add an equal quantity of chromate of potash of the strength usually employed by the manufacturers of chromic yellow, you will produce a green chromate of copper, that will retain its colour unchanged by repeat-



ed ablution. Chromate of potash, therefore, cannot be *substituted* for arsenic, if the experiment be made as Dr. Porter has directed."

The ferrocyanate of potash produces with arsenic, a blood red precipitate. If the precipitates, which contain arsenic, be dried, and exposed on an ignited coal, they will give a peculiar smell resembling that of garlic. If a little of an arsenical solution be placed on glass, and the two wires from a voltaic battery be brought in contact, metallic arsenic will be formed at the negative pole. If the wire, which conducts the galvanic fluid, be copper, it will be whitened like tombac, which alloy is actually formed.

Some of the salts of iron, as the deuto-acetate, have been used as reagents for the same purpose.\* But, notwithstanding all these tests, the most satisfactory evidence of the existence of arsenic is derived from its reduction to the metallic state. A small quantity of the matter suspected to contain arsenic, when mixed with a little dry black flux, and put into a narrow glass tube sealed at one end, and the bottom of the tube heated by the blow pipe till red for

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\*I recommended some years ago, in a paper I think in the *Memoirs of the Columbian Chemical Society*, the use of some of the salts of iron as tests for arsenic. At that time, no writer mentioned the application of the salts of iron for that purpose.

did not consider any preparation of iron, as a reagent for arsenic, in any respect decidedly advantageous, since we have so many other tests more decisive, and more to be depended upon. I thought no more of it until the recommendation of the deutoacetate of iron brought it to my recollection.



a minute, will give a *garlic* odour, and the *steel lustrated coating* of *metallic arsenic* will be seen about one fourth of an inch above the bottom of the tube.— This metallic arsenic may be examined with the reagents before mentioned, or placed between copper plates, and exposed to heat, which will give them a white stain, forming the *tombae alloy*. If a substance supposed to contain arsenic, be mixed with charcoal, or the black flux, and exposed in the same manner between plates of copper, they will also indicate it. Dr. Ure informs us, that tincture of ginger will produce with the cupreous reagent a green colour; and advises, therefore, the use of several reagents for the detection of arsenic. Tea, he remarks, covers arsenic from the same test, but that such poisonous tea becomes by its addition of an obscure violet, or olive red, scarcely yielding any precipitate. Sulphuretted hydrogen throws down a fine yellow sulphuret of arsenic.

Orfila, who has written largely on poisons, speaks of the various modifications of the precipitates produced by arsenic, when contained in wine, coffee, tea, broth, &c. In a case of life and death, and the real existence of arsenic is to be made manifest, *without a doubt*, the fluid should be evaporated to dryness, and the residue exposed to heat as before mentioned. Brugnatelli has proposed as a test for arsenic, the blue compound of iodine and starch, which changes to a reddish hue with arsenical solutions. See *Corrosive sublimate*.



If the arsenic should be united with oil, boiling the mixture with water, and then separating the oil by the capillary action of cotton wick, may be resorted to. If with resins, they may be taken up by oil of turpentine; for it is found, that alcohol, although a solvent of resins, is also a solvent of arsenious acid. If the arsenic be combined with tea or coffee, it is necessary to separate the tannin, by means of gelatin, previous to the application of the reagents for arsenic.

White arsenic, or arsenious acid, according to Dr. Wollaston, exhibits a very beautiful phenomena when mixed with quick lime, and heated in a glass tube. At a certain temperature the mixture becomes ignited, the combustion gradually pervading the whole mass, and *metallic* arsenic sublimes. It is supposed in this experiment, that the arsenious acid gives out a portion of oxygen to another portion, converting the latter into arsenic acid, which unites with the lime into an arseniate of lime, while at the same time another portion of the arsenious acid is reduced. This experiment may be made with others to show the identity of arsenic.

When arsenic is exposed to the action of the blow pipe, it is dissipated with a garlic smell. Larger pieces, however, when heated on a piece of ignited charcoal, do not produce a smell; to effect which it must be *mixed* with powdered charcoal, and reduced. If arsenic is held in solution, it may be recognised by dipping into its solution a piece of charcoal, which is afterwards to be dried and ignited:



this experiment, with the methods of discovering arsenic, already mentioned, may be useful.

The arsenites are equally poisonous with the uncombined arsenious acid. Mr. Brodie by a number of experiments on rabbits and dogs, established a principle as to the operation of arsenic on the living system, namely, "the suspension of the functions of the heart and brain, occasioned by the absorption of these substances into the circulation, and their consequent determination to the nervous system and the alimentary canal."

As arsenic mineralizes metals or is combined with certain ores, the smelting of such ores, as well as the working of them, unless great caution be used, is extremely injurious to health. Miners gave to an unknown mineral, which often proved prejudicial to their health, the name of cabalt, derived from *cabalus*, a spirit. This spirit, according to the superstitious notions of the times, haunted mines, destroyed the labours of the miners, and gave them a great deal of unnecessary trouble. Such, however, were the injurious, if not the fatal effects of arsenic to miners, and those who worked the arsenical cobalt ores, that according to Professor Beckman, "it was once customary to introduce into the church service a prayer, that God would preserve miners and their works from *kobalts* and spirits."

The ancients, we remarked, were not acquainted with arsenic; but this fact is certain, that the principal ingredient of those secret poisons, which, in latter times, were brought to *perfection*, in France



and Italy, was arsenic. Charles VI. king of the two Sicilies, told his physician, Garelli, who communicated the same to Dr. Hoffman, in 1719, that the poison of Tophania, of infamous memory, was composed of an "arsenical calx dissolved in aqua cymbalaria," and the poison of Exilli, Sainte Croix and the Marchioness of Brinvillier, was also an arsenical mixture. They were both, in the opinion of Dr. Hahneman, arsenical neutral salts, i. e. a preparation of arsenic, (arseniate of potash) made by deflagrating nitrate of potash and arsenious acid in a crucible.

Dr. Fordyce remarks, in comparing the effects of arsenic and gold, that while the former is poisonous, the latter is a *cordial* in the pocket, and only a poison to the mind. When oxydized, however, it becomes poisonous; and the muriate of gold is thus strongly characterised.

For *antidotes* to arsenic, see the following article.

## CORROSIVE SUBLIMATE.

There are two preparations of mercury with chlorine, *viz.* calomel and corrosive sublimate. The former is the submuriate, now called the proto-chloride of mercury, in which the mercury is at the minimum of oxydizement; the latter is the corrosive muriate, or per chloride of mercury, containing in the oxyde a maximum of oxygen. Corrosive sublimate, next to arsenic, is the most virulent of the metallic poisons. Its presence may be recognized by several reagents; if a portion be exposed to heat



in a glass tube, it will rise and line the inner surface in the form of a shining white crust. When dissolved in water, its solution produces the following phenomena with reagents. If the solution be poured into the compound of iodine and starch, it will strike a red colour, the same as arsenic; but if to the arsenical fluid, thus coloured, we add some drops of sulphuric acid, the original blue colour will be restored, whereas it will not restore the colour produced by the corrosive sublimate.

Chromate of potash produces with corrosive sublimate a precipitate of an orange colour. Caustic potash put on sublimate, and made to act upon it with heat, will give a red colour, which by gentle ignition will disappear, and metallic mercury will rise and line the upper part of the tube. The solution of corrosive sublimate turns sirup of violets to green. The bicarbonates of potash and soda throw down a deep brick red precipitate, which, if heated, will afford metallic mercury. Caustic potash gives a yellow precipitate, and lime water produces an orange yellow colour. Water of ammonia gives a white precipitate, which changes to yellow by heat. Sulphuretted hydrogen, and hydrosulphurets, produce a black or blackish brown precipitate, which, when strongly heated, is wholly volatilized without any odour of garlic.

Dr. Parr says, that the saline mercurials may be discovered by adding ammonia, and heating the whole in a close vessel, when the mercury will be so far revived as to whiten copper on rubbing.



To exhibit the mercury in a metallic state by the agency of galvanism, is the method of discovering corrosive sublimate proposed by Mr. Sylvester. If a piece of zinc or iron wire, about three inches long, bent at right angles, the legs of which being distant about the diameter of a gold ring, be tied to a ring of that metal; and if a plate of glass, not less than three inches square, be laid as nearly horizontal as possible, and on one side some sulphuric acid diluted with six times its weight of water, spread to the size of a half penny, be placed, and at a little distance from this towards the other side some of the solution supposed to contain corrosive sublimate, till the edges of the two liquids join together; then, when the wire and ring, prepared as above, are laid in such a way that the wire may touch the acid, while the gold ring is in contact with the suspected fluid, if the smallest quantity of corrosive sublimate be present, the mercury will be reduced and cover the ring on the part which touched the fluid. These are the means usually employed for the detection of corrosive sublimate.

It may be useful to know, that in all cases of poison, the stomach should be relieved as soon as possible, by means of a strong emetic, drinking freely afterwards of diluting liquors, such as a decoction of barley with gum arabic, mutton and veal broths, &c. in order to sheathe the parts, and prevent their being acted upon. If arsenic should be the poison, oil, butter, and other fatty substances ought not to be administered, as they are said to dissolve and promote



its action ; but, in their place, mucilaginous and gelatinous substances must be employed. The sulphuret of potash, in the proportion of a drachm dissolved in a pint of water, is a remedy which some writers inform us, will afford great relief in cases of poison both from arsenic and corrosive sublimate.

Vinegar is recommended by some authors as an antidote for arsenic, the efficacy of which is denied ; milk, is also recommended by Morgagni, and oil of aniseed and ink by Navier. Dr. Chisholm, however, states that the juice of sugar cane is the best antidote.

Sulphuretted hydrogen water may, on the same principle, be used along with emetics ; but of all antidotes for corrosive sublimate, the white of eggs, or albumen has the preference. It is to be properly diluted with water previous to its use. Albumen converts the corrosive muriate or per chloride of mercury into calomel, or protochloride.

Albumen has a very sensible effect on solutions of corrosive sublimate. Dr. Bostock, (*Nich. Jour.* xiv. 142,) assures us, that if a drop of a saturated solution of corrosive sublimate be added to water containing 1-2000th part of its weight of albumen an evident milkiness will be produced, followed by a curdy precipitate. Corrosive sublimate is considered, therefore a very delicate test of the presence of albumen. The precipitate when dry, contains about 5-7ths of its weight of albumen.

While none of the earths form insoluble compounds with albumen, in which respect they resem-



ble the alkalies, the metallic oxydes exhibit a different character. The effect of albumen on sundry metallic solutions, is detailed by Dr. Thomson, in his *System of Chemistry*, vol. iv. p. 404, according to his own experiments; some of which we shall notice. With nitrate of silver, a copious reddish brown precipitate, not re-dissolved by ammonia; with nitrate of mercury, a white precipitate; with corrosive sublimate, a light white precipitate; with persulphate of copper, a greenish white precipitate; with nitrate and acetate of lead, a copious white precipitate, &c. If, as above remarked, the precipitate obtained by adding a solution of corrosive sublimate to albumen, contains 5-7ths of its weight of albumen, the remaining 2-7ths must be the corrosive sublimate, or rather, according to Dr. Ure, calomel or protochloride of mercury. If this conclusion be correct, the albumen during its solidification or coagulation must take a part of the oxygen from the oxyde of mercury, thus reducing the per oxyde to the minimum of oxydizement, a fact which seems reasonable, as it is remarked, that albumen during its coagulation absorbs oxygen. As albumen possesses some of the distinctive characters of gelatin, such as precipitating tannin from its solution, and forming a combination therewith, the idea has occurred to me, that gelatin might be also advantageously employed as an antidote to some mineral poisons. I am sensible, nevertheless, that the precipitates produced by gelatin in some metallic solutions are different from those occasioned by albumen; as, for instance, that



several metallic oxydes, when agitated in a solution of gelatin deprive it of its water, and that some metallic salts, likewise, precipitate gelatin from water. In these respects the effect of gelatin would be different from albumen.

## PREPARATIONS OF COPPER.

The acid combinations of copper, and the oxydes of copper, are all decidedly virulent, but in a less degree than the preceding. Copper, we have already seen, may gain admission into food in a variety of ways. Verdigrease, which is usually formed or some combination of copper with vegetable acids, in culinary concerns, is an active poison. The reagents for detecting this metal are several, the principal of which are the following: liquid ammonia, which produces a compound of a very deep blue, when added in excess to a solution of copper; ferrocyanate of potash, which is an excellent test, producing a brown or chocolate coloured precipitate in solutions containing the per oxyde; chromate of potash, occasioning a precipitate of brown chromate of copper; arsenite of potash, which forms with cupreous solutions a yellowish green precipitate, the arsenite of copper; the precipitation of metallic copper by a plate of iron; carbonated alkalies, which throw down a green carbonate, soluble with effervescence in acids; and hydrosulphuret of ammonia, as well as the hydrosulphurets generally, by forming a dark brown or black precipitate.



In a medical view, copper supports the doctrine of Linnæus, that medicine differs from poison, not in quality, but in power. In moderate doses, like other metals it is sedative, tonic, or antispasmodic. We have, however, mentioned the danger of employing vessels for culinary purposes, which contain any proportion of copper in their composition, for the metal is acted upon by acid and sebacious substances. The danger of employing such vessels has been found by experience, and particularly with the crew of the frigate *Cyclops*, noticed in a preceding lecture; but Mr. Bizard and others, have pointed out the deleterious consequences of using copper utensils.

When copper or its preparations is taken in large quantities, the symptoms are described to be "nausea, with a constant taste of copper remaining in the back part of the fauces; violent vomiting; the most dreadful oppression on the breast; the most acute pains of, and a burning heat in the stomach; cold; vertigo; bloody stools; watchfulness, increasing to delirium; faintings; convulsions; paralysis; and apoplexy; frequently with eruptions of the skin; sometimes resembling lepra."

The only chemical antidote to cupreous solutions whose operation is well understood, is water strongly impregnated with sulphuretted hydrogen gas. The alkaline hydrosulphurets, on account of their acridity ought not to be prescribed. We observed, that Dr. Chisholm recommended the juice of the sugar cane, as an antidote to arsenic. It is found that sugar, ob-



tained from the juice, is also an antidote to copper, but its mode of action is obscure. Orfila mentions, that persons who had swallowed by accident or intention poisonous doses of acetate of copper, recovered by taking large doses of sugar. What may appear incredible is, that he uniformly found when a quantity of verdigrease, sufficient to kill an animal alone in an hour or two, was mixed with sugar, and given to dogs, it proved perfectly harmless. It appears that sugar can neutralize both the oxydes of lead and copper, producing the neutral saccharates of these metals. When an ounce of white sugar is boiled with ten grains of verdigrease, a green liquid will be formed, which is not affected by the most delicate tests of copper.

There is another antidote to copper, viz. charcoal. Charcoal, in fact, has been recommended as a general antidote for poisons, as well as metallic preparations. Even when other remedies have failed in giving relief, in cases of poison by copper, charcoal powder is said to have been administered with the most beneficial effects. But so far as the experiments of Orfila are to be relied upon, the most certain antidote is unquestionably sugar.

Some writers affirm, that the encomiums passed upon charcoal as an antidote, are extravagant, and that charcoal can not be altogether depended upon. We know of no set of experiments with charcoal. As an antiseptic, its powers are unquestionable.

When copper has been inadvertently swallowed, it is seldom necessary to administer an emetic, as



the vomiting it excites is sufficiently active. Sickness and violent pain in the stomach may ensue without vomiting; in that case a few grains of sulphate of zinc, (white vitriol) may be given. If an emetic is not required, medical authors usually recommend the administration of mucilaginous substances, and oil, butter, and milk, with an occasional use of alkali. Soap is recommended by some; and a solution of sulphuret of potash (*hepar sulphuris*,) given with milk or with mucilages.

In the modern tables of chemical equivalents we find, that the saccharate of lead is 192; viz. 81, the equivalent number of sugar, and 112 that of oxyde of lead, but no mention is made of the combination of oxyde copper and sugar. If 72 be the number for the protoxyde of copper, and 81 for that of sugar, and the combination in those proportions, the saccharate of the protoxyde of copper must be 72. 81. 153 for its equivalent number.

Travis, in his *Medical observations and inquiries*, ii. 1, remarks, that copper was supposed to be a cause of scurvy at sea, introduced into the system of sailors, by a neglect in cleaning the culinary vessels of the ship. This idea, however, is fallacious. That it is injurious, in other respects, cannot be denied. See *Lecture II.* on the use of copper vessels for culinary purposes.

## PREPARATIONS OF LEAD.

The oxydes and salts of lead are very deleterious. We mentioned when speaking of wine, of the use of



lead and its acetate in correcting its acescency ; and the practice of adulterating wines with that metal, at different periods. The ancients knew the action of *spoiled* or sour wine on lead ; for in order to try their liquor, they usually immersed a plate of lead ; if it became corroded, they condemned the wine. Lead produces a particular disease called the poitau colic, (*colica pictonum*,) by the inhalation of vapours arising from lead, or the frequent handling of some of its preparations ; hence painter's and glazier's are frequently attacked by it, and especially those who work in the white lead manufactories. The effects of this metal, however small the quantity introduced into the system, is sooner or later fatal.

The introduction of lead into cider, we have mentioned when treating of sundry poisons. When united with cider, lead is supposed to produce the *poitau colic*. It may be presented to the cider, we remarked, in the instruments employed in pressing the apples, or added to correct the acidity of cider, in the same manner as wine. Sir G. Baker discovered lead in the Devonshire cider, which occasioned we are told, the poitau or dry cholic ; a disease that terminates by nervous spasms, convulsions and death. Lead taken in any quantity is highly deleterious to every animal. It *destroys irritability*, and hence occasions in the intestinal canal the disease we have mentioned. On this account its preparations are highly useful in external inflammations, bruises, &c. and when administered in proper doses, lessen the irritability of the arterial system, relieve internal hæmorrhages and spasms.



The vapours of lead from smelting houses are injurious.

Notwithstanding the *colica pictonum* is frequently the effect of handling and working in lead, Dr. Parr remarks, that “numerous are the printers, glaziers, and painters, who have never suffered from the saturnine colic.” The means of preventing this disease, are pointed out by the doctor: when glazier’s lead is flattened in a mill, the lead comes out warm, and should be handled in gloves; the printer should wash his hands with soap and water whenever he leaves his work for his meals, and smear them slightly with oil when he begins; the painter should have water at hand, and wash off immediately every atom of paint which accidentally falls on it, and each workman will find fat meat, particularly fat bacon, in a morning, useful, and occasionally, if costive, a dose of castor oil, or two ounces of olive oil may be taken. By these simple means, the doctor assures us, he has preserved the health of many, who have been constantly employed in either business, and experienced repeated attacks of cholera. In saturnine colics, the farmers in Devonshire have used with success equal parts of brandy and oil of turpentine, as an active stimulus to restore the irritability.

Doctor Parr, however, mentions as a fact, as he is not disposed to admit all that is said respecting the formation of carbonate of lead in particular instances, the solution of lead in other cases, &c. that he has kept vinegar in a vessel glazed with oxyde of lead in the usual manner, and could not detect the



the least particle of lead in it! He asserts also that no lead is taken up in the distillation of liquors through leaden pipes, nor in the preparation of oil of vitriol; both of which are contrary to fact. Why do we find sulphate of lead *in* oil of vitriol?

To counteract the effect of lead on the system, a course of sulphuretted hydrogen or hepatic waters, laxatives of various kinds, sulphur, castor oil, sulphate of magnesia, and calomel should be resorted to, added to warm sea bathing, and if necessary, a mercurial course. The proper counter poison, for a dangerous dose of sugar of lead, is a solution of Epsom or Glauber's salt, for the obvious reason, that they immediately decompose the acetate of lead, and form an insoluble sulphate of lead. The reagents for the detection of lead, are water impregnated with sulphuretted hydrogen gas, and the hydrosulphurets and hydroguretted sulphurets of the alkalies and some of the earths, which throw down the lead in the state of a dark brown sulphuret, which may be reduced on charcoal before the blow pipe. Hahneman's wine test, which is made of sulphuret of lime and super-tartrate of potash in water, is nothing more than water impregnated with the hepatic gas. This test, originally designed for the detection of lead in wines, is first mixed with a few drops of muriatic acid before it is used, in order that, if iron be present, it will have no effect on that metal. Sulphate, muriate, and carbonate of soda have also been used as reagents; they form respectively, a sulphate, muriate, and carbonate of lead, precipitates which are



immediately blackened by hepatic gas. The sub-carbonate of ammonia, is preferred by many; it forms a carbonate of lead, which is blackened in the same manner, and is readily reduced on charcoal before the blow pipe.

Chromate of potash produces a yellow precipitate (chromate of lead,) with saturnine solutions. Salts of lead are also characterized by a white precipitate, with ferrocyanate of potash, and a yellow by the hydriodate of potash.

Infusion of galls produces a dingy yellow precipitate with solutions of lead: hence gallic acid has been recommended as a test for lead. The insoluble salts of lead, or those that are insoluble in water, as sulphate of lead, may be decomposed by soda or potash, and the oxyde of lead then dissolved in nitric acid, which may be examined by the reagents already mentioned. The metal may be obtained by reduction. See *Adulteration of Wine*, Lecture I.

## PREPARATIONS OF BARYTES.

The salts of barytes are generally poisonous.—All the salts of barytes are white, and more or less transparent. The soluble sulphates produce with the muriate, nitrate, and other soluble salts of this earth, a precipitate of sulphate of barytes, which is remarkable for its insolubility in nitric or muriatic acid. If carbonate of barytes, which is also deleterious, be swallowed by mistake, the proper antidote is diluted sulphuric acid; and the counter-poison for the soluble salts, such as the muriate and nitrate of



barytes, is the speedy administration of a solution of sulphate of soda. In both cases, an insoluble salt of barytes is produced. Orfila (*Traite des Poisons*, Tom. p. 167,) prefers sulphate of soda as an antidote.

The native sulphate of barytes, heavy spar, or baroselenite, is found abundantly in every country, and a variety is met with in Derbyshire, called *cawk*.—The artificial sulphate is used as a pigment, under the name of permanent white.

The *Bolognian stone*, from which the Bolognian phosphorous is formed by calcination, is the same sulphate.

The native carbonate of barytes, called *witherite*, *barolite*, *arated baroselenite*, &c. is about 4.3 specific gravity, effervesces with acids if assisted by heat, and is only soluble in 4304 times its weight of cold water. Sulphate of barytes is the most insoluble substance which chemistry presents, requiring 43.000 parts of water to dissolve it at 60 deg.

The detection of barytes is readily performed.—If it be the sulphate it must be decomposed by carbonate of potash in a crucible; then digest the mass in water; and decompose the carbonate of barytes, thus formed, by nitric acid. The nitrate may be either exposed to heat to obtain the pure earth, or acted on by a solution of sulphate of soda, and the quantity of sulphate of barytes estimated. The carbonate may be examined by solution in nitric acid, &c. as before.

Professor Brande (*Manual of Chemistry*, article



*Strontium*,) very judiciously observes, in speaking of the resemblance between strontian and barytes, which has led to confusion in analysis, that "they are both found native in the states of sulphate and carbonate only ; both sulphates are soluble in excess of sulphuric acid, and nearly insoluble in water ; they are decomposable by similar means, as well the native carbonate : they are both crystallizable from their hot aqueous solutions, and both attract carbonic acid. The carbonates are each soluble with effervescence in most of the acids ; but the native carbonates are not so easily acted on as the artificial.—Pure ammonia precipitates neither one nor the other. The following are essential distinctions: Barytes and all its salts, except the sulphate, are poisonous. The corresponding strontitic salts are innocent. Barytes tinges flame yellow ; strontian red.

Strontian has less attraction for acids than barytes ; hence the strontitic salts are decomposed by barytes. The greater number of the barytic salts are less soluble than those of strontian, and they differ in their respective forms and solubilities. Pure barytes is ten times more soluble in water than pure strontian."

Furthermore, in your text book on Mineralogy by Professor *Cleaveland*, the *distinctive*, as well as the *chemical characters* of the sulphate and carbonate of barytes, and those of strontian are accurately described, with the habitudes of each before the blow pipe ; to which I refer you, for further information on this subject.

Carbonate of barytes has been recommended by

Carbonate



Dr. Taylor, in lieu of arsenic, as ratsbane, and is said to be preferable for the destruction of rats. He uses half an ounce in powder with four ounces of oatmeal, scented with six or eight drops of oil of aniseed.

The same care, however, is necessary as in using white arsenic. It may not be irrelevant to observe, that in using those active poisons, the vessels, &c. ought to be thrown away, and all descriptions of food safely secured from the deprivations of the rats, for after eating of the poison they go instinctively in search of water, food, &c.

### PREPARATIONS OF ANTIMONY.

Tartar emetic is a preparation of antimony, consisting of tartaric acid, oxyde of antimony and potash; and is, therefore, a triple salt denominated tartarised antimony, or tartrate of potash-and-antimony. It is nothing more than the supertartrate of potash saturated with the prot oxyde of antimony; and as the excess of acid in that salt combines with, and is neutralized by, the oxyde of antimony, the emetic tartar may be considered a combination of the two salts; viz. tartrate of potash, and tartrate of antimony. The action of reagents on this salt will detect its presence. Thus sulphuric, nitric, and muriatic acid decompose it, and precipitate a supertartrate of potash; soda, potash, and ammonia, precipitate an oxyde of antimony, and the carbonates of these alkalis also affect it in like manner; the alkaline hydro-



sulphurets precipitate Kerme's mineral, well known by its colour; and when exposed to the action of a red heat, it first blackens and leaves a residuum of metallic antimony and subcarbonate of potash. The precipitate produced in the above experiments, when mixed with black flux, and exposed to heat will produce a globule of metallic antimony. Tartar emetic, as its name expresses, when administered in certain doses, excites vomiting; but when given in an under dose, is capable of acting as a poison. The best antidote in that case is sulphuretted hydrogen waters, which unites with the antimony and converts it into a mild sulphuret. Various demulcent drinks, infusion of bark, &c. may also be given.

### NITRATE OF SILVER.

This salt is an active poison. It is a preparation of silver, in which the metal is dissolved by nitric acid. It is the lunar caustic of the apothecaries. It is known, that muriate of soda decomposes it, and forms a muriate of silver; hence it is used as an antidote. A solution of muriate of soda swallowed immediately after taking the nitrate of silver, will form an insoluble muriate, and the stomach is then to be emptied by an emetic.

### MURIATE OF TIN.

This preparation is also poisonous. If swallowed by accident, milk should be administered without delay.



It produces with it a coagulum of a mild and inoffensive nature.

### CORROSIVE ACIDS.

On the principle that alkalies combine with, and neutralise acids, they are the most proper counterpoisons to be administered in case of the accidental swallowing of corrosive acids. They must be used, however, in the form of solution, sufficiently diluted. Magnesia, or its carbonate, may also be administered. Mr. Fourcroy advises, in case of sulphuric acid being swallowed, the speedy exhibition of a solution of soap, or a mixture of carbonate of lime, or carbonate of magnesia.

### CAUSTIC ALKALIES.

On the same principle that alkalies neutralise acids, and render them inert, the acids are used to counteract the effect of alkalies when taken into the stomach. The acids preferred for this purpose, are acetic, or if it cannot be had, common vinegar, or lemon juice. They will unite with the alkali and produce either an acetate or a citrate, thus destroying the corrosiveness of the alkali.

### OXALIC ACID.

This acid is contained in the juice of the *oxalis acetosella* or wood sorrel, in combination with potash, forming the salt known under the name of salt



of sorrel.\* It is formed artificially by the acidification of sugar, by means of nitric acid; hence it is also called *saccharine acid*. It has a powerfully acid taste, and precipitates lime from lime water almost immediately, producing an insoluble oxalate of lime. Having the appearance of, it has been sold for, the sulphate of magnesia, or Epsom salt; a salt which it resembles in its crystallization. The mere taste, however, is sufficient to distinguish them; the oxalic acid is decidedly acid, while Epsom salt is decidedly bitter. Epsom salt is precipitated by carbonate of potash, but oxalic acid is not. Lime water has no effect on sulphate of magnesia; but with oxalic acid it forms an insoluble oxalate of lime.

Oxalic acid has been sold in London under the name of "Salts," and is usually bought for the purpose of whitening boot tops. Two or three drachms of it swallowed by mistake, will act as a violent poison. Very fatal accidents have already occurred by such mistakes. The immediate rejection from the stomach of this acid, by an emetic, together with copious draughts of warm water holding in solution bicarbonate of potash or soda, may be repeatedly given. Chalk and magnesia, diffused in water, may also be administered. In fact, a mixture of chalk

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\* The *oxalis acetosella*, *oxalis corniculata*, and different species of *rumex*, and the *geranium acidum* contain the oxalic acid in the state of binoxalate of potash. It is also found in the root of rheubarb; the same salt, Scheele discovered in a variety of roots and barks, and Vauquelin and other chemists observed the oxalic acid uncombined in the liquid which exudes from the *cicerparietinum*.



and water is recommended as the best antidote, because the oxalic acid by combining with the lime or the chalk, will produce an insoluble and inert compound, the oxalate of lime.\*

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\* We lately saw in the *Journal of the Royal Institution*, a comment by the editors on the use of blue paper, which covers sugar loaves, as a *test* for oxalic acid recommended by some person. It will only discover, like litmus, the presence of an acid, without pointing out, or designating the kind. Its *acid* nature can, as readily, be determined by the taste. While noticing the effect of acids or litmus, &c. the following remarks may not be irrelevant:

Many vegetable substances may be employed as tests for uncombined acids and alkalies. Thus litmus is a test for acids, which redden it; and reddened litmus is also a test for alkalies, which restore the original blue colour. This effect is owing to the mutual saturation of each other; for an acid and alkali, completely neutralized, neither indicate by reagents a *free* acid, nor a *free* alkali: if either one or other be in excess, the fact will be readily shown.

Alkanet root is recommended, in Silliman's *Journal*, vol. v, p. 348, by professor Hare, as a substitute for litmus. When used as such, he remarks, that it produces the same phenomena as litmus, but in a reversed order. The infusion or rather tincture of alkanet, is made *blue* by an alkali, and restored to its original colour, *red*, by an acid. Paper stained with alkanet, rendered blue by alkali, is, therefore, a good test for acids, and *vice versa*. The sirup of violets becomes red by acids, and green by alkalies; and the same effect takes place with the juice of March violets, or that of the scrapings of raddishes. The *blue Iris*, according to professor Olmstead, (*Silliman's Journal*, v, 403,) affords a good test for liquor.

As tests for alkalies, reddened litmus, tincture of brazil wood, tincture of turmeric, acidulous tincture of cabbage, and sirup of violets are used. The first turns blue, the second more or



## HYDROCYANIC ACID.

This acid, called also the prussic, is extremely virulent, producing death almost instantly, if the quantity taken be even very small. It has, however, been used in medicine, but in very small doses. It is this acid which exists in those cordials, made from bitter almonds, peach kernels, &c.—Some of which have caused immediate death.

The prussic acid has a strong smell of peach blossoms, or bitter almonds; its taste is first sweetish, then acrid, hot, and virulent, and excites coughing.

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less so, the third reddish brown, the fourth blue, and the fifth green.

These tests are generally very delicate. Thus, Bergmann has shown that paper stained with litmus, is reddened, when dipped into water containing 1.3521 of sulphuric acid; and the infusion of turmeric will become brown when the soda, in the water, amounts only to 1.2217th part. Paper stained with Brazil wood, Bergmann ascertained would become blue in water containing only 1.9945th part of carbonate of soda in solution. These effects clearly prove, that chemical action is exerted in infinitely small ratios. On the delicacy of tests we may add, that Dr. T. Thomson has detected in water the *one millionth* part of its weight of lead by sulphate of soda.

Nitrate of silver will detect muriatic acid in minutely small proportions; for one grain of common salt, dissolved in 42.250th grains of water, (rather more than 5 lbs.) will give a precipitate. This quantity does not contain more than 1.108333 part of its weight of muriatic acid.

Other instances may be mentioned of the power of reagents; as starch, which will indicate iodine in solution, in the infinitely small proportion of 1.450000, and tannin, which will form an immediate precipitate in a solution of 1.1000 of isinglass, and a very considerable precipitate when the gelatin is only 1.2000.



The water obtained by the distillation of the leaves of the lauro-cerasus, (of which notice has already been taken,) bitter kernels of fruits, and some other vegetable substances, are poisonous, on account of their containing this acid. Mr. Schrader, of Berlin, ascertained the fact that the water obtained from these substances, when mixed with lime-water gave a blue precipitate with sulphate of iron. In this experiment, the lime by uniting with the prussic acid, forms a hydrocyanate of lime, which, with the sulphate of iron, is decomposed; and produces a precipitate of the per ferrocyanate of iron, the hydrocyanic acid being changed by a portion of the iron into the ferrocyanic. The addition of lime water, or a very weak solution of potash, to distilled waters supposed to contain prussic acid, and the subsequent addition of sulphate of iron, will indicate its presence. Free prussic acid gives with nitrate of mercury, a black precipitate. Scheele found that prussic acid gave a white precipitate with nitrate of silver, and with nitrate of mercury, a black.

We have the following instances of the effects of the prussic, or hydrocyanic acid:

In the *Annales de Chimie* for 1819, we are informed, that M. B. professor of chemistry, left by accident on a table, a flask containing alcohol impregnated with prussic acid; the servant enticed by the agreeable flavour of it, drank a small glass of it. In two minutes she dropped down dead, as if struck with apoplexy.

Orfila remarks, that Scharinger, a professor at Vienna, prepared some concentrated prussic acid; he



spread a certain quantity on his arm, and died a little time thereafter.

From the experiments of Mr. *Magendie* it appears, that pure hydrocyanic acid is the most virulent of all poisons. A rod dipped into it, and brought into contact with the tongue of an animal, will occasion death before the rod can be withdrawn. A bird held over the mouth of a phial containing the acid, is almost instantly killed.

The following melancholy accident, which has lately occurred, is no doubt to be attributed to the hydrocyanic acid :

“The Edenton (N. C.) Gazete states, that a small child, about 2 years of age, after eating a number of yellow jessamine flowers, died in the space of half an hour. In a minute or two after eating them, she became perfectly blind.”

Eaton (*Manual of Botany*, p. 321,) describes two species of jessamine, or jasmine, the *fruticans* and *officinale*. The latter afford white flowers, and exhale a sweet and penetrating odour, particularly after rain. It is the common jasmine. The Italians prepare from the flowers, by means of cotton soaked in oil, a grateful perfume. See *Essential oil*.

There can be no question as to the poisonous properties of the yellow jessamine, from the instance above mentioned. If distilled, the water, we are of opinion, would give every indication of prussic acid.



## POISONOUS VEGETABLES.

Professor Eaton in his Manual of Botany, and in his Botanical Dictionary, has given a few concise rules for avoiding vegetable poisons, which we here introduce.

## PLANTS NOT POISONOUS.

1. Plants with a *glume* calyx, never poisonous; as wheat, Indian corn, foxtail grass, sedge grass, oats. Linnæus.

2. Plants whose stamens *stand on the calyx*, never poisonous; as currant, apple, peach, strawberry, thorn. Smith.

3. Plants with *papilionaceous* flowers, rarely if ever poisonous; such as the pea, bean, locust tree, wild indigo, clover. Smith.

5. Plants with *labiate* corols, bearing seeds without pericarps, never poisonous; as catmint, hysop, mint, motherwort, marjoram. Smith.

6. Plants with *compound* flowers, rarely poisonous; as sunflower, dandelion, lettuce, burdock.—Milne.

## POISONOUS PLANTS.

1. Plants with five stamens and one pistil, with a dull-coloured lurid-corol, and of a nauseous sickly smell, always poisonous; as tobacco, thorn apple, henbane, nightshade. The degree of poison is diminished where the flower is brighter coloured, and



the smell is less nauseous. As potatoes are less poisonous, though of the same genus with nightshade.—Smith, p. 415.

2. *Umbelliferous plants* of the aquatic kind and of a nauseous scent, are always poisonous; as water-hemlock, cow-parsley. But if the smell is pleasant, and they grow in dry land, they are not poisonous; as fennel, dill, coriander, sweet cicely. Smith, p. 416.

3. Plants with *labiate* corols, and seeds in capsules, frequently poisonous; as snap dragon, fox-glove.

4. Plants from which issue a *milky juice* on being broken, are poisonous, unless they bear compound flowers; as milkweed, dogbane. Milne.

5. Plants having any *appendage* to the *calyx* or corol, and eight or more stamens, generally poisonous; as columbine, nasturtion. Linnaeus.

#### MOST GENERAL RULE.

Plants with few stamens, not frequently poisonous, except the number be five; but if the number be 12 or more, and the smell nauseous, heavy, and sickly, the plants are generally poisonous.

In reference to the qualities of plants, it is observed, that plants of the same taste and odour, are generally possessed of similar qualities, and that the smell and taste are always the same. Richard divides the odours into fragrant, aromatic, ambrosial, (resembling amber,) alliaceous, foetid, and nauseous. On this division, Mr. Eaton observes; “As the fra-



grant, the aromatic and ambrosaic, are always free from all hurtful qualities, and as the foetid and nauseous, are generally poisonous, it seems that mankind have in some manner an instinctive principle by which food is to be selected."

In the preparation of secret poisons, of which we have already spoken, sundry poisonous vegetables, as the aconitum, were used; and it was the custom with the ancients to put criminals to death by the administration of potions consisting of nightshade, aquatic hemlock, aconitum, and other similar poisons. Thus the Athenians sacrificed one of the best and greatest of men, *Socrates*, by a cup of poison, said to have been made of hemlock!\*

In concluding these remarks, it may be useful to add, that no plant is more injurious in its effects on the human frame than the *deadly nightshade*, or *atro-*

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\*History informs us, that Solon, the celebrated Lawgiver, used a stratagem against the Cirrhæans, by "poisoning" their water. He changed the course of the river Plistus, which run through the town, and which it seems served them with water. The inhabitants, however, held out during that time against the besiegers. "He caused roots of Hellebore to be thrown into the Plistus, and when he found it was fully poisoned, turned the river in its proper channel: the Cirrhæans drinking greedily of that water, were taken with a continual flux, and forced thereby to give over the defence of their works." *Hist. Phil. art. Solon.*

The root of the *Helleborus hyemalis* has been examined by Vauquelin, with the view of ascertaining the nature of the bitter and acrid principle it contains. The principle he found to be an oil of a peculiar nature, which is extremely poisonous, and, according to Vauquelin, is to be found in many plants, and is the cause of their poisonous qualities.



*pa belladona*; and the alluring appearance, and sweetish taste of the berries have in many instances, particularly with children, been succeeded by the most fatal consequences. Several cases are mentioned of persons having swallowed three or four of them, and even a single berry or half a one, and produced death. The leaves are more powerful than the berries. They have, however, been used in medicine, both externally and internally, but with great caution.

The *atropa belladona*, which is poisonous in all its parts, produced, when eaten, what the ancients called *strychnomania*.

Plutarch describes certain strange and dreadful effects of a vegetable poison on the Roman soldiers, under the command of Anthony, during their retreat from the Parthians. This vegetable poison, it is supposed, was the deadly nightshade. "Their distress for provisions," says Plutarch, "was so great, that they were compelled to eat of the plants unknown to them. Among others they found an herb, of which many of them ate; who shortly afterwards lost their memory and their senses, and wholly employed themselves in turning about all the stones they could find; these were then seized with vomiting and fell down dead!"

The stramonium, thorn apple, or James-Town weed, (*datua stramonium*,) a weed common in the United States, of which it is a native, and is abundant on the Point, when taken internally, will occasion giddiness, torpor, and sometimes even death.—



Notwithstanding, it is an article in the *Materia Medica*, and has been used successfully in cases of epilepsy and convulsive disorders; and externally, in the form of ointment, for inflammations. The soporiferous and intoxicating qualities of stramonium are well known in the east, where it has been very improperly employed. The *seeds* are particularly injurious. Persons should be careful not to swallow them, as very alarming symptoms have been observed in such cases.

The nut of the *Haoceray*, a tree which grows in Brazil, is said to be a violent poison.

Opium possesses certain poisonous and narcotic properties, which are attributed to a substance called morphia.

Morphia is a peculiar principle obtained from opium, which, in consequence of being capable of neutralising acids, is considered a salifiable base. This substance was called the narcotic principle, as it was found to possess the intoxicating and poisonous qualities of opium. Dr. Thomson remarks, that when it is swallowed it produces the same effects as opium itself; but it acts much more powerfully when in a state of solution; and when in the solid state, it scarcely produces any effect, owing to the little action of the juices of the stomach on it. Orfila, (*Ann. Chim. et de Phys.* v. 288,) assures us, that its poisonous effects are counteracted by the vegetable acids, particularly vinegar, which are supposed to neutralise it. There is an acid which exists in opi-



um, called the meconic acid ; it is supposed to be united with morphia.

We are but little acquainted with the *principle*, or *principles*, of vegetable poisons. But it may appear remarkable, that the same elementary substances, should constitute in one instance a harmless substance, and in another, a most virulent poison. Thus, the dry poison of the viper, a poison in its fluid state which occasions the fatal effects of the viper's bite, when submitted to experiment, exhibits all the characters of gum arabic, in its appearance, in its feel, in its solubility in water and insolubility in alcohol, in its precipitation from water by alcohol, and in many other characteristic properties of that gum ; and yet, notwithstanding these facts, and the experiments of Fontana on the dry poison of the viper, and on gum arabic, from which he obtained the same results, how different are the effects of the two substances ! A humiliating proof of the insufficiency of chemical analysis, and of our little acquaintance with the *specific* principles of animal, and some vegetable poisons.

The leaves of the deadly nightshade have been examined by Melandri and Vauquelin. The latter obtained from them vegetable albumen, or gluten, a bitter nauseous substance, which constitutes the narcotic part of the plant, and nitrate, muriate, sulphate, superoxalate, and acetate of potash.



## ÆRIAL POISONS.

Several gaseous substances are known to destroy life; for the only proper air for the maintenance of life is that of the atmosphere, composed of a due proportion of oxygen and azotic gases.\* It is unnecessary to name the deleterious gases, as it is known

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\* According to Mr. Cavendish, atmospheric air is composed of 10 parts by bulk, of oxygen, and 38 parts of azote, or 79.16 azote, and 20.82 oxygen in the hundred. All the different experiments, which have been made at different times with eudiometers of various constructions, agree in their result, that the proportion of the component parts of air are always the same; viz. about 0.21 parts of oxygen gas, and 0.79 of azotic gas.—Atmospheric air always contains water, even during the driest time. The hydrometer is an instrument employed to determine the degree of moisture. The state in which water exists in the air is either by solution, in the same manner as water dissolves salt, or by mechanical suspension or mixture; the first is what is understood by vapour, and the second by steam. The quantity of vapour varies in the atmosphere, from 1.60th to 1.300th part of the atmosphere. Dalton judges that the medium quantity amounts to about 1.70th of its bulk. Carbonic acid gas exists also in the atmosphere, even at the greatest heights. Saussure found it at the top of Mount Blanc, the highest point of the European continent. By Dalton's experiments, the bulk of carbonic acid does not much exceed 1.1000 of the atmosphere. But immense quantities of carbonic acid must be continually forming, and mixing with the atmosphere, as it is known that respiration, combustion, and several other processes will produce it, which are going on continually. Other bodies are contained in the atmosphere, and are frequently detected in certain situations; thus hydrogen gas, carburetted hydrogen gas, which is often emitted by marshes, contagious matter, &c.



that all of the gases, with the exception of oxygen and the protoxyde of azote, cannot be inhaled without eminent danger. The most common gas of this description is one, which is very familiar to you, namely, carbonic acid, or fixed air. This gas is generated by combustion, especially of coal, and by the vinous fermentation and several other processes; and is found abundantly in mines, where it is called *choke damp*, and in caverns, wells and cellars. It is usually recognized by letting down a burning taper into the well or cellar; which, if it be present in any quantity detrimental to animal life, will be immediately extinguished. A portion collected in a bottle, and shook over lime water, will render the water turbid, forming carbonate of lime, which will be dissolved by an acid with effervescence. Thus, by the property which carbonic acid has of extinguishing flame, and by its precipitation of lime from lime water, the presence of the gas is readily detected. As a corrective, either fresh air should be admitted in the well or cellar by means of wind-sails, or quicklime thrown in; in the latter case, it will be absorbed, and combine with the lime.

Nothing is more fatal than sleeping in close rooms, with a charcoal fire, especially if there be no means of ventilation. Many instances are recorded of death having occurred by this deleterious air. Persons who have been suffocated, or animation suspended by breathing this gas, should be taken into the open air, and treated in the same manner as in other instances of apparent death.



The gaseous oxyde of carbon, according to Mr. Nicoll, has occasioned a singular disease among the workmen of a cotton manufactory at Argues, near Dieppe; and those who worked in the upper stories of the mill were particularly affected. A short account of the disease is noticed in Silliman's Journal, vol. vi. p. 199. It seems that the carbonous oxyde gas resulted from the decomposition of the oil by the heat of a cast iron stove, on which they were in the habit of placing their vessels of that fluid. The gas being lighter than atmospheric air, made its way to the upper stories of the manufactory, where it produced the most dangerous effects, such as vertigo, convulsions, a disordered imagination, &c. This, I believe, is the first instance on record of the deleterious effects of this compound of carbon and oxygen.

By the experiments of Mr. Davy, carbonic acid produces an acid taste in the mouth and fauces, and a sense of burning at the top of the uvula: and when arrived at the upper part of the trachea, it is instantly stimulated to such a degree as to excite a spasmodic contraction of the glottis, and renders it incapable of transmitting a particle of air into the lungs. The same effects are produced even when diluted with an equal bulk of atmospheric air. But when the proportion of the two gases is about three quarts of carbonic acid to nine of atmospheric air, the mixture may be breathed for a short time with impunity. This gas has been recommended in the cure of diseases of increased excitement, as pulmonary consumption. Patients of this description



have been persuaded to visit daily brew-houses, where there is constantly a copious production of fixed air.

The quantity of carbonic acid gas in atmospheric air may be learnt by eudiometry. If 100 parts of atmospheric air be thrown up a graduated tube, called an eudiometer, standing over lime water, the carbonic acid will be absorbed, and the amount of absorption will be shown by the scale. If the same quantity of atmospheric air be exposed to liquid sulphuret of potash, or in preference Davy's solution of nitrous gas in green sulphate of iron, the oxygen will be absorbed, and its quantity ascertained. The air which remains is azote. The quantity of hydrogen gas is usually determined by Volta's eudiometer; by detonating a given quantity of air, supposed to contain it, with a due proportion of oxygen gas, &c.

There are certain noxious effluvia of a gaseous nature, termed miasmata, which by mixing with atmospheric air, communicates to it a poisonous quality: the breathing of, or coming in contact with which, constitutes disease very often of a malignant nature. What this miasmata is composed of in all instances, is very uncertain. Thus the miasmata of marshes, of low wet morassy ground, &c. must be produced as well by vegetable as animal putrefaction, and consist of carburetted and sulphuretted hydrogen gas, some of the compounds of azote, &c. carrying with them perhaps some *specific* poison, which produces intermittent, remittent, and other fevers. But the miasmata, we know, from its effect on the system



differs considerably in its nature ; and its virulence is in proportion as it is concentrated or diluted with atmospheric air. If in Cuba, or any of the West India Islands, in New-Orleans, or other cities to the south, where the heat in summer is intense, a certain miasmata should be produced by the concurrent corruption of animal and vegetable matter, which produces the yellow fever ; are we not to believe that the same cause would produce the same miasmata in New-York, Philadelphia, or Baltimore, and occasion a disease of the same type, and equally malignant ? Inasmuch as causes operating in all respects alike, and similarly circumstanced, must produce the same effects ; it is but reasonable to conclude, that in order to prevent a recurrence of the yellow fever, the causes which produce the ærial poison alluded to ought to be removed, i. e. all putrifying animal and vegetable matter, from streets, alleys, and by-places ; and, where they have been, the frequent use of fumigations. Whether the miasmata be cyanogen, or carburet of azote, or any of its compounds, or any other gaseous substance, we will not inquire.\* It is a

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\* See an essay of the author, "On the formation of cyanogen or prussine, in some chemical processes not heretofore noticed," in the American Journal of Science and Arts, vol. vi, p. 149.

There is a poisonous wind in the desert of Arabia, called *samiel*, which kills without any apparent change on the body, except a total privation of irritability, and sometimes a distension of the blood vessels, and extravasation of their contents. The *samiel*, called also the *simoon*, comes from the northwest quarter. It is said to be a blast of hydrogen gas ; but this is altogether conjecture.



sufficient to attend to the fact, and apply a remedy for the evil.

The ancient Grecian story of the hydra, or many headed monster, which inhabited the marsh or fen of some extent, called Lerna, in the Peloponesus, between Mycenæ and Argos, had its origin in the pestilential miasmata, which extended its influence to a considerable distance. The hydra was considered by Virgil as a fictitious, or poetical animal; and although Bochart endeavored to make the whole story *literally* intelligible, as that Hercules was sent by Eurystheus to fight this formidable creature, and a crab came forth to his assistance, which was crushed by Hercules; yet Lancisi, physician to Pope Clement XI. with a clear and discriminating mind, perceived that important physical truths were concealed under this allegory. In a letter from the learned Dr. Mitchell, to the late Dr. Priestley, in 1799, the Lernian hydra is accounted for by the doctor, in which he explains very satisfactorily what was meant by the hydra.

“The word hydra,” says the doctor, “is derived from a Greek word, signifying *water*. This fluid then, detained upon the marsh of Lerna, favoured occasionally the production of unwholesome exhalations. Such vapours being at once injurious and invisible, were ascribed to some preternatural enemy or destructive monster; and being diffused or wafted around the country, and often cutting off both men and beasts, were fancied to be the effect of the supposed monster’s poison. According to her extent



and virulence, was she reported to have fewer or more heads for preparing and inflicting this poison."

The doctor gives many ingenious opinions respecting the drawing off the water, leaving the mud and slime, which he interprets the "cutting off a head;" the increase of deleterious gases, by exposing such a naked surface, or the sprouting forth of two in its place; the cauterising effect of the solar heat; the crab, or hydra's ally, as showing the frequent recurrence of difficulties to overcome them; the allegory of Hercules, meaning the insuperable courage and difficulties in the attempt, to which he adds the *chersydra*, who remained after the marsh or fen had dried up, derived from two Greek words, signifying *land not fit for the plough*, and the *monster of the fens*.

In short, as respects the deleterious poison thus typified, while the hydra was supposed to inhabit the water, the *chersydra*, or monster of the fens, was meant, in the language of the doctor, "the venomous and sickly condition of the neighboring atmosphere, after the water was exhaled, and the ground at the same time, not rendered arable thereby, typified by a poisonous serpent. It was thus expressive of the rage of the pestilential effluvia, which, sometimes, and under certain circumstances, continue in a virulent state, in dry weather, near their dried sources."

There is no doubt, that certain vapours or effluvia are capable of exciting various diseases, and affecting the system in different ways. Thus, in the celebrated Grotto del Cani, the effect of carbonic acid



gas is particularly seen. When a dog is thrown in, for a few minutes only, he appears perfectly lifeless : but when plunged in a neighboring lake, in consequence of the immersion of his whole body, he recovers almost instantly. In Russia, during frosty weather, where a number of persons live together in the same room, an incrustation is formed on the windows, from a condensation of the breath, perspiration, &c. The mephitic crust is mixed with the noxious fumes of candles, and of the stove with which the chamber is heated. When this crust becomes thawed, a deleterious principle is disengaged similar in its effect to carbonic acid, which proves, at least, a serious inconvenience to the people. The effect, however, of miasmata of every kind is well known ; hence intermittent, remittent, and yellow fevers, dysentery and typhus are the consequence. That of the last, sometimes called typhoid fomes, is generated in the human body itself.

For the communication of the plague, contact with a diseased person is said to be necessary ; and approach within two or three yards for that of typhus. We are told that the miasmata at Walcheen, extended their pestilential influence to vessels riding at anchor, a quarter of a mile from the shore. Marsh miasmata operates at a considerable distance, whereas the *virus* of the plague, small pox, measles, chin-cough, cynache maligna, and scarlet fever, as well as of typhus and jail fever, is confined to a very small space.

Although contagion exists in certain portions of



the atmosphere, and marsh miasmata seems to be its principal cause, to which we may add all *moist earth*, as well as the *accidental* putrefaction of animal and vegetable substances, yet it is known, that contagious matter acquires peculiar virulence from confinement. Dr. Parr, in his Medical Dictionary observes, "that the last plague which infested the town in which we now write arose from a traveller remarking to his companion, that, in a former journey, he had the plague in the room where they sat. 'In that corner,' said he, 'was a cupboard, where the bandages were kept; it is now plastered; but they are probably there still.' He took the poker, broke down the plastering, and found them. The disease was soon disseminated and extensively fatal." Bed clothes, and particularly blankets, can contain the contagious fomes, in an active state, for almost any length of time. They ought, accordingly, to be fumigated with particular care. To avoid infection, fumigations with vinegar and the mineral acids may be used. The gaseous or æriform poisons are destroyed or neutralised by nitric acid vapour, muriatic acid gas, chlorine gas, and sulphurous acid gas. The latter is used in the east against the plague.

Dr. C. Smyth proposed the use of nitric acid vapour to destroy contagious matter, and although M. de Morveau had preceded him in recommending acid gases, he received a parliamentary reward for this supposed discovery.

Vinegar when combined with aromatic oils, constitutes a preparation called the *vinegar of four thieves*,



as four persons first employed it to enable them to plunder the victims of the dead. The most certain, effectual, and active agent for disinfecting air, is chlorine, formerly oxymuriatic gas. This gas is known to destroy effluvia of every kind; and in our opinion, inasmuch as hydrogen seems to be the principal ingredient, or bond of union between other elements, which forms miasmata, or matter of contagion, it chemically unites with hydrogen, and, while it produces hydrochloric acid, the other constituents are disengaged. The miasmata, therefore, ceases to be poisonous, as it ceases to exist. The *disinfected bottle* of Morveau is nothing more than a strong bottle secured in a wooden case, and the stopper kept down by a screw. In this glass about one ounce and a half of powdered black oxyde of manganese is put, to which is added three ounces of muriatic acid and the same quantity of nitric acid. Two thirds of the bottle must be empty. It is covered with a plate of glass, which is ground and polished so as to close the bottle accurately, and which is raised by a single turn of the screw. These materials, if the bottle is opened daily, will last six months.—The bottle may contain manganese and muriatic acid alone, or a mixture of manganese, common salt, and diluted oil of vitriol. Nitrous and muriatic acid fumigations may be made by putting in the first instance, nitrate of potash, and in the second muriate of soda, into a bowl or porringer, placing it on some coals, and pouring on them sulphuric acid. Fumigations with chlorine may be made by using accor-



ding to Thenard, (*Traite de Chimie*, I. 193,) one part of black oxyde of manganese, and five or six parts of muriatic acid; or one part of manganese, four parts of common salt, and two parts of sulphuric acid, diluted with the same quantity of water.

If oxyde of manganese cannot be had, the red oxyde of lead may be used. The materials may be placed in an earthen vessel, and stood on a chaffing-dish of live coals.

Vessels, containing the materials for this gas, should be distributed in the same neighborhood; and where any peculiar smell is known to exist, whether from putrefaction or other cause, the fumigation should be more copious and constant. We are decidedly of opinion, and fact will bear us out, that chlorine gas is the only active and certain agent to annihilate effectually the miasmata or poison, which creates the malignant yellow fever, and all other gaseous poisons.

The fumigation of the holds of ships, admitting afterwards a free circulation of atmospheric air by means of wind-sails, and repeating alternately this practice, will prove equally advantageous in removing any deleterious effluvia.

## ANTIDOTES FOR VEGETABLE POISONS.

We have seen that the class of vegetable poisons is very numerous; and plants, which partake of deleterious properties, are recognised by several botanical characters.



Sundry plants of the narcotic tribe, when taken or eaten by mistake, often act as poisons to the system. A very common poison, is some species of fungus, commonly called toad stool, which resembles very nearly the mushroom, as well as hemlock, nightshade, foxglove, &c. Certain principles obtained from vegetable substances are decidedly poisonous, as the *picrotoxin* obtained from *cocculus indicus*, and *nicotin* which exists in tobacco.

Vegetable substances are frequently deleterious in their natural state. We have a prominent instance of this in the cassava or cassada of the West Indies. In its crude or unprepared state it acts as a most deadly poison; but when the juice is expressed, and the root afterwards baked, it becomes a wholesome and nutritive food.

Emetics of sulphate of zinc, and tartar emetic, are used in the case of vegetable, as with mineral poisons; after which the patient should be made to drink copiously, if possible, of liquors acidulated with the juice of lemons, vinegar, or sulphuric acid, giving the preference, however, to the former.

A powerful antidote against vegetable poisons has been recommended by M. Drapier; it is the fruit of the *feuillea cordifolia*. He gave dogs the *rhus toxicodendron*, hemlock, and *nux vomica*, and all those that were left to the effects of the poison died, but those to which the above fruit was administered recovered completely, after a short illness. To ascertain whether the antidote would act externally, he took two arrows, which had been dipped into the



juice of the *manchenille*, and slightly wounded with them two cats. To one of these wounds he applied a poultice of the fruit, while the other was left without any application. The former produced no inconvenience; but the wound of the other, containing also the poison, caused convulsions in the animal, and death ensued.

The *scutellaria lateriflora*, recommended by the late Dr. Spaulding, is said to be an infallible means for the prevention and cure of the hydrophobia after the bite of rabid animals.

We may add here, that the *pure water of ammonia* (*aqua ammonia puræ*,) has been successfully used for the bite of venomous serpents.

It is observed, that when narcotic poisons have been swallowed, and tremors, &c. have been produced, cold bathing has been very beneficial. Baccius mentions its efficacy against the poison of the juice of the mandrake. The Indians are recovered from the stupefaction occasioned by the *datura*, by moistening the soles of their feet with cold water; dogs stupified by the carbonic acid gas of the Grotto del Cani, are recovered by being thrown into the neighboring lake; and cold water has been particularly useful in recovering persons from the stupifying effects of ardent liquors. It is also remarked, that when poisons or infectious miasmata have been communicated to the body, which very often lie dormant till some exciting and generally debilitating cause gives them activity, cold bathing is useful; and during the progress of an epidemic, it is also recommended as a valuable part of the prophylaxis.



The Brazilians cure the wounds from poisoned darts with the juice of the *Cad-opia*, which they pour into the wound. It is also used against the bite of serpents.

When cantharides, or Spanish flies are imprudently taken into the stomach, nitre, camphor, milk, oil, mucilage of gum arabic, and copious diluting drinks are the usual antidotes.

As an antidote to all poisons, the *theriac* of Andromachus had a high reputation. This medicine, according to the original recipe, contains about sixty ingredients. Pliny remarks, that so many drugs were used in one preparation, to make people more confident in their favour.

Dr Parr is of opinion, that from the number of poisonous plants sometimes used in such remedies; it was also an object to accustom the constitution to their effects, so that, at other times, they may be harmless.

The older physicians had a variety of remedies against poisons. Thus, Hippocrates attributes to a well known plant, called rue, (*ruta graveolens*,) not only the power of resisting the action of contagion, but different kinds of poison. In this view it has been extolled by Boerhaave.

Dr. Girard, of Lyons, recommends as a *remedy* for drunkenness, dilute liquid ammonia, which has been long used as an antispasmodic. He considers fits of intoxication as a nervous affection. Seven or eight drops of this alkali in half a glass of water, is stated to be sufficient to rouse a person from this



state of morbid condition. "It operates," says an article in Silliman's *Journal* iv, 385, "not by the decomposition of the wine or alcohol, but by modifying the sensibility of the mucous membrane of the stomach, and acting upon the innumerable nerves which are distributed over it, and transmit to the brain the impression they have received."

### ERGOT. SPURRED RYE.

This substance is more or less deleterious, and should never be ground up with grain. It is a morbid swelling of the seed, and called *ergot* by the French. There are, however, two kinds; the *malignant ergot*, which is the black, or dark coloured, and the *simple ergot*, of a pale violet colour, said to be perfectly harmless.

Ergot, in fact, is an enlarged elongated seed, projecting out of a glume, of the colour already mentioned, and of a brittle texture. It is observed, "that grain growing in low ground is more or less subject to it. Also spring grain more than winter grain; and rye more than wheat, barley or oats." Ergot, notwithstanding its deleterious properties, has been used successfully as a medicine, when administered in proper doses.

A very ably written paper on the ergot of rye, (*clavus Secalinus*, *secale-corniculatum*, &c.) by Dr. Tully, may be seen in the *American Journal of Science*, ii, 46. From analysis, it is said to contain a colouring matter, soluble in alcohol; a white oily



matter, of a sweetish taste, which is very abundant ; a violet colouring matter insoluble in alcohol ; phosphoric acid, and vegeto-animal matter which yields much thick oil, and ammonia, by distillation ; and lastly, a small quantity of free ammonia.

The doctor, after treating of its medical uses and effects, gives the following remarks, which are undoubtedly at variance, in some particulars, with the generally received opinions :

“ With respect to the poisonous qualities of the *clavus*, (ergot,) and its power of producing malignant and epidemic diseases, there seems to be *no* foundation for such opinions. The quantity taken with bread must of necessity be so small, it must be diffused in such a quantity of flour, and so changed by the panary fermentation, as to become completely inert. Besides, it must have been eaten from time immemorial, as well since, as before the occurrence of the diseases that have been attributed to it, as to cause them to be looked upon as a phenomena.”  
See *Med. Repos.* of N. Y. 1817.

Mr. Davy, in his *Agricultural Chemistry*, in speaking of vegetable disease, very justly remarks, that wet weather is the most favourable to the propagation of mildew, funguses, rust, and the small parasitical vegetables, and dry weather to the increase of the insect tribes.\*

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\* The *diseases* of plants are chiefly the following : In old trees there is a kind of ulcer. The juices undergo a change, and acquire a certain state of acidity, which gradually corrodes and destroys the solid parts. The seat of this disease is said to be under the bark. Vauquelin examined the morbid



## SLOW POISON FROM THE TURKEY HAIR.

The turkey (*meleagris gallo-pavo*,) of the male kind, is distinguished from the female by the hair, or tuft, which hangs from the breast. Although this beard or tufting, contains nothing in itself of a deleterious nature, yet we are assured that in some of the West India islands, it is employed by the negroes in a singular manner to destroy life imperceptibly. We have heard, indeed, of some practices of

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liquor of the elm, which is particularly subject to this disease, and found it to be acrid and saline. The bark over which this liquor passes acquires an alkaline taste, and becomes white; he found it to effervesce with acids, and contain as much as 84 per cent. of carbonate of potash. Vauquelin has shown, that the production of this white matter, which surrounds the ulcer, must have destroyed 55 lbs. weight of the wood of the tree.—The blight, is another disease which attacks grain of different kinds. It has been examined by Fourcroy and Vauquelin, who found an acrid oil, putrid gluten, charcoal, phosphoric acid, &c. but no traces of starch. Some other diseases have been pointed out.

Some excellent observations on this subject may be found in the *Memoirs of the Agricultural Society of Philadelphia*.

Certain peculiarities of the atmosphere affect, no doubt, the vegetable kingdom; it is observed, with respect to animals, in a peculiar manner. Forster (*Researches about Atmospheric Phenomena*, p. 180,) informs us, that in the summer of 1810, almost all the *plane trees*, with the rough bark or rind, became diseased in the neighborhood of London, and for many miles round, while the smooth rind plane trees, (*platanis orientalis*,) and sycamore trees, (*acer pseudo platanus*,) remained healthy. How far electricity may be concerned, it is difficult to say; but many are of opinion, that its agency is great. This may, indeed, produce one of the peculiarities in the atmosphere, besides heat, cold, damp, &c. which affect the functions of organised bodies.



the kind in this country, although the fact we believe is but little known, and not much credited.

The hair is cut into very small pieces, and mixed along with the flour in the making of bread.—Such bread, when eaten, is acted on by the gastric juice in the usual way, and, being assimilated with other food, passes off; but the *hair*, it appears, remains untouched, and gradually attaches itself to the coats of the stomach. The consequence is, that inflammation of the stomach or gastritis of the phlegmonous kind is produced. Arsenic, corrosive sublimate, alkalies, mineral acids, &c. food of an improper nature, the too frequent use of spiritous liquors and the like, all produce the *same* disease.—Inflammation, thus excited, is marked by a violent pain in the region of the stomach, with great soreness, distention, and flatulency, vomiting, especially after any thing is swallowed, distressing thirst, restlessness, anxiety, &c. with debility, constant watching, delirium, and a quick, hard, and contracted pulse. A greater loss of strength is experienced as the disease increases in violence, with faintings, a short and interrupted respiration, cold clammy sweat, hiccups, coldness of the extremities, an intermittent pulse, and the patient soon expires.

This is the effect produced by such poisons when received into the stomach.

Hair is distinguished, properly speaking, into that which is strong and stiff, as bristle, and that which is soft and pliable as wool; to which we may add the finest of all, called down. The composition of



the whole are closely allied. It contains gelatin, to which it owes its suppleness and toughness, and which may be separated by boiling. From the experiments of Hatchett it appears, that the hair which loses its curl in moist weather, and which is the softest and most pliable, is that which yields its gelatin most easily, and strong and elastic hair yields it with great difficulty, and in the smallest proportion.—This is precisely the fact with the tuft of the turkey.

A variety of experiments have been made by Vauquelin on human hair. With common hair, a weak solution of potash will dissolve it, so will the acids very gradually, and alcohol will extract from it two kinds of oil.

The colouring matter he supposes is an oil, which is blackish green in black hair, and white in white hair. Nothing, however, is particularly known as to the composition of different kinds of hair. We may add, that Vauquelin detected an animal matter, a solid oil, a greyish green oil, iron, oxyde of manganese, phosphate of lime, carbonate of lime, silica, and sulphur.

We will now consider another branch of our enquiry, namely, *the detection of sundry adulterations in chemical preparations, &c. used in medicine and the arts.*

The adulteration of articles is carried to a great extent in Great Britain; and if we believe Mr.



Accum, it would seem, that nine tenths of the most potent drugs and chemical preparations used in Pharmacy, in London, are vended in a sophisticated state by the dealers who would be the last to be suspected. The same may be said of sundry pigments or colouring substances; of acids; alkalies; materials used in the arts; soaps; dye-stuffs, and a long catalogue unnecessary to enumerate.

The practice of sophisticating articles has been common with all nations. Professor Beckman, in speaking of the manufacture of colours, hints at these adulterations. "Thus," says he, "they (the Dutch,) pound cinnabar and smalt finer than other nations, and yet sell both these articles cheaper. In like manner they sift cochineal, and sell it at a less price than what is unsifted." In London, we are assured by Mr. Accum, that nine tenths of the drugs and preparations are adulterated, which pass through the hands of dealers. The same may be said with many of our retail, and well as wholesale dealers; for the fact is too well known to be refuted, that a number of articles are frequently *mixed*, and otherwise intentionally adulterated. Is there any instance, I would ask, of a more palpable fraud than that of manufacturing out of one seroon of merchantable indigo as many as five or six, or more, and imposing it on the public as *genuine* indigo? A fraud which was practised some years ago in Philadelphia. Suppose a druggist were guilty of dyeing yellow bark red, or mixing with the powdered bark a quantity of bol armen, and selling it as the genuine red bark;



or of grinding with the crystals of tartar sulphate of potash, &c. in order to increase the quantity of cream of tartar; or mixing flour, &c. with a variety of official roots in the powdering of them, or of performing any other adulterations, whether with drugs or colours, such deceptions would necessarily call for a minute examination in *all* articles vended under so *questionable a shape?*

### ULTRAMARINE.

This pigment is made from the azure stone, or lapis lazuli; and is a beautiful and unchangeable blue.

The composition of azure stone is silica, alumina, sulphur, and soda. (M. M. Clement and Desormes *Ann. de Chim. tom. 57.*) The finest specimens are brought from China and Persia.

The blue is manufactured from the azure stone as follows: The stone is made red hot, and plunged into water to render it easily pulverisable. It is then powdered, and mixed with a varnish composed of rosin, wax, and boiled linseed oil, and the mixture is put into a linen cloth, and repeatedly kneaded with hot water. The first water is thrown away; the second gives a blue of the first quality; and the third, one next in value. This process is mechanical; for the colouring matter of the azure stone appears to adhere less firmly to the foreign matter, with which it is associated, than it does to the resinous cement; hence its separation, and finally, by repeated washings, &c. with hot water, is deposit-



ed. Clement and Desormes, however, consider the process as a species of saponification.

A substitute has lately been recommended for ultramarine. It consists in mixing the phosphate of cobalt, which is an insoluble purple powder, (formed by decomposing the nitrate or muriate of cobalt with phosphate of soda,) with eight parts of gelatinous alumina, and exposing the mixture to heat.

When Sir H. Davy examined the ancient pigments at Rome, an account of which he published in the Philosophical Transactions for 1805, he examined also the Egyptian azure, a paint which had retained its colour for seventeen hundred years. He found that 20 parts by weight of opaque flints, 15 parts of carbonate of soda, and 3 of copper filings, when exposed to the action of a strong heat for two hours, produced a substance of exactly the same degree of fusibility, which, in a pulverised state, gave a fine deep sky blue.

The adulterated ultramarine, as it is usually mixed with indigo, Prussian blue, or some similar substance on account of their comparative cheapness, when mixed with concentrated nitric acid will undergo no immediate change; but the genuine ultramarine should become deprived of its colour. This is the most conclusive property.

### INDIGO.

This is a blue colouring matter extracted from the Indigo plant,\* and is nothing more than coloured fe-

\* Indigo may be procured from the woad, *Isiatis tinctoria*,



cula. When first extracted it is green, but becomes blue by exposure to air. Indigo should become green or greenish yellow when deoxydized, a process well known in dyeing. There are several qualities of indigo. It should contain, in general, 50 *per cent.* of pure colouring matter, which is insoluble in water. When exposed to a heat above 400 deg. F. it produces a crimson smoke, which is supposed to be the pure indigo, and when condensed it yields crystalline needles. If any considerable residue remain, it indicates an adulteration, and with earthy or metallic substances, which may be analyzed. It should become green, or greenish yellow with 2 parts of sulphate of iron, and one of lime; and in this green state be soluble in the caustic alkalies. It should also be soluble in sulphuric acid, forming the *liquid blue dye*, leaving little or no residue; and when a little of this sulphate of indigo is diluted, the addition of iron or zinc should destroy its colour, which should also take place with chlorine. Hence a solution of indigo in sulphuric acid, has been recommended for measuring the strength of chlorine or oxymuriatic solutions in bleaching.

Water when boiled on it should dissolve no more than about a ninth of its weight, leaving the colouring matter untouched. Indigo is insoluble in al-

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by digesting it in alcohol, and evaporating the solution. The crystalline grains, thus obtained, gradually become blue by the absorption of oxygen. But the indigo of commerce is procured from the wild indigo, (*indigofera argenta*,) the Guatimala indigo, (*indigofera disperma*,) which yields the greatest quantity of indigo. It is prepared by fermenting the leaves of those trees or plants in water.



cohol, ether, and in fixed and volatile oils.—Muriatic acid has no action on the colouring matter; but when digested on it, it dissolves some earthy and extractive matter with a portion of iron.

Nitric acid, on indigo, converts it into artificial tannin, and it loses its colour. Pure indigo, when mixed with liquid fermentable materials, should be speedily deoxydized, and again become blue by exposure to the air. This is also a method of setting an indigo vat.

Indigo has been largely adulterated, and sold in our market. The adulteration, of which we speak, as it came to our knowledge, was effected chiefly with logwood and starch; this compound was then mixed with a certain part of genuine indigo.

This fraud, however, may be discovered by using the tests above mentioned, which will point out the adulteration either by showing the decided impurity of the indigo, or the quantity of foreign matter with which it is mixed.

By the method of adulteration, practised by a druggist then living in Philadelphia, who was detected of the fact, one seroon of merchantable indigo would make of the spurious six or eight! The colouring matter of the logwood was first imparted to the starch, a small portion of copperas being used, and the *coloured starch* was then mixed with a given quantity of the real indigo. The fraud, however, was soon discovered, but not until he had disposed of several seroons. Those acquainted with the quality of indigo, can form a near estimate of its kind, and



purity. The break, or fracture of indigo is a good criterion. Sulphuric acid, we remarked, will dissolve the colouring matter; if the *residue* should exceed a certain amount, it may be considered as foreign matter. Chlorine water is also a good test.

It is supposed that the *indicon* of Dioscorides, and the *indicum* of Pliny and Vitruvius, were the same as our modern indigo. It was a blue pigment brought from India, which, when diffused in water, produced an agreeable mixture of blue and purple. It was often adulterated by the addition of earth. On that account, the kind which was soft without any roughness, and which resembled an inspissated juice, was esteemed the best. Pliny (lib. xxxv. cap. 6, sec. 27, p. 688,) speaks of a method of distinguishing pure from adulterated indigo, which consists in *burning* it; the pure, he observes, gives an exceedingly beautiful purple flame, a fact already noticed, accompanied with a smell similar to that of sea water.—The ancients remarked, that good indigo when pulverised is of a blackish colour. Mr. Beckman observes, that in Pliny's time, people coloured a white earth with indigo in the same manner as coarse lakes. This earth was the *annularia*, or in Pliny's words, "the beautiful white with which the ladies painted or ornamented themselves." The *laccos chromatinoos*, also of the ancients, is supposed to be our indigo.

During the reign of Queen Elizabeth, the importation of indigo was prohibited in England, and the prohibition was not taken off till the reign of Charles



14. It was also prohibited in Saxony, and Colbert restricted the French dyers to a certain quantity of it. It was considered a corrosive substance, and called *food for the devil*.

### ANTWERP BLUE.

This paint or colour is frequently adulterated, and sometimes with indigo. This admixture may be detected by the use of chlorine; for genuine Antwerp blue will not be deprived of its colour when thrown into liquid chlorine. Chlorine has the property of discharging certain colours, but on this colouring substance it has no action.

### PRUSSIAN BLUE.

This pigment is sometimes adulterated. When pure it should consist of nothing more than ferrocyanic acid and per oxyde of iron. But in consequence of using allum in the process, in order to increase the quantity of the precipitate, the Prussian blue of commerce always contains alumina.

The preparation of Prussian blue consists in calcining animal substances, particularly dried blood, according to the original recipe published by Woodward in 1724, with potash, dissolving the calcined matter in water, and adding the fluid to a mixed solution consisting of sulphate of iron and allum. The powder which precipitates is at first green, which is separated by filtration, and muriatic acid is affused



upon it; it then assumes a beautiful blue colour. It is afterwards washed and dried.

The perferrocyanate of iron when exposed to a heat of 400 deg. in the open air takes fire. When pure, neither water nor alcohol has any action on it. It is decomposed by boiling solutions of potash, soda, lime, barytes and strontites, forming soluble ferropussiates, leaving a brown deut oxyde of iron, and a yellowish brown subferropussiate of iron.— There are three characters, however, of the genuine Prussian blue, *viz*: adding aqueous chlorine, which will change the blue to a green colour, in a few minutes, especially if the blue be recently precipitated; water impregnated with sulphuretted hydrogen gas, will change the blue to the white ferrocyanate of iron; and sulphuric acid, not diluted, will decompose and destroy its colour, which would not be the case altogether if it contained the least quantity of indigo, a substance with which it is sometimes adulterated. The purple flame will also recognize the presence of indigo.

It is used for the purpose of a paint, and alumina gives a body to the colour.

### VERDITER.

This blue pigment is a preparation of copper, obtained by adding chalk to a solution of copper in nitric acid. It is, therefore a carbonate of copper.— All verditer, however, contains about 7 per cent of lime; more than this quantity renders it of an infe-



rior blue. Sometimes, in fact, chalk is added, in order to adulterate it. It should contain 50 per cent of pure copper. This may be learnt by dissolving a given quantity in nitric acid, and precipitating the metal by a piece of iron. The quantity of lime may be ascertained by adding to a portion of the nitric solution oxalate of ammonia, which will throw down an oxalate of lime.

### SMALT.

This pigment is made by fusing glass with zaffre, an impure oxyde of cobalt, and pulverising the glass. The *azure blue* is prepared in the same manner. If adulterated, the fact may be known by the affusion of acids, &c. as pure smalt or pure azure blue will not be acted upon by acids, except, however, the fluoric.

It is observed, that the colouring matter of oxyde of cobalt on vitrifiable mixtures, is superior to that of any other metal. One grain gives a full blue to 240 grains of glass. Blue glass is coloured with oxyde of cobalt. A flux, as it is termed, of silica, potash, and lead, is coloured by the addition of a small quantity of the cobalt. Oxyde of cobalt is also employed, for the same purpose, to give a blue glaze to pottery. Thus, likewise, in the imitation of some precious stones, it communicates a particular colour. The beryl, for instance, is very accurately imitated by fusing with a particular flux, called a paste, a mixture of glass of antimony and oxyde of cobalt,



in the proportion of two of the latter to twenty-four of the former.

*Brice* is levigated smalt, and rather lighter than the preceding. It may be examined as the former.

### CARMINE.

Carmine is a red pigment prepared from cochineal. It contains the colouring matter of cochineal, an insect which feeds on, and is supposed to derive its colour from the *cactus opuntia*. The colouring matter of this insect, M. M. Pelletier and Caventou have named *carminium*, but Dr. John calls *cochinelin*. The properties of the colouring principle of cochineal are that it is fusible at 122 deg. very soluble in water, less so in alcohol, and insoluble in ether unless by the intermediation of fat. Acids change it from crimson to a bright red, and then to yellow; alkalies, and protoxydes generally speaking, turn it to violet. Alumina combines with it, and forms a beautiful lake, or carmine. In the opinion of M. M. Pelletier and Caventou true carmine is a triple compound of an animal matter, *carminium*, and an acid which enlivens the colour. Muriatic acid will change the colouring matter into a fine scarlet. Scarlet is produced exclusively with the colouring principle of cochineal, which is fixed upon wool by nitromuriate of tin and tartar. A crimson colour is produced by allum.

Several processes are recommended for the preparation of carmine; some advise the use of solutions of tin and tartar, and others the use of allum,



of alumina. Carmine, heretofore, was supposed to consist of the colouring matter of cochineal, united with oxyde of tin, or with alumina. It is an excellent, but very expensive colour, and is liable to adulteration.

Mr. Accum assures us, that *genuine* carmine should be entirely soluble in liquid ammonia. Should carmine contain vermillion, the fact may be known by examining it in the same manner as Florentine lake.

Carminium, or the colouring matter of cochineal, is very soluble in water; and the watery solution has a fine carmine colour. Without noticing the action of different substances, it will be sufficient to remark, that chlorine acts on this colouring matter very considerably, giving it first a yellow colour, which it gradually destroys altogether. If no animal substance be present, it occasions no precipitate in the solution of carminium in water; and hence chlorine water is recommended, as a reagent, to discover the presence of animal matter in this colouring principle. Iodine has the same effect as chlorine, but in a less sensible degree.

### FLORENTINE LAKE.

This colour is prepared from the refuse cochineal liquor, left after the separation of carmine, with a small addition of Brazil wood, and precipitating by allum, or a solution of tin. Sometimes Brazil wood is altogether used. In that case the pigment is very inferior.

Florentine lake should contain neither vermillion



ner red lead, nor indeed any foreign pigment. If a small portion be exposed to the action of the blow pipe on charcoal, the lead will be discovered by a metallic globule; or by dissolving the lake in nitric acid, and adding hydrosulphuret of ammonia, or any of the tests for lead. Vermillion will be volatilized by heat. If a small portion of the suspected lake be mixed with a little lime, and exposed to heat in a glass tube, the vermillion, if it be present, will be decomposed, and mercurial vapour be condensed in minute globules on the sides of the glass.

### MADDER LAKE.

This is the colouring matter of madder, (*rubia tintorum*.) obtained by adding to an infusion or a decoction of that root, first a solution of allum, and afterwards another of potash. It is, of course, like similar lakes prepared with allum, a combination of colouring matter, and alumina.

The examination of this lake may be conducted as before stated. It requires double the quantity of chlorine water to destroy the colour of a decoction of madder, than what is necessary to effect the same change in a decoction of an equal weight of Brazil wood; a fact necessary to be observed in our own experiments on these substances. The red colouring matter of madder is soluble in alcohol, which remains when the alcohol is evaporated. In a decoction of madder, the fixed alkalies produce a violet colour; and sulphuric acid a fawn coloured, and sul-



phate of potash, a red precipitate. Sundry saline substances produce different coloured precipitates. As to the reagents, by which the purity of madder and carmine lakes may be determined, in a conclusive manner, the fact of the solubility of alumina, and the colouring matter of these substances in a concentrated solution of potash or soda, will point out in these alkalies proper tests or solvents.

### ROSE PINK.

This is a preparation of Brazil wood, made by throwing into a decoction of that wood a quantity of chalk, together with a solution of alum, to which some potash is added. It is nothing more than the colouring matter of the wood, precipitated by the alumina, and *absorbed* by the carbonate of lime. The quantity of chalk is, therefore, variable. The proportion of colouring matter, thus absorbed, may be, if necessary, readily ascertained.

### ROUGE.

Although carmine is *usually* sold and used as rouge, which is the most expensive of the two, yet rouge, properly speaking, is a preparation of the flowers of the *carthamus tinctorius* or safflower. The washed flowers are digested in a solution of carbonate of soda, which takes up the red colouring matter, which is precipitated by the addition of lemon juice. The precipitate is then washed, dried, and mixed with a portion of powdered talc, or French chalk.



The colouring matter of rouge should be wholly soluble in alkali. What remains is either talc, or some other foreign substance. Speaking of the colouring matter of the carthamus we may add, that it is of two kinds, red and yellow. The yellow is readily extracted by water. The red, however, is employed by dyers. It has a stronger attraction for cotton than the yellow; and even in the dyeing of cotton, in consequence of that affinity, the two pigments are separated.

### VERMILLION.

There are two sulphurets of mercury; the black and red. Vermillion is the red sulphuret, which is the same as a fictitious cinnabar, but made into an impalpable powder.

The black sulphuret, or ethiops mineral, is called the protosulphuret of mercury. When mercury is added by degrees to its own weight of melted sulphur, and the mixture constantly stirred; or when one part of mercury and two parts of sulphur, are triturated together in a mortar, the black sulphuret will be formed. When this is heated red hot in proper vessels, cinnabar, or the red sulphuret, will be sublimed, which, when reduced to fine powder, takes the name of vermilion.

Vermillion, on account of its price, is frequently adulterated, either with red lead, carbonate of lime, or dragon's blood. Its adulteration with red lead is particularly injurious, as it is often used to colour



sugar in confectionary, and for other purposes. If it be adulterated with the red oxyde of lead, its detection may be attempted by digesting it in acetic acid, and adding to the solution water containing sulphuretted hydrogen gas, which will occasion the well known brownish black precipitate. If this precipitate be collected, and exposed to the action of the blow pipe on charcoal, metallic lead will be obtained.

The presence of carbonate of lime may be known by acetic acid; the effervescence will ensue, and the solution when tested with oxalate of ammonia, will give an oxalate of lime. The presence of dragon's blood is recognised by alcohol, which will produce a blood red tincture. Alcohol has no effect on pure vermillion.

## RED LEAD.

Lead unites with oxygen in three proportions, forming the protoxyde of lead, which is yellow; the peroxyde which is brown; and the red oxyde, or red lead, which appears to be a compound of the yellow and the brown. When lead is melted, and exposed to the air, a pellicle forms on its surface, and the lead gradually becomes converted into an oxyde; or if this powder be exposed to further heat, a greenish yellow powder will be produced; and if this powder be exposed to heat some time longer, in an open vessel, it absorbs more oxygen, assumes a yellow colour, and is called *massicot*.

If *massicot* be put into a furnace, when pulveris-



ed, and the flame be allowed to play upon it, in a proper reverberatory, constantly stirring it, at the expiration of 48 hours it will be converted into a beautiful red powder. This powder is minium or red lead.

Red lead is a tasteless powder, of a deep red colour, and very heavy; its specific gravity being 8.940. It is composed of

Lead,	100
Oxygen,	11.08

The per oxyde of lead, which is of a brownish colour, contains by weight

Lead,	100
Oxygen,	15.384

The prot or yellow oxyde is composed of

Lead,	100
Oxygen,	7.692

The red oxyde of lead may be adulterated with red ochre, or some cheap colour of that kind. Such additions, however, diminish its specific gravity.—The addition of water to the lead, and stirring it repeatedly, will, in a great measure, prove this fact. The red lead being a much heavier substance will subside first, leaving the ochre in suspension. The ochre, however, may be recognised by a few simple experiments.

With respect to the coarser red pigments, as *red ochre*, *light red*, *Venetian red*, &c. with *Spanish brown*, they are seldom if ever adulterated. A kind of factitious *red chalk* has been made of red lead, *crocus martis*, &c. mixed with clay, and baked to a



certain degree. But as red chalk is merely coloured by oxyde of iron, as it is found in the earth, the presence of red lead, if its detection is attempted, may be effected by the rules already given.

*Terra Sienna*, a brown ochre of an orange cast, is used by painters both in its raw and burnt state. When burnt, it acquires a deeper colour, owing to the oxydizement of the iron it contains. It is sometimes mixed with other browns.\*

## YELLOW PIGMENTS.

Chromic yellow is a beautiful yellow paint. It is composed of chromic acid and oxyde of lead.

Chromate of lead has been made in some considerable quantity in the United States. The ore from which the chromic acid is obtained, is an ore of iron, usually, though we think improperly, called the chromate of iron, for the chrome does not seem to be originally in the state of chromic acid. The ore, however, is pulverised, mixed with nitrate of potash, and the mixture exposed to a strong heat in a crucible; chromate of potash is thus formed, which

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\* Boles are viscid earths, more friable than clay, but less coherent. They are soft and unctious to the touch.

The principal boles are the following: Armenian bole, of a bright red colour with a tinge of yellow; French bole, of a pale red colour, variegated with specks of white and yellow; the bole of Blois, which is yellow, and lighter than the common yellow ochre; Bohemian bole, also yellow with a tinge of red; Lemnian earth, of a palish brown; and Silesian bole, of a pale yellow colour. All these boles when exposed to heat change their



is dissolved in water. This solution is then added to acetate of lead; a double decomposition takes place, and chromate of lead is precipitated, which is washed and dried.

True chromic yellow should not effervesce with nitric acid. Genuine chromate of lead, according to Thomson, is soluble in the fixed alkalies without decomposition. Nitric acid also dissolves it; but muriatic and sulphuric acids decompose it, precipitating the lead in the state of muriate or sulphate.—According to Brande, however, when potash or soda in solution is digested on chromate of lead, an orange-coloured solution of the *alkaline chromate* is formed, which, when treated with sulphuric acid and evaporated, furnishes crystals of chromic acid.—Here is certainly a contradictory opinion. If the fixed alkalies dissolve chromate of lead without decomposition, the alkali must merely act as a solvent of the pigment; but if they decompose chromate of lead, forming thereby an alkaline chromate, the oxide of lead must remain at the bottom. By treating the alkaline chromate with sulphuric acid, a sulphate of alkali is formed, while the chromic acid is precipitated.

The use of nitric acid, as a solvent of chromate of

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colour. When made into little masses, and stamped with certain impressions, they are called *terra sigillatæ*.

True bole, if it be immersed in water, after it is fully dried, should fall asunder with a crackling noise. A piece put on the tongue soon falls to pieces, impressing a slight sense of astringency. Bole is often found in Wacke and basalt, as in Silesia, Hessa, and Sienna in Italy, and in the cliffs of the Giant's Causeway, Ireland. It has been found in the United States.



lead, and of sulphuric and muriatic acids as precipitants of the lead, as above stated, furnish the best proofs of the purity of this pigment.

The several yellows, as *Indian yellow*, a preparation of chalk with fermented urine; *king's yellow*, a preparation of orpiment; *patent yellow*, a fused submuriate of lead; *Naples yellow*, a preparation of lead and antimony; *yellow ochre*, an earth coloured with oxyde of iron; *massicot*, the yellow oxyde of lead; *Dutch pink*, a preparation of French berries and chalk, &c. are seldom adulterated. But the presence of the vegetable colouring matter of turmeric itself, may be detected by an alkali, to which it will impart the well known brownish red colour. Gamboge, if suspected in any of these pigments, will show itself on the addition of alcohol.

A yellow pigment may be obtained from the agrimony (*agrimonia eupatori*), as well from its leaves and stalks as from its closed flowers, by making a decoction, and adding a diluted solution of bismuth.

A water colour, called *weld yellow*, much used by paper hanging manufacturers, is the colouring matter of weld precipitated with an earthy base. For the preparation of this pigment, whiting and alum are mixed with water, and boiled together; then a strong decoction of weld is made, and poured on the whiting and alum; and after boiling the whole for a few minutes, it is poured out, and dried.

### PRUSSIAN OF COPPER.

This pigment is of a chocolate brown, and has late-



ly been introduced as a good colour of that description. It is, however, expensive, and adopted only as a water colour. It is prepared by Mr. Hume of London, by decomposing the sulphate of copper by the ferrocyanate of potash. It is, therefore, a ferrocyanate of copper. It should be entirely free from sulphate of potash, and when digested in caustic potash be completely decomposed, leaving an oxyde of copper. When exposed to the blow pipe on charcoal, it is decomposed, and the copper reduced.

The most perfect brown is produced when the copper is oxydized to the maximum; hence the per salts of copper should be preferred. The precipitate should be well washed to separate the sulphate of potash. In consequence of the precipitation of copper of a brown colour from its solutions by ferrocyanate of potash, the latter has been recommended, and is used as a reagent for copper. If the per oxyde be combined with the ferrocyanic acid, the pigment must be the per ferrocyanate of copper.

In the preparation of Prussian alkali (ferrocyanate of potash,) in order to obtain it free from any ferroprussiate of iron, which it holds in solution when prepared in the usual manner, Dr. Henry first suggested the use of the ferrocyanate of copper. This is digested in a solution of pure caustic potash.—The prussiate of potash, as it was formerly called, which is thus prepared, is a purer preparation for a test than that formed by digesting a solution of potash on the perferrocyanate of iron.



## LECTURE IV.

### BROWN PIGMENTS.

Several of these colours are liable to adulteration. Thus *bistre*, which is the carbonaceous basis of wood soot, collected in the chimney, after having been washed in water to separate any pyroligneous acid or ammoniacal salt, should be entirely free from burnt umber. If it contain umber, or other incombustible substance, it may be proved by exposing it to heat; pure bistre will entirely consume, without leaving any earthy or metallic residue.\* Of the other browns

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\* Wood-soot contains several substances, and what is rather remarkable, a large proportion of pyroligneous acid, which we have noticed under the head of *Wood vinegar*. The quantity is sufficient to preserve meat; for on making a mixture with water, in due proportions, the water will unite with the empyreumatic acid, i. e. the pyroligneous acid containing empyreumatic oil, which has been successfully applied to that purpose. This fact we deem worthy of repeating, as soot can be had at any time, whereas wood vinegar must be prepared from wood by distillation. No doubt, however, but the *infusion* of soot in water, also contains a portion of ammoniacal salt. Soot,



*Cologne earth, umber, asphaltum, and brown pink,* little need be said. The Cologne earth is often spurious. It is prepared from an earth found in the neighborhood of Cologne; but as earths which contain iron, may be burnt of a certain colour, according to the heat, the imitation of true Cologne from light brown earths has been attempted.

The earthy lignite found near Cologne, in beds of from 20 to 30 feet thick, is sometimes called, and used for Cologne earth. Its colour is nearly black, or blackish brown, and is but little heavier than water. It is known, however, from the real Cologne earth by its combustibility. It burns like tinder, with little or no flame. It often contains pyrites, and then furnishes alum, and passes into aluminous earth. Alum is manufactured in the United States from pyritous lignite. See Allum.

Asphaltum, if adulterated with earthy substances, may be examined with oil or spirit of turpentine. As it is a solid bitumen, and wholly soluble in turpen-

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it is known, was formerly the basis of an officinal preparation, called the tincture of wood-soot. The carbonaceous part of wood-soot, which forms the pigment above mentioned, is of a brown colour; and by the repeated ablutions of water, the saline matter, as well as the pyroligneous acid, &c. are separated. The soot from vegetables, the formation of which always indicates an imperfect combustion, (as stoves have been so continued as to burn their own smoke,) differs from the soot of animal substances. Of this fact we have an instance in the former preparation of sal ammonia. In Egypt, where sal ammoniac was originally made, camel's dung is used as fuel: the soot of which was collected, and sublimed. By this operation



tine, any foreign admixture may be thus detected. Asphaltum, as a colour, is affected considerably by the temperature. It is of great antiquity, and is said to have been the cement used by the Egyptians, and for the purpose of pitch.

Brown pink is a paint of little durability, but should be entirely free from umber. Its preparation consists in impregnating chalk with a decoction of fustic, the colour of which being heightened by the addition of potash. This colour is liable to change by acids, as the acids act on the colouring matter of the fustic.

### BLACK PIGMENTS.

Of the black pigments, especially those employed for water colours, none presents such a diversity of character as *Indian ink*. This is owing to the different modes of preparing it. Some have supposed it to be a preparation of the gall of the cuttle fish; this, however, is an error. It is ascertained by experiment, that lamp-black forms the basis of this ink, but

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the muriate of ammonia was separated from the other substances; but, before it could be used, it was usually resublimed.—See *Sal Ammoniac*.

The painful sensation on the eyes produced by ordinary smoke is well known; this is attributed to the pyroligneous acid. That smoke contains a large quantity of moisture, or vapour, derived from the wood, especially if it be green, is very apparent of a frosty morning; it appears more thick and dense, which is owing to the partial condensation of the vapour by the abstraction of caloric.



that it is remarkably fine, and free from any oil or turpentine. The soot that constitutes lamp-black varies in quality according as it is obtained from tar, turpentine, or oil. The best and finest lamp-black is prepared by the combustion of oil ; and in the small way, by collecting it in a tin funnel over a lamp : it will be found decidedly superior to the ordinary lamp-black.

The quality of lamp-black may be improved by heating it at a given temperature, on a plate of sheet iron, or exposing it to heat in a covered crucible. To prepare Indian ink, a due quantity of the fine lamp-black is to be mixed with size or animal glue. Several recipes, however, are given.

Indian ink may be examined by dissolving it in water, and filtering the solution. The water holding the gelatin in solution, if sufficiently diluted, will pass through the filter, leaving the atramentous matter, which may be examined for charcoal, &c. The lamp-black should burn entirely away, without leaving a residue, and when thrown on ignited nitre in a crucible produce a deflagration. The gummy fluid may be tested either for gum or gelatin ; for the former by silicate of potash, (*liquor of flints*,) and for the latter by a solution of tannin. All the Indian ink imported into the United States, does not come from China ; a large quantity is made in England. The English, however, is coarse, rough, and gritty, and generally has a blueish cast. The Cashew nut, we may remark, furnishes a native black colour. See *Lac*.



*Lamp black* ought to be the soot of oil, but is now the soot of tar, turpentine, dregs of pitch, pine knots, &c. which is inferior in quality to the first. The ordinary lamp black may be improved either as before stated, or by heating it in confined vessels, which certainly gives it a more perfect blackness. We do not recollect of any fraudulent adulteration of lamp black. It should, however, when burnt, be entirely consumed, without leaving any residue; and alcohol digested on it should not extract any turpentine, or rosin. It ought to be free from grit and feel impalpable between the fingers.

What is called *ivory black* in the shops is not the carbon of ivory; which, being remarkably compact, furnishes a dense compact coal; but that which is sold is the ordinary bone black, an animal coal much inferior to the true ivory black. In fact the latter is scarce and costly, whereas the bone black is plentiful and cheap. The perfection of this colour, depends on the due carbonization of the bone. The gelatin of the bone appears to be the principal substance which is carbonized.

Bones when burnt to ashes, furnish phosphate of lime, a substance which has been used in painting, and for other purposes. Ivory black may be mixed with charcoal.

In the operation of grinding carbonized bone, which is performed in a mill, a due proportion of charcoal, we have known to be added, and the whole ground together, and sold as ivory black; a name, however, given by usage to bone black. As the two



coals is a mechanical mixture, that of the animal being heavier than that of the vegetable, when they are thrown into water, the latter will swim while the former will gradually subside. Ivory black containing charcoal readily takes fire, a circumstance attributed to the vegetable coal. The quantity of charcoal, however, is variable. If some of this mixed black be projected into an ignited crucible containing nitrate of potash, a deflagration nearly as brilliant as if charcoal alone were used will ensue; and if nitric acid be poured on, it will furnish, especially if the coal be previously heated, an abundance of deutoxyde of azote, along with carbonic acid gas. A mineral black, called *black chalk*, is also used as a colour. This native chalk is an intimate mixture of carbon, silica, and alumina.

The *blue black* is a vegetable coal. It is prepared of the best quality from vine stalks, carbonized in a covered crucible, or iron cylinder.

## PURPLE PIGMENTS.

Of these the ordinary crocus martis is the most common. It is a preparation of iron, and is liable to be adulterated with colcothar of vitriol. If the crocus martis is the *saffron* coloured oxyde of iron, and answering to the red oxyde in its quantity of oxygen, and colcothar of vitriol the same as the peroxyde of iron, there can be no difference in the composition of the two; but notwithstanding they are thus identified by Dr. Ure, the calcined copperas or



colcothar is altogether different from the red or peroxyde of iron.

All the sulphuric acid is not disengaged in the preparation of colcothar, however the iron may be oxydized to the maximum; and, therefore, the substance which remains after the calcination of vitriol, is in fact a subsulphate of iron. As pigments, however, they may be used alike; but when employed for the polishing of metals, every artisan, or workman, will give the preference to crocus.

Crocus martis besides being mixed with the subsulphate of iron, is frequently adulterated with red ochre, and red lead. The detection of these substances may be effected by the processes already given. A purple lake may be prepared from logwood,—by making a decoction of the wood, and adding the muriate of tin. The muriate of tin precipitates the colouring matter of a purple colour.

The *purple powder of Cassius*, although not employed as a pigment in the proper acceptation of the term, is much used in enamel painting, and for tinging glass of a fine red colour. It is prepared by precipitating muriate of tin with, or by immersing a piece of tin in a solution of gold. It is composed of peroxyde of tin and oxyde of gold, in the proportion of about three parts of the former to one of the latter. The purple of Cassius when digested in nitro-muriatic acid should be decomposed, and the gold taken up, while the tin remains; and muriatic acid ought to dissolve the tin, and leave the gold. In ammo-



nia it is soluble, forming a deep purple liquor. See *Artificial Gems*.

The *gold powder* for painting is a preparation of gold leaf. The best process for making it, consists in triturating the leaves of gold with a little clear honey : and when the gold is sufficiently divided, wash off the gold with water. The powder is then to be digested for a few minutes in muriatic acid, perfectly pure, and the acid removed by repeated ablutions with rain water. Pale gold powder may be prepared in a similar manner, from gold alloyed with silver. *Silver leaf*, treated in a similar way, furnishes silver powder. The purity of gold powder may be known by its being wholly soluble in nitro-muriatic acid, and by its precipitation in a metallic state by the protosulphate of iron. If any residue should be left it may be examined. Silver powder should be soluble in nitric acid, and the silver precipitated by copper; or the precipitate obtained by muriate of soda, should be wholly soluble in liquid ammonia. Silver powder has also been prepared, by precipitating silver from its solution by a plate of copper.

A gold powder for gilding silver without heat, has also been made by soaking linen rags in a concentrated solution of muriate of gold, drying them, and setting them on fire. The ashes contain minutely divided gold and charcoal. Gold precipitated from its solution in aqua regia, by the green sulphate of iron, may be used for the same purpose.

Gold powder is also made by amalgamating gold with mercury; separating the extraneous mercury by



squeezing the amalgam in a fine muslin; and the mercury from the gold by diluted nitric acid. The gold will remain in powder.

*Shell gold* and *shell silver* are the same as gold and silver powder, only mixed with gum and put into shells.

The *aurum moscaium*, or Mosaic gold, which is used in some of the ornamental arts, is the persulphuret of tin: it is prepared by subliming a mixture of 12 parts tin, 7 parts sulphur, 3 parts mercury, and 3 parts sal ammoniac. When pure, it is in the form of light scales, which have the colour of gold, and readily adhere to other bodies. The same compound may be formed, by heating the per oxyde of tin with its weight of sulphur.

Besides being used as a pigment for giving a golden colour to small statue or plaster figures, &c. it is also said to be mixed with melted glass to imitate lapis lazuli.

When pure, and exposed to heat, a part of its sulphur is separated, and is converted into common sulphuret of tin, which has a lead colour. Another character is, that it is soluble in a solution of potash assisted by heat, the solution having a *green* colour, from which a yellow powder (hydrosulphuret of tin, according to Proust,) is precipitated by the addition of an acid.

## GREEN PIGMENTS.

Of this class of pigments, some of the preparations



of copper are particularly noted.\* *Scheele's green* is a compound precipitate, of arsenious acid and oxyde of copper, and is formed by mixing arsenite or potash with sulphate of copper. The precipitate should be well washed to separate the sulphate of potash. If the sulphate be contained in it, the fact may be known by digesting a portion of the pigment in water, and filtering the fluid; then, by adding to separate portions, muriate of barytes and tartaric acid, we discover both the sulphuric acid and potash. If it be mixed with carbonate of copper, an acid will cause an effervescence, and the solution may be examined as in other similar cases. If carbonate of lime be suspected, the solution may be examined for that earth. An *excess* of acid, it will be observed, will take up both copper and lime; but lime will decompose a cupreous salt.

*Verdigrase* is the most common, and at the same time the most valuable of the cupreous pigments. It is copper corroded by the action of grape stalks,

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\* The salts of copper are recognised by the following properties: They are almost all soluble in water, or become so by the addition of an acid, the solution having either a blue or green colour. Ferrocyanate of potash produces a chocolate brown, especially with the persalts. Hydrosulphuret of potash gives a brownish black precipitate. Gallic acid a brown precipitate.—A plate of iron precipitates the copper in a metallic state.—See the *Detection of copper*, in a preceding lecture.

The salts of copper, when heated before the blow pipe, give a fine green flame. The oxyde of copper with microcosmic salt and borax, forms a yellow green glass while hot, but which becomes blue green as it cools.



refuse of grapes, &c. It is called the green oxyde, or subacetate of copper.

The amount of the admixture of impurities in verdigrease may be learnt, by digesting one part of verdigrease in twelve parts of distilled vinegar for some time, suffering it then to stand, and collecting and weighing the insoluble part. The acetate of copper may be evaporated and crystallized. Should the verdigrease contain sulphate of copper, it may be known by boiling it in water, and evaporating the solution. Crystals of acetate of copper will first separate, and afterwards those of the sulphate of copper. Muriate of barytes will detect the sulphuric acid. If tartrate of copper should be present, it may be known by dissolving a portion of the verdigrease in distilled vinegar, and adding to the solution muriate of barytes, which will produce a white precipitate soluble in muriatic acid.

The French verdigrease, according to Phillips, (Annals no. 21,) contains 43.5 per oxyde of copper, and the English 44.25.

The *crystallized verdigrease*, or crystallized acetate of copper, a salt which is formed by dissolving the common verdigrease in distilled vinegar, and crystallizing the solution, should, if pure, be entirely soluble in six times its weight of boiling water, and the solution not affected by muriate of barytes. A precipitate occasioned by the latter is an indication of the presence of sulphuric acid. Sulphate of copper may be recognised by crystallization.

It seems according to the British Journal of Science, no. xxvii, that before verdigrease is pressed



into cakes, it is in the form of light blue acicular crystals of a silky lustre, which, by the action of water, are resolved into a soluble acetate, and an insoluble subacetate of copper, the latter being decomposed by cold water, which changes it to a brown colour. Mr. R. Phillips, (Annals no. 21,) who made these researches, has not ascertained whether the verdigrease is thus resolved into oxyde of copper, or remains as a sub salt.

The process used at the present day for the manufacture of verdigrease, is the same as that which was employed in the time of Theophrastus, Dioscorides, and Vitruvius. Every green oxyde, however, was comprehended under the name of *ærugeo*. Professor Beckman, who has examined this subject with his accustomed accuracy, in speaking of the explanation of verdigrease, remarks: "The ancients for this purpose, used either vessels or plates of copper, or only shavings and filings; and the acid they employed was either the sourest vinegar, or the sour remains left when they made wine: such as the grapes become sour, or the stalks and skins after the juice had been pressed from them." He mentions also the exposure of copper to the vapour of the acid, in the same manner as Theophrastus describes for the corroding of lead, in making white lead, a practice pursued in modern times.

The adulteration of verdigrease was also common; for it appears the ancients frequently adulterated it with stones, particularly pumice stones reduced to powder, and sometimes with copperas. The cop-



peras they detected by roasting the verdigrease, which become red.

The greater part of the verdigrease in ancient times was made in Cyprus, which was celebrated for its copper works, and in the island of Rhodes. The vermicular verdigrease was no other than verdigrease united with gum, and drawn into threads like worms; a practice censured both by Pliny and Dioscoredes. For the same reason the Italians gave the name of *Vermacelli*, which we noticed heretofore, to wire drawn paste of flour and eggs used in cookery.

The pigment called *Brunswick green*, is usually prepared by digesting copper in a solution of muriate of ammonia, by which the metal becomes gradually corroded; or, according to another process, digesting the oxyde of copper, in a solution of supertartrate of potash, by which the tartrate of potash-and-copper is formed. Leonardi observes, that this triple cupreous salt constitutes the better kind of Brunswick green. It is largely adulterated with both whiting and cerusse. The former is known, first by an effervescence on the affusion of acid, and secondly by testing the solution for lime. Cerusse or white lead is recognised by treating a solution in acetic acid for lead, as before mentioned.

*Sap green* is a vegetable pigment, obtained from the juice of buck thorn berries (*rhamnus catharticus*,) by inspissation.

Like the syrup prepared from the same juice, which is used in medicine, it is frequently adulterated. Mr. Accum assures us, that the sirup of buck-



thorn berries, instead of being made from the real berry, is prepared by English apothecaries from the berries of the buck thorn, and black berry bearing alder, and of the dog berry tree; and that a mixture of these two berries are exposed for sale by the vendors of medicinal herbs. This abuse may be discovered by opening the berries: those of the buck thorn have always four seeds; of the alder, two; and of the dog berry, only one.

The buck thorn berries bruised on paper, stains it of a green colour, while the others do not. The pigment, therefore, which should be nothing more than the pure colouring matter of the buck thorn berry, may in like manner be adulterated.

The same colour, sold as *sap green*, has been prepared from the flower of the blue lilly.

It is extremely difficult to detect colouring matter, the character of which is not well marked, and when nearly allied; but as verdigrease is often mixed with sap green, its presence may be easily shown by the use of ammonia.

## WHITE PIGMENTS.

The genuine *flake white*, or majistery of bismuth, is frequently adulterated with *cérusse* or white lead. It is used as a cosmetic, but is apt to blacken like lead by sulphuretted hydrogen gas.\* It should be

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\* Cosmetics, of either bismuth or lead, injure the skin, and are blackened by hepatic gas. Waters, for instance, which are decidedly hepatic, have been known to produce this effect, when



entirely free from lead. There are several white pigments, some of which are of a much cheaper and coarser kind; thus *Spanish white*, which is chalk pulverised and washed; *egg shell white*, and *oyster shell white*, *calcined hartshorn*; *glass white*, &c.—But of the white pigments, *white lead*, called the white oxyde and carbonate of lead, and ceruse, is the most liable to adulteration.

White lead is properly a compound of the yellow, or protoxyde of lead and carbonic acid. It is prepared by rolling leaden plates spirally so as to leave a space of about an inch between each coil, and placing them vertically in earthen pots, at the bottom of which is some good vinegar. The pots are to be covered, and exposed for a length of time to a gentle heat either in a sand bath, or, as is more usually the practice, by bedding them in dung. The vapour of the vinegar, assisted by the oxygen which is present, corrodes the lead, and converts the external part into a white substance, which comes off in flakes, when the lead is uncoiled. The plates are thus treated repeatedly until they are corroded through. The flakes are then ground in a mill, and the powder for particular purposes washed.

they have been used; bathing in them, or the gas coming in contact with the body, will immediately effect this change. Such instances have occurred, to the no small mortification of the ladies who employed them. To obviate this effect, chalk, fine white clay, or Spanish white, is now substituted; the practice however, of *painting*, as it is called, is confined to a few. It is an ancient custom; but its antiquity, in our opinion, is no argument for its continuation.



Lead when exposed to the action of air and water will gradually oxydize, absorb carbonic acid, and become white lead. Hence water kept in leaden cisterns contracts lead ; for the water line, where the water and air come in contact, is crusted with a white substance. See the effects of lead on water, Lecture I.

The most common substance with which white lead is adulterated is chalk, next to which is the carbonate and sulphate of barytes, and sometimes sulphate of lead. Solution in acetic acid with effervescence, and adding oxalic acid, or oxalate of ammonia will show the presence of chalk ; and sulphate of soda, to a portion of the same solution, will indicate barytes, by forming an insoluble sulphate. If any residue should occur after the acetic acid ceases to act, we may infer the presence of sulphate of lead or sulphate of barytes.

The quantity of lead contained in cerusse may be readily ascertained, either by reduction with charcoal in the usual manner, or by solution in an acid, and the metal precipitated. In fact, it may be examined in the same way as the native carbonate of lead. For this purpose introduce 134 grains into a sufficient quantity of nitric acid diluted with about two parts of water ; an effervescence will ensue, and the carbonic acid may be estimated by the loss of weight, which, if the statement of Brande be correct, should be in the above quantity 22 grains. Filter the solution, and if there be any insoluble residue, wash, dry, and weigh it, and set it aside for further



examination. By deducting this weight from 134 grains, deducting 22 for the carbonic acid, its quantity will be known. To the filtered solution add sulphate of soda, which will throw down sulphate of lead. It consists of one proportional of sulphuric acid, equal to 40, and one proportional of oxyde of lead, equal to 112, whence the oxyde may be deduced. But the easiest method is to separate the lead in its metallic state from the nitric solution. For this purpose immerse a plate of zinc, which will precipitate metallic lead, the zinc taking the place of the lead, forming a nitrate of zinc. The quantity of metallic lead in 134 grains of the carbonate, deducting 22 grains for the carbonic acid, will be about 103.04 grains; deducting also the quantity of oxygen in 112 grains of the yellow oxyde of lead, which exists in the white lead. The proportion of oxygen, according to Bezelius, is nearly 8 per cent.

It is sufficient to know, however, that genuine white lead should be entirely soluble in acetic or nitric acid.

The residue in the above experiment may, nevertheless, be boiled in a solution of carbonate of potash, the fluid then filtered, and examined for barytes or lead, and the residue again treated with acetic or nitric acid. The artificial sulphate of barytes is employed as a pigment under the name of *permanent white*.\*

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\* Water-colours, as *Reeve's*, are nothing more than the pigments we have mentioned, ground impalpably fine, and mixed with weak isinglass size, or strong gum water, and formed into



## ALLOYS OF COPPER.

As some of the alloys of copper are important, a general notice of them may be useful. With arsenic, it forms a white alloy, called white copper, but

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cakes in oblong square moulds, in which they receive certain ornamental impressions, the maker's name, coat of arms, &c.—They have been made up in boxes in this country, according to the English mode. The same colours mixed with gelatinous or mucilaginous matter, are often sold in shells. But the water colours prepared by the Chinese, in small china pots and arranged in a portable chest, with folding doors, accompanied by the *utensils* for mixing the colours, are generally superior to the English. The goodness of water colours depends, of course, on the purity of the pigments, their pulverization into an impalpable powder, and their mixture in due proportions with gummy matter, which not only serves to unite the particles together, but also when mixed with water, and applied with the brush, to prevent the colour from rubbing off. Oil colours, on the contrary, are mixed with drying oil, and are used chiefly for coarse work, as house-painting. Dried oil is a preparation of linseed oil, made by boiling the oil with litharge, which separates a quantity of mucilage from the oil. Spt. of turpentine is usually added to thin the paint and facilitate its drying.

Nicholson (*Mechanical Exercises*, p. 319,) gives the following list of useful colours for house painting :

*Black*—lamp black.

*White*—white lead.

*Yellow*—ochres, also patent yellow.

*Blue*—Prussian blue, and blue black.

*Red*—red lead, vermillion and purple brown, or India red.

—— crimson, lakes, to which add vermillion, or white according to the *tone*.

*Green*—grass, verdigrease.

—— invisible, dark ochre, blue and a little black.

*Green*—a good, patent yellow and Prussian blue.

—— pea, mineral green.



more properly white tombac, in which, however there is usually a little tin or bismuth : with zinc or spelter it forms brass, the proportion of the metals being variable, as in English brass there is 1.3d of zinc, and in German or Swedish, from 1.5th to 1.4th of copper ; hence in English brass the alloy will consist of two parts of copper by weight, and 1.8th, part of zinc, equivalent to one atom of each metal, but in Dutch brass the compound is 2 atoms copper

*Chocolate*—India red and black.

*Lead colour*—black and white.

*Brown*—umber, raw and burnt.

—— mix black, red, and dark ochre.

*Purple*—mix lake, blue, and white.

Yellow and red make an orange colour ; red and blue, a purple and violet ; blue and yellow, a green ; light ochre, Prussian blue, and a little black, an olive ; India red and white, a flesh ; white and umber, a stone ; and black, blue, white, and a little India red, a peach colour.

Sir H. Davy (*Phil. Trans.* 1815,) made some interesting experiments at Rome on the colours used by the ancient artists. He found the reds to be minium, ochre, the yellow orpiment and massicot ; the blues, formed from carbonate of copper, or cobalt, vitrified with glass ; the purples, made of shell fish, and probably from madder and cochineal lakes ; the blacks and browns, lamp black, ivory black, and ores of iron and manganese ; and the whites were chalk, white clay, and cerusse. Various pigments, but principally ochres, were found among the ruins of Herculaneum and Pompei. They had regular paint shops.— See *Bartholemey's Travels*, &c.

As to the great durability of pigments, as some are known to have preserved their original colour for 1700 years, it depends entirely on their basis. Coloured frits, or glasses, are unquestionably the most indestructible, as Sir H. Davy ascertained by his experiments.



and 1 atom zinc. With zinc also, it gives rise to pinchbeck, Prince's metal, Prince Rupert's metal, &c. the proportion of zinc sometimes amounting to nearly one half of the whole: the ancient orichalcum was also an alloy of the same metals. With tin it unites in variable proportions, forming gun metal, bell-metal, bronze, and the mirrors of telescopes, the ductility of the copper being diminished, while its hardness, tenacity, fusibility, and sonorousness are increased. Bronze and gun metal are composed of from 8 to 12 parts of tin and 100 parts of copper, which is the same alloy used by the ancients for sharp edged instruments before the method of working iron was brought to perfection: brass guns, improperly so called, made at Woolwich, England, are composed of from 8 to 12 parts of tin, to the 100 of copper; the purest copper requiring the most, and the coarsest the least. This also is more sonorous than iron; hence brass guns give a much louder report than those made of cast iron. Bell metal is an alloy of 3 parts of copper and one part of tin; but the proportion of tin varies, as less tin is used for church bells than clock bells, and in small bells as those of watches, a little zinc is added to the alloy. The *conch* of the East Indians is composed of tin and copper, in the same proportions as in bell metal.—The speculum metal of the ancients, was composed of 2 parts of copper, and 1 part of tin; but Mudge's composition is 32 parts of copper, and 14.5 of tin: Copper will also unite with tin, in the operation of tinning, 21 grains of the latter being sufficient to



cover a pan 9 inches in diameter, and 3 inches three lines in depth; more than this will melt off. When copper plates are cemented with calamine, (an ore of zinc,) they are converted into a fine kind of brass, which is hammered out into leaves in Germany, and sold under the name of Dutch gold, or Dutch metal. Ancient daggers, like their cutting instruments, were composed of copper and tin, in the proportion of about 83 of the former to 16 of the latter: some of the ancient coin was also made of copper with the addition of a small quantity of tin; but in the formation of their brass, which they much valued, they used an ore of zinc called cadmia. The ancients, in their writings, frequently confound as the same, copper, bronze, and brass. Tutenag is said to be an alloy of copper, zinc, and a little iron.

Jewelry trinkets are alloys of gold and copper, in which the proportion of the copper to the gold is variable, and sometimes so great that they ought to be placed under the alloys of copper. Copper renders gold less ductile, harder, more fusible, and of a deeper colour. This is the usual addition in coin; but for the purposes of coin, Mr. Hatchett considers an alloy of equal parts of silver and copper preferable. A fifth part of silver renders gold greenish; the compound is always paler in proportion to the quantity of silver added. A pale greenish yellow gold, is formed by uniting 11 parts of gold to 1 of zinc. Gold coin, sterling or standard gold is a mixture of pure gold with 1.12 of some other metal. The metal used is always either copper or silver, or a mixture of



both. In British coinage, a pound of standard gold is coined into 44 1-2 guineas, or 20 troy pounds are coined into 934 1-2 sovereigns. In expressing the fineness of gold, the whole mass is supposed to weigh 24 carats, of 12 grains each, either real or proportional, so that gold of 23 carats fine implies a mass weighing 24 carats, and the quantity of pure gold 23 carats. This alloy of gold and copper, constituting jeweller's gold, varies in the number of carats of pure gold: gold of 12 to 18 carats fine, is the kind most-ly employed for trinkets, watch chains, &c. Green gold of the jeweller's, is usually an alloy of gold and silver.

Having noticed in a cursory manner, the principal alloys of copper, we purpose in the next place to mention briefly the several methods of examining these alloys, with the view of ascertaining the proportion of their constituent parts.

The alloys of gold may be examined by nitric acid; for nitric acid it is known exerts no action on that metal, whereas it dissolves copper, silver, and several other metals.

But the analysis of most of the alloys of gold is performed by a process called cupellation, which consists in exposing the alloy along with lead to the action of heat, in a cupel, a vessel made of bone-ash. The lead melts, then oxydizes, and finally vitrifies; the glass of lead then unites with the foreign metals, as copper, lead, tin, &c. and is absorbed by the cupel, while the gold not being oxydized, and therefore not acted upon by the vitrified oxyde of lead,



remains in the vessel. Quartation is often necessary in cupellation. By knowing the quantity of alloy submitted to experiment, the loss it has sustained will indicate the proportion of foreign metals. In an alloy, however, of gold and silver, cupellation cannot be used; but if copper, tin, bismuth, &c. be in the alloy, these metals will be separated. To separate silver from gold, nitric acid is used, which dissolves the former, and leaves the latter. The silver may be precipitated by muriate of soda, in the form of muriate of silver.

If a triple alloy of gold, silver, and copper is to be examined, we may digest it in nitric acid, which will take up the silver and copper, and leave the gold in the form of a black powder. This powder may be fused into a button and weighed. The copper may be precipitated by iron, and the silver by a solution of muriate of soda.

It may be of importance, very frequently, to determine the proportions of copper and zinc in brass; for the relative proportions of the two metals vary in the different kinds of brass. There is usually from 12 to 18 *per cent.* of zinc. In the formation of brass, a mixture of granulated copper, calamine, and charcoal, is exposed to heat; the calamine is reduced, and the metallic zinc unites with the copper, and the alloy is usually cast into plates. A beautiful brass may be made, according to Sage, by exposing to heat in a crucible 50 grains of oxyde of copper, 100 of calamine, 400 of black flux, and 30 charcoal powder. Three parts of copper and one of zinc are the proportions for Manheim gold.



Brass may be examined in the following manner: Dissolve it in nitric acid, and add a considerable excess of the solution of potash, and boil. The alkali will decompose the nitric solution, and precipitate the metals in the state of oxydes; but, as an excess of alkali is added, the oxyde of zinc will be taken up, leaving that of the copper. Collect the oxyde of copper, and wash it; then expose it to a strong heat: 125 parts will indicate 100 of copper. To the filtered alkaline solution, containing the zinc, add an excess of muriatic acid, and afterwards carbonate of soda, which will precipitate the zinc in the state of carbonate. When this precipitate is washed, dried, and exposed to a red heat, it will then be the oxyde of zinc; 123 parts of which indicate 100 of metal.

If an alloy of copper, as copper and zinc, be digested in sulphuric acid diluted with an equal quantity of water, the solution filtered, and a plate of zinc or iron immersed, the copper will be precipitated in a metallic state; or if the alloy be digested in nitromuriatic acid, composed of equal parts of nitric and muriatic acid, and the digestion continued till all the copper is dissolved, the solution filtered, and precipitated by carbonate of potash, the precipitate re-dissolved in a sufficient quantity of sulphuric acid, and the solution decomposed by a plate or cylinder of iron, metallic copper will be obtained. This process, we may remark, was recommended by Dr. Fordyce for analysing all copper ores, and is well adapted for the examination of alloys of copper, for



the purpose of determining the quantity of that metal. The zinc as well as the copper, is precipitated by the carbonate of potash, and are both taken up by the sulphuric acid; therefore, after the precipitation of the copper by the iron, the solution will contain the sulphate of zinc and iron. The quantity of zinc contained in the alloy, which is now in the solution, may be learnt by adding liquid ammonia in excess: the oxyde of iron, as well as the oxyde of zinc, will be precipitated, but as an excess of ammonia is used, the latter will be re-dissolved. If the liquid be now filtered to separate the oxyde of iron, and exposed to the action of heat, the ammonia will be volatilized, and the oxyde of zinc precipitated; or, if we saturate the solution with muriatic acid, adding no more than is sufficient to neutralize the ammonia, oxyde of zinc will fall down, which may be reduced to the metallic state by igniting it with half its weight of charcoal, in a closed crucible. If, on the addition of ammonia, the solution assumes a blue tint, it is a proof that all the copper had not been precipitated; but this tint will not be visible, if even copper be present, before the oxyde of iron is separated. If iron be in the alloy, as it is said to form a constituent part of the Asiatic tutenag, repeated digestion in nitric acid will render it insoluble. If the nitric solution be suffered to stand undisturbed, a brown powder, which is the oxyde of iron, will be deposited; this may be separated by the filter, and its quantity ascertained.

By the increase of weight which copper gains



when it combines with zinc, the assay of zinc ores has been performed. This process is exceedingly simple; the ore of zinc is first roasted, and stratified with its weight of the clippings of sheet copper, in a crucible; a cover is luted on the crucible, which is then exposed to a dull white heat for an hour; when cold, the contents are thrown into water, which separates the brass from the other matter; by weighing it, the increase of the weight of copper will be ascertained, which of course, indicates the quantity of zinc. In this process, however, a portion of zinc is always lost.

The examination of the alloys of copper and tin, as bell metal, speculum metal, bronze, gun metal, &c. is also important. It may be performed by digestion in nitric acid, which dissolves the copper, forming nitrate of copper, while it oxydizes, or converts the tin into an insoluble per oxyde. This per oxyde is to be collected, washed, and dried. It consists of 100 tin and 27 oxygen.

To the nitrate of copper add a solution of potash, till no further precipitation takes places; collect the precipitate on a filter, wash, and dry it. It is the per oxyde of copper, and contains in 125 parts, 100 of copper.

It will be observed, that these formulæ are sufficient for the examination of the alloys of copper, and may be employed for the analysis of all compounds of that metal with gold, zinc, and tin. Thus, if we submit to experiment tutenag, we will discover a larger proportion of copper than zinc; and likewise more cop-



per than exists in brass, in the alloys that constitute yellow tombac, Dutch gold, similor, Prince's metal, Prince Rupert's metal, pinchbec, and Manheim gold, and in the latter a portion of tin, which is added to improve the colour, although it impairs the malleability of the alloy. In the examination also, of the alloys of copper and tin, we will find the proportions of the two metals variable, and the copper always in the largest proportion, as in gun metal, bell metal, speculum metal, and bronze. In some of these alloys, as in Edward's composition for speculum, we may discover arsenic; and in some varieties of bell-metal, especially those calculated to make a shrill sound, we may detect zinc; for that metal, however small, will greatly increase the sonorousness of the alloy of tin and copper. By conducting similar experiments with the ancient cutting instruments, which were used before iron came into use, ancient copper coin, daggers, &c. all which were alloys of copper and tin, we may determine exactly the proportions of these two metals. We might mention also the examination of the alloys of gold and copper, forming coin, gold for jewelry, &c. for, by analysis, according to the process we have given, the proportion of gold may be invariably discovered. The same may be effected by weighing the alloy hydrostatically, when, by well known rules, the specific gravity may be determined, and the quantity of alloy ascertained; formulæ for which may be seen in Adam's Philosophy. It will be recollected, that it was by employing this hydrostatic principle, that Ar-



chimedus was able to discover the adulteration in Hiero's crown. The specific gravity of pure gold is 19.3.

As one of the methods for detecting arsenic, is to place it, or the powder supposed to contain it, along with powdered charcoal, or black flux, between copper plates, and expose them to the action of heat, by forming with copper an alloy called white tombac; we may remark, that this alloy, which may be also formed by fusing together in a close crucible copper and arsenic, (covering the crucible with common salt to prevent the action of air,) is white and brittle, and when the quantity of arsenic is small, it is both ductile and malleable. The quantity of copper, and also of arsenic, may be learned by dissolving the tombac in nitric acid, previously weighing it, and separating the copper in its metallic state by a plate of iron; the loss sustained will indicate the proportion of arsenic. The arsenic will be acidified by the nitric acid, and remain in the solution. If this be saturated with soda, the liquor filtered, and nitrate of lead added gradually, an arseniate of lead will be precipitated, 100 parts of which are equivalent to 56.5 of metallic arsenic. Another process may be adopted, similar to that described by Mr. Chenevix, for examining the native arseniate of copper; namely, digest the alloy in nitric acid, and add nitrate of lead, which will form an arseniate of lead; but if there should be an excess of acid, part of the arseniate will be held in solution; in that case, evaporate the fluid nearly to dryness, and add alcohol,



which will separate the whole of the arseniate of lead : to the remaining solution add potash, and oxyde of copper will be precipitated, 125 parts of which are equivalent to 100 of copper.

### SEALING WAX.

There are two kinds of sealing wax ; the red and the black. They both contain resin of a particular kind, and coloured with red lead, vermilion, or ivory black. A variety of recipes have been published for preparing them. Good red sealing wax, or that which is denominated superfine, should have a fine vermilion colour, and when broken a glossy and resinous fracture. It should inflame without difficulty, and exhale an aromatic odour resembling the mixed odour of burnt camphor and benzoin. It ought to dissolve in alcohol, leaving nothing but the colouring ingredient. This should be vermilion for the red, and ivory black for the black wax. The common sealing wax is usually made by melting resin and shell lac, and colouring it with red lead or ivory black. The superfine red wax is formed of resin shell lac, and camphor, with occasionally benzoic acid, and coloured with vermilion. Very inferior sealing wax has been sold for superfine, or No. 1, by *varnishing* it with a spirit varnish made by dissolving the best red sealing wax in alcohol.

In this way, even a mixture of common rosin and yellow wax, coloured with red lead, has been passed off for the genuine sealing wax. But the fraud is readily detected by breaking it, and burning a small



piece, observing the flame, smoke, &c. The colour which is communicated by vermillion, and by red lead, is readily recognised; the former is a bright red, and the latter a dull red. We may examine it, by first dissolving all resinous substances by means of alcohol, and proceeding with the residue in the usual way for the detection of lead or mercury. If the colouring matter be red lead, a piece of the wax put into a crucible and submitted to heat will be decomposed, and the lead reduced.\*

### COPAL.

This substance, usually called *gum copal*, is employed in the manufacture of the celebrated copal varnish. It is obtained from the *thus copallinum*. No less than eight species have been enumerated by Hernandez. As upon the purity of copal depends,

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\* There is one fact, which, perhaps, is worthy of remark.—When sealing wax is melted in the flame of a candle, it is more or less contaminated with lamp black, which arises not from the wax itself, but from the combustion of the tallow. To prevent this effect, if it be melted in the flame of a spirit of wine lamp, no carbon will be deposited. The wax will not be in the least coloured. This difference arises from the combustion of the two substances: in the combustion of tallow, water as well as lamp-black is produced; but, in the combustion of alcohol, no *smoke* is to be observed, as the products of combustion are water and carbonic acid, and consequently *all* the carbon is consumed.—We may also remark, that in the burning of oil in the Argand lamp, with a glass cylinder, the combustion is perfect; for the smoke (lamp black,) is wholly consumed by the current of atmospheric air formed by the cylinder, and hence the result is also carbonic acid and water: the carbon itself is consumed in the cylinder, in consequence of the free supply of oxygen.



in a great measure, the quality of the varnish, so it is of importance to determine its genuine character.

Copal is a white resinous substance, with a tinge of brown. It is sometimes opaque, and sometimes it is almost perfectly transparent. It differs from other resins in several particulars. Although it dissolves in alkalies, and in nitric acid with the usual phenomena, and agrees in this respect with the other resins, yet it is not soluble in alcohol, nor in oil of turpentine except by peculiar management. It resembles gum anime in appearance, but is easily distinguished by the solubility of this last in alcohol, and by its being brittle between the teeth, whereas anime softens in the mouth. The specific gravity of copal varies from 1.045 to 1.139.

Copal varnish is merely a solution of copal in a volatile menstruum. The goodness of this varnish is determined by its transparency, and freedom from colour. This solution is usually effected by melting the copal in a moderate heat, and mixing with it an equal quantity of linseed oil, which has been bleached. Oil of turpentine is also added with the linseed oil. In fact the best copal varnish is said to be formed by dissolving the copal in *old* oil of turpentine. Camphor, oil of rosemary, &c. have produced good copal varnish, when used with other substances as solvents of the resin.\*

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\* We may remark here, that varnishes are numerous; that they are all formed by the solution of resin in alcohol, or drying oil or essential oil, and hence are denominated spirit and oil varnishes. Lacquers, which are a kind of varnish, are pre-



## LAC.

This substance is used extensively in varnishes, in sealing wax, and in lacquers. It is deposited on dif-

pared usually by dissolving sundry substances in alcohol. Thus the lacquer for tin ware is formed by macerating shell lac and turmeric root in alcohol. Amber varnish is formed by dissolving amber in drying oil, and adding spirit of turpentine; mastic varnish, for fire screens, window blinds, transparencies, &c. is a solution of mastic in spirit of turpentine; gum elastic varnish, for ærostatic machines, is a preparation of that substance with oil of turpentine, or æther; and shell lac, gum elemi, common rosin, &c. have all been used for the preparation of spirit varnish. The coloured resins, as gamboge, dragon's blood, &c. are used in coloured varnishes.

The best gold varnish, or gold lacquer, is made by dissolving 2 oz. of shell lac in 2 oz. of alcohol, and adding 1 oz. each, of anatto and turmeric, and 30 grs. of dragon's blood. Varnish, when applied to a body, should be put on with care, and when dry, should be smooth, shining, and uniform. No granulations should appear; if so, we may infer the impurity of the resin employed in its fabrication. Coach bodies require the best copal varnish; the body is first painted before it is applied. This varnish is extremely beautiful, and should resist the action, as in fact all resinous varnishes, of the weather. As the solvent of resins is either sundry drying oils or alcohol, it is obvious that, as water has no action on resin, it can have none on varnish. To remove varnish, it is, therefore, necessary to employ alcohol and oils. A solution of gum-resin, when used as varnish, is affected in a degree by water, owing to its solvent power on the gum. Coarse varnishes are chiefly used for wood work, as turpentine varnish, in which the oil or spirit of turpentine is used as the solvent; but spirit varnish, as it communicates no stain, is generally used for paper, as for maps, globes, &c. Even drying oil, or boiled linseed oil, when ground with pigments, prevents the action of the weather on the same principle as varnish.



ferent species of trees, by an insect called *chremes-lacca*. There are various kinds of lac distinguished in commerce, as the stick lac which incrusts small twigs; the seed lac, which is the preceding boiled in water; and shell lac made by melting the seed lac, and reducing it to the state of thin crust. Stick lac yields to water a substance which is used as red dye. Water should dissolve the greater part of the colouring matter of lac, which varies from 15 to 1-2 per cent. but alcohol should dissolve the greater part of the resin, the chief ingredient in the composition of lac. In sulphuric acid, it becomes partly charred; but in nitric acid, it should dissolve, and the acid should produce the same changes on it as on other resinous bodies. Muriatic and acetic acids also act as solvents. The fixed alkalies readily dissolve lac. The colouring matter possesses the properties of extractive. The quantity of resin amounts from 68 per cent. in stick lac to 90 per cent in shell lac.

A solution of borax in water readily dissolves lac, and this solution has been applied to important purposes. The best proportions are 20 grains of borax, 4 ounces of water, and 11 grains of lac. We mentioned when speaking of *black pigments*, that Indian ink was a combination of lamp black and gum or gelatin; but an author assures us, that the *true* Indian ink is a mixture of this solution of lac in borax, with lamp black, and that the same solution may be employed for many of the purposes of varnish.

A very useful cement, which will resist moisture, is made by dissolving shell lac in alcohol, and mix-



ing it with a solution of isinglass in proof spirit. This cement if made very thick, and applied to pieces of china or broken glass to be mended, or joined together, and the ware then exposed to the rays of the fire,—the union will be so perfect, and at the same time so strong, that it is difficult to separate it. The *mastic* of jewellers is a cement composed principally of lac; but gum mastic is frequently used alone, the stone being previously made hot enough to melt it. The Armenian jewellers in Turkey, ornament watch cases with gems by glueing them on with similar cement.

A new cement has lately been imposed on the public, some of which I purchased in Philadelphia, for the purpose of joining broken ware; on examination I found it to be nothing more than shell lac cast into sticks. It is, however, an excellent cement. The pieces should be heated, and the lac melted on; then joined together as quickly as possible. The temperature required is about that of boiling water.

Lac is chiefly used in spirit varnish; the varnish however, is always coloured.

## AMBER.

Amber is undoubtedly of vegetable origin. It generally agrees with resins in its properties. It is brittle, light, and hard, sometimes transparent, but commonly yellow. When heated it softens, and loses some of its weight. In a strong heat it burns, leaving a quantity of ashes. Water has no action on it; but alcohol by long digestion, dissolves about 1.3d of



the amber, which becomes milky when mixed with water. This precipitate possesses the properties of resin.

Boiling fixed alkali dissolves it, and the compound has the characters of soap; for it is soluble in alcohol, and not thrown down by water. Sulphuric acid converts it into a black resinous mass, and nitric acid acts upon it, producing a copious disengagement of nitrous gas. When amber is distilled, it furnishes gaseous matter, an acidulous fluid, then an oil, and lastly an acid, the succinic. Amber becomes electric by friction. It was the *electrum* of the ancients. Neither fixed nor volatile oils have any action on amber, unless it has been previously roasted, or exposed to a melting heat. When thus heated, it combines with oils, and the solution forms amber varnish. Good amber should be in large pieces, of a yellow or *amber* colour, and, when submitted to experiment, should exhibit the characters we have mentioned.

Amber is used in the preparation of varnish; but as neither fixed nor volatile oils have any action upon it, unless it has been previously roasted or exposed to the melting heat, it is necessary, in order to effect its solution, to be treated in that manner.—When amber is roasted, it loses about one half its weight; and when mixed with three parts of dried linseed oil, and the mixture exposed to the action of a gentle heat, the amber will be dissolved. After being removed from the fire, and when nearly cold, four parts of oil of turpentine are to be added. This forms the amber varnish.



## ROSIN.

This substance although common, presents several varieties as to quality. What is denominated turpentine, which is obtained from different species of the *fir*, as the *pinus abies*, *sylvestris*, *larix*, *balsamea*, &c. has received different names. Thus, the *pinus abies* yields frankincense, which burns with a fragrant odour; the *p. sylvestris*, the common turpentine; the *p. larix*, the Venice turpentine; and the *p. balsamea*, the balsam of Canada. Some of these turpentines may be mixed with an undue proportion of spirit of turpentine; but the admixture may be detected by comparing it with the genuine.

Fluid turpentine, as it exudes from the tree, is composed of oil of turpentine and rosin; and, therefore, when it is distilled, the oil comes over, and the rosin remains behind. This residue is the common rosin, or colophonium. When, however, as in the distillation of spirit of turpentine, a quantity of water is put into the still along with the turpentine, the rosin then becomes yellow, and forms the yellow rosin of the shops. The yellow rosin when heated should not give out any oil. It should be brittle, and pulverise easily, be insoluble in water, but soluble in alcohol and spirit of turpentine. When exposed to the action of the sun and moisture, its colour, is gradually discharged, and finally becomes white, forming white rosin. Rosin forms the basis of coarse turpentine varnish. Pitch differs from rosin inasmuch as it is nothing more than inspissated tar.



## BALSAM, OR BALM OF GILEAD.

The balm of Gilead is a resinous juice obtained from an evergreen tree, or shrub, of Arabia. The finest is of a greenish colour called opobalsam. The second is the carpobalsam expressed from the fruit. The third variety is reddish, called xylabalsamum, prepared from a decoction of the branches. The plant was supposed to be the *amyris Gileadensis* and *opobalsam* Lin. Willdenow, vcl. ii. p. 334.

The first sort which naturally exudes from the plant is scarcely known in this country. It is turbid and whitish, of a strong pungent smell like that of turpentine, but much sweeter and more fragrant, of a bitter acrid astringent taste. On being kept it becomes thin, limpid, light, greenish, and of a golden yellow; after which it is thick like turpentine, and loses much of its fragrance. Having the smell of citron, or of a mixture of rosemary and sage flowers, its imitation has been attempted by mixing with oil of turpentine, some of the oils of rosemary and sage, and adding a due proportion of this mixture to the Canadian balsam. It is never so perfect, but the fraud may be detected by merely comparing it with the genuine. The Canadian balm of Gilead-fir affords a balsam that is often imposed as the genuine sort. If the true balsam is dropped in water when thin, it spreads itself on the surface, imparting to the water much of its taste and smell. The grosser part which remains at the top, is thick enough to be tak-



en up with a needle : this is reckoned a mark of its being genuine. If pure balsam is dropped on a woollen cloth, it may be washed off without leaving a stain, but the adulterated kind adheres to the place. The pure coagulates with milk, but the adulterated will not.

### CANADA BALSAM.

This is a turpentine which exudes from the *pinus balsamea* and *Canadensis*, has a grateful odour, is more or less white, and when pure, thick and visced. It is frequently thinned by oil of turpentine. Pure Canada balsam will not flow without it be heated.

### BALSAM OF COPAIBA.

This is obtained from the *copaifera officinalis*. It is at first colourless, but becomes yellow by time, without losing its transparency. The smell is fragrant ; the taste aromatic, bitter, and somewhat sharp, and permanent on the tongue.

By distillation in water we separate the oil from the resin ; and, in the former, the taste and smell of the balsam are concentrated. About half of the balsam rises, and is condensed in the receiver, in the form of oil.

Balsam Capaibæ unites with fixed and volatile oils, and with alcohol.

It is frequently adulterated with spirit of turpentine. The fraud is not easy of detection, as the bal-



sam itself contains this oil ; but the mixed balsam is thin, has more of the turpentine smell, and appears to envelope the peculiar smell of the pure balsam. When compared, therefore, with the genuine, the difference may be detected. The turpentine can scarcely be disguised if a little of the suspected balsam be rubbed in the palm of the hand. The turpentine is also thicker, and less yellow than the copaibæ. Another mode of adulteration is to distil a portion of the oil of copaibæ, with cheaper essential oils. This fraud can scarcely be detected. The balsam is weaker, and may be compared with the genuine. It will require a longer time, and more alcohol, for its solution than the pure.

### PERUVIAN BALSAM.

This is obtained from Peru, and procured from a tree, the *myroxylon peruiferum*. The native balsam which naturally exudes is white ; but this we never meet with. The inspissated balsam forms the white storax. This, however, is usually of a reddish colour. What is usually sold is the black or dark red balsam, which is a decoction of the branches inspissated. It does not mix with water, but imparts to it an aromatic smell. It is soluble in alcohol, but fixed oils take up the essential oil, and leave the resin.—Baume speaks of one adulteration of this balsam ; namely, with the second oil which rises from benzoin digested on poplar buds. By attention to its solubility in alcohol, and decomposition by fixed oils, the genuine balsam may be known from the spurious.



## BALSAM OF MECCA.

This is said to be the same as the balm of Gilead. The plant or tree which furnishes this balsam grows between Medina and Mecca, and according to Alpinus is brought to the green houses in the neighborhood of Cairo. This balsam, as well as the plant, which furnishes it is held sacred like the mistletoe of the Druids, which should only be cut with a golden sickle. Some branches yield only three or four drops in a day, and the most fertile ones only from thirty to sixty drops. The branches are burnt in the temples.

This balsam consists of a very fragrant ethereal oil combined with resin; the former may be separated from the latter by distillation. It is dissolved in alcohol only by heat, and the addition of water causes a milkiness, and a separation of the oil and resin. It unites with volatile oils.

According to Hasselquist (*Travels*,) it is adulterated with the Cyprian turpentine, the oil of sesamum, the fat of the ostrich, &c. The fine turpentine, which exudes from the ruptured vesicles of the *pinus balsamea*, is often substituted for this balsam. Although the Mecca balsam, and the balm of Gilead have been greatly extolled by the ancient physicians, who believed they possessed the powers of that empirical nostrum, the *elixir vitae*, which was supposed to give new life to embodied man, yet Quarin in his *Animadversiones Practicae* has informed us, that even the best of the Mecca balsam is scarcely, if at all, superior to boiled turpentine!



## SOAP.

Soap, a combination of fatty matter with caustic soda or potash, is frequently found adulterated.\*— Soap should be completely soluble in soft water, without leaving a residue. In London it is the practice to adulterate white soap with a very fine white clay, brought from St. Stephens, in Cornwall; a fraud which is easily detected by dissolving the soap in water, and observing the insoluble part.

Brown soap, which is the white hard soap colour-

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\* Without noticing the effect of elain and stearin, or of oleic and margaric acid, produced in saponification, in the constitution of soap, we may remark, that soaps are combinations of oil or fat with particular basis. Thus we have soft soap, made by fatty matter with caustic lie sufficiently strong to bear an egg; hard soap, by combining fat or oil with caustic soda; earthy soaps by adding earthy salts to a solution of soap in water, which are insoluble; and metallic soaps, by adding metallic salts to soap in the same manner. When caustic potash is used, the soap is soft; but when custic soda, it is hard: if, however, we add to the soft soap a due quantity of muriate of soda, it will be converted into hard soap, or soap of soda, a process used by our soap boilers. The muriatic acid unites with the potash of the soft soap, and forms muriate of potash, which remains in solution, and constitutes the *waste lie*; at the same time the soda, of the common salt, combines with the oil or fat and forms a new compound, which becomes hard, and is the same which is formed by the *direct* union of oil or fat with caustic soda.

If kelp, barilla, or natron, which contain the same alkali, (soda,) can be had cheap, there is more economy, and certainly more expedition in using it; as in Europe, up the Mediterranean, &c. it is chiefly employed. In the preparation of hard soap, from the soda of commerce, which is pounded and mixed



loured by rosin, may be adulterated in like manner with brown ochre, or other foreign substance.

Soft soap or soap of potash is a semi-fluid soap, prepared by boiling sundry fatty substances in caustic lie. When the *saturation* of the lie with fat is effected, the compound acquires a certain degree of consistency, and the *true* soft soap is formed, which is *then* mixed with a variable quantity of water.— This addition is by no means adventitious.

In order to make the soap bear a larger quantity of water, it is frequently combined with hard soap; or, in fact, rosin alone is often added in the boiling of the soft soap. Rosin, however, makes soap more detergent.

Any foreign ingredient in soap, such as earthy

in a wooden vessel with about a fifth part of its weight of lime, the *liviums* are made of different strengths: thus, the specific gravity of the *first lie* should be about 1.200. The quantity of oil made use of is about six times the weight of the soda. Olive oil makes the best soap; next to which is tallow. A great variety of oils may be employed. Whale oil has been long in use by the Dutch for the manufacture of soft soap. Hard soap varies very much in its proportion of water; fifty *per cent.* has even been detected, and thus the purchaser pays half of his money for water!

On the supposition that soap is a combination of the oleic and margaric acids, and admitting no adulteration, the composition of hard soap is stated as follows:

1 atom margaritic and oleic acids,	- - - - -	64.49
1 atom soda,	- - - - -	7.57
28 atoms water,	- - - - -	27.94

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100.00



matter, may be known by dissolving it in water.— Pure white soap should be wholly soluble in alcohol, and should consist of nothing more than tallow and soda. Alcohol digested on brown soap, as it is formed of a given quantity of rosin with the tallow and alkali, (which combination is soluble in alcohol,) should take up the whole of the soap. In hard soap the whole of the superfluous lie is totally extracted before finishing; but in soft soap, all the lie used is retained. It is supposed, as we remarked in a preceding note, in consequence of the combination of oleic and margaratic acids with bases, especially the former, in producing analagous compounds, and the existence of *stearin* and *elain* in fixed oils and tallow, which become changed into these two acids in the process of *saponification*, that soaps are nothing more than the combination of these acids with salifiable basis.

Very fine white soap is made of olive oil and soda. When this soap is impregnated with sundry essential oils, it constitutes the perfumed soaps. Windsor soap should be nothing more than pure white soap, of the first quality, scented with the oil of caraway seed. It is frequently adulterated with starch to give it a better appearance, and feel softer to the skin. This admixture may be detected by dissolving the soap in alcohol.

It is well known, that in consequence of the presence of earthy salts in sea water, soap cannot be used for washing with that water. In this respect sea water resembles the action of hard water, but in a



greater degree : See page 7. This effect may be prevented, in a considerable degree, by adding previously some potash, or soda, which will decompose the earthy salts, and thus prevent their action on soap. Advantage is taken of this fact by seamen; but the Chinese, although possessing no chemical science, in the true acceptation of the term, know the effect of sea water on soap, and are acquainted with the circumstance of its decomposition by salt water, and the use of alkali in preventing it. They, therefore, prepare a soap expressly for washing in sea water, some of which we have seen, and examined; it merely consists of an *extra* quantity of alkali, more than is actually required in forming the soap, so that while the extra portion decomposes the earthy salts, the soap itself suffers no change.

Soap has been used for other purposes besides washing, or rather soap of a particular make. Pliny informs us that the German soap, with which the Germans coloured their heads red, was imported to Rome for the use of the fashionable Roman ladies. Beckman observes "there is no doubt that the *pilæ mattiacæ*, which Martial recommends as a preventive of gray hair; the *caustica spuma*, with which the German's dyed their hair; and the Batavian froth or lather, which the Romans employed for colouring theirs, were German soap. It is probable that the Germans tinged it with those plants which were sent to Rome for dying hair; and according to the modern manner of speaking, it was more properly a kind of pomade than soap."



Before the invention of soap for washing, the ancients used the gall of animals, the sap of many plants, and plants of a saponaceous nature. Clothes were frequently cleaned by being rubbed and stamped upon in water, without the addition of any substance. Homer remarks, that Nausicaæ and her attendants washed their clothes in this manner in pits. At later periods ashes and a lie of ashes were employed for washing; and although the method of strengthening lie (depriving the alkali of carbonic acid,) by means of unslacked lime was known in the time of Paulus Ægineta, yet the Romans were unacquainted with potash, or the art of making it.

But an alkali, which nature presents in abundance in some parts of the world, we mean soda, or mineral alkali, was long known and used in washing.—This was the *nitrum* of the ancients, or as the people of Attica pronounced it, *litrum*. The lake Ascanius, mentioned by Aristotle and Pliny, in consequence of containing an alkaline liquor, was used by scourers for washing clothes; a fact also mentioned by Strabo of a water in Armenia. The same alkali occurs in Scripture under the name of *borith*, and was used for washing by the Hebrews.

The ancients made *ointments* of soda and oil, but not soap, which appears rather remarkable. In short, many substances were used for washing; even stale urine was collected for the purpose. Fuller's earth was also employed, of which nature was the *cretæ fulloniæ* of Pliny, and other earths, as the *terra cimolia*, &c. used for scouring and washing.



The action of soap in removing grease, dirt, &c. is well known; but if the object be to separate grease alone, as in the scouring of wool, woollen cloth, &c. it is not an uncommon practice to use potash, which combines with the oil or grease into a soap, and thus the grease is readily removed by water. A soap for the removal of grease spots or stains from linen, cambrics, &c. has been sold in small cakes; it is nothing more than the soap of soda containing a little excess of soda.

The liquid shaving soap, a few drops of which will form a lather with water, is merely a solution of soap in alcohol.

A liquid green and black soap is made in Picardy and Holland, by boiling the lixivium of soda, potash, or wood ashes, with the marc of the oil of olives, of nuts, or of mape; or with fat, or fish oil, &c. Marbled, or variegated soap, such for instance as washballs, is prepared by adding sundry substances in due proportions, as a solution of sulphate of copper, and sulphate of iron, which are decomposed by the alkali, and the oxydes of copper and iron are precipitated; which give a marbled appearance. Vermillion, infusion of cochineal, &c. are also used to communicate colour.

### POTASH, PEARL ASH AND BARILLA.

The adulteration of *potash*, *pearl ash* and *barilla*, articles of importance to the bleacher, dyer, glass-maker and soap boiler, is carried to a great extent, and



few objects of commerce are found more frequently sophisticated.

Potash and soda are compound bodies, having a metallic basis, called respectively potassium and sodium, united with oxygen; they are, therefore, metallic oxydes. When wood is burnt to ashes, the ashes lixivated with water, and the solution filtered, and evaporated to dryness potash will be obtained. It is not, however, in a state of purity; but when heated to redness in a reverberatory furnace, many of its impurities are burnt off; it becomes much whiter, assumes some degree of lustre, and is then the pearl ash of commerce. It still contains foreign matter, as some salts, and a large proportion of carbonic acid, from which it is separated when used by the soap boiler by means of quicklime. It is then caustic potash, and in its solid state is often used by surgeons under the name of *potential cautery*. When potash is submitted to the action of a galvanic battery, placed upon a disc of platinum attached to the negative end of the battery, and a wire from the positive extremity is made to touch the upper surface, globules of potassium will appear at the side in contact with the platinum disc, and oxygen gas will be liberated at the extremity of the positive wire. This discovery was made by Sir H. Davy in 1807. Gay Lussac and Thenard have since discovered, that potassium may be obtained, and in greater quantities, by passing potash through iron turnings heated to whiteness in a gun barrel. It will be sufficient at this time to add, that according to the result of differ-



ent experiments, potash is a compound of 100 potassium and 20 of oxygen, and that another compound containing more oxygen has been discovered, which is called the per oxyde of potassium. Another compound, containing less oxygen than potash, has also been pointed out.

Soda or the fossil or mineral alkali is found native in combination with carbonic acid, in different parts of the earth, particularly in Egypt; and is found abundantly in combination with muriatic acid, in the state of rock salt, sea salt, sal gem, &c. Various marine plants, especially different species of the *salsola* particularly the *salsola soda*, when burnt, and the ashes lixivated, usually furnish the soda of commerce. A plant called *barilla* in Spain, also produces it; hence it is likewise named barilla. The algæ, especially the fuci, furnish some quantities of soda. The ashes of these plants are known by the name of *kelp*; in France they are called *varec*. Soda has been obtained in considerable quantity from common salt, and Glauber's salt. Soda may be decomposed in the manner already mentioned from potash, and the basis obtained in a separate state. It is composed of 100 sodium, and 33.3 of oxygen. In one respect both sodium and potassium agree; viz. when they are brought respectively in contact with water they decompose it, and are changed into soda and potash; and when heated in oxygen gas, they burn with great splendour, and unite with a maximum of oxygen, forming the per oxydes of sodium and potassium. Sodium also, like potassium, when



exposed to the air, is speedily converted on its surface into soda. In short, its affinity for oxygen is similar to that of potassium.

The soda of commerce, we may remark, is very impure: it contains carbonic acid, common salt, and other foreign substances; it may be purified in the same manner as potash.

Potash or soda, obtained by means of alcohol, is a combination of potash or soda and water, or a hydrate of the alkali. These alkalies, it is known, are obtained in a pure state by depriving them of carbonic acid, and dissolving the dry caustic alkali in alcohol, and driving off the alcohol by heat. Pure potash was obtained by Sir H. Davy by exposing peroxide of potassium to heat; and pure soda, by burning sodium in a quantity of air just sufficient to convert it into soda.

As potash, pearlash and barilla are only valuable to the manufacturer in proportion to the real alkali they contain, this fact may be learnt by the quantity of acid they will saturate, which must depend on the quantity of free or absolute alkali. An instrument was invented for this purpose called an *alkilimeter*, founded on the principle above stated. The first instrument of the kind was that of M. Descroizilles, and the acid made use of was the diluted sulphuric.

The method recommended by Mr. Kirwan, and described in the *Transactions* of the Royal Irish Academy for 1789, was predicated on the quantity of alum decomposed by the alkali under examination. The principle is the same. The only merit that Des-



croizilles or Dr. Ure can claim, is improving on the principle and method of Mr. Kirwan; but Dr. Ure has certainly very greatly improved the alkilimeter, and made it a general and useful instrument,—the conclusion by which, instead of being arbitrary as in the French instrument, is now uniform and satisfactory. You will find the instrument described, and the mode of using it, in Henry, vol. ii. p. 381, to which I refer you.\*

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\* As the alkalimeter is of great utility, it may not be improper, nevertheless, to notice briefly its construction and application.

A tube nine inches and a half long, and three fourths of an inch internal diameter, having a lip, and holding 1000 grains of water, or a little more, is accurately graduated into 100 equal parts, which are subdivided in ten parts each, but the latter are sometimes dispensed with. These graduations are made by pouring in successive portions of water of 100 grains each.—The 1000 grains is marked 0; the tenth below this 10 and so on. The test acid is made by diluting one part of sulphuric acid of commerce of sp. gr. 1.849 with four parts of water. It is necessary to be provided with Dr. Wallaston's scale of equivalents; for, when an alkali is to be examined, we must find how many grains of sulphuric acid are required to neutralize 100 grains of the alkaline ingredient. For example pearl ash: we find 100 grains of subcarbonate of potash are equivalent to 71 grains of concentrated sulphuric acid, and 355 grains of the diluted acid, equivalent thereto, are put into the tube. Then fill the tube to 0 with water. Now the 100 measures contain a quantity of acid equivalent to 100 grains of subcarbonate of potash; each measure, therefore, in the tube is sufficient for the neutralization of one grain of the subcarbonate. Dissolve 200 grains of the potash in 2 oz. measures of distilled water, and filter the solution, and wash the filter with 2 oz. more of water, and mix the two together. Divide the solution in two equal parts. To one portion add the diluted acid very gradually, so as to attain the



If a given quantity of alkali be dissolved in water, and saturated with nitric acid, the presence of sulphuric and muriatic acid may be shown by using respectively nitrate of barytes and nitrate of silver.

As the earthy and metallic sulphates and muriates are incompatible with uncombined alkali, i. e. they cannot exist together in the same solution, we need not apprehend the presence of salts of that description.\* The alkalies, however, are combined with more or less carbonic acid; the amount of which

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\* We speak of the *solution* of the alkali. If these salts are mixed with *dry* alkali, no change will take place; but if the alkali should contain them as adulterations, the moment it is dissolved in water, decomposition will ensue.

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point of neutralization, which is known by the liquor having no effect on litmus paper and turmeric paper. The number on the test tube, at the level of the acid remaining in it, shows at once, without calculation, the quantity *per cent.* of subcarbonate of potash contained in the pearl ash, which is usually 80 per cent.

The process is the same for barilla, kelp, or any variety of the mineral alkali, except 93 of sulphuric acid are equivalent to 100 of subcarbonate of soda; and, according to Henry, we must take 93.5—465 grains, of sulphuric acid of density 1.141. We may mark on the tube, to spare trouble on any future occasion, at 355 grains *Equiv. of Subc. Pot.*; at 465 *Equiv. of Subc. of Soda*; at 520 *Equiv. pure Pot.* and at 783 grains *Equiv. pure Soda*. With regard to the further use of Wallaston's scale—for example with subcarbonate of potash in any sample of potash, it is to find its equivalent quantity of pure or caustic potash.—Thus, if the pearl ash contains 80 *per cent.* of subcarbonate, bring that number to subcarbonate of potash on the scale, and its equivalent in pure potash will be seen to be 85. The same instrument may be used to determine the strength of any acid whose equivalent is known, by reversing the foregoing process. It becomes then an acidimeter.



may be ascertained by noting the loss sustained after the effervescence ceases on the addition of acid, deducting from that loss the weight of acid made use of. But the principal point is to know the quantity of absolute alkali in the alkalies of commerce; and this, we remarked, depends on the quantity of alkali required to saturate a given portion of acid, and is more generally performed by the alkilimeter.

### MANGANESE.

This is another substance, frequently impure, or adulterated. It is important to the bleacher and glass maker; to the former, in preparing his bleaching liquor, and to the latter in rendering glass colourless.

The best manganese is of a velvet black colour, and when exposed to the action of heat, should furnish an abundance of *pure* oxygen gas.

Oxyde of manganese, before the blow pipe, gives with microcosmic salt in the *exterior* flame a fine amethyst colour, which disappears in the *interior* flame. With borax it gives a yellow hyacinth red glass. If, in consequence of the presence of iron, it does not give the requisite colour, the addition of nitre will form a glass of a dark violet while hot, and reddish violet when cold.

Chalk appears to be the principal admixture with manganese, which occurs with it in nature, and more frequently fraudulently added. The injurious effect of the presence of carbonate of lime, must be obvi-



ous when we consider the formation of chlorine by the admixture of muriate of soda, oxyde of manganese and diluted sulphuric acid; viz. that besides chlorine, we would have carbonic acid gas.

The detection of carbonate of lime is effected by first pouring nitric acid, diluted with eight or ten times its weight of water, on the suspected manganese. If an effervescence ensue, and the acid is afterwards affected by oxalate of ammonia, carbonate of lime is proved; the quantity of which may be known by adding to the solution carbonate of potash; and collecting, washing, and drying the precipitate, and then weighing it.

Some of the ores of iron may be found with manganese; and, in short, the two metals, may occur, as they frequently do, in the poorer brown pæmetetic and bog iron ores. The separation of the metals from each other, so as to ascertain the proportion of each, may be effected, according to Klaproth, by means of nitric acid with the addition of sugar, which will only act upon the manganese.

There are several processes that have been used for the same purpose. Thus, if the iron be in such a state of oxydizement as to be soluble in muriatic acid, a portion may be accordingly dissolved; and, after diluting the solution largely, adding a solution of crystallized carbonate of potash, (bicarbonate,) which will precipitate the iron in the state of a coloured oxyde, or rather carbonate, while the manganese in consequence of the excess of carbonic acid, will remain suspended.



When the *gray radiated ore of manganese*, in fine powder, is digested in muriatic acid, it is entirely dissolved, with the exception of about 3 to 4 *per cent.* of silica. The solution, containing manganese and a portion of iron, when mixed with ammonia will be decomposed; an oxyde of iron will be precipitated, and the manganese remain in solution. The oxyde of iron, if ignited with a little wax, will be reduced to the state of protoxyde. If the solution be evaporated to dryness, and the mass moistened with nitric acid, and then exposed to heat, the per oxyde of manganese will be obtained. By this process the real quantity of the per oxyde of manganese in a specimen of the ore may be ascertained.

Chlorine gas should be abundantly formed by the affusion of muriatic acid on oxyde of manganese; by which hydro-chloric (muriatic) acid is deprived of its hydrogen by the oxygen of the oxyde, water and chlorine being produced.

The *black wadd* of Derbyshire, is an ore of manganese, but very remarkable for its spontaneous combustion with oils.

## SULPHUR.

Brimstone, which comes to us in rolls, contains a variety of foreign substances, some added intentionally. Sometimes flour, gypsum, &c. are mixed with it, previously to its being formed into rolls, or sticks. The purest kind is the flour of sulphur, which is made from the common kind by sublimation. Mas-



sive sulphur is chiefly brought from Sicily. It occurs native, and is found associated with sulphate of lime, sulphate of strontian, and carbonate of lime. The crude sulphur is chiefly obtained from certain metallic sulphurets, as sulphuret of copper, by roasting them, and collecting the sulphur in a proper chamber, where it is gradually deposited; it is then melted, and cast into sticks or rolls.

In the preparation of gun powder, it is necessary that the sulphur should be pure. Any foreign substance, it is obvious, will injure the effective force of the powder, which we shall notice hereafter. In France, two methods are used for purifying sulphur for gun powder: the first consists in melting it in a large kettle, and suffering it to remain in a fluid state with a gentle heat, by which the greater part of the impurities, being heavier than the sulphur, gradually settle; the extraneous matter, which may float on the surface, is removed, and the fluid part separated without disturbing the sediment. This, however, at best is but an imperfect purification. But the second method consists in sublimation, and, therefore, is preferable. The vapour of the sulphur is received in large chambers, where it condenses. The residue, after sublimation, is *sulphur vivum*, composed of a portion of sulphur combined with the impurities, as the earths, &c.

The purity of sulphur may be ascertained by heating it gradually upon a piece of platinum leaf, or by distillation in a glass retort; if any thing remain fixed, it is an impurity; the quantity of which in the



sulphur may be learnt by weighing it before, and weighing the residue after the experiment. It should be perfectly soluble in boiling oil of turpentine.

Potash will act upon, and dissolve sulphur; hence sulphur should be totally dissolved by boiling it with a solution of pure potash. Any residue indicates foreign matter; the nature of which, if necessary, may be learnt by experiment.

Impure sulphur, when consumed by burning, leaves generally a residue of oxyde of iron, and silica.

The mode of ascertaining, with great accuracy, the proportion of sulphur in some compounds, as in gun powder, is by using chlorine. In gun powder, for instance, we first separate, and ascertain the quantity of nitre; then subject the residue, consisting of charcoal and sulphur, to the action of chlorine gas; and the chloride of sulphur, thus formed, is volatilized by heat, leaving the charcoal.

If any foreign substance be suspected in the *flower of sulphur*, it may be proved by the reagents already mentioned; but there is one substance usually met with in sublimed sulphur, viz. sulphureous acid. It may be recognised by the acid taste of the sulphur, and its effect on vegetable colours. Washed flower of sulphur should never contain it.

### MILK OF SULPHUR.

The milk of sulphur and the precipitated sulphur of the pharmacopeas, is liable to contain foreign substances.



It is prepared by precipitating the sulphur from the sulphuret of potash, or other alkaline sulphuret, by an acid, in consequence of which a compound of acid and alkali is found, which should be thoroughly washed off. If the acid employed as the precipitant is the muriatic, its presence may be known by washing the milk of sulphur in water, and adding to the *washings*, after filtration, nitrate of silver.

Milk of sulphur is a hydrate of sulphur, or a combination of sulphur and water. If exposed to heat, it will be deprived of its *whiteness*, and water will be given out; the sulphur will then assume its original colour.

Water dropped into melted sulphur, will give that portion with which it comes in contact, the white colour of the milk of sulphur; and sulphur sublimed in a vessel containing the vapour of water, will be converted into the same substance. The whiteness of sulphur, therefore, indicates the presence of water; and the natural colour of sulphur is greenish yellow.

### PLUMBAGO.

Plumbago, black lead, graphite, or carburet of iron, is a mineral composed of about 90 to 95 *per cent.* of carbon with the remainder in the *per cent.* of iron. Although anthracite approaches it in its composition, being usually pure carbon with a smaller proportion of iron, they are sufficiently characterised and distinguished by their physical properties.—Black lead soils the hands, and gives the well known



mark on paper. But there is another mineral which resembles, and has been taken for graphite ; this mineral is known by the name of sulphuret of molybdenum, and is not so abundant as the black lead.—The mark of the two on porcelain; the agency of sulphuric acid, &c. will point out the difference between them.

Plumbago is infusible and burns with great difficulty.

In consequence of the action of muriatic acid on the iron and clay, which often contaminate plumbago, Messrs. Berthollet and Scheele availed themselves of this method of purifying it. The liquor being decanted after digestion upon the plumbago, the residue is then washed, and submitted to distillation to separate the sulphur. Ten parts of nitrate of potash, and one part of plumbago, projected into an ignited crucible, will deflagrate, and leave carbonate of potash, and a small portion of oxyde of iron in the crucible. These proportions were adopted by Chaptal.

Besides the use of plumbago for the making of pencils, which should in fact be nothing more than plumbago sawed into pieces, and in the manufacture of inferior pencils by kneading it with mucilage, or fusing it with sulphur, a fraud easily discovered by the assistance of fire, which burns the sulphur, or by means of water which dissolves the mucilage; it is also employed to lubricate certain instruments, polish or glaze shot, for razor strops, for the fabrication of crucibles, lute for retorts when mixed with clay



and cow's dung, and to defend iron from rust. In 1699, Homberg communicated a process for preserving iron from rust, which has been found extremely useful. It consists in making a mixture of 8 lbs. of hog's lard, by melting it with a little water, with four ounces of camphor, and after removing the mixture from the fire, adding, while yet hot, a small quantity of plumbago, to give it a leaden colour.—The utensils must be heated to such a degree, that the hand can scarcely be applied to them.

In this state the composition must be rubbed on, and afterwards wiped when the piece is dry.

As plumbago which is used to defend iron from rust, and for other purposes, is always sold in a ground state, it should be entirely free of any adulteration. If it contain lamp black, the mere exposure to heat will burn it off. It is sometimes, however, necessary to identify, as well as judge of the purity of black lead. This may be effected by projecting it on red hot nitrate of potash, in a crucible, which will produce a detonation in consequence of the carbon; then dissolving the decomposed nitre, and collecting the oxyde of iron, and ascertaining its weight. It should not exceed 10 *per cent*. We may also remark, that the quantity of carbon in the graphite may be known, since 12.709 of carbon are required to alkalize 100 of nitre.



## INDELIBLE INK.

Genuine durable marking ink should be compound of a solution of nitrate of silver, and carbonate of soda or of potash. The preparation, as sold in the shops, is in two phials; the smallest contains the nitrate of silver, and the largest the carbonate of potash, which is usually coloured red by vermilion.

If a portion of muriatic acid, or a solution of muriate of soda, be added to a small portion of the liquid in the small phial, it ought to give a copious white precipitate of muriate of silver. This precipitate should be soluble in liquid ammonia. Muriatic or any of the acids, poured on the red powder ought to effervesce. When dissolved in water, and tartaric acid added, a precipitation of the bitartrate of potash should ensue, if it be the carbonate of potash, and the solution should give the usual indications of alkali, as reproducing the colour of reddened litmus paper, changing turmeric paper to a brown, &c. The vermilion, after the solution of the alkali, on account of its weight, will settle to the bottom.

The effect of durable ink is obvious: when the stuff to be marked is washed in the alkaline solution, and dried, and the nitrate of silver applied in the usual manner, a double decomposition takes place; the nitric acid of the nitrate unites with the potash, forming nitrate of potash, whilst the carbonic acid of the carbonate combines with the oxyde of silver. After a short time, especially by exposure to the sun, the carbonate of silver is decomposed, in consequence



of the deoxydizing rays; and the silver, thus partially reduced, remains permanently combined with the fibres of the stuff.\*

Durable ink is a better marking material than either the Cashaw nut, or printer's ink, both of which have been used for the same purpose. It resists more effectually the action of soap, and seems to acquire more durability by exposure to the light, a circumstance which cannot be said of other preparations. Some other metallic salts have been recommended for a similar purpose; but the preparation of silver appears to be the most perfect. I have found that deoxydized indigo, such as is prepared in the bath for dying, when judiciously applied to stuffs, communicates a pretty permanent mark.

The mark occasioned by deoxydized indigo, it is to be observed, is not to be confounded with the blue mark, also made of indigo, frequently found on Irish linens. The latter is calculated to wash out; and consists, therefore, of nothing more than indigo mixed with gum or mucilage.

In the recipe for the preparation of durable ink by the late professor Woodhouse, there is a portion of tincture of galls; but the effect of the galls is calculated to make the ink *less* durable, which has been found by experience. The Doctor supposed, that

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\* The effect of nitrate of silver in the silvering of ivory, is well known. A piece of ivory immersed in a strong solution of nitrate of silver, and exposed to the sun's rays will become black, and, if rubbed, the silver will make its appearance. This effect is decidedly owing to the deoxydizing power of the solar rays. The same principle has been applied to various ornamental purposes.



the gallic acid by combining with the silver, would produce a more durable compound, the gallate of silver. As it is known that the durability of this ink depends on the intimate union of the silver with the vegetable fibre, all additions of this kind must be injurious.

With respect to the proportion of nitrate of silver and carbonate of potash, we may observe, that no given proportions are absolutely necessary. The stuff, or part to be marked, should be first soaked in the alkaline liquor, which may be made by dissolving half an ounce of carbonate of potash in four or six ounces of water; and when dry and smoothed, the solution of the nitrate of silver in water, made to saturation, is to be applied by a pen.

Accum, (*Chem. Amus.* p. 215,) givest he following proportions: two drachms of fused nitrate of silver, dissolved in six drachms of water, and thickened with two drachms of mucilage. For the mordant or alkaline liquor, dissolve half an ounce of carbonate of soda, (carbonate of potash, however, is generally used,) in four ounces of water, and mix the solution with half an ounce, by measure, of thick mucilage of gum arabic. There is one advantage in using the carbonate of soda; namely, that when put upon the stuff to dry, it will not deliquise or remain moist.

### CORAL.

There are several kinds of coral known by its colour. Thus the white coral, called *officinarum* oc-



*ulatum*, the black coral, *pseudo corallium nigrum*, and the red coral, or *corallium rubrum*. Coral, according to the ancient naturalists, was considered a vegetating stone, and Dioscorides, Pliny, Cæsalpinus, and Tournefort, a plant, which it greatly resembles. It is known, however, to belong to the zoophytes, and is the work and habitation of a polypus. The internal parts are very hard, but the external covering is soft, and the extremity is still softer. It hardens by age. The surface is mamillated, and each mamilla is the residence of an animal. By calcination it is found to consist of many concentric laminæ. Several of the tribe of zoophytes have been chemically examined by Merat-Guillet, in which he found animal matter of the nature of coagulated albumen, sometimes being almost liquid, but generally of the consistence of cartilage, and carbonate and phosphate of lime. With respect to the white and red coral, and articulated coralline, he found them to consist of nearly equal parts of carbonate of lime and animal matter.

Red coral or *gorgonia nobilis* in natural history, of which we shall speak at present, is soluble in nitric acid with effervescence, its colouring matter is destroyed, and the calcareous part is dissolved. There remains a tubulated membrane of a yellow colour, containing a gelatinous substance. Red coral consists of an internal stem, composed of gelatinous matter and carbonate of lime, and an external covering of membrane hardened by carbonate of lime.



The red coral has been chiefly used in medicine. It is found adhering to rocks and other bodies, particularly in the Indian and Mediterranean seas, and in the Persian gulph.

The common testacea coloured with dragon's blood are sold for it. The fraud may be discovered by shaking it in water; for the colouring matter being separated, the other becomes white, whilst red coral is still red. We speak of the prepared coral of the shops.

If necessary the sophisticated, a fictitious powder, may be examined by acids, and the different tests.

Certain dentrifice has been sold under the name of coral tooth powder; but it is of little moment, as it is added principally as a colouring ingredient. The colouring matter is usually bol armen.

## BEZOAR.

Concretions are sometimes found lodged in the stomach and intestines of animals, which have been named bezoars. Its name is derived from a Persian word, which signifies an *antidote*. There are various divisions of the bezoar: the true oriental, or the oriental bezoar stone from the East Indies, obtained from a species of goat in Persia. This stone, finely powdered, and made into balls, were called Gascoigne balls, from Gascoign their inventor. A sophisticated medicine without bezoar, is sold in Europe for this preparation. The accidental bezoar, brought from the West Indies, and South America, is found



in the stomach of an animal of the stag kind. The porcupine bezoar, or gall stone, is found in the gall bladder of an Indian porcupine. It is carried in the pocket as an amulet, and hired in Portugal at a shilling a day ! The bezoar simæ, or bezoar of the monkey, are stones found in the stomach of certain monkeys in Brazil and the East Indies. All the true bezoars, when rubbed, exhale a perfume ; and, when cut through, found to contain a nuclus, successively covered by laminæ of an ammoniacal magnesian phosphate, mixed with a coloured extractive vegetable matter, and certain fluids of a bilious kind. These give a green colour and the smell of musk. The oriental bezoars have been examined by Fourcroy. He considers them as an animal resin different from any other concretion. They are softened by heat, easily penetrated by a hot needle, exhaling an aromatic and musky odour ; they burn and inflame with a thick smoke, impart a colour to boiling water, and dissolve in alcohol, which they colour. They are dissolved by caustic alkalies, differing in this from vegetable resins.

Bezoars are frequently imitated. The false bezoars are prepared with powdered oyster shells made into small balls with gum water, and perfumed with ambergris. They may be known by their effervescing with acids, and, when cut, have no concentric laminæ. When broken, they do not present any crystalline stræ, and when rubbed on paper previously covered with chalk, do not leave an olive coloured mark. The Goa and Malacca stones are of this kind.



The boasted virtues of these bezoars, such as the power of destroying poisons and reanimating the vital powers, are altogether founded in error. They are indigestible in the stomachs of the animals in which they are found.

### AMBERGRIS.

This substance is found floating on the sea, near the coasts of India, Africa, and Brazil, usually in small pieces, but sometimes in large masses. Concerning its origin various opinions have been entertained; some supposed it was the concrete juice of a tree, others that it was a bitumen; but it is now ascertained to be a concretion, which is formed in the stomach or intestines of the spermaceti whale.

Pure ambergris resembles wax in its tenacity, softness, and easily yielding. Its taste is insipid, but it has an agreeable smell, which improves by keeping. It swims in alcohol. Its specific gravity varies from 0,849 to 0,844. It grows soft in a very gentle heat, and melts at 122 deg. It is volatilized completely in a white smoke, leaving only a trace of charcaol. It is soluble in alcohol, which takes up near 1-12th of its weight, but is insoluble in water. According to Newman, if the spirit is impregnated with a little essential oil, the ambergris will dissolve more readily in it. Acids have little action on it. Nitric acid dissolves it, evolving nitrous gas, carbonic acid, and azotic gas. A brownish liquid is formed, which leaves, when evaporated to dryness, a brown substance



resembling resin. It is soluble in alkalies, forming a soap which dissolves in water; also in fixed and volatile oils, and in æther.

Adipocire, a substance which resembles both fat and wax, has been obtained from ambergris. Its quantity amounts to 52.8 parts.

According to the analysis of Bouillon La Grange, ambergris is composed of 52. adipocire, 30.8 resin, 11.1 benzoic acid, 5.4 charcoal.

Besides the characters already mentioned, we may add, that ambergris is opaque, rugged, of a greyish ash colour, mingled with yellow and white or greenish spots. It adheres to the teeth, and when bitten affords but little smell, except it is heated and then it is very fragrant. When melted it produces no *froth*. It may be broken into scaly fragments, but cannot easily be powdered. The genuine is always speckled with green and white spots; the less it is variegated, the worse. The inferior kind approaches to a deep black. Its purity is usually ascertained by penetrating it with a hot needle, when its peculiar odour will be exhaled. It should possess, at the same time, the properties already noticed.

A counterfeit ambergris is often met with, compound of musk, civet, storax, labdanum, and aloes wood; and it is frequently adulterated with bullock's blood flavoured with musk and civet. The genuine, however, may be readily distinguished from the counterfeit, and the adulterated, by attending to the characters and properties already described.



## DRAGON'S BLOOD.

This is a resin of a red colour, obtained from the *calamus rotang*. When powdered, it is crimson. It readily melts, and takes fire. When assisted by heat, it is almost totally soluble in alcohol, to which it imparts a red colour. It is also soluble in expressed oils; but yielding little or nothing to water. These are the characters of *pure* dragon's blood. The Dutch often adulterate it with mixtures of gum arabic, Brazilwood, alum, &c. These are detected by means of water, which will dissolve them, and the water will become coloured.

Alum is known by the usual reagents; viz. muriate of barytes for the sulphuric acid, ammonia for the alumina, and muriate of platinum for the potash, as alum is a triple salt composed of sulphuric acid, alumina, and potash.

Dragon's blood, or the *sanguis draconis* of the shops, is often used in the adulteration of other articles. Thus vermilion has been adulterated with it; but it is easily discovered by alcohol, with which it forms a red tincture, whereas vermilion alone will communicate no colour. It is a component part of the styptic powder of the *Pharmacopæia*, and is used to give a red colour to certain varnishes.



## TIN PUTTY.\*

Tin putty is an oxyde of tin, formed by levigating the oxyde which is formed on tin when kept for some time in fusion, and is employed principally as a polishing powder. When the protomuriate of tin is precipitated by ammonia, it falls in the state of a hydrate of the protoxyde, which may be used as tin putty. If this oxyde should be adulterated with chalk, or white lead, it may be examined according to the rules already given. When exposed before the blow pipe, it should become yellow, then red, and when approaching to ignition black. If iron or lead be mixed with it, the colour will be dark brown. Upon charcoal, in the interior flame, it will become and continue white. If originally white, and free from water, it undergoes no change of colour by heating. It is very easily reduced on charcoal, which is facilitated by a drop of solution of potash.

The *powdered tin* of the pharmacopæia, formed by shaking melted tin in a wooden box rubbed with chalk in the inside, is used occasionally as a vermifuge; but according to Orfila, in consequence of its

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\*The salts of tin are more or less soluble in water, usually giving the solution brown or yellow tinge. Ferrocyanate of potash produces a white precipitate; hydrosulphuret of potash a brownish black with the proto salts, and a yellow precipitate with the per salts; corrosive sublimate a black precipitate with the proto salts, but a white precipitate with the per salts; muriate of gold gives a purple precipitate with the proto salts, but neither gallic acid, nor the infusion of galls, occasion any precipitate.



slight oxydizement, the metal is rendered poisonous.

### MOTHER-OF-PEARL.

Mother-of-pearl shells are composed of alternate layers of coagulated albumen and carbonate of lime, commencing with the epidermis and ending with the last formed membrane. True mother-of-pearl contains usually 66 *per cent.* of carbonate of lime, and 24 *per cent.* of membrane.

Mother-of-pearl when exposed to a red heat, exfoliates, blackens, emits a strong foetid odour, and finally becomes partly dark grey, and partly a fine white. With acids it effervesces at first strongly, but gradually more and more feebly. The lime is thus taken up, and thin membranous substances remain, which, according to Mr. Hatchett, have the property of coagulated albumen.

The Japanese make quadrille fish, and other articles with rice paste, which so nearly resemble those made of mother-of-pearl, that Americans and Europeans are often imposed upon. This imposition is readily detected by examining the mother-of-pearl by an acid; if it effervesces, it is genuine, and if not, we may judge it to be made of rice. When the fictitious pearl is exposed to heat, it will exhibit very different characters from the real pearl.



## PEARL.

This calcareous concretion is found in porcelaneous shells. It is of a globular form, of a bluish white colour, iridescent, and brilliant. The iridescence is attributed to its laminated structure. Its basis is carbonate of lime enveloped in membranes; and, in fact, is composed of concentric and alternate coats of the two substances. The chemical properties of pearl are similar to the mother-of-pearl, and its distinguishing character is its solubility in acids, accompanied with effervescence, a fact well authenticated in the earliest history.\*

Pearls have always been prized as an ornamental part of dress. In Pliny's time they were worn by the wives of the inferior public officers, in order that they might rise in the costliness of their dress to the ladies of the first rank!

The art of *forcing* shell fish to produce pearls was known in the first centuries of the Christian era, to the inhabitants of the red sea. To notice the *pearl*

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\* Cleopatra is said to have dissolved a pearl in vinegar.—Beckman, quoting Pliny and Macrobius as to the fact, is of opinion, that she must have employed stronger vinegar than that which we use at our tables, on account of their “natural enamel.” He is also of opinion that she broke and pounded the pearls before she put the vinegar on them, and, that she might be able to drink it, she diluted it with water. The solution could have been nothing more than acetate of lime. That pearls are soluble in vinegar is remarked by Pausanius and Vitruvius. Pliny says, that Claudius gave to each of his guests a pearl dissolved in vinegar to drink.



*fishery* of modern times would be irrelevant to our subject. Linnæus is supposed to have discovered the *secret* of producing pearls, a long account of which is given in Beckman's *History of Inventions*.

The manufacture of artificial pearls was not known when Pliny wrote, and is altogether modern. Sundry methods have been recommended for the imitation of the true pearl, most of them, however, have proved defective, and the deception is soon detected. The first imitation was with glass; a second by using an amalgam of tin; a third by employing wax, and covering it with a peculiar varnish, which were praised on account of their lustre; and the last, which succeeded much better, was the invention of a French bead maker, named Jaquin: He prepared glass pearls; but their brilliancy consisted in a certain animal substance he discovered, and is thus described by Beckman: "Jaquin once observed, at his estate near Passy, that when those fish called *ables* or *ablettes* were washed, the water was filled with fine silver coloured particles. He suffered this water, therefore, to stand for some time, and obtained from it a sediment, which had the lustre of the most beautiful pearls; and which, on that account, led him to the attempt of making pearls of it."

He called the soft shining powder the *essence of pearl*, and covered the inside of small yellow glass beads with it, mixing it first with a solution of isinglass.

The invention of these pearls, according to Reaumur, must have been in 1656. The imitation, it is



said, was so complete, that jewellers and pawnbrokers were deceived by them. The art is still practiced, and no doubt improved. Nothing can be more easy of detection than these imitative pearls, although they may resemble the real pearl in their physical characters, and deceive the best judges. A real pearl put into diluted nitric or muriatic acid will effervesce, and dissolve; but a glass pearl, treated in this manner, will not be acted upon. A pearl made of wax, and varnished, if put into a little *boiling* alcohol, will be entirely dissolved; a glass pearl, treated in the same manner, will be insoluble.

### CARBONATE OF MAGNESIA.

The carbonate of magnesia of the shops, more strictly a subcarbonate, is prepared by adding a solution of carbonate of potash to another of sulphate of magnesia, and washing off the sulphate of potash which is formed. Carbonate of magnesia, even dried at 212 deg. always retains a portion of water. It should be entirely free from sulphate of potash. This may be proved by boiling it in water, filtering the fluid, and adding to separate portions muriate of barytes, and tartaric acid. Magnesia is most liable to adulteration with chalk; and sometimes sulphate of lime is found in it, being derived from the water used for edulcorating it. Sulphuric acid forms with magnesia and lime two salts; one which is highly soluble, and the other almost insoluble. If, therefore, magnesia be digested in sulphuric acid, diluted with



6 or 8 times its weight of water, and be entirely taken up, and the solution remain transparent, it may be pronounced free from lime. In this experiment the lime, if it had existed, would have shown itself by a turbidness, and in a short time by a sediment of sulphate of lime. The presence of lime may be also shown, by making a solution of the magnesia in muriatic acid, and adding thereto a solution of bicarbonate of ammonia, which will throw down carbonate of lime, and leave the magnesian solution unaltered. By exposing this last to heat, carbonate of magnesia will subside.

### CALCINED MAGNESIA.

This is that preparation of magnesia, which is formed by exposing the common carbonate to the action of a red heat. The carbonate loses its water, as well as its carbonic acid. It may be examined by the same tests as for the carbonate. It ought not to effervesce with acids. It should be free from taste, and water digested on it, should not manifest the least properties of lime water, such as becoming turbid when carbonic acid gas is passed through it, which may be done very conveniently by the mouth with a glass tube, &c. If this effect takes place, the carbonate of magnesia employed for calcination evidently contained carbonate of lime, and quicklime consequently formed.

The solution of magnesia in muriatic acid, muriate of magnesia, ought to remain clear when oxalate of ammonia is added.



Henry's calcined magnesia, which is usually sold in boxes, in consequence of importation, is considerably expensive.

Like many other chemical and pharmaceutical preparations, which are imported, it has no preference over the American calcined magnesia, notwithstanding it is purchased as a superior article. It is time such prejudices, which have no existence in truth, were obliterated. Unless the calcined magnesia be preserved in *close phials*, it will absorb carbonic acid from the atmosphere, and become a carbonate.

Magnesia may be detected in compound bodies, if the proportion of alumina, if present, does not exceed the magnesia, and if they do not contain much metallic matter, by exposing them to the action of the blow pipe, previously adding a drop of a solution of cobalt; when strongly heated it will produce a faint reddish colour like flesh, which is scarcely visible by the light of a lamp. Magnesia also, like the other alkaline earths, is fusible in combination with the fluxes into a clear, colourless glass; but on adding a further quantity of the earth, the glass becomes opaque.

## FLOWERS OF ZINC.

The white oxyde of zinc, or flowers of zinc, is prepared by exposing zinc to a red heat. It takes fire, burns with a bright flame, and condenses into a white flocculent substance. This preparation was called *pompholix*, *nihil album* and *philosopher's wool*.



When made by the combustion of the metal, it is always gritty, owing to some particles of the metal.—For pharmaceutical use, it is best prepared by adding ammonia to a solution of sulphate of zinc, (white vitriol.)

Flowers of zinc are sometimes coloured by iron, contaminated by lead or arsenic, and adulterated with the carbonate and sulphate of lime. Solution in nitric acid, the excess of acid neutralised by ammonia, and the solution then mixed with tincture of galls, will detect the iron.

Chalk will occasion an effervescence on adding the acid; and if to a portion of the solution, we add oxalate of ammonia, the lime will be precipitated.

Gypsum is dissolved by boiling water, and the solution may be tested for sulphuric acid and lime.

White arsenic is recognised by digesting the oxyde in acetic acid, and adding a solution of sulphuretted hydrogen, which will occasion a yellow precipitate, (sulphuret of arsenic,) in which arsenic is proved by its garlic smell on hot coals. With the same reagent lead will produce a black precipitate; and should the precipitate also give a garlic smell, we may infer then both the presence of lead and arsenic.

### CALAMINE.

Calamine, or the impure carbonate of zinc of the pharmacopæias, occurs native. It is an ore of zinc, of which there are two distinct varieties; the one a



true carbonate of zinc, and the other a compound of oxyde of zinc and silica. The carbonate may be formed artificially by decomposing sulphate of zinc with carbonate of potash.

The *lapis calaminaris* of the apothecaries', is nothing more than the impure carbonate of zinc, i. e. the native carbonate, pulverised to an impalpable powder, and washed. It should neither contain grit, sand, nor any foreign admixture. The zinc may be separated from the calamine by digesting it in muriatic acid. The residue will indicate the silica. Then evaporate the muriate of zinc to dryness, and redissolve the mass in water. To the solution, thus formed, add caustic ammonia in excess, which will precipitate, and then redissolve the oxyde of zinc. If any iron should have been taken up by the muriatic acid, it will show itself in the form of oxyde. The quantity, at any time, scarcely exceeds 2 *per cent*. By supersaturating the ammoniacal solution with muriatic acid, and then adding carbonate of ammonia, carbonate of zinc will be precipitated, which, when dried and ignited, ought to weigh from 60 to 70 grains for every hundred of the calamine.

Zinc may be detected even in the automalite by the blow pipe. If a small portion of soda placed along with the ore or other mineral on charcoal, be exposed to the interior flame of the blow pipe, the metal will be reduced, and burn with its characteristic flame, and deposite its oxyde upon the charcoal.



## WHITE PRECIPITATE OF MERCURY.

The white oxyde of mercury, and the white precipitate of mercury of the Dispensatories, but more properly the submuriate of mercury-and-ammonia, is a white tasteless substance. It is formed by mixing together the solutions of the perchloride of mercury and muriate of ammonia, and decomposing the triple salt thus formed, the muriate of mercury-and-ammonia or *sal alembroth*, by subcarbonate of potash. The most probable adulteration of this substance is either white lead or chalk. The former may be discovered by digesting it in acetic acid, and adding aqueous sulphuretted hydrogen, which will produce the well known black precipitate, or by adding any of the other tests for lead. If chalk is present, there will be an effervescence, and the solution will indicate lime by the addition of oxalic acid.

Oxyde of mercury, before the blow pipe, becomes black, and is entirely volatilized.

## ETHIOP'S MINERAL.

Ethiop's mineral, or black sulphuret of mercury, is prepared by pouring mercury into melted sulphur, by which a combination is formed. The black sulphuret yields by sublimation the red sulphuret, vermillion, or cinnabar. In the black sulphuret, the union between the mercury and sulphur should be perfect. Neither globules of mercury should be discovered by a magnifier, nor should it communicate



a white stain to gold. By heat, it should be entirely volatilized. If the sulphur be first extracted by a solution of caustic potash, the residue when exposed to heat ought entirely to separate. The admixture of ivory black may be detected by its leaving a residue when sublimed, but the precise nature of which is to be learned by experiment.

The quantity of mercury may be determined by digesting the sulphuret in dilute nitric acid, which will take up the mercury; decomposing this solution by carbonate of potash; and collecting the precipitate, and boiling it for a minute or two in the alkaline liquor, and mixing it with charcoal powder, and distilling it. The mercury will rise, and be condensed.

### TURPETH MINERAL.

Turpeth mineral, called also the yellow oxyde of mercury, but more properly the subpersulphate of mercury, is a yellow powder occasionally used in medicine. When sulphuric acid is boiled on a certain quantity of mercury, as three of the former to one of the latter, a white mass is obtained, which is the perfect persulphate of mercury; and when we pour on this persulphate boiling water, it is separated into two distinct salts, the bipersulphate which remains in solution, and the subpersulphate which forms the insoluble yellow powder. The characteristic property of the purity of this preparation is, that when digested in distilled water, it should not communicate an



acid taste, neither should the water precipitate muriate of barytes. It should also be entirely evaporable.

There is another preparation called the *nitrous turpeth* that resembles turpeth mineral. It is formed by pouring on pernitrate of mercury a quantity of boiling water, which separates it into the superpernitrate of mercury and supernitrate. The latter, or nitrous turpeth may be known from the former in several different ways. If sulphuric acid be poured on it, and heat applied, it will give out nitrous acid vapour, and a persulphate of mercury will result. Both these turpeths, (but of the two the turpeth mineral is only sold in the shops,) may be adulterated with massicot, or yellow oxyde of lead. Its detection may be effected in the manner we have so frequently mentioned. Should yellow arsenic be suspected, its garlic smell on hot coals, &c. will determine its presence.

### RED PRECIPITATE PERSE.

The red oxyde of mercury, or precipitate perse, is the per oxyde of that metal, but made by exposing mercury in a proper matrass to the action of heat and air. It has an acrid and metallic taste, and is poisonous. It acquires a black colour when heated, but becomes again red on cooling. It is rarely found adulterated. Red lead may be discovered on heating it, for the mercurial oxyde is entirely volatilized upon a red hot iron.

This oxyde differs from that prepared with nitric



acid. The red precipitate of the shops, which is employed as an escharotic, contains invariably a portion of nitric acid, notwithstanding the heat used in its preparation.

When mercury or its protoxyde, is exposed to a heat of about 600 degrees, it combines with additional oxygen, and is converted into a per oxyde. When mercury itself is thus treated, its surface becomes gradually black, and then red; and at the expiration of several weeks, the whole is converted into small crystals. Although mercury is converted into the oxyde by nitric acid, yet that it "possesses exactly the properties of the oxyde" *perse*, as Dr. Thompson informs us, is altogether erroneous; for the oxyde by nitric acid retains a part of the acid. They both, however, are poisonous, and act as escharotics when applied to the skin.

The *red oxyde perse* contains

Mercury	100
Oxygen,	7.99

It contains twice as much oxygen as the protoxyde.



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## LECTURE V.

### RED PRECIPITATE.

The red oxyde of mercury by nitric acid, or red precipitate, called the *hydrargyri nitrico-oxydum* in the London Pharmacopæia, ought to possess a brilliant shining red appearance, with small spiculæ of a resplendent lustre. It is prepared by exposing nitrate of mercury to the action of heat. The acid is decomposed, and a substance remains consisting of per oxyde of mercury with a small portion of nitrate.

Nitric acid dissolves mercury either with or without heat, and the concentrated solution gradually deposits crystals, which are a proto-nitrate of mercury; but if hot water be poured upon them, the subproto-nitrate is separated. If the oxyde of mercury, however, be dissolved in nitric acid, and evaporated to dryness, a white crystalline mass, but deliquescent in the air, will be produced; this mass is the pernitate of mercury. Water also decomposes this salt, dissolving the supernitrate, leaving the subpernitrate in a brown powder. But, with respect to the red oxyde of mercury per nitric acid, we may observe, that all these salts and subsalts, if exposed to heat in a crucible will furnish the red oxyde.



Red precipitate should be of a bright shining red colour; indeed the shining appearance of its spiculæ, if such they may be considered, is a criterion of its purity. All red precipitate, although pure, does not however, present this character, at least in any degree. This is attributed to the mode of preparation. The common process is to dissolve the mercury to saturation in nitric acid in Florence flasks, and expose the flasks to heat in a sand bath; the nitrate will become solid, first white, then yellow, and lastly red, or red when cold. If the solution be made in a large vessel, and suffered to crystallize, and the crystals exposed to the action of heat in a crucible, the red precipitate will then have that shining appearance.

The only substance, with which red precipitate is liable to be adulterated, is red lead; the detection of which is readily performed by dissolving it in acetic acid, and adding to the solution the usual reagents for lead. Like the red oxyde of mercury *per se* it ought to be entirely volatilized by heat.

### MERCURIAL OINTMENT.

Mercurial ointment is a preparation of mercury, which is also liable to adulterations. It is prepared by triturating in a mortar a given quantity of crude mercury with hogs lard, adding the necessary quantity of suet to render it firm. In the blue ointment, as well as in the blue pill, the mercury is said to be in the state of black oxyde. The goodness of mercurial ointment depends on the minute division of the mercury in the fat; or, in the language of the



apothecary, the mercury should be completely *killed* or rubbed in. No globules, therefore, should be discovered either by the magnifier, or by rubbing it on paper. The addition of old ointment, or rancid fat, will promote the union of the mercury and fat more expeditiously.

Sundry powders as rhubarb, and oils, as spirit of turpentine, besides sulphur and some other substances, have been added to mercurial ointment for the same purpose. Turpentine may be recognised by its smell, especially when the ointment is heated, and sulphur communicates to it a *black* colour, but may be known by exposing the ointment to heat, or treating it with a solution of potash, and filtering the fluid, and then testing it for sulphur, or sulphureted hydrogen gas in the usual way.

Mercurial ointment, however well prepared, will impart its mercury to metals; hence copper, gold, &c. when rubbed with it, acquire a silver colour. When the ointment is melted, and suffered to remain undisturbed, the mercurial oxyde will gradually subside. Some consider mercurial ointment as nothing more than minutely divided mercury mixed with fat.

## MERCURY.

Mercury or quicksilver is a metal, which, although found native in comparatively small quantities, is obtained from the ore called native cinnabar, or red sulphuret of mercury. This ore is pulverised, mixed with lime or iron filings, and distilled. The mer-



cury passes over, and a residue consisting of sulphur and lime, or sulphur and iron, remains in the retort. Mercury is purified by distillation. *Pure* mercury should evaporate entirely, without leaving any residue. Hardly any metal is so liable to adulteration as mercury, in consequence of the property it possesses of dissolving and combining with some of the baser metals. The union of mercury with metals constitutes amalgams. Some of the baser metals are volatile, and hence they even rise with the mercury. This, however, is not the case with lead, bismuth, and tin; metals with which it is most frequently adulterated. The dull aspect of mercury generally indicates its impurity. Impure mercury becomes tarnished, and covered with a coat of oxyde, by long exposure to the atmosphere. It also adheres to the surface of glass; and, when shaken with water in a bottle, forms a black or dark grey powder, owing to the separation and gradual oxydization of the foreign metals. I have found even mercury of the purest kind, which is sold in the shops, when treated in this manner to produce a black or grey film, notwithstanding the same mercury had been passed through chamois leather. It may in a great degree, be purified by this means. Lead and tin seem to be the principal metals in the adulteration; and when some zinc or bismuth is used, the mercury is capable of taking up more. The solution of mercury in nitric acid may be examined. Thus, if to a portion of the solution we add aqueous sulphureted hydrogen, the presence of lead will be



shown by the well known blackish precipitate, which will detect lead even in so small a quantity as one part in 15263 of mercury. Sulphate of soda, added to another portion of the solution, will precipitate a sulphate of lead, which, when dry, will indicate 72 per cent of metal. If the nitric solution be prepared without heat, and the mercury should have contained bismuth, on the addition of water, there will a white precipitate. If tin be present, it may be determined by adding a weak solution of muriate of gold, which will produce with it a purple precipitate, the powder of Cassius.

There is another mode of proceeding in the examination of mercury. It consists in taking the oxyde formed by the water on the mercury, and digesting it in acetic acid, and testing the solution for lead, &c. as already stated. The evaporation of the mercury may be performed in a platinum, or silver spoon.

Native mercury usually contains a variable quantity of silver, and some traces of gold.

It is obvious, that owing to the impurity of mercury, its solution in acids must also be impure.—Hence, for the purpose of preparing chemical reagents, as well as other uses, for barometers, thermometers, &c. the mercury should be perfectly pure.

## CALOMEL AND CORROSIVE SUBLIMATE.

There are two very important preparations of mercury, which have been long known, and in use; we



mean, *calomel* and *corrosive sublimate*. These are both combinations of the same metal with the same acid, differing, however, in a very essential particular,—that of the degree of oxydizement of the metal.

According to the old nomenclature, calomel is a submuriate, and corrosive sublimate an oxymuriate of mercury. These names are, however, retained.

There are many processes for preparing the protochloride of mercury; but the most usual is to combine an additional quantity of mercury with the perchloride. Four parts of the perchloride of mercury, and three parts of running mercury, are to be triturated in a mortar, till the mercury ceases to appear, or is killed, as the apothecaries term it, and the whole is converted into a homogenous mass. This mass is put into subliming vessels, and exposed to the action of heat; the protochloride will sublime.

The protochloride of mercury is usually mixed with a little of the perchloride, from which it is removed by repeated sublimations, or washing it with water.

It may be prepared also in the humid way, according to Scheele's method, by mixing together the solutions of nitrate of mercury and muriate of soda. But, as there is also formed in this process a precipitate of subnitrate of mercury, Chenevix has shown, that, to prevent its formation, and consequently to obtain the protochloride free from subnitrate, it is necessary to mix the solution of common salt with some muriatic acid. According to Chenevix 100 parts contain 11.5 muriatic acid and 88.5 protoxyde.



The perchloride, or corrosive muriate of mercury may be prepared in several ways. We shall only notice two processes; namely, by using perntrate of mercury, and sulphate of mercury.

Mix equal parts of decipitated common salt, calcined sulphate of iron, and dry perntrate of mercury; introduce the mixture into a sublimer, and apply heat. The corrosive sublimate will rise, and attach itself to the upper part of the matrass. The residue will consist of sulphate of soda, &c.

The second process consists in mixing equal parts of persulphate of mercury and dry common salt, and subliming them in the same manner in a strong heat. The residue will be sulphate of soda. The same salt is formed by passing chlorine gas through a solution of nitrate of mercury, and evaporating the solution; the perchloride will crystallize. According to the analysis of Mr. Chenevix, 100 parts of the perchloride consists of 18 muriatic acid, and 82 peroxyde of mercury, on the supposition that it is a compound of muriatic acid and red oxyde of mercury; but if the proportions be corrected, so as to correspond with the real composition of the perchloride it will contain in the hundred parts, 24.07 of chlorine, and 75.93 of mercury.

It will be sufficient to remark, that calomel should be completely saturated with mercury, and contain no corrosive sublimate. Owing to the imperfect washing and levigation of calomel, it is apt to retain a portion of the corrosive muriate. This may be known by putting some of it in a phial with



lime water, and frequently shaking it, which will indicate corrosive sublimate by producing a reddish yellow colour. Or water may be digested on calomel, and, when filtered, mixed with lime water.—When calomel is rubbed in a glass mortar with pure ammonia, it should become intensely black, and exhibit nothing of an orange hue. If one part of calomel be boiled for a few minutes with 1-32d part of muriate of ammonia, (sal ammoniac,) in 10 parts of distilled water, and the solution filtered; and if carbonate of potash be then added, it will produce a precipitate, if the calomel contained corrosive sublimate; if not the fluid will remain transparent. If it contain corrosive sublimate, it will form with the sal ammoniac, the triple muriate of mercury and ammonia, or sal alembroth, which is recognized by the addition of carbonate of potash. As the compound which corrosive sublimate produces with muriate of ammonia is very soluble, that salt has been advantageously used in washing of calomel.

The *perchloride of mercury*, or deuto chloride of Thenard, is a soluble and very active mercurial salt, which is extremely poisonous, and necessary to be used with caution. The chemical characters of this salt have been considered when treating of poisons. If we suspect arsenic in this salt, which may be added to increase its virulence as a poison, it is discovered in the following manner; make a solution of a portion in distilled water, and add carbonate of ammonia. A precipitate will be formed, which must be collected on a filter. Let this precipitate be



examined, as it may contain something more than mercury. To the filtered solution add a few drops of sulphate of copper and ammonia, or ammoniacet of copper. If it occasions a precipitate of a yellowish green colour, we infer the presence of arsenic.—For the different reagents for *Arsenic*, see Lecture III.

### GUN-POWDER.

It may be necessary to ascertain the purity of *gun-powder*, as well as the proportions of the ingredients, viz. nitre, sulphur and charcoal, made use of in its preparation. Although not liable to adulteration, it is nevertheless apt to be contaminated with foreign substances, which must injure its effective power.

The goodness of gun-powder depends on the purity of the materials, the proportions which are used, and the accuracy with which the mixture is made. It is granulated by passing it through parchment sieves, corresponding in size to the grain required; and glazed or polished by giving it a rotatory motion in a barrel, which is made to revolve on its axis.

The following proportions are used in France for war powder, hunting powder, and mining powder.

	<i>War.</i>	<i>Hunting.</i>	<i>Mining.</i>
Saltpetre,	75	78	65
Charcoal,	12. 50	12	15
Sulphur,	12. 50	10	20

Very frequently gun-powder becomes damp, and



even moist, by exposure to air. This effect is owing to the absorption of moisture, and indicates the presence of some deliquescent salt or salts, and consequently the impurity of the saltpetre.

Gun-powder, however well prepared, will absorb a certain portion of moisture. One of the trials of gun-powder established in foreign service, which should undoubtedly be with us, is by exposing one pound of each sort, accurately weighed, to the atmosphere for 17 or 18 days: during which time, if the materials are pure, it will not increase any thing of any amount. One hundred pounds of good gun-powder should not absorb more than 12 ounces or somewhat less than one per cent.

There are several modes of proving powder. That by the improved eprouvette is the most certain. The strength of powder is usually determined by the manufacturers by measuring the range, or distance of a shell or ball of a certain weight thrown from a small mortar, with a given weight of powder. Rubbing it in the hands, to find whether it contains any irregular hard lumps; blasting a small quantity of each sort on a copper plate, and comparing it with approved powder, &c. are also used in the proving of gun-powder.

We are informed, that in the British service, the first examination is by rubbing it; the second by blasting two drachms of each kind on a copper plate, and comparing the effect with an approved powder. In this proof it should not emit any sparks, nor leave any beads or foulness on the copper. Two ounces



of powder, as a charge, is then put into an eight inch mortar, with an iron ball of 64lbs. and the range is observed, which is compared with approved powder. The best cylinder powder gives about 180 feet range, and pit 150 ; but the weakest powder, or powder that has been redried, &c. only from 107 to 117 feet. The merchant's powder is received if it gives a range of 1-20th less than the king's powder, with which it is compared.

Fine grained, or musket powder, is usuall proved in a different manner ; a charge of 4 drachms is put into a musket barrel with a steel ball, which should perforate a certain number of half inch wet elm boards, placed three fourths of an inch asunder, and the first 39 feet 10 inches from the barrel. Approved powder passes through 15 or 16, and restoved powder from 9 to 12.

The force of gun-powder is owing to the sudden formation of a number of gaseous elastic fluids, which suffer expansion at the moment of their production. The combustion of gun-powder is evidently owing to the decomposition of the nitre by charcoal. The products are carbonic acid gas, azotic gas, sulphurous acid gas, and probably sulphuretted hydrogen. No perceptible quantity of water is formed, as Mr. Cruickshank has ascertained.—What remains after combustion is some carbonate of potash, sulphate of potash, a little sulphuret of potash, and unconsumed charcoal. In good powder these are seldom seen, as they appear to be volatilized, &c. by the heat.



The manufacture at all times, even during the late

It is said that the strength of powder is not increased by granulation, for the granular state prevents the whole of the powder taking fire instantaneously.

Dr. Bruce (*Mineralogical Journal*, vol. 1, p. 112,) observes, that the gun powder manufactured in the United States, is said to be defective, from a disposition either to effloresce or deliquesce; and in the use of the salt petre of Kentucky, from its containing sulphate of soda and nitrate of lime, not being properly refined, gun powder in his opinion may effloresce, but more especially deliquesce; for, while the air deprives the sulphate of soda of its water of combination, and nitrate of lime attracts moisture from the surrounding air, a mixture of these salts may be so made with nitrate of potash, that the nitrate of lime may deprive the potash of its water of combination, and nitrate of lime attracts moisture from the surrounding air, and in consequence of this addition of water, deliquescence may ensue, even when the atmospheric air and moisture are excluded. If the salt petre, however, is pure, all this is prevented.

In a report of the Secretary of the Treasury in 1810, on American Manufactures, although the total amount of gun powder made in the United States was not known, it appears that two of the most extensive works, that of Brandywine and near Baltimore, manufactured annually 675,000 lbs. which, if necessity required, might be greatly increased.



war, has been adequate to the consumption. The report also states, that the importation of foreign powder amounted to 200,000 pounds, and the exportation of American powder to 100,000 pounds.

Since writing these remarks, I accidentally saw in the Boston *Evening Gazette*, a paragraph respecting the quality of American and British gun powder.—The writer assures us, that after witnessing a series of experiments made with the English and American powder, by using the Brandywine eprouvette, Du Pont's was decidedly the best. By the same eprouvette, the strength of the lady Johnston's T. P. powder was found to be on an average 25 degrees, while Du Pont's of the same size was 27 1-2 deg.; and some of Du Pont's tried in 1821, (being then nine years old,) gave 56 deg. The following are also averages of its strength :

Du Pont's F. r	gives 33 deg.
„ F. g	„ 30 „
„ F. F. r	„ 40 „
„ F. F. g	„ 36 „
„ F. F. F. r	„ 50 „
„ F. F. F. g	„ 46 „

We notice these experiments as Mr. Du Pont's powder is generally acknowledged to be the best; it is also known by the name of the *Brandywine gun powder*. To do justice, however, to other powder-makers, we may add, that we have seen gun powder made at other works very little, if any, inferior to Mr. Du Pont's. And why not? There is no se-



cret in the process; for every powder manufacturer, who understands his business, must know, that the *secret* consists in refining the salt petre perfectly, so as to have *pure* nitrate of potash; the preparation of the coal in iron cylinders, so that the wood may be carbonized thoroughly; the separation of foreign impurities, which occur in the brimstone of commerce; using the proportions prescribed; and lastly, giving strict attention to the manipulations of grinding and mixing the materials, and granulating and drying the powder.

The French, from having paid great attention to the preparation of gun powder, make it as good in every respect as the English. But in the following remarks, extracted from Bristed, (*Resources of the British Empire*, p. 316,) a different opinion, though we think incorrectly, is entertained. There may, it is true, be some samples of powder, and perhaps damaged, which would throw ball a less distance than the English, and this may be the fact in the following instance: The superiority of English naval warfare over the French, which is asserted by Bristed, he attributes in some degree to the powder. Thus, he observes: "On 25th May 1808, at Bombay, a comparison was made between the British and French powder, used in the gallant action of the San Fiorenzo with the French frigate La Piedmontaise, &c. From a seven-inch brass mortar, with three ounces of powder, a 50 lb. brass ball was projected at an angle of 45 deg.; and an average of three trials gave 595 feet to the San Fiorenzo, and



516 feet to the La Piedmontase ; giving a balance of 79 feet in favour of the British powder."

Several substances have been used with a view to increase the force of powder, or to economise in its use. Thus, at Cherbourg, in France, where it has been the practice for twenty years, a mixture of equal parts of gun powder, and dry fine saw dust has been used in the place of all powder, and with the same effect in blasting rocks. Whether the *force* is actually increased is a question: we would be inclined to attribute it more to the presence of air in the interstices between the powder and the saw dust; since *confined* air, it is known, by its expansion at the moment of the formation of the gaseous fluids from the powder, (to which and their great dilitation, the force of fired gun powder is attributed,) will greatly *add* to the force, equal in the present instance to one half of powder. The fact, however, I noticed in the Statesman of N. Y. with comments, believing its application useful, and, at the same time, economized for blowing rocks.

A mixture of quicklime with powder, Dr. Blane, a Tuscan physician, assures us will give to the powder one third more strength; and for the blasting of rocks, it is said also, to produce the same effect as all powder. A certificate to this purpose is published in Silliman's *Journal* by Col. Gibbs, of the person whom he employed for blasting. The Col. attributes the effect to the desiccation of the powder.

That it *does not*, however, add to the strength of gun powder, but on the contrary diminishes it, was as-



certained in France by a set of experiments made for that purpose by M. L. Maitre, and Col. Charbonel, noticed by M. M. Botte, and Riffault, in their *Traite de l'art de Fabriquer la Poudre a canon*, p. 301.

They employed pure dry powder, dry powder mixed with quick lime, moist powder pure, and moist powder mixed with lime.

The object of these experiments was to ascertain, if quicklime added to the *force* of powder, either as a fourth component part, and acting chemically, or by merely absorbing the moisture which the powder contains.

The charge of each was three ounces. The results are thus detailed : The range.

Powder, dry, and pure 738.2

Powder, dry, and mixed with quick lime 690.1

---

Difference in favour of dry powder 48.1

---

Powder, moist, and pure 714.1

Powder, moist, and mixed with quick lime 642.2

---

Difference in favour of moist powder 71.11

It has been asserted also, that the force of gun powder is increased by water, alcohol, and ether, in consequence of the great expansibility of these fluids ; but according to the experiments of Botte and Riffault, the range of ball was much less when these fluids were used successively, than when the dry and pure powder alone was employed.



To determine the quantity of saline matter in gun powder, let a given quantity be boiled with four times its weight of water, and collect, wash, dry, and weigh the residue. The temperature should not exceed 212 deg. The loss indicates the quantity of nitre, and, if present, other soluble salts. The solution may then be examined for sulphuric and muriatic acid, and for lime and magnesia in particular.—The insoluble residue, consisting of charcoal and sulphur, may be exposed to heat on an iron plate. The residue will indicate the quantity of charcoal, and by the loss sustained, the quantity of sulphur. Chlorine gas, brought in contact, will take up the sulphur, and leave the charcoal. See *Nitre, Sulphur,* and *Charcoal*.

### PURE POTASH.

Pure potash is the potash of commerce deprived of its carbonic acid, and otherwise purified. Caustic potash is the ordinary common caustic of the shops, prepared by depriving potash of carbonic acid, and casting it into sticks. Pure potash should be perfectly soluble in twice its weight of water. The solution should not effervesce with acids. If nitric acid be poured into a solution of potash, and a precipitate is formed not soluble in acid, it will indicate selica; but if it is soluble in a slight excess of acid, it is alumina. Lime is shown in the caustic solution by saturating it with nitric acid, and adding thereto oxalic acid or oxalate of ammonia, or by the addition of



bicarbonate of potash, which will produce carbonate of lime. Barytic water, if it produces a precipitate soluble in nitric acid with effervescence, will indicate the presence of carbonic acid; but if the precipitate is insoluble in nitric acid, the inference would be that it is the sulphuric.

To distinguish potash from soda, several methods are used, which we purpose to enumerate. When exposed to the air potash will absorb moisture, run *per deliquium*, and become oily; soda, on the contrary, will first become moist, but finally dry up, and form a white powder. Potash when neutralized by sulphuric acid, will furnish a salt on evaporation in small irregular crystals, which have more or less the shape of six sided prisms terminated by six sided pyramids, and requiring sixteen times its weight of water to dissolve it. Soda neutralized in the same manner, crystallizes in large transparent, channelled, six sided prisms which effloresce, or fall to powder, when exposed to the air. These crystals are soluble in less than half their weight of boiling water. If a little tartaric acid be dropped into a solution of sulphate of potash, a number of minute crystals are deposited; but sulphate of soda treated in the same manner, produces no effect. If muriate of platinum be dropped into a solution of sulphate of potash, a yellow precipitate will appear, but not with sulphate of soda.

### SOLUTION OF PURE POTASH.

The solution of pure potash, or the *liquor potassæ*,



may be examined as the preceding. It may be assayed for sulphuric and muriatic salts, by saturating it with nitric acid, and adding the necessary reagents. It should not contain carbonic acid; and, therefore, when mixed with barytic water, ought to remain transparent. The precipitate, if there be one formed, ought to effervesce in, and be dissolved by nitric acid. The redundancy of carbonic acid is also shown by an effervescence, on adding sulphuric acid. If the solution should contain lime water, by mixing it with water impregnated with the carbonic acid, or with bicarbonate of potash, or passing air through it from the lungs by means of a tube, will detect it by producing a milkiness, which will disappear on adding an acid. The strength of this solution is uniform. According to formulæ, one wine pint ought to weigh 18 ounces troy.

### CHLORATE OF POTASH.\*

Chlorate of potash is frequently mixed with the chloride of potassium, or muriate of potash, in consequence of the formation of that salt in the prepara-

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\*The salts of potash, with few exceptions, are soluble in water. Many of them can be obtained in the state of crystals; but, in general, they have a less tendency to form regular crystals than the salts of soda. Tartaric acid produces a white granular sediment of supertartrate of potash. A solution of sulphate of alumina dropped into a salt of potash, produces octahedral crystals of alum. Exposed to a red heat, they will not be volatilized like the salts of ammonia. If the acid contained



tion of the chlorate. The chlorate of potash should be entirely free from it. It may be detected by adding to a solution of the chlorate in water, a few drops of nitrate of silver, which will occasion a white precipitate, (*chloride of silver*,) but with the pure chlorate no effect will take place. It is extremely difficult, however, to separate the whole of the chloride of potassium; and even with the purest, some traces may be found.

Chlorate, formerly hyperoxymuriate of potash, is prepared by passing a current of chlorine gas through a solution of caustic potash, either by means of Woulfe's apparatus, Knight's improved apparatus, Hembel's contrivance, which has many advantages, or any apparatus by which the saturation can be effected. The solution will crystallize, and the crystals must be carefully separated from the mother water, which contains muriate of potash.

### NITRATE OF POTASH.

Nitrate of potash, nitre, or saltpetre is received either in a crude, impure, or crystallized state.—

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in the salt be combustible, it will be decomposed, furnishing a residue of carbonate of potash and some charcoal. If incombustible, the salt usually fuses; to which, however, there are some exceptions. They are not precipitated by infusion of nut galls, nor by ferrocyanate of potash; but a solution of platinum throws down an orange coloured precipitate. They are not affected by sulphuretted hydrogen gas, nor by the addition of a hydrosulphuret, except when their acid has a metal for its basis.



Crude or unrefined saltpetre contain a variety of foreign substances, and the object of the refiner is to separate them. Thus, in rough saltpetre we often find the nitrates of lime, magnesia, and soda, and muriates and sulphates of the same substances, which exist, however, in variable, and uncertain quantities. It is easy to satisfy ourselves of this fact. When crude or rough saltpetre is dissolved in water, the soluble salts will be taken up, leaving very frequently a copious sediment, consisting of sulphate of lime, oxyde of iron, &c. If the solution is filtered, and examined with nitrate of barytes, sulphuric acid will be shown; if examined with nitrate of silver, muriatic acid; and if with carbonate of potash, the presence of earths. We may remark, however, that the earthy salts are less frequent, because the potash used in extracting the saltpetre in the first operation, not only converts the earthy nitrates into nitrate of potash, but also the earthy muriates and sulphates into the salts of that alkali.

If crude saltpetre should consist of a mixture of nitrate of potash and muriate of soda, it is evident, that its purification would depend altogether on the separation of the muriate; but as it is difficult to separate the whole of the muriate, even in the best refined saltpetre, traces of muriatic acid are always detected. Solution of pure nitre neither precipitates nitrate of silver, nor nitrate of barytes. These tests it is obvious, show the presence of sulphuric and muriatic salts. The quantity of muriate of soda may be learned by weighing the precipitate, if any be produced by the nitrate of silver; for every hundred



grains, when washed and dried, will denote about 42 1-2 of muriate of soda.

Nitrate of potash when decomposed by sulphuric acid, should produce nothing in distillation but nitric acid; and when fused in a crucible heated to redness, and deflagrated by charcoal, the residue should consist of carbonate of potash, without any earth, metallic oxyde, sulphur, or soda.

Nitrate of potash is found native, and is also the product of art. In the artificial nitre beds, from which nitre is extracted by lixivation, there is a mixture of animal and vegetable substances, with old rubbish, calcareous earths, &c. By the concurrent putrefaction of the animal and vegetable matter, nitric acid, besides the usual products of putrefaction, is generated, which attaches itself to the alkalies and earths existing in the bed. It appears that the azote, at the moment of its liberation from the animal matter, and probably by the decomposition of ammonia, also generated, unites with the oxygen of the atmosphere, and forms nitric acid.

Nitre at one time was altogether made in France by artificial nitre beds. It is extracted by lixivation with wood ashes, the alkali of which decomposes the earthy nitrates, &c. and refined by solution, further addition of potash, filtration, evaporation, and crystallization. Double refined saltpetre is that which has been treated a second time in the same manner. If saltpetre should become moist in the air, it is a sure indication of the presence of deliquescent salts, as muriates of lime and magnesia, and



that it has not been properly refined. Gun powder made with saltpetre of this description, as well as in other respects impure, would be either unfit for use, or very inferior in its power. See *Gun Powder*.

In the United States there are several caves or caverns of considerable extent, which contain an abundance of nitrous earth. These caves exist mostly in the Western country, and have already yielded immense quantities of saltpetre.

Nitrate of potash has occasionally been found in them; but the nitric acid, for the greater part, is united with lime, forming nitrate of lime, or calcareous nitre. From the vast extent of these caverns, and the inexhaustible supply of nitrous earth, we may feel assured, that in the article of saltpetre, so essential in warfare, no deficiency for many centuries will be experienced. The extraction of saltpetre is performed by merely lixivating a mixture of the earth and wood ashes, by which the acid of the nitrate of lime unites with the potash of the wood ashes, and the lime with any carbonic acid from the ashes remains with the insoluble substances. The nitrous liquor, thus obtained, is boiled down, and constitutes the saltpetre of the first boiling. This saltpetre, like that obtained from artificial nitre beds, is very impure; and requires to be *thoroughly* refined before it is fit for the manufacture of gun powder.

Many remarkable facts are connected with these saltpetre caves. One which has appeared to me as the most striking is, that after every particle of



saltpetre has been extracted from the earth, if the same earth be placed in the cavern it will in a short time yield as much saltpetre as before. There must be something peculiar in the earth, which has evaded all research, or something in the atmosphere of the cavern more than what is known, to produce this singular effect. If the earth furnishes nascent azote, we may then account for the generation of nitric acid by its union with the oxygen of the atmosphere.

The origin of nitrate of lime, in caverns, is altogether inexplicable in our present state of chemical knowledge.

In Georgia, at Nicajack, in Raccoon Mt. is a cavern which contains the nitrate both of potash and lime; one bushel of the earth yields from three to ten pounds of crude nitre. The cavern in Madison county, about 60 miles from Lexington yields, in the bushel, from one to two pounds of nitre. The rock ore of Kentucky is a sandstone richly impregnated with nitrate of potash, one bushel of which frequently affords ten pounds and sometimes twenty pounds of nitre. The nitre obtained from these rocks is almost wholly free from nitrate of lime, and is preferred for the manufacture of gun powder. Masses of native nitre weighing several pounds, are occasionally found in the fissures of these sand stones. Calcareous caverns, containing nitre, occur in Ohio, Tennessee, and in some parts of Virginia and Maryland.

Dr. Mitchell says, in a note to *Philip's Minerolo-*



gy, p. 115, that "during the late contest with Great Britain, the saltpetre of Kentucky was brought abundantly to New-York, for the powder mills."—See *Med. Repos.* vol. 9, p. 86—88.

Nitrate of potash is recognised by placing it on hot coals. Whether pure or mixed with earthy or saline substances, a vivid combustion, accompanied by a hissing noise and slight detonations, will take place. It sometimes occurs native in the form of an efflorescence or a crust, and substances to which it adheres often have a mouldy appearance. Nitrate of lime has a sharp and bitterish taste, and is also found on the surface of the earth in efflorescences, or in delicate needles. On burning coals it slowly melts, and, as it dries, slightly detonates.

From nitrate of potash it is distinguished by its taste, and the addition of oxalate of ammonia to a solution in water. This salt almost always accompanies nitre, and appears in fact to be formed along with it, when circumstances are favourable.

In the immense deserts of Persia and Arabia, for the space of seven hundred miles, travellers inform us, that the quantity of nitre and other salts is so considerable as to impregnate very sensibly the neighbouring lakes and rivers, and has, on that account, been denominated the *Great Saline Desert*.

During the American revolution, every effort was made to obtain nitre. Such was the zeal and industry, at that time, that, as Dr. Black assures us in his *Lectures*, the floors of the tobacco houses were dug and lixivated. The late Dr. Rush, one of those



inflexible patriots who signed the Declaration of Independence, informed me, that numerous essays were written at that period, on the different means of obtaining saltpetre; and notwithstanding the difficulties encountered, and the scarcity of the article, the supply soon became sufficiently ample. The same zeal was subsequently manifested in France, in the institution of saltpetre works in the different departments, and the instruction of young men in the processes of extracting and refining of saltpetre.

### SULPHATE OF POTASH.

The salt which remains in the retort, after the distillation of nitric acid from nitrate of potash by sulphuric acid, is *sulphate of potash*. There are two sulphates; the neutral and the bisulphate. The latter usually remains after the distillation of nitric acid, and, therefore, to make the neutral sulphate, it is necessary to saturate the excess of acid with potash. Sulphate of potash, or *vitriolated tartar* should be free from any foreign salt, and excess of sulphuric acid; which may be known as well by the taste, as its action on the tincture or infusion of litmus. When this salt is heated with charcoal, it produces sulphuret of potash.

### CARBONATE OF POTASH.

Carbonate of potash, subcarbonate of potash, salt of tartar, and salt of wormwood, are synonymous



terms; and imply the purified, and generally the granulated carbonate of that alkali sold by the apothecaries. Its most common appellation is salt of tartar; a name given to it in consequence of being prepared from tartar. It is the alkali of tartar. We have already spoken of the method of ascertaining the quantity of absolute alkali in pearlash, potash, and barilla of commerce. It remains to point out the usual method of examining the carbonate in question.

The solubility of salt of tartar, like the alkalies generally, is very considerable; and its attraction for water is so great, in common, however, with caustic potash, that when exposed to the atmosphere, it will absorb it, and run *per deliquium*. If pure, it should dissolve in twice its weight of cold water; any insoluble matter is an impurity. Frequently an insoluble residue equal to one fourth remains, consisting of sulphate of potash. The nature of the adulteration will be shown by dissolving the sediment in diluted nitric acid; the siliceous earth only will remain undissolved. By using the nitrates of barytes and silver, we may detect sulphuric and muriatic acids, and oxalic acid or oxalate of ammonia, will determine the presence of lime. One hundred parts of nitric acid specific gravity 1.36, will saturate seventy parts of dry carbonate of potash, which are equivalent to forty-eight parts of pure potash.



## BICARBONATE OF POTASH.

The other salt formed by the union of potash and carbonic acid, is the *bicarbonate*. It is formed by passing a current of carbonic acid into a solution of the common carbonate; or, according to a more expensive method, by the action of carbonate of ammonia on carbonate of potash. This salt crystallizes in four sided prisms, with dihedral summits. They require for their solution four parts of water at 60 degrees. It is sometimes used in preparing extemporaneous ærated alkaline water. Its purity may be judged by its taste, which should be slightly alkaline; by its crystallization; by its degree of solubility; by the quantity of carbonic acid it contains; and, generally, by the use of the reagents mentioned in the preceding article. We may add here, in relation to the precipitates, that 100 parts of sulphate of barytes are equivalent to 74 of sulphate of potash, 100 of muriate of silver are equivalent to 52 of muriate of potash, and 100 of oxalate of lime are equal to 77 of carbonate of lime.

## ACETATE OF POTASH.

When potash is saturated with acetic acid a salt is formed, called in the old pharmacopæias the *febrifuge salt of Sylvius* and *diuretic salt*. The acetate of potash is soluble in four times its weight of alcohol, by which it may be separated from other salts that are insoluble in that fluid.



The foreign salt most likely to contaminate it is the neutral tartrate of potash, or soluble tartar; which is recognised either by the addition of tartaric acid producing a precipitate, or by adding acetate of lead or muriate of barytes, either of which will give a precipitate soluble in acetic or muriatic acid. Sulphates are detected by the last mentioned tests, but the precipitate in that case is insoluble in nitric or muriatic acid. Acetate of potash is soluble in its weight of water at 60 deg. and the solution has a saline acid taste.

### SULPHURET OF POTASH.

When potash is fused in a crucible with a given quantity of sulphur, a compound results, which has been long known under the name of *liver of sulphur*. This sulphuret of potash should contain no lime, which may be known by dissolving it in water, and adding the reagents for that earth. Liver of sulphur is very deliquescent, and very soluble in water, forming the hydroguretted sulphuret of potash, a compound of supersulphuretted hydrogen, or hydroguretted sulphur with potash. This is altogether different from that preparation, which is formed by passing a current of sulphuretted hydrogen gas through a solution of potash, as the latter, correctly speaking, produces a hydrosulphuret of potash.—These two compounds may be distinguished by nitric acid: with the hydroguretted sulphuret of potash, it gives a copious precipitation of sulphur, but



with the hydrosulphuret, if properly made, no precipitate.

Sulphuret of potash should be kept as dry as possible. When breathed upon, there is instantly a foetid odour, like that of rotten eggs, which will colour a silver spoon almost immediately. This is owing to the decomposition of the moisture, and the evolution of sulphuretted hydrogen gas. When sulphuret of potash is dissolved in water, a hydroguretted sulphuret, with sulphate or sulphite of potash is produced. It is from the sulphuret of potash, by solution in water and the addition of sulphuric or muriatic acid, that the milk of sulphur is produced, which is a hydrate of sulphur.

### SULPHITE OF POTASH.

Potash when combined with sulphurous acid forms the *sulphite of potash*; a salt which, by exposure to the air, changes rapidly into the sulphate. Should that be the case, it may be known by using the test for sulphuric acid. This salt is readily formed by passing sulphurous acid through a solution of potash.

Sulphurous acid gas has been long used for bleaching; woollens, straw bonnets, &c. are whitened by the *fumes* of burning sulphur, and the effect is owing to the production of this acid. Sulphurous acid, especially when united with alkalies, unites with oxygen, and is changed into sulphuric acid.

It is sometimes found in natural waters, and gives



them the smell of burning sulphur. If a few grains of the black oxyde of manganese be put into a phial of water containing this acid, it will loose its peculiar smell in a short time, owing to the combination of the acid with the oxygen of the oxyde. This is one of the means recommended for recognising the presence of this acid in a mineral water.

By the action of sulphuric acid on some of the metals, as lead or mercury, in the formation of metallic sulphates, sulphurous acid gas is liberated in abundance.

### SAL PRUNELLA.

Nitrate of potash when fused and cast into moulds, forms *sal prunella*. It is nothing more than salt petre deprived of its water of crystallization. The fusion should be conducted carefully, and in a heat below redness; if higher, the salt petre will be decomposed, and furnish oxygen gas and nitrite of potash; and if the heat be white, the products would then be oxygen, azote, and dry potash. Some sprinkle the nitre, when in fusion, with sulphur; which must contaminate the *sal prunella* with sulphate of potash.

This salt may be known by dissolving the *sal prunella* in water, and adding nitrate of barytes. Muriate of soda may exist in it, in consequence of the impurity of the salt petre.



## TARTRATE OF POTASH.

When the excess of acid in cream of tartar, or supertartrate of potash, is saturated with potash, the neutral *tartrate of potash*, commonly called *soluble tartar* is formed. This salt is immediately affected by tartaric acid. Hence it should afford a copious precipitate with tartaric acid, and produce the supertartrate. Sulphate of soda is sometimes used to adulterate it. It may be detected in the usual manner, by solution in water, and the addition of muriate of barytes. The sulphate thus produced, should be insoluble in diluted muriatic acid.

According to Mr. Richard Phillips, 100 parts of tartar require 43.5 of carbonate of potash for saturation.

## TARTRATE OF POTASH AND SODA.

When the excess of acid in cream of tartar is saturated with carbonate of soda, the *triple tartrate of potash and soda* is formed; a salt formerly called *Sel de Seignette*, and now *Rochelle salt*. It forms irregular prismatic crystals. This salt is composed, according to Vauquelin, of 54 tartrate of potash and 46 of tartrate of soda per cent. Of foreign salts, sulphate of soda is the most likely to be found. This adulteration may be detected by dissolving the Rochelle salt in water, and adding acetate of lead or muriate of barytes. If the sulphate be present, the former will give a precipitate of sulphate of lead in-



soluble in acetic acid; and the latter a precipitate insoluble in muriatic acid.

### SUPERTARTRATE OF POTASH.

This salt called also the bitartrate of potash, and known by the familiar name of cream of tartar, is originally deposited from the must, or juice of grape either during its fermentation, or in the casks containing the wine. The deposit is more or less crystallized, and usually red; hence the red tartar of commerce.\* It is, however, more commonly called argol or crude tartar. The must of grapes (of the *vitis vinifera* of Linnæus) contains, as we have observed, a considerable portion of saccharine matter, which furnishes alcohol by fermentation, and an acid, principally the tartaric united with potash. In the fermentation a redundancy of tartar is precipitated, and also by the standing of the wine. The tartar is coloured in consequence of the colouring matter contained in the husks, &c. of the grape, which is frequently taken up intentionally by suffering the fermentation to take place on the skins, thus giving rise to the different red wines.

Crude tartar is purified by solution, filtration, and crystallization, and then becomes white. It is now

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\* Tartaric acid has been found in a variety of vegetable substances, besides the juice of grapes. We shall name a few of them, viz. the pulp of the tamarind, the *rhus typhinum*, *vaccinium oxycoces*, *rheum raponticum*, *morus alba*, *pinus sylvestris*, *abies* and *larix*, *leontodon taraxicum*, &c.



the *crystals of tartar*, and when pulverised takes the name of cream of tartar.

The bitartrate of potash is a salt of very difficult solubility, requiring 120 parts of water at 60 degrees, and 30 parts at 212 degrees for its solution. In consequence of this great, comparatively speaking, insolubility of the super or bitartrate, we perceive why tartaric acid precipitates potash from its solution by the immediate formation of supertartrate of potash, and why, therefore, it is employed as a reagent for that alkali. With soda, on the contrary, it forms a supertartrate of easy solubility, which does not precipitate.

The crystals of tartar may be adulterated by sulphate of potash. This is detected as follows: pour on half an ounce of the powdered crystals, two or three ounce measures of distilled water, and, after shaking the mixture frequently, let it stand undisturbed. The sulphate of potash being more soluble will be taken up, leaving the supertartrate. The solution will have a bitter taste, and, on adding muriate of barytes, will give a precipitate insoluble in muriatic acid.

If a solution of the tartar be made in hot water, and the same reagent added, the same effect will ensue; but the precipitate, as before, must be insoluble in muriatic or nitric acid.

In the powdered crystals of tartar, or cream of tartar, besides the presence of sulphate of potash, we may frequently detect sulphate of soda. A little of the tartar thrown into water, will, if sulphate of so-



da is present, be immediately dissolved, which is known by its taste, and the addition of muriate of barytes. If there be reason to suspect the admixture of calcined plaster of Paris, (although we have never known that adulteration,) the fraud may be detected by dissolving the tartar in a large quantity of water, and the precipitate or sediment examined for tartrate of lime, as well as the solution for lime, and of course, for sulphuric acid; as a part of the sulphate of lime may be found in solution, and also in consequence of the decomposition, some sulphate of potash.

### PURE SODA.

Pure soda, by which we mean the alkali free from any foreign substance, may be tested in the same manner as pure potash. It may contain potash, the discovery of which is effected by adding to its aqueous solution muriate of platinum, which will form a buff coloured precipitate, if it be present. Muriate of platinum, in such cases, produces a triple compound of potash, oxyde of platinum, and muriatic acid.

When soda is exposed to the air, it soon becomes covered with an efflorescence of carbonate of soda. Soda may be distinguished from potash; it forms an *efflorescent* paste, while potash under the same circumstances *deliquesces*.

If excess of tartaric acid, we remarked in our preceding subject, be added to a solution of soda, no



precipitation will take place, whereas in a solution of potash it occasions a copious precipitate consisting of minute crystals of tartar. But these facts have been fully stated heretofore.

### SODA WATER.

Water was a long time impregnated with carbonic acid gas by means of Nooth's apparatus; and alkaline solutions were *ærated* by the same contrivance. In consequence of the acidity, briskness, and pungency, added to the medicinal effects of certain natural waters containing carbonic acid, their imitation has been attempted. Soda water, however, is nothing more than water holding in solution about 8 or 10 grains of soda or mineral alkali to a pint, and charged usually with three or four times its bulk of carbonic acid. Water merely surcharged with carbonic acid, is more frequently sold as soda water; but soda water is decidedly more beneficial than the mere *ærated* water, although the latter contains all the carbonic acid, and is very agreeable as a beverage.

By the usual contrivance for impregnating fluids with gases, it is impossible to combine a sufficient quantity of carbonic acid; hence an expedient has been adopted, which not only saturates the water and the alkali, but surcharges the whole in an eminent degree. This contrivance consists in using a forcing pump, and pumping the gas from a gasometer, and forcing it into a copper vessel tinned in the inside,



which contains the alkaline solution. This is the present mode of preparing soda water. The preparation of other waters, which contain carbonic acid, is effected in a similar manner, proportioning the carbonic acid gas accordingly.

Ærated waters when drawn from the fountain, should *foam* considerably, a criterion that the water has been well charged with carbonic acid. But to determine whether the water actually contains soda, it is necessary to examine it chemically. For this purpose a portion of the water may be evaporated, and the residue, if alkaline, will be known by its taste. A portion of sulphuric acid poured on it will occasion an effervescence; and the salt, when crystallized, will exhibit the characters of Glauber's salt.

Water containing alkali in solution, it is admitted, will receive more carbonic acid than the plain water.

We mentioned in a former lecture, that when soda water is allowed to remain any length of time in the copper vessels, especially if they are imperfectly tinned, or the tinning worn off, it is liable to contract a portion of copper. Water, however slightly impregnated with copper, is in a degree deleterious, and frequently occasions vomiting, or pain in the abdominal viscera. If water of ammonia be added to the suspected water, copper will be detected by the mixture becoming more or less blue. The presence of lead may be known by aqueous sulphuretted hydrogen, or Hahneman's wine test, which will give a dark brown precipitate.



Extemporaneous soda water is now prepared by using a vegetable acid with bicarbonate of soda.— They are put up in boxes, contained in separate papers. When the two are dissolved, alternately, in a glass of water, a disengagement of carbonic acid gas takes place, occasioned by the action of the acid on the carbonate. Soda powders, when properly made, and kept from the moisture of the air, are an excellent substitute for soda water. At sea, in particular, they must prove very beneficial. There are several manufacturers of these powders, none of which, however, are superior to those of Lynch and Clarke, Wall-street, New-York.

If the bicarbonate of soda is properly prepared, the soda powders, must, of course, be good.

The proportion of alkali and acid in each paper, which is designated from each other by the colour of the paper, is about ten grains, and this quantity is used for a half pint tumbler. It is to be observed, that in the action of the acid on the alkaline carbonate, a salt is produced, which remains in solution: if the acid be the citric, which is usually the case, the salt is then a citrate of soda. Sometimes sirup is used to impart a more agreeable taste, and at the same time to prevent the rapid disengagement of the fixed air. It is better to dissolve the powders in separate glasses, with each half full of water; and to mix them in *one* glass as quickly as possible.

If 320 grains of bicarbonate of soda be dissolved in a pint of water, a table spoonful of the solution will contain ten grains; and if in another pint of wa-



ter twice the quantity of the bicarbonate of potash be dissolved, viz. 1 1-4 oz. and 4 scruples, the solution will then contain twenty grains in a table-spoonful. Now the quantity in each, admitting that ten grains of the soda is the usual proportion in a glass of soda water, will make thirty-two glasses.—By putting a spoonful of each in separate tumblers, filling them nearly half with water, and mixing them briskly, extemporaneous soda water will be made in the most expeditious manner. The excess of acid in the bitartrate of potash will be sufficient, or thereabout, to neutralise the soda; and the salt, which will result by the union of the two, is the tartrate of potash-and-soda, or sal Rochelle; the quantity, however, being so small as not to act as a cathartic. As the proportion of acid is not material, and the acid generally, but especially the vegetable, may be used; a very pleasant beverage, partaking also of the character of sirup, an addition which is frequently made, may be prepared by substituting the lemon sirup. The citric acid will act on the bicarbonate; carbonic acid will be disengaged, which will be prevented from escaping, or at least not so rapidly, by the saccharine matter of the sirup; and citrate of soda will be formed.

This method of producing *sweetened ærated soda water* has advantages.



## MURIATE OF SODA.\*

Sea salt, common salt, muriate of soda, hydrochlorate of soda, or chloride of sodium, terms which are used to express the same salt, is scarcely ever found free from earthy salts, which are chiefly muriates of lime and magnesia. They are usually contained in the brine and adhere to the salt. It is to the presence of foreign salts, and principally the earthy muriates, that some salt is so feeble in its effect as a preservative to meat, and often so injurious to beef in particular. They appear to injure, as well as retard, the antiseptic properties of the pure salt. Some of the salt made in this country is of this description. Salt, however, which contains these muriates, is generally humid or moist, owing to their deliquescence. After ascertaining the fact by ex-

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\*The salts of soda are more soluble than the salts of potash. Many of this class of salts contain a large quantity of water. When exposed to a red heat, they usually speedily melt, and, finally, when all the water is driven off, the salt appears in a white powder. If the acid be combustible, it is destroyed; but if it be fixed, the salt melts again at a red heat. The shape of the crystal, will readily determine the base of the salt; or, if its crystallization is irregular, the salt may be decomposed by sulphuric acid. Sulphate of soda is easily recognised by the shape of its crystals, so is also nitrate of soda. Salts of soda are not precipitated by tartaric acid, nitromuriate of platinum, infusion of galls nor ferrocyanate of potash. The two last, however, will produce, a precipitate if the acid has a metallic basis. With the salts of soda, sulphate of alumina does not produce octahedral crystals of alum, as with the salt of potash, another very distinguishing character.



periment, the best mode of getting rid of these impurities is by re-dissolving the salt, and again boiling it, carefully separating the mother water. Another mode may be resorted to, but more expensive, viz. by adding a due quantity of soda, filtering the solution, and evaporating it to dryness, by which the earthy muriates will be decomposed, and changed into muriate of soda. The mother water, at all times, should be carefully separated from the salt.

The common salt of commerce is not sufficiently pure for the purposes of chemistry. It may be imperfectly purified by repeated crystallizations. But the following process will effectually purify it. Dissolve it in four times its weight of water, and filter the solution; first add muriate of barytes, then of carbonate of soda, as long as any precipitate continues to fall. Separate the precipitates by filtration, and evaporate slowly till the salt crystallizes.

The ocean is the great depository of common salt, for nearly one thirtieth part of its weight is muriate of soda. Immense beds of sal gem or rock salt are found in some countries. Magnesia and lime may be separated by making a solution of salt in water, and adding carbonate of potash. If 100 grains be dissolved in an ounce of water, and carbonate of ammonia added, carbonate of lime, if the salt had contained muriate of lime, will be precipitated. Of this precipitate, 100 parts when washed and dried, at 300 degrees, are equivalent to 110 of dry muriate of lime, or chloride of calcium. If the filtered liquor be now boiled nearly to dryness and magne-



sia be contained in it, the carbonate of that earth will fall; 100 parts of which are equal to 134 of dry muriate of magnesia. Sulphate of magnesia or sulphate of soda may be detected by using the test for sulphuric acid; and if a solution of the salt be evaporated and crystallized, crystals of Glauber's salt will be readily recognised. Carbonate of ammonia, added to the fluid, will retain the magnesia in solution, which will be precipitated by phosphate of soda.

### SULPHATE OF SODA.

Sulphate of soda, or Glauber's salt, being one of the cheapest salts, is seldom, if ever, adulterated. It should be perfectly neutral, and, therefore, not affect either litmus or turmeric paper. In a crystallized state it contains about 56 per cent of water. If it contains iron, the fact may be known by tincture of galls, or ferrocyanate of potash; if muriate of soda, with which it is frequently contaminated, by sulphate of silver; and if salts of lime, by carbonate of ammonia. Sulphate of potash is recognised by its sparing solubility. Effloresced salts are as active as the crystallized. One half the quantity is sufficient for a dose. Glauber's salt is manufactured from the mother water of sea water, by the combustion of the *tamarix gallica*, and is the result of several chemical processes. Thus, it is formed in the distillation of muriatic acid from muriate of soda by sulphuric acid; in the sublimation of sulphate of ammonia and muri-



ate of soda, for the preparation of corrosive sublimate and calomel; in the calcination of sulphate of lime, muriate of soda and clay, &c. besides by the combustion of certain maritime plants.

Having noticed the preparation of Glauber's salt from sulphate of lime, an article so abundant and cheap, it may not be improper to mention the proportions of the substances used, as given by Funcke. Eight parts of calcined sulphate of lime (gypsum,) five of clay, and five of muriate of soda, (common salt,) are made into a paste in water, then burnt in a kiln, and the mass taken out and powdered; it is then lixivated, and the solution evaporated, and set aside to crystallize. This is unquestionably a very economical method of preparing Glauber's salt. We see, however, no particular advantage in using calcined gypsum, inasmuch as water is added to form the paste; and, therefore, the ordinary powdered plaster, which is strewed over land, will answer the purpose. Calcined gypsum, as it absorbs water, and becomes hard in a short time, may on that account be preferable. Glauber's salt is manufactured in the eastern states from the mother water of sea water, after the separation of common salt; hence it contains muriate of soda, frequently sulphate of magnesia, and is generally imperfectly crystallized.

### CARBONATE OF SODA.

Carbonate of soda of the shops, or subcarbonate of soda of the Pharmacopæias, often contains sul-



phate and muriate of soda. Kelp and barilla belong to this class of alkalies. This may be examined in the same manner as potash and pearl ash of commerce, if we wish to determine the quantity of real alkali.

To discover the presence of sulphate and muriate of soda, we must first saturate a given weight of the soda pure dilute nitric acid; and to one portion add nitrate of barytes, which will give a precipitate of sulphate of barytes, and to another portion nitrate of silver, which throws down muriate of silver; 100 parts of which are equal to 41 of sea salt.

Carbonate of potash may be detected by adding to a saturated solution of the carbonate, tartaric acid in excess; bitartrate of potash will precipitate in crystalline grains.

### BICARBONATE OF SODA.

The bicarbonate of soda, which is usually formed by passing carbonic acid through a solution of the ordinary carbonate, contains 32 *per cent.* of soda, and 44 *per cent.* of carbonic acid. It has a slightly alkaline taste. This salt is largely used in preparing the extemporaneous aerated soda water. A mixture of the two carbonates occur native, but in an impure state. Thus, it occurs in Africa, in several lakes, &c. and is usually called *Trona*.

Natron and mineral alkali are the same as soda. As respects the bicarbonate, it is frequently contaminated with the carbonate of soda: it is difficult, how-



ever, to detect it. The best criterion would be the quantity of carbonic acid liberated, and the loss which the salt sustains on saturating it with a given *weight* of acid. The native bicarbonate of soda, called *trona*, found in the province of Sukena, is crystallized in hard striated masses, and is not altered by exposure to the air. The common carbonate of soda forms large beautiful crystals.

### SUBBORATE OF SODA.

Subborate of soda or *borax*, called in its impure state *tincal*, contains when pure, about 34 *per cent.* of acid. It is decomposed by sulphuric acid, and furnishes boracic acid. It is sometimes adulterated with common salt, and alum. The fraud may be detected by dissolving a portion of the salt in water, saturating the excess of alkali with nitric acid, and adding respectively nitrate of silver and nitrate of barytes. The alumina may be thrown down by ammonia.

### NITRATE OF SODA.

Nitrate of soda, or *cubic nitre* crystallizes in rhombs. It is often found in crude nitre, and nitre sometimes occurs in it. The presence of nitrate of potash may be shown by muriate of platinum, which will detect the potash.

The sulphate and muriate of soda may be detected as before mentioned.



## PHOSPHATE OF SODA.

Phosphate of soda, or *soda phosphorata*, is prepared by saturating phosphoric acid with soda. Its crystals contain about 60 *per cent.* of water, and when heated it loses its water of crystallization, and melts into a glass. If a globule be heated before the blow pipe, it assumes the dodecaedral figure as it cools.

This salt, although not usually adulterated, may be examined for foreign salts by the tests before mentioned.

The whole of the phosphoric acid may be separated by using sulphate of magnesia, and carbonate of ammonia, as heretofore noticed. As phosphoric acid is thus separated, and phosphate of soda employed as a reagent for detecting the presence of magnesia, after the addition of carbonate of ammonia; the precipitate formed, in such cases, will determine the relative quantity of each substance.— One hundred grains of the precipitate will indicate 19 of pure magnesia; 44 of carbonate; about 66 of muriate of magnesia; and 62 of dissicated, or double that quantity of crystallized sulphate of magnesia.— If the precipitate be calcined, the phosphate of magnesia will indicate 38.5 of magnesia, or equivalent to 22.6 grains of the crystallized sulphate of magnesia; and every hundred parts will indicate about 61 *per cent.* of phosphoric acid.

The ammoniaco phosphate of magnesia, (the triple salt which is thrown down,) contains according to



Fourcroy, equal weights of phosphate of ammonia, phosphate of magnesia, and water.

## SUPERSULPHATE OF ALUMINA AND POTASH, ALUM.\*

Supersulphate of alumina-and-potash alum, is prepared in several ways, either by roasting certain clays, or argillites, which contain pyrites, &c. and lixivating them in the usual manner, with the addition of potash ; or by the direct union of alumina and sulphuric acid, and treating the lixivium in the usual mode.

The observations of professor Cleaveland (*Elementary Treatise on Mineralogy and Geology*,) on

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\* Most of the salts of alumina are soluble in water. They have an astringent taste ; are not precipitated by oxalate of ammonia nor by tartaric acid, like the salts of yttria ; neither are they affected by ferrocyanate of potash, nor by tincture of galls, which distinguish them from the salts of glucina and yttria. Phosphate of ammonia produces a white precipitate, and hydriodate of potash a precipitate which becomes yellow, and continued permanent. When sulphuric acid, and then sulphate of potash, are added to a salt of alumina, octahedral crystals of alum will be formed.

Alumina is recognised before the blow pipe, if it be not combined with a large proportion of metallic matter, or of magnesia, by forming with a drop of nitrate of cobalt a bright blue colour. It may be discovered in this manner in the agalmatolite. Alumina combines more slowly with the fluxes than the other earths, and forms a clear gloss, which does not become opaque.



the modes of obtaining alum are perfectly correct; *viz.* that if salt exists, already formed, in earths or friable minerals, it is extracted by lixivation; but, if the mineral be solid, it must be previously calcined. Thus, if the alum stone of La Tolfa be merely lixivated, it yields no salt; but, after calcination, it becomes disintegrated by the gradual action of moisture and the heat of the sun, and then yields its alum by lixivation.

When minerals of an argillaceous nature, contain pyrites or sulphuret of iron, and are roasted, the sulphur is acidified by the oxygen of the air, which may be gradual; but the sulphuric acid, thus produced, does not unite with the iron—it combines with the alumina.

When the argillaceous mass is sufficiently disintegrated, the alum is extracted by lixivation, a due quantity of potash is added, and the salt is crystallized.

Alum has been manufactured in a very large quantity by Dr. Troost, in Maryland, at Cape Sable. It is produced by the decomposition of pyrites, &c.—Cleaveland describes the process as follows: “At Cape Sable, large quantities of pyrites occur in a bed of earthy lignite, from 5 to 12 feet thick, and covered by a sandy alluvion from 15 to 20 feet thick. This ore, being collected into heaps 10 or 12 ft. high, and covering from 4000 to 5000 square feet, soon takes fire; after an interval of 12 or 14 months, the remaining mass is lixivated in large hoppers; the so-



lution, thus obtained, is concentrated by boiling; potash is added, and alum obtained by crystallization. These works have yielded annually about 120 tons of alum."

The presence of pyrites, or sulphuret of iron, in coal, has frequently occasioned spontaneous combustion. Sulphuret of iron, it is known, will absorb oxygen, and, while the sulphur is acidified and the iron oxydized, for the formation of sulphate of iron, if the decomposition takes place in contact with coal, the caloric which is put into a distributable state will set it on fire. The same phenomena ensues in the instance above mentioned, where lignite, in contact with pyrites, is inflamed.

Combustion of this kind produces, by the conversion of the sulphuret into sulphate of iron, not alum, but a salt of iron. This, however, is decomposed by alumina, and produces alum with the addition of potash.

The veins of pyrites, which produced the more ancient conflagrations of the Phlegrean fields, between Naples and Cuma, and which, in some places, are entirely consumed, are remarkable on account of this spontaneous combustion.

Alum is also manufactured in Salem, Mass. The *Salem Observer* states, that the works give constant employment for twenty men. Blue vitriol is also manufactured there. But the manufacture cannot be lucrative, if the "importation of most of the raw materials of which it is composed," as the writer informs us, is to be depended upon, since it is known,



that at Cape Sable it is prepared in abundance by the decomposition of earthy lignite containing sulphuret of iron, where no raw material is necessary to be imported. Alum has been made in other parts of the United States by a direct union of its constituent parts.

The Observer also considers "it a happy coincidence that the interests of this establishment (the Salem) and the interests of commerce, are mutually promotive of each other." To this we may remark, that no manufactory in the country can be efficient and permanent, which depends on raw materials from abroad; we must have them within ourselves, if ultimate success is to crown our labours. Hence the alum works at Cape Sable are *permanent*, and profitable; and hence also many other chemical manufactories in this country, for the same reason, will stand against all foreign competition. With *temporary* establishments the principle may answer, but not with a permanent manufacture.

Alum is acid, and hence reddens vegetable blues. It furnishes octahedral crystals, but will not crystallize without alkali. It is necessary in some of the arts, especially in dyeing, that this salt should be pure, particularly that it ought not to contain either iron, or copper. The former is recognised on adding to a solution of alum ferrocyanate of potash, by the production of the blue ferrocyanate of iron; and copper is known by adding an excess of ammonia.

The most injurious contamination of iron is sul-



phate of iron. To separate it, Mr. Thenard recommends dissolving the alum in boiling water, and agitating the solution with rods as it cools.—The salt is thus reduced to a fine granular powder, which being washed two or three times with cold water, and drained, yields a perfectly pure alum.

Ammonia may be detected in alum by dissolving it in water, and mixing quick lime with the solution, and exposing the mixture to heat in a retort connected with Woulfe's apparatus. The ammoniacal gas will be thus collected, and absorbed by water; and the alkaline water, if saturated with an acid, and evaporated to a dry salt, will give the quantity of ammonia.

There are several varieties of alum. Thus, if ammonia be used in the place of potash, or along with it, previously to crystallization, we have a supersulphate of ammonia and ammonia; and if urine and muriate of potash be used in its fabrication, a variety of alum is formed, which is a mixture of two salts. These bisulphates, if dissolved in water, and treated with gelatinous alumina, will furnish a neutral triple salt, which precipitates in a nearly insoluble state.—This precipitate is what was originally called *alum saturated with its earth*.

Cubic alum is considered a fourth variety of alum, and is formed when an unusual quantity of potash is added to alum liquor. The salt crystallizes in cubes, and contains an excess of alkali.

The aluminous mordant used by calico printers,



which they mix with starch or gum and apply to stuffs by means of blocks, or stamps, is prepared by decomposing alum by acetate of alumina and sulphate of lead. The acetate of alumina is preferable to alum for topical dyeing, for sundry reasons.

### MURIATE OF AMMONIA.\*

Muriate of ammonia or sal ammoniac, is sometimes impure, being contaminated with sulphate of ammonia. This salt, although originally made by sublimation of the soot furnished by the combustion of the fæces of the camel, is now prepared chiefly by the decomposition of sulphate of ammonia by muriate of soda. As an article of commerce, it comes in heads or cakes, being formed in that shape by sublimation; but when dissolved in water, and

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\*The salts of ammonia, with but few exceptions, are soluble in water. When mixed with potash or quick lime, they give the smell of ammonia. If a salt containing magnesia be added, and afterwards phosphate of soda, they give a copious white precipitate. When exposed to heat, they are volatilized, except when the acid has a fixed metal or phosphorous for its base, in which case the acid alone remains. They are not affected by infusion of nut galls, or the ferrocyanate of potash; but they produce with a solution of platinum an orange coloured precipitate. As this precipitate is analagous in appearance to that produced by the same reagent with salts of potash, the presence of muriate of ammonia may be readily shown by adding potash or quicksilver, when the well known ammoniacal smell will become apparent.



crystallized, it forms octahedral, prismatic, and plumose crystals.

The purity of muriate of ammonia may be determined by its volatility ; for when heated, it ought to sublime without leaving any residue. If there should be any residue, and it is necessary to examine it, the best mode is to diffuse it in water, which will take up any soluble salt. This solution may then be examined. The residue may be treated with nitric or muriatic acid, and likewise examined for either earths or metals.

Sulphate of ammonia, which is volatile, and cannot be detected by sublimation, may be recognised by dissolving the sal ammoniac in water, and adding muriate or nitrate of barytes. If mixed with pure potash or lime and distilled, sal ammoniac should yield ammoniacal gas, and nothing remain in the retort but muriate of potash, or muriate of lime.

Muriate of ammonia has been found native but containing foreign matter, and is frequently yellow from the presence of sulphur.

## CARBONATE OF AMMONIA.

Carbonate of ammonia presents at least two varieties ; the common, sometimes called the subcarbonate, and the bicarbonate. The former is the *sal volatile ammonia* of the shops. It is considered by professor Brande as a *hydrated carbonate of ammonia* ; or rather, that in the decomposition of muriate



of ammonia by carbonate of lime, the process always made use of, the hydrated carbonate is formed. When carbonate of ammonia, having a pungent odour, is exposed to the air, it loses its odour, ceases to redden turmeric or render blues green, and becomes an hydrated bicarbonate of ammonia. Hence there are three carbonates of ammonia.

Carbonate of ammonia, when pure, is entirely volatilized. If it should contain any muriate of ammonia, by solution in water, and the use of the tests for muriatic acid, it may be detected. After having exposed a portion of the carbonate to heat, the residue if any, must be examined. It may contain carbonate of potash, or carbonate of lime, or both. The former will be indicated by an alkaline taste, and, when dissolved, affording the usual phenomena with tartaric acid, and muriate of platinum. Carbonate of lime may be proved by making a solution in acetic acid, noting the effervescence, and adding the tests for lime. Both these impurities are more likely to occur, if the carbonate be purchased in powder instead of the lump.

If the alkali be saturated with nitric acid, and the usual tests added, sulphuric and muriatic salts, lime and iron, if present, may be recognisad.

### CARBONATED LIQUID AMMONIA.

*The solution of carbonate of ammonia, or carbonated liquid ammonia, is usually prepared by distilling muriate of ammonia and carbonate of potash.*



It is the *common water of ammonia*, or *spirit of sal ammoniac*. The preparation of ammonia, called the *liquor ammonia subcarbonate*, of the London Pharmacopæia, is a solution of the carbonate in water, in the proportion of 4 ounces to a pint of fluid.

The specific gravity of the liquor of carbonate of ammonia should be 1.150. With acids it should effervesce, and when mixed with alcohol occasion a strong coagulation. This coagulation of a completely saturated watery solution of carbonate of ammonia by alcohol, is called the *offa alba Helmonti*.

### WATER OF PURE AMMONIA.

The *solution of pure ammonia in water*, *liquor ammonia*, *caustic ammonia*, *ammonia fluor*, &c. is prepared by distilling muriate of ammonia and quicklime, or by saturating water with ammoniacal gas as it proceeds from the same mixture. As this water of ammonia should be nothing more than a combination of pure ammonia and water, the presence of the least portion of carbonic acid, for instance, would destroy a part of its strength or pungency, and of course, lessen the quantity of real uncombined alkali. The water should be fully saturated with the gas.

To determine the presence of carbonic acid, we need only add a portion of muriate of lime, which is not decomposed by pure ammonia. If a precipitation takes place, it will indicate its existence, as a carbonate of lime will be formed. The presence of saline matter may be detected by saturating the alka-



li with nitric acid, and applying the tests for muriatic and sulphuric salts. The specific gravity of the pure water of ammonia should be as 905 to 1000 at 60 deg. Faht. A saturated solution is 0.875, water being 1000. Water at 50 degrees absorbs 670 times its volume of ammonia.

In considering the preceding preparations, viz, carbonate of ammonia, carbonated liquid ammonia, and water of pure ammonia, we perceive some important differences. Carbonate of ammonia of the shops, or volatile salt of ammonia, vulgarly called smelling salts, is prepared by subliming a mixture of about equal parts of muriate of ammonia, and carbonate of lime; in which we form, by double decomposition, carbonate of ammonia and muriate of lime; the first sublimes, and the last remains at the bottom of the sublimer. When, however, a mixture of muriate of ammonia, carbonate of potash, and water are distilled, muriate of potash and carbonate of ammonia are formed; and the latter will be held in solution with any free ammoniacal gas: but if, in the place of carbonate of potash, we use quicklime or caustic alkali, or receive pure ammoniacal gas in water, the water of pure ammonia will be the product.

As muriate of ammonia is thus decomposed by potash and quicklime, and the ammonia disengaged either combined with carbonic acid, if the carbonate of potash be used, or in a free state; an extemporaneous smelling bottle, equally pungent with the concrete volatile alkali (carbonate of ammonia,) may



be prepared by simply mixing these substances together, and introducing them into a phial. We mention this fact although it may have occurred to you, to show, that if the pungency of the alkali be all that is required, to stimulate the olfactory nerves, and no carbonate of ammonia, or liquid ammonia at hand, sal ammoniac may be advantageously substituted.



the present time, and in the future, the  
people of the world are to be  
taught to love one another, and  
to live in peace and harmony.  
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## LECTURE VI.

### NITRATE OF AMMONIA.

Nitrate of ammonia, a salt formed by saturating diluted nitric acid with carbonate of ammonia, and evaporating the fluid, should be free from muriatic and sulphuric acid, and, therefore, neither contain muriate nor sulphate of ammonia. It is this salt which is used for the preparation of nitrous oxyde, or protoxyde of azote, called also the *exhilerating gas*. When purchased in the state of salt, for the purpose of experiment, it would be as well to examine it before using it. Solution in water, and the addition of nitrate of barytes and nitrate of silver, to separate portions of the solution, will be sufficient for that purpose. The nitric acid should be completely saturated, which may be known by the taste, and the use of litmus paper. Nitrate of ammonia contains a variable quantity of water in its crystals. It ought to be decomposed *entirely* at 500 deg. furnishing by its decomposition water, and nitrous oxyde.

Should there be any residue after the action of heat, it may be regarded as an impurity, and proba-



bly a fixed salt, the nature of which may be known by experiment.

### SPIRIT OF HARTSHORN.

Spirit of hartshorn is a fluid containing variable quantities of carbonate of ammonia (or Sal. C. C.) in solution, impregnated with Dippel's animal oil. It is frequently mixed with the carbonated water of ammonia, and often with the *aqua ammonia puræ*, not only to increase its pungency, but to enable it to bear dilution with water. This fraud is rather difficult of detection. With the spirit of hartshorn alcohol occasions a very copious coagulation, owing to the presence of carbonate of ammonia; but if, on adding the alcohol, no considerable coagulation ensues, an experiment which ought to be made by way of comparison with some genuine spirit of hartshorn, the sophistication is proved. Spirit of hartshorn should have the specific gravity of 1.500. The addition of acids which has been recommended to detect the presence of the pure water of ammonia, or rather the non existence of carbonate of ammonia, by not producing an effervescence, is altogether falacious; for, although the spirit of hartshorn may contain the pure water of ammonia, yet the carbonate is always present, and of course would effervesce.

Spirit of hartshorn, although originally prepared from the horn of the hart, is now furnished by the distillation of bones. Bones consist essentially of gelatin and phosphate of lime, and when charred furnish



*bone black*, or, when burnt, *bone ash*; but when submitted to destructive distillation, they are also decomposed, and furnish other products arising from a new arrangement of elementary principles. Thus it is, that we obtain an impure volatile alkali, contaminated with animal oil, more or less empyreumatic, and a considerable quantity of the salt of hartshorn, now called carbonate of ammonia. The liquor first obtained is redistilled before it is fit for use. It is more economical, and the ammonia obtained much purer, by distilling muriate of ammonia with quick lime, or potash. The product is then either the water of pure ammonia, or the carbonated water of ammonia. The only possible difference is, that in the spirit of hartshorn there is a portion of Dippel's animal oil, one of the products of the distillation of bone. Spirit of hartshorn is now economically made, at the same time that bone is carbonized in iron cylinders.

### ACETATE OF AMMONIA.

The acetate of ammonia, or the *spirit of mindererus*, should be prepared by saturating distilled vinegar with carbonate of ammonia. When prepared with coloured vinegar, as for instance the cider vinegar, the fluid is of a very dark colour. The vinegar as well as the distilled, should be free from foreign acids, and the ammonia from foreign alkali.—This fact may be learned by employing the necessary reagents.



## SULPHATE OF LIME.

Sulphate of lime is a mineral, which occurs abundantly either crystallized, foliated, or compact. Selenite, or the foliated subspecies, presents some varieties, as the massive and acicular : gypsum includes all those varieties having a granular or fibrous structure, whose texture is compact and earthy ; and plaster-stone, or plaster of paris is a subspecies which is found near Paris, at Montmartre.

Sulphate of lime often occurs in spring water, to which its *hardness* is generally attributed. See *Water*.

It will be recollected, that some calcareous stones, as the carbonates, comprehending lime-stones, chalks, marble, stalactites, pearl-spars, marls, testaceous tufas, &c. are soluble in nitric and muriatic acid, and are recognised by their effervescence, and the solution producing an insoluble precipitate, (oxalate of lime,) with oxalate of ammonia ; but the combination of lime with sulphuric acid, if pure, neither effervesces, nor is soluble in acids. The examination of gypsum, or compounds of sulphuric acid and lime, is usually effected by boiling one part with four times its weight of carbonate of potash, in a sufficient quantity of water, and separating the insoluble mass, which now consists of carbonic acid and lime. This mass is then to be dissolved in diluted nitric acid, and the nitrate of lime evaporated to dryness, and its weight ascertained. On this nitrate more than half its weight of strong sulphuric acid is



to be poured, and heat applied till all the fumes (nitric acid vapour,) cease to appear. To the dry sulphate, thus obtained, add twice its weight of cold water, filter off the fluid, and expose the residue to a dull red heat. The quantity of lime may be estimated, by deducting from the weight of the insoluble mass 59 parts. The nitrate of lime may be exposed to a red heat for some hours, when it will be converted into quick lime.

Plaster-stone, properly so called, is preferred as a cement, owing to the presence of carbonate of lime, which amounts to about 17 *per cent.*; and, in fact, to make a good cement with calcined sulphate of lime, a certain quantity of quick lime must be added. Plaster-stone differs from the gypsums in that respect, and hence it slightly effervesces with acids.

Sulphate of lime is used for various purposes:—when ground, and strewed over land, it facilitates vegetation, and is, therefore, extensively used by farmers: when granular, pure, and compact, it is used in the imitative and ornamental arts by the name of alabaster; which, however, is not to be confounded with common calcareous alabaster; but works made of it, as busts, statues, &c. are less durable and less valuable than marble: when exposed to the action of heat, the water, which is generally from 18 to 22 *per cent.* is dissipated, and calcined gypsum or plaster is obtained. The water of crystallization, or which constitutes a component part of gypsum, exists invariably in the varieties we have mentioned;



but in the anhydrous sulphate, there is a total absence of water of crystallization.

Calcined gypsum recovers its original hardness when mixed with water: hence its use in casting statues and busts in moulds, for stucco and various other ornamental work, and for taking impressions of medals and coins. The finer kinds of sulphate of lime, as selenite, furnishes the best plaster; it is usually mixed with gum water, after being pulverised; but for coarser work this is not indispensable.

Stucco may be coloured, by previously mixing with the plaster and water different pigments.

Sulphate of lime, when calcined, should be kept from the air, as it absorbs moisture, and is thereby injured; indeed the time required for *fixing* it, when used, is only a few minutes, and the operator is obliged to be expeditious. The calcination of gypsum may be readily performed in a common iron pot placed over a fire.

In selecting the gypsum, it should be as free from colour as possible; for some, it is known, contains variable quantities of oxyde of iron, which cannot fail to injure the whiteness.

In the calcination of plaster-stone, as it contains carbonate of lime, it is obvious quicklime is also produced: when this kind of plaster solidifies, the water not only unites with the sulphate of lime, but also with the lime, forming a hydrate of lime, which, like a similar compound in mortar, gradually absorbs carbonic acid. The stucco work, nevertheless, is not impaired, although the presence of quicklime is



better adapted when the plaster is employed as a cement. Free caloric is given out during the combination of the water.

If sulphate of lime should effervesce, an indication of carbonic acid, we may generally infer the presence of carbonate of lime. Its quantity may be known by weighing a given portion, and digesting it in muriatic acid, which will dissolve the carbonate of lime, and ascertaining the amount of residue and deducting it from the original weight; or the lime may be thrown down from the muriatic acid by carbonate of potash, and the carbonate of lime exposed to the action of heat, and the quicklime weighed.

### ACETATE OF LIME.\*

Acetate of lime may be prepared by saturating common vinegar with lime, but is generally made by saturating the vinegar formed during the distillation of wood, and which, in that case, contains more or less empyreumatic oil. Should it contain the latter, it may be known both by its smell and taste. When

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\*The salts of lime, for the greater part, are insoluble in water; and some, which are soluble, cannot be crystallized.—When a salt of lime is insoluble, it is necessary to decompose it, by boiling it with a solution of carbonate of potash. The soluble salts remain uncharged with pure ammonia, but are precipitated by potash or soda. Oxalate of ammonia occasions a white precipitate. Citrate or tart rate of ammonia has the same effect, but not so immediately. They are not precipitated by ferrocyanate of potash; but infusion of nut galls affects some of them.



gently torrefied this *smell* is said to be removed.—The salt, if then decomposed by sulphuric acid in distillation, will furnish a colourless and grateful vinegar. When acetate of lime is mixed with a solution of alum, an acetate of alumina will be formed, and remain in solution. The acetate of lime should be entirely free from iron. The presence of this metal may be shown by tincture of galls, and by ferrocyanate of potash. Acetate of lime when mixed with sulphate of soda, will produce sulphate of lime and acetate of soda. The latter may be separated from the sulphate of lime by filtration, and decomposed by sulphuric acid.

### ACETATE OF ALUMINA.

Acetate of alumina, a preparation used very extensively by the calico printers as a mordant, is prepared by decomposing the acetate of lime, or acetate of lead, by a solution of alum. Sulphate of lead is precipitated in the latter instance, and sulphate of lime in the former. It is of importance that this salt should be pure, and free as well from iron, as from lime and magnesia. The detection of these substances may be severally effected by using the tincture of galls, oxalate of ammonia, and carbonate of ammonia, with phosphate of soda.



## ACETATE OF IRON.\*

The acetate of iron is a salt much used in dyeing. There are two salts of this kind; the proto acetate and per acetate. The first is formed by digesting sulphuret of iron in acetic acid, and the second by digesting metallic iron. The calico printers and dyers usually prepare their iron liquor by dissolving iron in pyroligneous acid, or by mixing the solutions of acetate of lead and sulphate of iron. The iron liquor should not contain any sulphate of iron, which may be known by adding muriate or acetate of barytes. Iron liquor is preferred in many operations of dyeing to any other salt of iron.

## ACETATE OF ZINC.†

Acetate of zinc is formed either by dissolving the

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\* The salts of iron are characterised in general by their solubility, the solution having a greenish or yellowish red colour, and an astringent taste. Ferrocyanate of potash occasions a blue precipitate, or which becomes blue by exposure to the air. Aqueous sulphuretted hydrogen produces no precipitate in the proto-salts, but render the solution nearly colourless, whereas the hydrosulphuret of potash with all the salts of iron, occasions a black precipitate.

Gallic acid, or the infusion of nut galls, produces a black or purple precipitate, at least if the solution has been for some time exposed to the air.

Phosphate of soda occasions a white precipitate. Succinate of ammonia with the peroxydized salts, gives a flesh coloured precipitate, which effect is not produced with the proto salts.—Benzoate of ammonia gives a yellow precipitate with the per-salts.

† The salts of zinc, for the greater part, are soluble in water.



oxyde of zinc in acetic acid, or by decomposing the sulphate of zinc with acetate of lead. The acetate of lead should be entirely decomposed, as well as the sulphate of zinc; neither of which should exist with the acetate. Some of the acetate may be dissolved, and the solution examined for sulphuric acid, if it should contain sulphate of zinc; and for lead, if the acetate of that metal should be suspected.

### ACETATE OF LEAD.\*

Acetate of lead, or sugar of lead is formed by dissolving the white oxyde or carbonate of lead in acetic acid. It is sometimes called a super acetate, but the salt is neutral. When dissolved in water, and the smallest portion of carbonic acid is present, a

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and the solution is colourless and transparent. The effect of reagents are: ferrocyanate of potash produces a white gelatinous precipitate; hydrosulphuret of potash and sulphuretted hydrogen gas, a white precipitate; infusion of nut galls no precipitate; alkalies occasion a white precipitate soluble with ease in sulphuric or muriatic acid; zinc is not precipitated in a metallic form by any of the other metals; but sulphocyanate of potash and hydriodate of potash produces, respectively, a white precipitate.

\* The salts of lead are recognised by some of them being soluble, and others insoluble in water, without an excess of acid; by their yielding very readily a button of lead before the blow pipe; by their more or less sweet taste, accompanied with some degree of astringency; by the production of a white precipitate with the ferrocyanate of potash, and a black precipitate by hydrosulphuret of potash and aqueous sulphuretted hydrogen; by a white precipitate with gallic acid, and the infusion of nutgalls; and by the precipitation of lead in a metallic state by a plate of zinc, forming the lead tree. See *Adulteration of Wine*.



white insoluble compound of lead falls, a little acetic acid is liberated, and the solution then becomes sour. Water containing sulphates and muriates in solution, affect acetate of lead, by producing a turbidness more or less great.

What is called the subacetate is the same as the *Goulard's extract of lead*, which is usually made by dissolving litharge in vinegar. If litharge be boiled with sugar of lead, the same compound is formed.

If the acetate of lead should be adulterated with acetate of lime, or acetate of barytes, they may be detected by adding to a diluted solution oxalic acid for lime, and sulphuric acid for barytes. Acetate of lead ought to be entirely soluble in water. When distilled with sulphuric acid, it should furnish acetic acid, or radical vinegar, and sulphate of lead remain in the retort. If any other metal, besides lead, be suspected, the fact may be proved by treating it with the usual reagents.

## SULPHATE OF ZINC.

Sulphate of zinc, or white vitriol, is obtained pure by dissolving zinc in diluted sulphuric acid. The common sort often contains iron, and is of a dirty yellow colour. The iron may be detected by tincture of galls.

If sulphate of zinc be dissolved in water, and liquid ammonia added to the solution, the oxyde of zinc and oxyde of iron will be precipitated; but on adding an excess of ammonia, the former will be ta-



ken up, leaving the latter; and, if no residue be left we may then infer that the salt was free from iron. The oxyde of zinc may be separated from the ammonia by the addition of an acid.

Sulphate of zinc may be easily purified by dissolving it in water, and putting into the solution a quantity of zinc filings. The zinc precipitates the foreign metals, and takes their place. The solution is then to be filtered, evaporated, and crystallized.— Besides iron, sulphate of zinc is often contaminated with copper and lead, which may be detected by the usual reagents. In consequence of these foreign substances, sulphate of zinc is usually coloured, and, when dissolved in water, lets fall a dirty brown sediment.

It is generally formed in the large way by roasting sulphuret of zinc, or blende, by which the sulphur is acidified; then dissolved in water, and the solution filtered, evaporated and crystallized.

### SULPHATE OF IRON.

Sulphate of iron, green vitriol or copperas is a sulphate of iron, with the iron oxydized to the minimum. It is the proto sulphate of iron, and crystallizes in green rhomboidal prisms. It is usually formed by the decomposition of pyrites, or sulphuret of iron, and is prepared also by the solution of iron in diluted sulphuric acid. It is also found native, but the native salt is rare, and generally impure. The other salt of iron is the per sulphate, commonly called the red sulphate of iron.



Copperas or sulphate of iron is manufactured in Vermont, at Strafford, from pyrites. The pyrites is found with quartz. It is broken into small fragments, and thrown into a heap. On applying water the decomposition commences, and so much heat is evolved, as presently to raise the temperature of the heap to such a degree as to char wood, boil water, sublime sulphur, &c. Sulphurous acid gas, we are told, is disengaged in abundance. In the course of three or four weeks the whole is disintegrated, and ready to fall into the state of powder. It is then lixivated with water, and the solution evaporated and crystallized. The process is well described by Dr. Locke, in a communication in Silliman's Journal iii. p. 326, who remarks, that the iron pyrites contains some sulphuret of copper, and hence the lixivum is impregnated with sulphate of copper, which is decomposed by suspending in the liquor some fragments of old iron. The copper, thus separated, the workmen call "copper mud." Four men, it seems, manufacture 100 tons of copperas in a year, besides attending to other employment. Some of the decomposed sulphate of iron is found native, a barrel of which it is stated, furnishes 333lbs of copperas!

Copperas was manufactured in Lancaster, Pa. during the revolution, from the cubic pyrites, called in that neighbourhood Lancaster *jack stones*: the pyrites were first roasted, then exposed to air and lixivated, &c. in the manner already mentioned. The process is fully detailed in Dr. Pennington's *Chemical Essays*, written in 1793. Iron pyrites occur in



abundance in the United States, but we have heard of few establishments for the manufacture of cop-peras.

It is very certain, that as the process is by no means complicated, nor expensive, and pyrites so abundant in certain parts of the United States, the manufacture of sulphate of iron would be advantageous. It is to be recollected that an extensive bed or mass of pyrites is found at Cape Sable, accompanying earthy lignite, from which many tons of alum have been made. See *Alum*. When these pyrites are exposed to the air, they gradually decompose, and combustion ensues.

Sulphate of iron is scarcely ever adulterated.— Sometimes the presence of sulphate of copper is suspected, which may be detected by solution in water, and the addition of ammonia in excess. The vitriol may be purified, and the copper completely separated by immersing a plate of iron. Metallic copper will be precipitated.

### RED SULPHATE OF IRON.

The *persulphate of iron*, in which the red oxyde is combined with sulphuric acid, does not crystallize, but furnishes a deliquescent mass of a brown colour. This salt should contain none of the green sulphate. A mixture of the two salts I have imperfectly detected, and separated, by crystallization; the red sulphate constituting the mother water. Unless the crystals are soon separated they disappear. The



persulphate forms the most intense colour with an infusion of galls ; and in that respect is preferable to the common sulphate for the preparation of ink and black dye. The red sulphate is produced in the mother waters of the sulphate. The red sulphate may be formed very advantageously by treating the green sulphate with nitric acid.\*

\* Having mentioned writing ink, it may not be amiss to add, that ordinary ink powder, from which ink is prepared by infusing it in vinegar and water, is merely a mixture of powdered galls, green vitriol, and gum arabic. The proportions are two ounces of galls, half an ounce of vitriol, and a drachm of gum. These proportions will make a pint or more of ink. Although the per oxyde of iron, and consequently the per salts of iron, furnish the most intensely black ink, which was formerly supposed to be nothing more than a combination of gallic acid and oxyde of iron, yet it is now known, that ink also owes its blackness to the presence of tannin, which is likewise in combination ; hence, strictly speaking, writing ink is a tanno-gallate of iron. By substituting the persulphate of iron, for the common sulphate, in the same proportion, I have succeeded in forming a very brilliant black. The ancient writing ink, which was so indestructable, had a carbonaceous basis, and in that respect resembled our modern printing ink. Dr. Lewis (*Phil. Com.* p. 377,) made a number of valuable experiments on the formation of writing ink. He found the fullest black was produced, when equal weights of galls and sulphate of iron were used ; but the ink soon fades. To make it permanent the galls ought to be thrice the weight of the vitriol. The addition of logwood increases the blackness of the ink. The following recipe is recommended by Dr. Lewis for making the best ink :

Logwood,	1 ounce.
Nutgalls in powder,	3 do.
Green vitriol,	1 do.
Water	1 to 2 quarts.



## PROTOMURIATE OF IRON.

When iron filings are dissolved in muriatic acid, and air excluded, the *protomuriate of iron* results; and by exposure to air, or the addition of a little nitric acid, it is changed into the *per muriate*. This per muriate forms the basis of the *tinctura ferra muriatis* of the London Pharmacopæia. If sulphate of iron should be suspected in either of the muriates, owing to the use of an impure acid, it may be known

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The logwood and nutgalls are to be boiled together, adding more water as it evaporates; then strain the decoction, and add the vitriol, after which one to two ounces of gum arabic. In the recipe given by Brande, (*Chemistry*, p. 506, Am. edit.) 3 ounces of galls, and one ounce each of green vitriol, logwood shavings, and gum arabic are infused in a quart of vinegar, digested for several days, and strained for use. Three grains of corrosive sublimate to every pint of ink, will prevent it effectually from becoming mouldy; more so, in fact, than cloves.

The colour of writing ink is apt to fade by age. It may be restored by washing the writing with an infusion of galls. Acids destroy ink; but to prevent, in a measure, this effect, and otherwise improve ink, Mr. Brande recommends the addition of an ounce of Indian ink to the above quantity of materials.

Accum (*Chem. Amus.* p. 251,) observes, "that we have at present no ink of a similar kind, equal in durability and colour, to that used in former times, as will at once become obvious by an inspection of many of the MSS. written in England in the time of the Saxons." Mr. Close, (*Nich. Journ.* 8 vo. ii. 145,) however, has proposed an indelible writing ink made by dissolving with the assistance of heat, 25 grains of gum copal in powder in 200 grains of oil of lavender, and mixing this solution with 2 1-2 to 3 grains of very fine lamp-black. This composition is particularly useful for writing the labels of bottles.



by diluting it with water, and adding thereto muriate of barytes.

## MARTIAL FLOWERS.

The *flores martiales*, or the present *ferrum ammoniatum* of the Pharmacopœia, which is prepared by subliming a mixture of muriate of ammonia and per oxide of iron, may be examined for copper, if there is reason to suspect the presence of that metal. This preparation of iron consists chiefly of muriate of ammonia and per muriate of iron.

## NATIVE PRUSSIAN BLUE.

The mineral called native Prussian blue, which sometimes occurs in the form of a blue earthy powder, is the same as the protophosphate of iron, and is employed occasionally as a pigment.

The colour may be weakened by sundry additions; the presence of which is shown by experiment.

The proportion of phosphoric acid may be learned by dissolving the mineral in nitric acid, and adding acetate of lead, which will form a phosphate of lead, and from the weight of the phosphate the quantity of phosphoric acid is determined. The iron may be separated from the nitric acid by ferrocyanate of potash, &c.

The native blue phosphate of iron, blue iron earth, or native Prussian blue, is impure; containing more



or less alumina, and some silica. When first taken out of the earth, as in the locality in New-Jersey, an account of which I published in Bruce's *Mineralogical Journal*, it has an argillaceous feel, and a milky appearance; but, by a short exposure to the air, becomes blue, owing, in all probability, to the absorption of oxygen. It is then dry, and the pieces when broken represent a uniformity of colour, and, in some instances, are remarkably friable, crumbling to pieces between the fingers. In this state, however, it is easily ground, and mixed with oil. The alumina, doubtless, makes a good basis for the phosphate of iron, in the same manner as in the Prussian blue of commerce. If pulverised very fine, and mixed with gum, or size, it will form a very good water colour; not equal, however, to the perferrocyanate of iron, which is the blue pigment usually employed for that purpose. For an account of *Blue Pigments*, see a preceding lecture.

### MURIATE OF GOLD.

Muriate of gold, a salt lately introduced in medicine in syphilitic diseases, but without any decided advantages, is prepared by dissolving gold in nitro muriatic acid, and evaporating the solution. The muriate, if pure, should be wholly soluble in water; decomposed by phosphorous and charcoal; precipitated in the state of *purple powder of Cassius* by protomuriate of tin; and the gold obtained in its metallic state by the protosulphate of iron. It should also



be entirely decomposed by æther, forming an *æthereal solution of gold*.\*

### NITRATE OF SILVER.†

Nitrate of silver or *lunar caustic* is readily formed by dissolving silver in nitric acid. It may be observed, that if the nitric acid contains the muriatic, muriate of silver will be produced, and render the solution turbid. If the silver contains copper, the solution will have a greenish hue; and if it contained gold, it will remain undissolved in the form of a black powder.

Nitrate of copper is frequently found in this salt,

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\* When sulphuric æther is mixed with a solution of muriate of gold, the æther reduces the gold, which remains in solution forming the *æthereal solution*, and the muriatic acid thus separated forms a distinct fluid containing very little gold. This solution of gold is used as an easy method of gilding steel. When highly polished steel is immersed in it, a coat of gold is formed upon it, and the æther evaporates. By means of a brush, figures may be delineated on polished steel instruments, as on razors, scissors, pen knives, &c. In this way, the points of thumb lancets may be preserved from rust. The steel should be immersed into water the moment it has been gilt.

† The salts of silver are readily reduced before the blow pipe on charcoal. A plate of copper precipitates the silver in a metallic state, so does also a solution of sulphate of iron. Ferrocyanate of potash occasions a white precipitate; hydrosulphuret of potash a black; muriatic acid and alkaline muriates a white precipitate resembling curd; and gallic acid, and infusion of nut galls, a yellowish brown precipitate, in most of the solutions of silver.



either derived from impure silver, or intentionally added. Copper is detected by dissolving the salt in pure water, and adding to the solution an excess of pure ammonia.

The watery solution of lunar caustic, occasions, with muriate of soda, a copious precipitate resembling curd.

The whole of the silver is separated from the nitrate, by immersing a plate of copper, and nitrate of copper is produced.\*

### TARTRATE OF POTASH-AND-ANTI-MONY.

The *tartar emetic*, *tartarized antimony*, or *antimoniated tartrate of potash*, but more properly the *tartrate of potash-and-antimony*, is a triple salt formed by saturating the bitartrate of potash with oxyde of antimony.

Tartar emetic should crystallize in an octahedral and tartrahedral form. It is decomposed by the al-

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\* In consequence of the solubility of silver in a preparation of sulphuric acid, made by dissolving one pound of nitre in eight or ten pounds of sulphuric acid, this compound has been economically employed for recovering silver from old, plated goods. It is said to dissolve about one fifth of its weight of silver, but does not act upon copper, lead, or iron. The acid should be kept at a temperature of between 100 deg. and 200 deg. Fah't. and the plated copper added in small pieces, frequently stirring the acid. The silver is separated by muriate of soda, and the muriate of silver, thus formed, reduced by fusion with carbonate of soda.



kalies; by sulphuretted hydrogen and hydrosulphuret of ammonia, which produce orange coloured precipitates; and by bitter and astringent vegetable infusions, but they do not render it inactive as a medicine. It will be sufficient, however, to add, that with acetate of lead it should produce a precipitate completely soluble in dilute nitric acid, and with sulphuret of ammonia a gold coloured sulphuret of antimony.

The tartar emetic, which is sold in a pulverised state, may contain both sulphate and tartrate of potash. In that case, with regard to the sulphate, solution in water, and the addition of muriate of barytes, and insolubility of the precipitate in muriatic acid, will determine the fact. The presence of iron, copper, &c. may be readily detected by the usual reagents. If sulphate of zinc, or white vitriol, be suspected, the zinc may be rendered manifest by first adding ammonia, which will precipitate the protoxyde of antimony, along with the oxyde of zinc, as well as some other metals, if present. If we continue to add ammonia as long as any thing is taken up, the residue will consist of oxyde of antimony, &c. and may, if required, be examined. The ammoniacal solution, if it contains oxyde of zinc, will occasion a precipitate if nitric or muriatic acid be gently added; or, by evaporation, the oxyde of zinc will be deposited.

The protoxyde of antimony is fusible and volatile at a red heat.

When tartar emetic is dissolved in water, it may



be well to observe, that the acids, as sulphuric, nitric, and muriatic, poured into it, precipitate a bitartrate of potash. When tartar emetic is exposed to a red heat, it first blackens, and afterwards leaves a residuum of metallic antimony and subcarbonate of potash. "From this Phenomena," says Dr. Ure, in his edition of Nicholson's *Chemical Dictionary*, "and the deep brownish red precipitate, by hydrosulphurets, this antimonial combination may readily be recognised." The precipitate, if dried on a filter, and heated with black flux, will give a globule of metallic antimony.

Galls, in the form of infusion, are said to be an active precipitant of tartar emetic. It is said to separate only an oxyde of the metal. When a plate of iron or zinc is plunged into antimonial solutions, a black powder precipitates in great abundance.

Tartar emetic has been employed in the fabrication of spurious ipecacuanha; which is either put to the common ipecacuanha to increase its strength, especially if old, or added in certain quantities to pulverised roots, which resemble the ipecac. The fraud may be discovered by infusing the suspected ipecacuanha in water, which will take up the tartar emetic, and by the use of reagents.

Although tartar emetic may be purchased in a crystallized state, yet the fact is well known, that the crystallized salt is not uniform in its constitution.—It is, therefore, always advisable to pulverise it, if bought in that state, before using it.



## MURIATE OF ANTIMONY.\*

When the oxyde of antimony is combined with muriatic acid, a muriate of antimony is formed, which was formerly called the *butter of antimony*. The particular character of this salt is, that when mixed with water it is decomposed, and forms a white precipitate, formerly known by the name of *Algoroth's powder*, and considered by some a submuriate, and by Brande as a hydrated protoxyde of antimony.—The muriate of antimony is a deliquescent salt, and is a powerful caustic. The precipitate obtained by water, has been used for the preparation of tartar emetic. Iron may be detected as before mentioned.

## VITRIFIED SULPHURETTED OXYDE OF ANTIMONY.

The *glass of antimony*, or vitrified sulphuretted oxyde of antimony, is very liable to adulteration, and particularly with the glass of lead; a fraud which

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\* The salts of antimony have the following distinguishing properties: Their solutions are usually brown, and are frequently decomposed during solution in water, a white precipitate being formed.

Ferrocyanate of potash occasions a white precipitate, which is merely an oxyde of the metal. When concentrated, no precipitation takes place. Hydrosulphuret of potash produces an orange coloured precipitate. Gallic acid occasions a white precipitate, which is merely, in the opinion of some, the oxyde of the metal separated by the water of the gallic acid. A plate of iron or zinc precipitates a black powder. See the detection of *Antimony*.



was largely practised upon the London druggists.— It was imported from Germany and Holland. This adulteration is easily detected by dissolving the finely powdered glass in hot nitric acid, diluting the solution and filtering it. If the filtered liquor be now mixed with a solution of sulphate of soda, a white precipitate of sulphate of lead, if lead were present, will be obtained.

Mr. Luke Howard, who paid much attention to this adulteration, as appears from his observations in the *Philosophical Magazine*, xxxv. 236, in substance, that glass of antimony has a rich brown or reddish colour, with the usual transparency of glass; that the glass of lead is duller, much less transparent, and even sometimes opaque; that the specific gravity of the true never exceeds 4.95, while that of the spurious is 6.95, or comparatively as 5 to 7; that the true dissolves with an hepatic smell in muriatic acid, and the solution is turbid without a sediment, whereas the spurious turns the acid yellow, giving out the odour of chlorine, and leaving much sediment; that when a little of each solution is dropped separately into water, the true deposits oxyde of antimony in a copious white coagulum, and is likewise precipitated by sulphuret of ammonia of an orange hue, while the spurious gives no precipitate in water, neither does it give an orange precipitate, but affords one of a brownish black; that the spurious produces with acetic acid a sweetish salt, having the properties of acetate of lead; and that even a very small mixture of the spurious may be known by its delasing, more



or less, the *bright orange* colour of the precipitate occasioned by sulphuret of ammonia.

### CROCUS OF ANTIMONY.

When the protoxyde of antimony is combined with larger quantities of the sulphuret, the compound called the *crocus of antimony*, *liver of antimony*, &c. is produced. This preparation is largely employed in the manufacture of tartar emetic.

Should it be sophisticated with red lead, the fraud may be detected by dissolving it in acetic acid, filtering the solution, and adding a solution of sulphate of soda, which will throw down a white precipitate.

Sulphuretted hydrogen, while it produces with antimony an orange coloured precipitate, forms with lead a precipitate more or less black.

### PRECIPITATED SULPHURETTED OXIDES OF ANTIMONY.

*Kermes mineral*, the *golden sulphur of antimony*, and the *precipitated sulphur of antimony*, are preparations of the same mineral. They are made either by dissolving the alkaline sulphuret of antimony in water with heat, and allowing the *kermes* to precipitate as the fluid cools; or by adding to the antimoniated alkaline sulphuret, even after the separation of the *kermes*, dilute sulphuric acid, which produces a precipitate of a *golden colour*. A hydrosulphuretted oxyde is produced in the first instance, and a



sulphuretted hydrosulphuret in the second. When the acid is added, it will be sufficient to observe, that the sulphur falls in combination with the kerme's that remains in solution, and sulphate of potash is also produced. The precipitates should be well washed; the former, to separate any alkaline sulphuret that may be attached to it, and the latter, to wash off the sulphate of potash.

Kerme's mineral and golden sulphur of antimony, should neither have an alkaline, nor acid taste.— With the microcosmic salt and with borax, before the blow pipe, they should form a hyacinth coloured glass, and emit at the same time a sulphurous or hepatic odour. They ought to be soluble in tartaric acid, as well as in nitric acid, and the solution give with the alkalies a white precipitate. The kerme's mineral, the most expensive of the two, is of a dark brown colour, and is readily known from the precipitated sulphur of antimony. When the black sulphuret of antimony (antimony of the shops,) is treated with a diluted acid, for the purpose of forming *pure* sulphuretted hydrogen gas, there remains in the retort or gas-bottle a large quantity of the golden sulphur of antimony, formed in consequence of the union of the hydrosulphuretted oxyde with sulphur.

## PHOSPHATE OF LIME AND ANTIMONY.

The *antimonial powder*, or *James' powder*, is a phosphate of lime-and-antimony, prepared at present by dissolving the phosphate of lime and prot ox-



oxyde of antimony in muriatic acid, and precipitating them by ammonia. This mode of preparation renders the compound more uniform in its composition, and effects. The old process consisted in calcining hartshorn with sulphuret of antimony, and pulverising the phosphate, which was more or less a mechanical mixture.

James' powder has little or no taste, and is insoluble in water. If mixed with tartar emetic, that salt may be detected by solution in water, filtering the solution, and adding the tests already mentioned.

If it contain chalk, it will effervesce. Muriatic acid will dissolve antimonial powder without decomposition, a mean of ascertaining its purity, which will again be precipitated by ammonia. Phosphate of lime is of itself soluble in muriatic acid; hence, by digesting common bone in that acid the gelatin and alluminous matter will be left, retaining the shape of the bone, while the phosphate of lime will be dissolved.

The addition of ammonia will throw down the phosphate. Hence Mr. Chenevix took advantage of this fact, for the preparing antimonial powder, by making a compound solution of the prot oxyde of antimony and phosphate of lime, and precipitating them together.

### SULPHATE OF MAGNESIA.\*

Sulphate of magnesia, or *Epsom salt* is found in

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\* The salts of magnesia, for the greater part, are very soluble.



mineral springs, as the springs of Epsom, and in sea water; and is frequently made by calcining certain minerals which contain magnesia and sulphur, or sulphuret of iron. It is from this salt that the *magnesia alba* of the shops is prepared.

Epsom salt as it occurs in commerce is often deliquescent, a property which it possesses in consequence of the admixture of muriate of lime and muriate of magnesia, which are known to absorb moisture, and run *per deliquium*.

If a solution of this salt in water be made, we may detect the presence of muriatic acid by the addition of sulphate of silver; and of lime, by using either oxalate of ammonia, or bicarbonate of ammonia, which does not precipitate magnesia. Or we may proceed with the solution as follows: add nitrate of barytes until all the sulphuric acid is separated, then filter the solution and add nitrate of silver. The latter will precipitate the muriatic acid, in combination with the silver. If some sulphuric acid be poured on sulphate of magnesia, containing the muriate aforementioned, muriatic or hydrochloric acid gas will be apparent, not only known by its peculiar

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and capable of crystallizing. They are decomposed by the alkalies, and carbonated alkalies, but not by sulphate of soda, which, more properly, does not occasion any precipitate. Phosphate of soda produces no effect; if, however, ammonia be added a white precipitate then falls, consisting of phosphoric acid, ammonia, and magnesia. Ferrocyanate of potash occasions no precipitate in a salt of magnesia, unless the acid has a metallic base.



smell, but by *white clouds* when a stopper moistened with ammonia is presented to it.

Muriate of soda is not unfrequently found in abundance, mixed with the sulphate of magnesia.—The salt in that state, is not deliquescent. It will, however, occasion a precipitate with sulphate of silver.

There is another salt, which has been discovered in Epsom salt; it is the triple sulphate of magnesia-and-potash. It is sparingly soluble, is less bitter than sulphate of magnesia, and occasions a grittiness in the mouth. But the salt, with which the Epsom is most likely to be adulterated, is sulphate of soda. Even this salt may be made to resemble the magnesian salt in appearance, by briskly agitating it at the moment when it commences to crystallize. If the Epsom consist *wholly* of Glauber's salt, thus irregularly crystallized, the fact may be known by adding carbonate of potash, which, of course, will produce no precipitation. If only a part should consist of sulphate of soda, the solution may be mixed with pure ammonia, and *heat* applied; then separate the precipitate, consisting of the magnesia, by filtration; evaporate the fluid to dryness, and expose the mass to such a heat as will volatilize the sulphate of ammonia, when that of the soda will remain fixed. Ten grains of the dried crystals, or effloresced salt, indicate about twenty-two and a half of crystals.

It is known that about 57 parts of subcarbonate of potash will decompose 100 parts of crystallized sulphate of magnesia, and afford between 35 and 36 of



the dry carbonate. If the salt, therefore, give a *less* proportion of carbonate of magnesia than here stated, we may safely infer the presence of sulphate of soda.

Oxalic acid has been used by mistake for Epsom salt. Its acid taste, and precipitation of lime water will detect it.

### ACID OF BENZOIN.

Acid of Benzoïn, commonly called flowers of Benzoïn, is obtained from the so called *gum benzoïn*, of the shops, by sublimation, by boiling the benzoïn with quicklime, and decomposing the benzoate of lime with muriatic acid. This acid is soluble in 30 parts of boiling water, and very sparingly in cold water. It should have a white colour, and peculiarly grateful smell. When in the least oily it has a dark colour; and, if burnt in the sublimation, an empyreumatic flavour. Benzoïn acid may be purified by solution, filtration, and crystallization. It is soluble in alcohol. When exposed to heat, it ought to evaporate. Any residue may be regarded as an impurity, which may be examined by the usual reagents.

### ACETIC ACID.

Acetic acid or radical vinegar, formed either by distilling the metallic acetates *per se*, or with sulphuric acid, is often contaminated by sulphurous and sulphuric acid. The first gives an unpleasant sensa-



tion, and peculiar smell, which ceases if some black oxyde of manganese be put into it. Sulphuric acid is known by the barytic test; copper, by ammonia, and lead, by the hydrosulphurets. Its specific gravity should be 1.066. See *Vinegar*.

### TARTARIC ACID.

This acid, called also the acid of tartar, is often sophisticated with the bisulphate of potash. It is obtained from cream of tartar by dissolving it in water, and saturating the excess of acid with carbonate of lime; a tartrate of lime is formed, which is decomposed by sulphuric acid; the sulphate of lime is then separated by filtration, and the tartaric acid remains in a fluid state, which may be evaporated and crystallized. As only the excess of acid in cream of tartar is separated by this process, we may obtain the whole of the acid in the remaining tartrate of potash by adding muriate of lime, and treating the tartrate of lime as before; or, instead of using carbonate of lime in the first instance, we may employ altogether muriate of lime, and the products would be muriate of potash and tartrate of lime.

Tartaric acid, we remarked when treating of wine, exists in the grape in combination with potash; and when the must is fermented, is deposited usually with colouring matter in the form of red tartar. This red tartar is also deposited from wine in wine casks. When redissolved, filtered, evaporated, and crystallized, it then forms the white tartar, or crystals of



tartar, which in a pulverised state is our cream of tartar. The bitartrate of potash exists, however, in a greater or less degree in wine; and very frequently the acescency of wine is owing to another acid, the acetic, generated by the acetous fermentation.—See p. 34.

In consequence of the combination of tartaric acid with lime, and the insolubility of the compound, the Greeks and Romans, without knowing its action, used lime or calcined oyster shells to correct the acidity of this wine; a practice still preserved with our modern wine merchants. The use of lead in correcting the acesency, was also known; but the solubility of the lead in wine does not depend on the tartaric acid, although it separates it from the fluid, as the tartrate of lead is insoluble, but on the presence of other acids, as the acetic: sugar of lead when added to sour wine, containing tartaric acid, forms a tartrate of lead; but lead thrown into wine, the acidity of which is owing as well to acetic as to tartaric acid, will be soon corroded, and tartrate and acetate of lead formed; the latter, if all the tartaric acid be taken up, will remain in solution. With respect to the presence of sulphuric acid in tartaric acid it may be shown by dissolving the acid in water, and adding acetate of lead. If an insoluble precipitate should be formed, the presence of sulphuric or muriatic acid, or of both is inferred.

A precipitate of tartrate of lead is always produced, but is known from the sulphate or muriate of lead by its entire solubility in pure nitric or acetic



acid. The precipitate occasioned by the muriate of barytes, should be insoluble in muriatic acid, if sulphuric acid had been the cause of the precipitation.

Tartaric acid when added to solutions of potash, unites with the alkali, and gradually precipitates in the form of bitartrate of potash.

### BORACIC ACID.

Boracic acid, or *sedative salt of Homberg*, is obtained from borax by solution in hot water, and the addition of sulphuric acid. The crystals of pure boracic acid are in small hexangular scales, which are totally dissolved in five times their weight of alcohol. This solution when set on fire should emit a green flame. It has no smell; but, when sulphuric acid is poured on it, a transient odour of musk is produced. Borax is a salt composed of this acid united with soda.

### SUCCINIC ACID.

Succinic acid, or *acid of amber*, is prepared by the distillation, or sublimation of amber. It is purified by forming it into a succinate of lead, and decomposing the succinate by sulphuric acid. The ordinary process is to dissolve it in water, and crystallize repeatedly. In the former case, nitrate or muriate of barytes will show whether any sulphuric acid remains mixed with the succinic solution; and



if so, it may be withdrawn by digesting the liquid with a little more succinate of lead. If tartaric acid be suspected, it may be known by adding cautiously to the solution of acid in water, carbonate of potash, which forms a very difficult soluble bitartrate. If muriate of ammonia be present, nitrate of silver will discover the muriatic acid, and a solution of pure potash the ammonia, by producing the odour of ammonia. And if the acid of amber is soluble in twenty-four parts of cold, or eight of hot water, and is volatilized on a red hot iron without leaving any residue its purity may be inferred.

### SULPHURIC ACID.

Sulphuric acid, *vitriolic acid* and *oil of vitriol*, is an acid formed by the combustion of sulphur.

Sulphuric acid was originally prepared by the distillation of green vitriol. It is now formed by the combustion of sulphur with nitre in leaden chambers, at the bottom of which is placed a quantity of water, in order to unite with, and condense the sulphuric acid. By the combustion of sulphur, in contact with nitrate of potash, sulphurous acid gas is generated, as a part of the oxygen of the nitric acid is thus taken up. The nitric acid is, therefore, decomposed and furnishes also a given quantity of deutoxyde of azote, or nitrous gas. That it is not the nitrous acid vapour, which is disengaged, is evident from the subsequent effect. We have then in the chamber sulphurous acid gas, nitrous gas, and atmospheric air, composed of oxygen and azote. The moment



the nitrous gas comes in contact with the atmospheric air, it seizes its oxygen and forms nitrous acid, which then exists in the state of vapour. The sulphurous acid now decomposes the nitrous acid, in which the water facilitates the decomposition; and while it reduces the nitrous acid to its original state, that of nitrous gas, it is converted into sulphuric acid. When more air is admitted into the chamber, the same gas is again converted into nitrous acid, which is again decomposed, and thus every new accession of sulphurous acid produces more sulphuric acid. The materials are renewed from time to time, until the water in the chamber becomes sufficiently saturated with the acid: The diluted acid is then gently evaporated until the acid is sufficiently concentrated; and, to make it perfectly pure, is distilled in glass retorts.

The specific gravity of sulphuric acid should be 1.848 at 60 deg. Faht.

When of a greater density there is reason to suspect the presence of sulphate of lead. When diluted with water, it should remain transparent; if not, and a sediment is formed, the presence of sulphate of lead may be referred.

If iron or copper be suspected, saturate a portion of the diluted acid with pure carbonate of soda, and add to a portion of it the ferrocyanate of potash, and to another, tincture of galls; the former will strike a blue, and the latter a black colour. To another portion add ammonia; this will detect copper by forming a blue colour. If lead be suspected, (the great-



er part of which, however, will have been precipitated on the addition of the water,) add the usual reagents for that metal, as the hydrosulphurets.

If sulphate of potash be present, the acid must be saturated with ammonia, and the whole evaporated to dryness, and the dry mass then exposed to heat, which will volatilize the sulphate of ammonia, and leave the sulphate of soda or of potash. The residue, dissolved and examined, will indicate one or the other, or both. After saturating with ammonia, muriate of platinum will show the presence of potash by producing a precipitate. The sulphate of lead may be collected, and reduced on charcoal by the blow pipe.

### SULPHUROUS ACID.

Sulphurous acid, or *aqueous sulphurous acid*, is water saturated with sulphurous acid gas. Water thus impregnated, is often used in bleaching; the effect of which may be shown with the infusion of litmus, and of red roses. The sulphurous smell ceases a short time after the addition of the black oxyde of manganese. Should the sulphurous acid be contaminated with sulphuric or other acid, it would redden, instead of destroying the colour of the infusion of litmus.

### NITRIC ACID.

Nitric acid is frequently adulterated. The nitric



and nitrous acid, and aqua fortis are composed of the same elements, oxygen and azote ; the latter, however, in a state of dilution.

Nitric acid may be prepared in the small way by putting nitrate of potash into a tubulated retort, connecting the retort with a tubulated receiver, and pouring on it a little more than half its weight of sulphuric acid, and applying heat. The sulphuric acid will unite with the potash, forming sulphate of potash, which will remain in the retort, and the nitric acid pass over, and be condensed in the receiver. By exposure to the light, the acid will be changed into the red fuming acid, improperly called nitrous acid. On the large scale, especially for the preparation of aqua fortis, iron vessels with stone ware heads, and a series of stone ware receivers are used. Common aqua fortis, or rather the *aqua fortis duplicatus*, is a mixture of equal parts of nitric acid and water.

Nitric acid is capable of absorbing very different proportions of nitrous gas ; and when it is placed in contact with it, it first acquires a pale yellow colour, then a bright yellow, and as the absorption goes on, it becomes dark orange, then olive, then a bright green, and when saturated a bluish green. The quantity of nitrous gas, thus absorbed, is very great. Dr. Priestley (1 p. 383,) remarks, that a quantity of acid equal in bulk to four penny weights of water, absorbed 130 ounce measures of gas, and then was not saturated. Sir H. Davy, (*Researches* p. 37,) has given a table of the component parts of the acid, of different colours and densities. The colour of ni-



nitric acid depends also, in a degree, on the water it contains. If a fourth part, by weight, of water is added to yellow nitric acid, it will assume a green colour; and when equal parts of water are added, it becomes blue. Nitric acid may be rendered colourless, or deprived of its nitrous gas, by the agency of heat; hence yellow nitric acid becomes colourless in this manner. The gas carries with it, however, a portion of acid.

As the saltpetre, which is used in the distillation of nitric acid, is generally impure, the acid obtained from it is more or less contaminated.

Nitric acid in its most concentrated state should have the specific gravity of 1.1500. It should be perfectly colourless, and as limpid as water. The presence of sulphuric and muriatic acid may be shown by diluting it, and adding nitrate of barytes and nitrate of silver. If both the sulphuric and muriatic acids be present at once, it will be necessary to add nitrate of barytes as long as any precipitate falls, which will disengage the sulphuric acid; and, after separating the precipitate, to add to the remaining fluid nitrate of silver, which will throw down the muriatic acid in combination with the silver.

### NITROMURIATIC ACID.

Nitromuriatic acid, or *aqua regia* is prepared by mixing due quantities of nitric and muriatic acid, or, as formerly, by dissolving muriate of ammonia in nitric acid. This acid is the solvent for gold and



platinum. If sulphuric acid be suspected, it may be diluted with water, and examined with muriate of barytes. Nitromuriatic acid, if properly made, should act powerfully on gold, and the solution when boiled furnishes nothing more than muriate of gold.

### MURIATIC ACID.

Muriatic acid, or *spirit of sea salt*, is obtained by distilling muriate of soda with sulphuric acid. It is nothing more than water saturated with muriatic acid gas.

The preparation of muriatic acid consists, therefore, in the saturation of water with muriatic acid gas. This may be effected by causing the gas, as it proceeds from a retort containing muriate of soda and sulphuric acid, to pass through water in a series of Woulfe's bottles, or in Knight's apparatus; or by distilling a mixture of muriate of soda, sulphuric acid, and water, having at the same time a large receiver, and connected, with one or two of Woulfe's bottles by means of a tube leading from the *tubulure* of the receiver. Muriatic acid is usually made on the large scale by distilling the mixture in the same apparatus as is used for nitric acid, with, however, some variations.

As muriatic acid is a compound of chlorine and hydrogen, therefore called hydrochloric acid by Thénard, the *bleaching gas*, (chlorine,) is prepared from it by sundry processes, which have for their object the separation of the hydrogen. Thus, if muriatic



acid be digested on the black oxyde of manganese, or on the red oxyde of lead, its hydrogen will unite with the oxygen furnished by these oxydes and form water, while the chlorine gas will be evolved. If a mixture of muriate of soda, and oxyde of manganese be acted upon by diluted sulphuric acid, the same gas will be obtained.

According to a more modern *rationale* of the production of the chlorine from these substances, considering common salt free from water, the chloride of sodium, in which chlorine alone is combined with the metallic basis of soda (sodium,) water is said to be decomposed previously to the liberation of chlorine, and that its oxygen unites with its sodium, to form soda, and its hydrogen with the chlorine constituting hydrochloric acid. Now, in a mixture of chloride of sodium, oxyde of manganese, sulphuric acid, and water, the first effect is the decomposition of the water, the second the formation of soda, and the disengagement of hydrochloric acid, and the third and last, the action of the oxygen of the oxyde of manganese on the muriatic acid, which unites with its hydrogen, derived originally from the water, and chlorine gas is evolved, and water reproduced.

Chlorine, we may observe, is used for bleaching, either in the state of gas, or combined with water, or with lime as in Tennant's bleaching powder, or with alkali. It is the *disinfecting gas* of Morveau; and its preparation and use, for destroying contagious matter, deleterious miasmata, may be seen in the article on *ærial poisons*.



Muriatic acid generally contains iron, which communicates to it a yellow colour ; the pure acid being colourless. It may be detected in the same manner as recommended under the head of sulphuric acid. Sulphuric acid is also detected by the reagents we have mentioned.

The specific gravity of muriatic acid should be 1.170. That of commerce is generally from 1.156 to 1.160.

When muriatic acid is mixed with nitric acid, the product is the nitro muriatic acid. It is decomposed in the mixture ; and the new acid consists of nitrous acid, chlorine, and water.

### OPIUM.

When incisions are made in the unripe seed vessels of the *papaver somniferum*, a milky juice exudes, which gradually concretes into a dark brown coloured mass. This is opium.

The minutæ of the process is unnecessary to mention, since opium is known to be the inspissated juice of the poppy, and the manipulations consist in forming it into cakes, rolls, or balls, and covering them with poppy, or tobacco leaves for transportation.

We may remark, that the cultivation of opium is extensively pursued in the East Indies ; nearly 600,000 pounds weight of it are annually exported from the Ganges.

The colour of opium is reddish brown, inclining



to black. It has a strong and very peculiar smell.—Several qualities are to be found in the shops; but the best is that usually called Turkey opium. It is generally more free of foreign matter; and, for that reason, better adapted for officinal preparations.—Those acquainted with the appearance of opium, can always judge of its quality. It is, however, largely adulterated, and the detection of foreign substances is rather difficult. Opium, we observed, should be nothing more than the inspissated juice of the poppy; but it is adulterated by an extract of the plant, obtained by boiling; by a powder of the dried leaves and stalks, mixed with some kind of gum; by rice flour, and by other substances not quite so agreeable as these.

In the East Indies when the opium is collected, it is beat up with honey and water; the former is added to prevent its drying, and its quantity is sometimes so great as to soften its bitterness. Belon observes, that frequently a pound of opium contains only four ounces of pure genuine opium. The purification of opium, according to the pharmacopæia, consists in dissolving it in twelve times its weight of proof spirit, filtering the tincture, and evaporating it to dryness.

Besides resinous and extractive matter contained in opium, which are distinct from the narcotic principle, as it was called, there can be no question, that the peculiar properties of opium are owing to the presence of a substance possessing all the characters of alkali, which appears to exist in combination with



a peculiar acid, and that when separated from the latter cannot be used even in small quantities without great caution. We have had occasion to mention the narcotic and other properties of opium, in our article on *poisonous vegetables*, &c. which see.

In Europe it was first introduced as a medicine by Paracelsus; but in the east it has been used from time immemorial as an intoxicating drug.\*

What is called the *narcotic principle* was obtained from opium, by Desorme in 1803, and was found to contain the poisonous and intoxicating qualities of opium; but this principle is found to be a new vegetable alkali, called *morphia*.

The preparation of morphia may be effected by boiling a concentrated infusion of opium with a small quantity of magnesia; a deposit will be obtained, which is to be collected on a filter, washed with cold water, and acted upon by weak alcohol in a moderate heat for some time. Very little morphia, but a large proportion of colouring matter, is separated. The acid matter, after being drained in a filter and washed with a little cold alcohol, is to be boiled with a large quantity of rectified alcohol; the solution filtered, and suffered to cool, when crystals of morphia will be formed.

As opium contains meconiate of morphia, the the-

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\* Several memoirs have been written on the manufacture of opium. In the *British Journal of Science* (8th and 9th vols.) and in the 1st vol. of the *Edinburg Phil. Jour.* are two important papers on the manufacture of British opium. It has been made in the United States.



ory of the process, it is obvious, is the decomposition of the meconiate by the magnesia, and the morphia is displaced. Without enumerating all the chemical characters of this substance, morphia unites with the acids forming salts, and acts with great energy on the animal economy, so much so indeed, as Dr. Ure informs us, that a grain and a half taken at three different times, produced such violent symptoms upon three young men, that Serturmer was alarmed lest the consequences should have proved fatal.

With regard to the other constituent of opium, the meconic acid, it will be sufficient to add, that it may be prepared by first precipitating the morphia from a solution of opium by ammonia, and adding to the remaining fluid muriate of barytes, by which the meconic acid with other substances is thrown down. Alcohol is added to remove the extract, and sulphuric acid to separate the barytes. The meconic acid is now left in combination with a portion of the morphia; from which it is separated by repeated solutions and evaporations. This acid unites with basis, and forms a distinct class of salts.

Mr. Vogel asserts, although it is denied by Robiquet, that meconic acid will precipitate iron from its muriate, and as its power of precipitating solutions of that metal is so great, he proposes it as a more delicate test than even the ferrocyanate of potash.

Vinegar, we remarked heretofore, has been usually prescribed to counteract the effects of a dangerous dose of opium; but in the opinion of Orfila, it aggra-



vates it. The proper remedy, no doubt, consists in the immediate administration of powerful emetics, as sulphate of zinc or sulphate of copper.

## ALCOHOL AND ÆTHER.

*Spirit of wine, alcohol, and æthers*, are frequently sophisticated, or not of the proper strength. The best and most decisive mode of ascertaining the strength of spirit of wine and of æthers, is by determining their specific gravity.

Rectified alcohol should be 800 to 1000, common rectified spirit of wine 835; proof spirit 820; sulphuric æther, if purified, 729, commonly 750; sweet spirit of nitre 834, &c. The æther should be entirely free from acid, and, therefore, ought not to redden the colour of litmus. Sulphuric æther should not affect muriate of barytes.

With respect to the various mixtures of alcohol and water, with and without addition, as we find them in brandy, rum, gin, whiskey, &c. the subject has already been noticed, and the means of detecting the different frauds as practised by distillers, and dealers in those liquors, in a preceding lecture.

## ESSENTIAL OILS.

The *essential* or *volatile oils* differ in regard to their volatility and peculiar aroma or flavour, from the fixed oils; the former are obtained by distillation, and the latter by expression.



Volatile or essential oils, it is to be observed, differ in their consistence. Lavender, rosemary, and rue, furnish, for example, very fluid oil; the oils of cinnamon and sassafras are thicker. Some constantly preserve their fluidity; others become concrete by the slightest impression of cold; and others again, possess the concrete form, as the oils of roses and elicampagne. Volatile oils differ from each other in another respect, besides their peculiar odour, by which they are known and designated; namely, they vary in their colour and weight: the oil of roses is white; oil of lavender, a light yellow; that of cinnamon of a brown yellow: oil of chamomile of a fine blue; oil of millefoil, of a sea green, &c. and, generally, are so light as to swim on water, although some are heavier than water, as the oils of sassafras and cloves.

It is remarked, that the taste of the volatile oils in general is hot, but do not always partake of the pungency of the plant, a fact that the pungency does not uniformly exist in the essential oil, but in a bitter principle totally distinct. We have an example of this in the oil of pepper, which has no pungency, and in the oil of wormwood, which is not bitter.

The quantity of essential oils, furnished by plants, is variable, nor is the proportion always the same, owing to various circumstances: as, for instance, some afford most when green, others when dry, besides the influence of accidental circumstances, as the soil, climate, time of extraction, and the age of the plant.

A fraud has been practised in the preparation of



some essential oils, which may be proper to notice; the leaves or flowers are soaked in olive oil previously to distillation, and some of the oil, it is said, rises with the volatile oil. In this way, we are assured, nearly all the oil of chamomile sold in the shops is prepared. It is to be observed, that, in the distillation of a flower, for the purpose of procuring its oil, water is always put into the still; and the oil that rises, in the present instance, must be that portion of the fixed oil which was *absorbed*, and no doubt assimilated with the essential oil, as the quantity of the latter is considerably increased. But olive oil, or the oil of ben, which has no taste and flavour, has been used to extract essential oil by mere digestion.

There are several methods used to retain the aromatic principle. The art of the perfumer consists in applying the aroma, or odorous principle, at pleasure to various substances. Perfumes are either dry or liquid. The perfumed bags, or sachets, contain mixtures of aromatic plants, or aromas in their native state; perfumed powders receive their fragrance from aromatic oil; and sundry pastes are perfumed in the same manner. Liquid perfumes are nothing more than sundry odoriferous waters, prepared either by distillation from flowers, or from the essential oil, or solution of the oil in alcohol.—Scented spiritous cordials are various liquors containing some aromatic oil, and sweetened with sugar. Cordials, we may remark, are nothing more than spiritous liquors distilled from certain substances, which communicate the peculiar taste and smell,



and mixed in due proportions with sugar, or sirup. The *eau divine* of the French, for example, is a scented cordial made by distilling citron with orange-flower water and spirit of wine, and adding to the distilled liquor a sufficient quantity of sugar.

The remark of Mr. Chaptal on the subject of perfumes is correct; *viz.* "that in all perfumes which are a little complicated, the nose is the best chemist that can be consulted; and a good nose is as requisite and essential to a perfumer, as a strong head is to a geometer."

Essential oils on account of their value are often found adulterated, either with cheaper volatile oils, with fixed oils, or with alcohol. Distillation will discover the fixed oils, as heat elevates the essential oils, and leaves the fixed oils; and if paper be moistened with the oil, and held before the fire, the fixed oil will leave a stain. If the oil be entirely essential, no stain will remain on the paper. If alcohol be added to an adulterated essential oil, which contains a fixed oil, it will leave the fixed oil on evaporation. The presence of cheaper essential oils is determined by the smell.

To essential oils, alcohol is often added to increase their quantity. This solution of essential oil in alcohol is transparent, but looks thin. The detection is easily made by adding water, which, if there be any alcohol, a *milkiness* will ensue.

The difference in essential and fixed oils, with respect to their chemical characters, is well defined. Fixed oils, we remarked, are generally obtained by



pressure, and essential oils by distillation; and moreover cannot be volatilized without decomposition, which takes place at a temperature of about 600 degrees. Essential oils, on the contrary, evaporates at a moderate temperature. Fixed oils, generally speaking, are insoluble in alcohol, whereas essential oils are readily taken up by that fluid, and such solutions become turbid on the addition of water, owing to the union of the alcohol with the water, and the consequent separation of essential oil.—Fixed oils when exposed to the air become viscid, and acquire a degree of rancidity, but essential oils placed under the same circumstances totally evaporate. Linseed and nut oil, when boiled with litharge, acquire the property of drying when exposed to the air, and hence become *drying oils*.

In *perfumed essences*, the essential oil is combined with alcohol; in *distilled waters*, the water is impregnated by the oil.

Very often a scentless vegetable oil is impregnated with the aroma of another oil. The oil, or *atter* of roses, is frequently mixed with olive oil. This fraud is discoverable by evaporating a portion of it when the olive oil will be left. The Italians prepare from the flowers of the jasmine (*jassaminum-officinale*,) a grateful perfume, by soaking cotton in the best salad oil, and placing in glass vessels alternately layers of this cotton, and of the flowers. After remaining for some time to soak, the latter are found to have given the whole of their fragrance to the oil in the cotton. The oil is then pressed out for use.



The essence of bergamot is obtained from the rind of a variety of orange much cultivated near the town of Bergamo, in Italy, whence it has obtained its name. The rind is cut into small pieces, and the oil is pressed out into glass vessels.

The true *Russian oil*, which is used for the purpose of making the hair grow, is nothing more than depurated bear's grease, and is therefore an animal oil. It is frequently adulterated with sweet oil.

In the preparation of certain perfumes, the oil of ben-nut is highly recommended, as it does not grow rancid by long keeping like the common expressed oils. It is impregnated with the odour of jasmine, and other flowers, by stratifying them with cotton dipped in oil as above mentioned.

## OLIVE OIL.

We mentioned that olive oil was liable to be contaminated with lead, either from the manner it was prepared, or by standing in leaden cisterns, and that the detection of lead was effected by shaking a portion of suspected oil in aqueous sulphuretted hydrogen, which, if it were present, occasions a black or dark brown colour. Olive oil is sometimes adulterated with the fixed oil of certain seeds; to detect which nitrate of mercury has been recommended.—The nitrate, for this purpose, is prepared by dissolving six parts of mercury, without heat, in seven and a half parts of nitric acid, of the specific gravity of 1.36. This solution when shaken with olive oil, so-



lidifies in a few hours; a criterion of the absence of other fixed oils; but if adulterated, it does not become solid. This test we give on the authority of professor Brande, of the Royal Institution.

The fruit of the olive tree (*olea europa*,) which furnishes the salad or olive oil by pressure, when intended to be eaten, must be steeped in an alkaline lixivium, and then pickled in salt and water, to remove an acrid, bitter, and unpleasant taste. In the preparation of the oil it is observed, that if the olives be indiscriminately gathered and heaped together, sound an unsound, without selection, the oil is always bad.

### OIL OF CAJEPUT.

This oil is seldom, if ever, found free of adulteration. The real oil is obtained by the distillation of the *melaluca leucandron* of Linnæus. The oil is highly fragrant and aromatic, and a few drops of it will destroy insects. It is of a green colour, with a smell of turpentine, and the taste of peppermint. It is the best solvent for the cacutchouc, or Indian rubber. The genuine oil is rarely met with, and its place is generally supplied with a preparation of turpentine and camphor, with the oil of cardamom, and coloured with some green vegetable. Thurnberg describes it of a grass green colour, equally fluid with ardent spirits, burning or evaporating without leaving a residue. The smell resembles that of camphor, mixed with turpentine. Goetz says, that it has a terebin-



thinate odour, followed by that of savine. He considers it genuine when a drop rubbed on the temples occasions a pungent pain in the eye, with a discharge of tears. Many travellers seem to agree that its green colour is not essential to it, but in some measure adventitious, owing to an addition of the berries and leaves. Some again think that it is owing to copper; the presence of which, however, may be detected by adding liquid ammonia. The Dutch formerly made it by adding to the oil of rosemary some camphor, with a little oil of cardamom, and giving the mixture a green colour.

An imitative cajeput oil is made usually by druggists, in the manner before spoken of, namely, by dissolving camphor in oil of turpentine, adding either oil of cardamom or oil of rosemary, and colouring it by digesting it on some green vegetable, or green grass.

The genuine oil should evaporate entirely, and at a moderate temperature, without leaving any residuum: but if the fabricated oil be subjected to the same experiment, the turpentine will evaporate, as well as the essential oil of rosemary or of cardamom, and if the heat be not carried too high, the camphor and the colouring matter will remain. If alcohol be digested on this residue, the camphor will be dissolved, which may be separated by the addition of water. Alcohol may be mixed with a portion of each of the oils, the genuine and spurious, and afterwards examined.



## CAMPHOR.

Camphor, in its crude state, as it comes from the East Indies, principally Japan, where it is obtained from the *laurus camphora*, by sublimation, is always contaminated with impurities, from which it is freed by a second sublimation in glass vessels, by using a given quantity of lime. It is then in a semitransparent and concrete state. In many respects pure camphor resembles the essential oils; by its volatility, inflammability, and solubility in alcohol. It is converted into an acid, the camphoric, by distillation with nitric acid. There are several species of camphor, such as the common, the camphor of volatile oils, and that obtained by heating oil of turpentine with muriatic acid.

The best crude camphor should be in large grains, very white, without the appearance of dirt; but as it is seldom imported perfectly pure, being adulterated with foreign matter, usually earth, the detection of earthy matter, and its quantity determined, may be effected by exposing a given weight on an iron plate to a heat sufficient to evaporate the camphor. The residue, if any, will show the amount of foreign admixture. This may be examined by solution in acids, and the usual reagents.

The same fact may be learned by dissolving a given weight of the camphor in alcohol; and ascertaining the quantity of insoluble residue. The camphor may be separated from the alcohol by the addition of water, and collected on a filter, and dried, and



weighed. There is, however, a large quantity of water in crude camphor. I have not seen any that did not contain from five to ten, or more per cent of that fluid. Exposure to a very moderate temperature, will evaporate the water. The camphor has then a dry feel. The refining of camphor, from the crude, as it is brought to our market, is a process exceedingly simple, notwithstanding so much has been said on the subject. A glass sublimer, or balloon as it is called, usually holds from four to six pounds.—The camphor is made fine, and introduced into it, along with one or two ounces of dry hydrate of lime (lime slacked and dried,) or pulverised quicklime. The balloon is now placed in a sand bath, and heat applied. The camphor melts, and evaporates, and condenses on the *upper* part of the glass, and takes the shape of it. This head is usually from an inch to two inches in thickness. The glass is broken in order to get it out, and the residue is sometimes resublimed. Refined camphor is never contaminated. It should, however, dissolve wholly in alcohol.

### SPERMACETI AND TALLOW.

It may be necessary sometimes to distinguish between spermaceti and tallow, or more properly, whether the former has been adulterated with the latter, or other fatty substances, as in spermaceti candles. Candles which are sold as the pure spermaceti are seldom, if ever, free from the admixture of fat or tallow; and the fraud cannot well be detec-



ted unless we attend to the chemical properties of each substance respectively.

Spermaceti is a peculiar oily substance obtained from the cranium of the spermaceti whale, the *physter macrocephalus*, and from some other species. It is first mixed with some liquid oil, which is separated by means of a woollen bag, and the last portions are removed by an alkaline ley, and the spermaceti is afterwards purified by fusion. It is a white substance, having more or less a crystalline structure, and scarcely any taste. It is distinguished from most other fatty bodies by the crystalline appearance, which it always assumes. When sufficiently heated, it may be distilled over without much alterations. It is soluble in boiling alcohol, but separates again as the solution cools. One hundred parts of alcohol, of the specific gravity .816 dissolve 6.9 parts of it. It is also soluble in æther, and in *hot oil of turpentine*, but precipitates as the solution cools. It forms an emulsion with hot ammonia, which is neither decomposed by cooling, nor by water; but the spermaceti is immediately precipitated by the addition of an acid.

Tallow, suet, and lard will not distil, like spermaceti; but they afford by destructive distillation, first a portion of water, and then a white oil, very small indeed, which finally concretes, and a black mass remains in the retort.

If spermaceti is pure, it will distil entirely; if it contain suet or fat, it will leave a black residuum, and at the same time an abundance of carbonic acid and



carburetted hydrogen come over. In this case also the odour is so offensive and powerful, that it is absolutely impossible to endure it. Fat is insoluble in alcohol and æther; spermaceti is soluble in these fluids. Therefore, a mixture of spermaceti and tallow when digested in alcohol will be decomposed; the spermaceti taken up, and the tallow or fat remain. By this means the quantity of tallow may be ascertained.

The acids have scarcely any action on spermaceti, if pure; but if a little nitric acid is poured on fat, it converts into a yellow coloured substance, which Fourcroy considers an oxyde of fat. If spermaceti, therefore, be adulterated with fat, when treated with nitric acid it will become yellow. The most conclusive character seems to be the solubility of spermaceti, and the insolubility of fat, in alcohol. This fact added to the property of being distilled, and without leaving a residue, will serve to distinguish one from the other, and to show the presence of fat or tallow in spermaceti. Alcohol, we must observe, when boiled on hog's lard, takes up two proximate principles called *stearin* and *elain*.

## WAX AND TALLOW.

In the preparation of wax candles, tallow may be added. The fraud may be discovered by using alcohol. If boiling alcohol be poured on wax, it will dissolve it. Rather more than 20 parts of alcohol are required to dissolve one of wax. As the solu-



tion cools, the greater part of it will precipitate. If the wax contain tallow or fat, the latter will remain undissolved, and may be examined. The residue may contain a principle of wax, called *myricin*, and, therefore, the solution in alcohol cannot be altogether relied on. Dr. John ascertained, that when wax is digested in a sufficient quantity of boiling alcohol, it is divided into two distinct substances; one, called *gerin*, is taken up by the alcohol, and the other, which he named *myricin*, remained undissolved.—By examining, however, the residue, we may judge of its nature.

When wax is boiled with a solution of fixed alkalis in water, the liquid will become turbid, and after sometime the *soap* will separate, and swim on the surface; and if an acid be added, the wax will separate in flakes, without much alteration in its properties. Fat treated in that manner, will form a soap, and the addition of acid will unite with the alkali, and separate the fat, but not in flakes. The soap too, is uniform in its appearance.

But there is one character by which the purity of wax may be judged. If pure, sulphuric, muriatic, and nitric acid will have no action upon it, whereas if it contain the least quantity of tallow or fat, nitric acid will colour it more or less *yellow*, and the acids have more or less action.

Wax when exposed to a temperature of 150 deg. melts, and at a higher temperature is converted into vapour, which burns with a brilliant flame. At a red heat it burns in contact with air.



The fruit of the tallow tree (*croton sebifera*,) furnishes the Chinese with a kind of tallow for the manufacture of candles, which is not equal to wax or spermaceti, but are more firm than those of tallow. The candles made from this substance are very white, but are sometimes coloured by adding a little vermillion.

### WHITE AND YELLOW WAX.

The former is the bleached yellow wax, called also virgin wax; the latter is the ordinary wax of commerce.\*

Wax, we observed, should be soluble in boiling alcohol; but there will be more or less of the myracin separated, which must be taken into consideration. The purity of white wax may be determined pretty accurately by its physical characters; but it may, nevertheless, be submitted to experiment.—Yellow wax is seldom adulterated. It may be purified by melting it, and suffering it to remain undisturbed for a short time before it is poured off.

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\* What is called the myrtle wax, which is made in this country, is extracted from the seeds or berries of the *myrica cerifera*, and also from the *pela* of the Chinese. The berries are merely put into a kettle with water and boiled, and then gently squeezed; the wax is melted out, and swims on the surface. It is skimmed off, strained and suffered to become cold. It burns with a white flame, with an agreeable aromatic odour and produces little smoke. The coating of leaves is of a waxy nature; also the covering of resins, plums, oranges and similar fruits.



## HAIR POWDER.

Hair powder is an article frequently adulterated. It should consist of nothing more than pure *feculæ*, obtained either from grain, or potatoes. The manner of preparing this *feculæ* is easy. The grain is ground, as is usually the practice, or the potatoes dried and rasped, or powdered, and then washed in an *abundance* of *cold* water, by which the *feculæ* is separated from the other proximate constituents.

Hair powder should be impalpable, very light, and when mixed with *cold* water, neither form a paste, as with flour, nor show any gritty or hard sediment. Flour with which it is more frequently adulterated, contains a considerable quantity of gluten; and as starch or *feculæ* will not make a paste unless heat be applied, (and then a tremulous jelly like substance, more or less transparent,) the detection of gluten is readily effected. Hair powder, if pure, and washed in cold water with the hand, will leave no gluten; but if, on the contrary, it contains it, and consequently flour, more or less gluten will be separated, while the *feculæ* or starch will precipitate.—The cold water, in which hair powder is diffused, should not be contaminated with saline, or other substances.

Chalk, or whiting, is another substance used in the sophistication of hair powder. It may be detected by adding a very dilute muriatic acid; an effervescence will ensue; and the fluid, when filtered, and tested with oxalate of ammonia, will show the pres-



ence of lime. The same may be effected, though less perfectly, by boiling the whole in water, and *straining* out the feculæ; then treating the insoluble part with muriatic acid, and examining the solution as before.

If any of the white clays be mixed with hair powder, which, like chalk and gypsum, must add greatly to its weight; the discovery may be effected by testing the solution for alumina, and the insoluble part will point out the presence of silica. Calcined sulphate of lime or gypsum, may be detected by boiling the hair powder in a *large* quantity of pure water; then strain, and filter the fluid. If we add to separate portions of this fluid the usual tests for sulphuric acid and lime, the presence of gypsum will be rendered manifest. But these substances are heavier than hair powder, and are simply mechanical mixtures, if the adulterated hair powder be mixed with water, they will fall to the bottom. By burning off the vegetable matter of hair powder, (which, if pure, should be consumed entirely, gluten not being here considered,) the foreign impurities may be detected, and their quantity estimated. This residue may be examined by the rules before mentioned.

There is another process, which may be used to discover whether hair powder is adulterated with lime, by using sal ammoniac. A small portion of this salt when put to the suspected hair powder, and a little warm water poured on; if the powder has been adulterated with lime, a strong smell of vola-



the alkali will arise from the mixture. This negative proof, as we infer the presence of lime by the smell of ammoniacal gas, (the lime decomposing the muriate of ammonia,) is sufficient to warrant that conclusion.

Hair powder is sometimes scented, and sold as perfumed hair powder. The perfume consists of the essence of bergamot, oil of roses, and frequently powdered orris root, and sometimes of a mixture of sundry aromatic oils.

### ANATTO.

The seeds of the *bixa orellana* are separated from the capsules, and pounded and steeped in water for weeks or months, and then subjected to the press, by which the colouring matter is obtained. This colouring matter is anatto. It appears to be confined to the surface of the seed. Anatto is usually in hard cakes or rolls, brown without, and red within. It should be perfectly soluble in alcohol, and in weak alkaline solutions. A decoction of anatto in water has a peculiar smell, and disagreeable taste. Its colour is reddish yellow, and alkalies render it orange yellow. The acids should throw down from this mixture an orange coloured precipitate. The chemical nature of this colouring matter appears to be intermediate, between extractive and resin.

Anatto is used in dyeing, and as a colouring ingredient for cheese, and is sometimes used to give a rich colour to butter. It has also been mixed with chocolate.



Those who roll it from the *rocou* generally adulterate it, sometimes with Spanish brown, and render it soft by using molasses. In England it is frequently adulterated with vegetable matter, and the colour is heightened by the addition of vermillion. Sometimes the vermillion itself is adulterated with red lead; and hence anatto, thus adulterated, has communicated deleterious properties to cheese.

Anatto is soluble in alcohol. If any residue should be left, it may be examined for Spanish brown, vermillion, or red lead. When a portion of the anatto is dried, and mixed with chlorate of potash, and subjected to heat in a crucible, the vegetable matter will be burned, and if any mineral adulteration be present, it will show itself in the remaining residue. For red lead, the residue may be acted on by acetic acid, and the solution tested by aqueous sulphuretted hydrogen. If ochre be present, the solution will contain iron, which may be examined by tincture of galls, and the residue will be more or less gritty, indicative of silica. To detect vermillion the best mode is to dissolve the anatto in alcohol, and mix the sediment with lime, and distil it; the mercury will pass off, and be condensed in globules.

## TURMERIC.

Turmeric or *curcuma longa*, called the Indian long rooted turmeric, is brought from the East Indies.—The root is ground to powder for use. It has a



slight aromatic and bitterish taste, and somewhat disagreeable smell. It gives out its virtues both to water and to spirits; by distillation with water, a small quantity of essential oil is obtained and from the remaining decoction a bitter extract is procured by evaporation. The spiritous extract retains nearly the whole virtues of the root. The infusion, as well as the tincture, is rendered brown by alkalies; hence it is used as a test for uncombined alkalies. The alkaline earths, as magnesia, affect it in like manner. To water it gives a yellow, but to alcohol a red colour. If the alcoholic tincture be applied to hot marble, it will impart a durable colour.

Turmeric is chiefly used for a colouring ingredient. It forms a component part of curry powder. Turmeric powder is often adulterated either with flour or Indian meal, or more commonly with yellow pease, a fraud practised considerably in London. The detection of farinaceous substances may be accomplished in the manner already spoken of: viz. by separating the fecula and gluten, if the latter be present, by means of cold water. If the suspected turmeric be boiled in water, the decoction will become thick and pasty, thus indicating the presence of flour or pease. If starch be dissolved in the water, iodine will discover it, by forming an iodine of starch; a compound of a blue colour.

### PERUVIAN BARK.

Although there are various descriptions of this



bark, commonly called yellow and red, which possess different medicinal powers, and which are mentioned by writers on the materia medica, yet both the pulverised yellow and red bark have been considerably adulterated; the former with the quercitron, and the latter with the bark of the cherry, to which *bol armen* is added. It is necessary to notice the chemical characters of Peruvian bark. The presence of the bark of the *quercus nigra* may be known by its astringent taste, and boiling it in water, which will produce a yellowish brown colour.— This decoction is rendered lighter by acids, and darker by alkalies. Muriate of tin gives a copious bright yellow precipitate; sulphate of iron a dark olive precipitate; and sulphate of copper a precipitate of a yellow colour, inclining to olive.

The colour of the genuine red Peruvian bark is reddish brown, and has a slight bitter taste, with more or less astringency. Water in which the powdered bark is macerated, acquires the property of reddening vegetable blues, and contains a portion of citric acid, some muriate of ammonia, and muriate of lime. There is also besides extractive matter, a portion of resin, tannin, kinic acid, lime, and bitter principle. The admixture of *bol armen*, or any other earthy substance is readily detected by burning off the vegetable matter, or by diffusing it in water, when the earth will be deposited, and the bark suspended.

We recollect that a quantity of red spurious bark was offered for sale in Philadelphia, in the *quill*,



and on inspection was found to be the common yellow bark dyed with a decoction of log and red wood. On another occasion a fraud of a highly criminal nature was practised in the adulteration of bark, by the use of litharge as a colouring ingredient, which produced very serious consequences. Litharge may be detected either by putting the bark in water, when it will precipitate, and the precipitate may be examined by solution in acetic acid, and the addition of sulphuretted hepatic water; or by burning it with chlorate of potash, and examining the residue, or submitting it to the action of heat on charcoal, when metallic lead will be obtained. Bark if dyed in the quill, with redwood and logwood, when boiled in water, and the decoction examined by sulphate of iron, muriate of tin, sulphuric acid, &c. will readily be discovered.

### COCHINEAL.

This insect furnishes the colouring matter for scarlet dye, which is also the basis of lake and carmine.- Lake is a combination of *carminium* and alumina, and carmine is a mixed precipitate consisting of animal matter, carminium, and oxyde of tin, or alumina. Cochineal may indeed have its colouring matter extracted, and then dried, and made to appear like, and sold as, the cochineal of commerce; but this fraud is readily detected by making an infusion of the insect in hot water, which, of course, will not impart any colour, or very feebly. A com-



parative experiment may then be made, by using some of the genuine cochineal; and, if necessary, the infusion or decoction tested with muriatic acid, alum, muriate of tin, &c.

### SPANISH LIQUORICE. LIQUORICE BALL.

Spanish liquorice, also called black sugar, is an extract obtained from the root of the *glycyrrhiza glabra*. It is said that more than two hundred tons weight of it are annually manufactured in Spain, a considerable portion of which is sold to the London brewers for brewing. It contains a peculiar kind of sugar, starch, gluten, a brown thick resinous oil, and some earthy salts.

Liquorice powder is frequently adulterated with flour. The detection is rather difficult, but nevertheless may be attempted in the usual manner for discovering gluten, and feculæ.

### ISINGLASS, OR FISH GLUE.

A gelatinous substance obtained from the *accipenser sturio*, and several other kinds of fish, is called *ichthyocolla*, or isinglass. The internal skin is boiled in water, and the decoction is strained, and inspissated, and formed into convoluted pieces. The sounds and air bladders of fresh water fish, in general, furnish the most flexible and transparent isinglass. It has been made from the sturgeon, and other fish in the United States. Boiling the sounds and air blad-



ders, &c. gives the purest isinglass; but the usual process consists in separating the exterior membrane, cutting the bladder, &c. lengthwise, and forming them into rolls, or small pieces, and drying them. A very inferior kind of fish glue is prepared from sea wolves, porpoises, sharks, cuttle fish, whales, and all fish without scales. The tails, fins, &c. are boiled in the same manner as in forming ordinary glue.

There are various qualities of this substance sold in the shops.

Good isinglass may be recognised by its white colour; by its degree of transparency; and by its freedom from smell. It should dissolve almost entirely in water, and when mixed with a solution of tannin be entirely precipitated. One hundred grains of isinglass were found by Mr. Hatchett to contain rather more than ninety-eight of soluble matter.

Isinglass is used in lieu of the white of eggs for clearing of coffee, in the clarification of spiritous liquors, in the purification of *blanc maunge*, and in the manufacture of English court-plaster.

A solution of isinglass, sufficiently concentrated, if often mixed with calves' feet jelly. Even the addition of wine and spices to isinglass jelly, in the same manner as to calves' feet jelly, will so nearly resemble it, that they can scarcely be distinguished.

If one part of isinglass be dissolved in one hundred and fifty parts of hot water, the solution on cooling is wholly converted into a jelly; but one part of isinglass in one hundred and fifty parts of water,



does not become concrete, though it is more or less gelatinous.

## GLUE.

Glue is extracted from the cuttings and pairings of skins, horns, and the hoofs and ears of horses, oxen, calves, sheep, &c. by first soaking them in lime water, and afterwards boiling them, by which the gelatin is extracted.

Glue differs in its strength, and hence some is preferred to others. Good glue is distinguished from bad by holding it between the eye and the light. If it appears of a strong dark brown colour, and free from cloudy or black spots, it is considered good. The best glue is said to swell considerably without melting, by three or four days immersion in cold water, and recovers its former dimensions and properties by drying. Glue which appears thick and black, is usually melted over again and some fresh added.—Glues are found to differ in consistence, colour, taste, smell, and solubility. Some will dissolve by agitation in cold water, which is said to be a proof that it wants strength, while others are only soluble at the point of ebullition. Glue is perfectly soluble in water, forming a viscid fluid, which, when dry, preserves its tenacity and transparency in every part.—In proportion to the age and strength of the animal from which it is produced, it has more solidity, colour, and viscosity. To obtain glue as colourless as possible, a very small quantity of water is used for



extracting the jelly, and a moderate heat is used in evaporating it. Flander's glue owes its whiteness and transparency to this treatment.

A colourless glue, called size, is procured from the skins of eels, vellum, parchment, different species of white *leather*, &c.

Gelatin forms a constituent part of the solid parts of animals, and, therefore, an essential part of bones, ligaments, tendons, membranes, skin, muscles, hair, &c.

Gelatin is characterised by certain properties, the most common and familiar is its precipitation from its solution by tannin, a combination which is formed in the process of tanning leather. See *Portable Soup*.

### ADULTERATION OF ARSENIC.

We have already noticed the characteristic properties of arsenic, or rather of arsenious acid. White arsenic, white oxyde of arsenic, and arsenious acid, names which imply the same substance, may, if purchased in powder, be frequently found adulterated. The adulteration may consist of carbonate of lime, sulphate of lime, carbonate of barytes, or sulphate of barytes. If muriatic acid be poured on it, it will cause an effervescence if carbonic acid is present.—The solution may be examined for lime by oxalate of ammonia, and for barytes by sulphuric acid. Sulphate of lime may be discovered by boiling the arsenic in a large quantity of water, saturating the ar-



senious acid thus taken up by potash, and adding to separate portions of the filtered liquor muriate of barytes, and oxalate of ammonia. If arsenic, containing sulphate of barytes, be mixed with an equal quantity of carbonate of potash, and boiled in water for some time, an arsenite and sulphate of potash will be formed, and remain in solution, and carbonate of barytes found at the bottom.\* The latter may be collected on a filter, dried, and its weight ascertained. When dissolved in nitric acid, and the nitrate exposed to strong heat, pure barytes will be left; or, if the solution be acted upon by sulphuric acid, sulphate of barytes will precipitate, which, when weighed, will give the original quantity of the sulphate contained in the arsenic. The solution of arsenite and sulphate of potash, may be examined for sulphuric acid by the usual reagents.

As neither the carbonates of lime and barytes, nor the sulphates of the same earths, are volatilized by heat, pure arsenious acid being volatile; we may detect in a general way the presence of these substances by exposing the arsenic to the action of heat. The residue will afford a pretty correct criterion of the quantity of foreign substances, making due al-

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\* The decomposition of sulphate of barytes by carbonate of potash, is usually effected by reducing the crystallized sulphate of barytes to powder, mixing it with three parts of carbonate of potash, and fusing the mixture for half an hour in a silver crucible. The fused mass is then boiled in water. The carbonate of barytes, thus produced, when digested in nitric acid, and the nitrate exposed to a strong heat, will produce pure barytes.



lowance for the escape of carbonic acid. It may be examined by solution in acid, &c. as before mentioned.

Before the blow pipe, white arsenic should entirely volatilize in a white smoke with a strong odour of arsenic. It is blackened by the action of combustibles. It is distinguished from arseniate of lime by its solubility in water, which is about as one to eighty times its weight of water, at 60 degrees.—

White arsenic, if required pure, should be purchased in the lump.

## RED AND YELLOW SULPHURET OF ARSENIC.

These sulphurets are seldom adulterated. Their purity may be determined by exposing them to heat. The red sulphuret, or realgar, melts easily, burns with a bluish flame, and is volatilized by the blow pipe, exhaling white fumes of arsenic, and the odour of arsenic and sulphur. Nitric acid poured upon it, causes its colour to disappear. Realgar is a lively red, often more or less tinged with yellow. Its streak and powder are orange yellow.

The yellow sulphuret or orpiment is usually of a lemon yellow colour, which is often shining and very beautiful. Its streak and powder have the same colour as the mass.

When exposed to heat, it exhibits the same characters as the red. Hence, before the blow pipe, it is principally volatilized with a white smoke, accom-



panied with the odour of arsenic and sulphur. A small earthy residue usually remains. It melts somewhat less easily than realgar, and, on cooling, assumes an orange tinge.

The experiments of Proust and Thenard show, that the arsenic in both the sulphurets is in a metallic state, though combined with the sulphur in different proportions. Realgar, if melted with sulphur, produces orpiment; and orpiment when combined with an additional quantity of arsenic, is converted into realgar.

The Turks use orpiment in the depilatories, which serves to render bald the top of the head. The Chinese use realgar in medicine.

### ARSENITE OF POTASH.

The pharmaceutical preparation sold in the shops, under the name of *Fowler's solution of arsenic*, is usually prepared from the powdered white arsenic, which, we have seen, is often adulterated. When white arsenic, thus impure, is boiled with a solution of potash, we not only lose a great part of the strength of the preparation, but that which is made is contaminated. The presence of sulphate of barytes, for instance, would produce in the fluid sulphate of potash; which may be determined by the addition of muriate of barytes, or by evaporation and crystallization.

In preparing Fowler's solution, the white arsenic



should be powdered from the lump, which we have generally found to be pure.

If arsenite of potash be mixed with the ammoniated sulphate of copper, or rather for this experiment with acetate of copper, an arsenite of copper, or *Scheele's green* will be precipitated, and acetate of potash remain in solution. If, after separating the arsenite of copper by the filter, we examine the fluid with muriate of barytes, and the arsenical solution was free from sulphate of potash, no precipitation will take place.

### WHITE OXYDE OF BISMUTH\*.

This preparation is used in medicine in dyspeptic diseases. It is formed in the same manner as the majistery of bismuth. It is called subnitrate of bismuth.

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\* Salts of bismuth are soluble, but they generally decompose on the addition of water. The solutions of bismuth in acids is usually colourless; and water, when added, occasions a white precipitate, composed of the oxyde of bismuth, and a small portion of acid. Ferrocyanate of potash produces with these solutions a white precipitate, hydrosulphuret of potash a dark brown, and gallic acid a light yellow precipitate. A plate of tin or copper, precipitates the bismuth very often in a metallic state.

Oxyde of bismuth in a spoon before the blow pipe, melts to a brown glass. With microcosmic salt it forms a grey yellow glass; a further proportion of oxyde renders it opaque. With borax it forms a grey glass, which decipitates in the interior flame, and the metal is reduced and volatilized. It is easily reduced on charcoal.



When bismuth is dissolved in diluted nitric acid, the solution is colourless; but if water be added, it will become turbid, and a white precipitate formed, which is the oxyde of bismuth. This oxyde is combined with water, and a small portion of nitric acid. The majistery of bismuth is the same oxyde, but containing, it is said, more of the subnitrate, which is produced by adding a larger quantity of water.

Pearl white, another preparation of bismuth, is formed by decomposing the nitrate of bismuth with carbonate of potash. It is said, however, that in order to produce the pearly appearance, muriatic acid is added to the nitric solution before the addition of potash.

The white oxyde of bismuth, when used as a medicine, should be entirely free from lead; but as it is blackened by sulphuretted hydrogen gas, like lead, it is obvious that this test will not distinguish between the two metals. To detect lead, let the oxyde be dissolved in acetic acid, and add to the solution sulphate of soda; if it be present, sulphate of lead will precipitate, which may be examined in the usual manner.

## NATURAL AND ARTIFICIAL GEMS.

The imitation of gems may be traced to a remote period, and has of late been brought to great perfection. The idea of communicating a particular colour to glass, in imitation of precious stones, was put into practice in the time of Pliny, who, besides oth-



ers, mentions artificial hyacinths, sapphires, and a black glass resembling our obsidian, which he calls *gemma vitrae*. That the art must have been in some respects perfect is evident from the deceptions which were practised with them. Tertulian ridicules the folly of paying as dear for coloured glass as for real pearls. The glass houses of Alexandria, were celebrated among the ancients for the skill and ingenuity of the workmen employed in them. An Egyptian priest made a present to the emperor Adrian of several glass cups which sparkled with colours of various kinds, and which, as costly wares, the emperor used only on grand festivals. Seneca mentions one Democritus, who had discovered the art of making artificial emeralds. This, however, was said to be done by giving a green colour to quartz, or rock crystal.

Porta, Neri, and some others have given directions for colouring glass. Sundry discussions soon after took place as to who discovered, and applied certain colouring ingredients. The purple powder of Cassius was one of them. What is denominated paste, is a glass made in imitation of gems. The paste, however, is usually considered the base, which consists of silica, potash, borax, red oxyde of lead, and sometimes arsenic. Colourless quartz and boracic acid are likewise used. The glass should be well made, and the denser it is, the greater the beauty of the artificial stone.

The colours are imparted by the following substances; for *topaz*, glass of antimony, Cassius' pur-



ple, and per oxyde of iron; *ruby*, oxyde of manganese; *emerald*, green oxyde of copper and oxyde of chrome, or acetate of copper and per oxyde of iron; *sapphire*, oxyde of cobalt; *amethyst*, oxyde of manganese, oxyde of cobalt, purple of Cassius, or oxyde of manganese and oxyde of cobalt; *beryl*, glass of antimony, and oxyde of cobalt; *syrian garnet*, or ancient carbuncle, glass of antimony, Cassius purple, and oxyde of manganese, &c.\* Many other substances have been used; but these will give an idea of the colouring ingredients of glass, in the preparation of gems; an art, which has of late years been brought to that perfection, as to produce artificial gems possessing all the physical characters of the real stones, even to deceive the eye of the experienced jeweller. Some stones cannot be imitated, on account of the different colours in the same stone, the arrangement or distribution of those colours, &c. Thus agate, which is an aggregate of various siliceous stones, as chalcedony, opal, carnelion, jasper, &c. is of this kind. The true precious stones have usually silica for their bases, and, in general, are so remarkably hard as to scratch glass. All the varieties of quartz are infusible before the blow pipe; but with the compound blow pipe, a piece of rock crystal will melt into a white glass. An artificial

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\*The following composition when fused, is said to imitate the garnet very closely;

Purest white glass,	2 ounces.
Glass of antimony	1 ounce.
Powder of Cassius,	1 grain.
Manganese,	1 do.



gem submitted to the blow pipe will soon melt.—Quartz is fusible with a flux. Different colours may be given to quartz by heating it, and then plunging it into some metallic and vegetable solution, which possesses colour. The smoke of burning wood will impart a brown colour.

Artificial gems are readily fusible before the blow pipe, as they are nothing more than coloured glasses, and are less hard than natural gems. Precious stones are, for the most part, infusible before the common blow pipe; and with respect to hardness, are generally superior to glass; hence they scratch glass. Neither the artificial nor the natural gems, provided they are composed of a due proportion of silica, are acted upon by acids, except the fluoric, which we know takes up the silica, and passes off in the state of silicated fluoric acid. If we are desirous of examining an artificial gem to ascertain its colouring ingredient, we may introduce into a crucible one part of the gem and three parts of potash, and fuse them together. A compound of silica and potash will thus result, which is soluble in water, forming the silicated alkali. This fluid, and the insoluble part which will subside, consisting of the metallic oxyde, &c. may be treated by reagents.\*

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\* We have omitted the greater part of this article, consisting of 12 pages at least, on the chemical and physical characters of the, so called, precious stones; and although it was merely a summary of their properties in general, and in that respect interesting, yet we were obliged to omit it, to admit other articles, or to have swelled the work, as it is now much larger than we anticipated.



## GOWLAND'S LOTION.

We notice this cosmetic, not that we believe it altogether safe as a wash, especially when used in any quantity at a time, but that a spurious lotion is frequently sold as the genuine, which is prepared with arsenic in the place of corrosive sublimate. An arsenical solution, although blended with the milk of almonds, and mixed with a due proportion of sulphate of zinc and acetate of lead, by which an acetate of zinc and a sulphate of lead are formed, as in the genuine lotion, must be more or less injurious to the skin.

If arsenic, or arsenious acid be suspected, the fact may be known by adding to the filtered fluid the ammoniaret of copper, (ammoniated sulphate of copper of some,) when a yellowish green precipitate of arsenite of copper will be formed; or by adding hydrosulphuret of ammonia, collecting the precipitate, and throwing it on ignited coals, and recognising the presence of arsenic by its garlic smell. See *Arsenic*.

Genuine lotion should neither show a precipitate in the first instance, nor afford a precipitate which would give a garlic odour on hot coals. It is prepared by adding eight quarts of water to one pound of bitter almonds,\* and forming an emulsion in the

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\* There are two kinds of almonds, the sweet and the bitter.—The former are used for sweet emulsions and other purposes. Proust remarks that the emulsion may be curdled by heat, and that a whey is obtained from it, containing gum, extractive matter, and sugar, and a curd, which yields oil by expression.—



usual manner ; then making a solution of eight ounces of acetate of lead, and eight ounces of sulphate of zinc, each in a quart of water ; and putting into *pint bottles* one ounce measure of each solution, eight grains of finely powdered corrosive sublimate, and as much water as will fill the bottles one half, adding for the other half the almond emulsion. The mixture when shaken is fit for use. This is the correct formulæ for the once celebrated Gowland's lotion.

### MILK OF ROSES.

While noticing cosmetics, we may remark, that

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When bitter almonds are expressed, an oil is obtained, and all the bitter matter remains in the cake, which is soluble in watery and spiritous menstrua. We mentioned, (*see Hydrocyanic Acid*,) that bitter almonds contain a deleterious principle. A water distilled from them, partakes also of the same properties.

Some are of opinion, as Mr. Nicholson, that the vegetable principle of bitterness in almonds, and the kernels of other fruits, is only destructive to animal life when separated from the oil and farinaceous matter. This principle, however, exists independently of oil, or farinaceous matter, and exerts its influence or power whether they be present or not, and is now known to be prussic acid. If bitter almonds, &c. containing this acid, be swallowed by mistake, the best remedy after emetics, is a combination of sulphate of iron with bicarbonate of potash.

To birds in particular, bitter almonds are a fatal poison.—The *eating* of them was supposed to prevent the intoxicating effect of wine. We may add also, that they are frequently used instead of apricot kernels in ratifia, and in the place of the *lauro-cerasus* in making counterfeit brandy, and also very improperly, by confectioners for flavouring sundry articles ! See *Spiritous Liquors*.



this preparation, called the milk of roses, owes its peculiar consistence to the oil of almonds, in conjunction with potash, to which wax is occasionally joined.

The cream or milk of roses is prepared by Chaptal, by taking equal parts of rose water, spirit of wine *a la rose*, and spirit of sugar. He colours it with an infusion of cochineal.

The common recipe is one ounce of sweet oil of almonds, three quarters of an ounce of a concentrated solution of potash, one quart of water, and half a drachm each of the essential oils of lavender and rosemary which are mixed together. The mixture assumes a milky or rather saponaceous appearance.—When a drachm of white wax is melted, and mixed with the oil of almonds, previously to the admixture with the other ingredients, the *whiteness* as well as the consistence is greatly increased. The milk of roses, improperly so called, has been extolled as a cosmetic, but without much cause. Genuine milk of roses should be white, have a thick consistence, and not separate on standing.

The safest and best cosmetic we are acquainted with, is one which was recommended in the *Pocket Conspectus* many years ago, consisting of nothing more than the milk of sulphur (*lac sulphuris*,) mixed with a weak solution of acetate of lead, a preparation we have found to remove cutaneous eruptions without difficulty, and is decidedly as effectual as solutions of sublimate.



## EAU DE LUCE.

There are several recipes recommended for the preparation of eau de luce, which is nothing more than the volatile alkali rendered more pungent by different additions.

The best formulæ, however, appears to be by mixing about 20 drops of the volatile oil of amber, with one ounce of alcohol, and twelve ounces of ammoniated spirits. A solution of soap in alcohol, added to the oil of amber, and mixed with caustic ammonia (*aqua ammonia puræ*,) is more frequently adopted.

Good eau de luce, on standing, should not separate, but preserve its milky appearance, and not lose its pungency, or peculiar smell.

Professor Beckman, (*Hist. Invent.* ii, 489,) speaking of eau de luce, remarks, that when of the best quality it always retains its *milky* colour, which is not the case when spirit of sal ammoniac (*aqua ammonia carbonatis*,) and oil of amber are mixed together.

“As a soap,” says Beckman, “it is employed to remove from cloth many spots which cannot be removed by common soap; and it is fitter for this purpose as it very speedily evaporates. Mixed with water it is administered also for various diseases and accidents; such, for example, as the bite of some snakes; and, in consequence of its strong smell, it acts, when held to the nostrils, as a powerful stimulant in cases of fainting. But it is requisite that those who use it for the latter purpose should know,



that a small drop of it, if it come in contact with the eye, would occasion blindness."

Eau de luce was first made in Paris; but an apothecary at Lisle gave it a blue colour by means of copper, because, we are told, he was not able to give it a milky appearance, and hence it received the name of blue eau de luce. Dossie (*Elaboratory laid open*, printed at 1758,) published the formulæ for making this preparation.

Eau du luce, we remarked, in consequence of its pungency, is a powerful stimulant to the olfactory nerves; but the most common preparation for this purpose is what is commonly called the *smelling salts*, or *sal volatil*, which is the concrete carbonate of ammonia. This is usually scented with the essence of lemon or of bergamot, and frequently eau de luce is added. The salt of vinegar, as it is improperly called, is used for the same purpose. This preparation consists chiefly of acetic acid, or radical vinegar.

We may remark here, that the *offa alba Helmontii* is likewise a preparation of ammonia: if one part of a saturated solution of carbonate of ammonia in water, be mixed with two parts of pure alcohol, a complete coagulation will take place, which is the *offa alba* of Helmont and Trommsdorf; and if the alcohol be previously coloured with cochineal, the coagulum will have the appearance of *blood*, which will liquify by the friction of the hand; hence the mystical ceremony in some of the Neapolitan and Greek churches, which is imposed on the people as the *liquifaction of the blood of St. Johannes*!



## RED SAUNDERS.

Saunders is a hard wood the produce of the *pterocarpus santalinus*, a tree which grows on the Coromandel coast. The yellow or citrin saunders is a beautiful wood of the colour of lemon peel, and has a fragrant smell resembling a mixture of musk and roses. The white saunders as they are called, also possess a fragrant smell and aromatic taste. The red saunders is of a dense and compact texture, remarkably heavy and very hard. It is exported to Europe in logs, the outer part of which is a dusky, and the inner of a blood red. It has but little smell and taste. The wood is at first light red, but becomes very dark by exposure to the air. It is used chiefly for colouring drugs. The colouring matter is of a resinous nature, and hence it is taken up by alcohol, but not by water. The alcoholic tincture is a fine red.

Ground brazil wood has been sold for red saunders ; but the imposition is readily detected, as was first pointed out by Dr. Lewis, by the red saunders yielding no colouring matter, whereas Brazil wood will impart its colour almost immediately, a distinction which cannot be mistaken.

## CIVET.

Civet is a kind of perfume, which bears its name from the *civet-cat*, as it is obtained from the inguinal region of that animal. It is squeezed out of the ca-



vity, where it is secreted every other day. Good civet is of a clear, yellowish or brownish colour, neither fluid nor hard, but about the consistence of honey, and uniform throughout; of a very strong smell, quite offensive when undiluted, but agreeable when only a small portion of civet is mixed with a large one of other substances. With oils, both expressed and distilled, it readily unites, but is not acted upon by alcohol or water. The Italians make it an ingredient in perfumed oils, and thus obtain the whole of its scent. Oils dissolve the whole of it. It is very rare to meet with civet unadulterated. The substances usually mixed with it, are lard and butter; it is almost impossible to distinguish the adulteration, or discover it.

## MUSK.

Musk is scented into a kind of bag situated in the umbilical region of the quadruped called *moschus moschifer*.

The characters of musk are, that it is brownish red, feels unctuous, tastes bitter, and has an intensely strong aromatic smell. Musk, in consequence of its high price, is frequently impure. It is partially soluble in water and in alcohol; the former acquires its smell, but the latter does not retain it. It is wholly soluble in nitric and sulphuric acids, but the odour is destroyed. When rubbed with potash or soda, it developes the odour of ammonia. Oils do not act upon it. Rectified spirit of wine



(alcohol) takes up the whole of the active part of musk. Dr. Parr, (*Medical Dictionary*, vol. 1, p. 1008,) assures us, that the tincture of musk, prepared with alcohol, although of itself having no smell, will, in the quantity of a drop or two, communicate to a quart of water a rich scent; and that the quantity of water, which may thus be flavoured by a certain known proportion of musk, he considers is the best criterion of its goodness.

The best musk is brought from Tonquin in China, in thin bags, with brownish hairs; an inferior sort from the East Indies is in bags with white hairs.

The best musk, besides the characters we have mentioned, when chewed or rubbed with a knife on paper, is bright, yellowish, smooth, and free from grittiness; and when laid on a red hot iron, will inflame, and burn almost entirely away, leaving only an exceedingly small quantity of light greyish ashes.

Artificial musk is a pharmaceutical preparation made by pouring nitric acid on oil of amber. It has little of the odour of musk; it resembles more that of nitrous oxyde.

### EBONY.

Hard, heavy, and compact wood, as the apple-tree, &c. is frequently stained or dyed to resemble ebony, and often passed off as such. The detection may be effected by a few experiments, which we shall notice.

The true ebony is produced chiefly in the island



of Madagascar, and the Mauritius. It is an exceedingly hard and heavy kind of wood, susceptible of a very fine polish, and on that account used in masaic and inlaid work, for toys, &c. It is of different colours, most usually black : also red, and green ; the first is mostly preferred. The best is a jet black, free of veins and rind, very massive, astringent, and of an acid, pungent taste. It yields an agreeable perfume, when laid on burning coals ; when green it readily takes fire. Green ebony is not confined to inlaid work, it has been used in dyeing. Of red ebony, called also Grenadilla, we know little more than the name. There is an ebony which comes from the West Indies ; it is either white or black. It is a fine timber wood, has a smooth even grain, which takes a good polish, and is used principally by turners, although seldom, we believe, in this country. The heart is usually the complexion of jet. The bastard ebony, growing in the West India islands, called mountain ebony, which is a dark brown, is often employed for different purposes.—The specific gravity of real black ebony is 1.209, and the only woods which are heavier, are *lignum vitæ*. (sp. gr. 1.333,) pomgranate, (sp. gr. 1.354,) and Dutch box, (sp. gr. 1.328,) whereas the others, as beech, alder, maple, apple, pear, &c. are considerably less. Ebony, therefore, will sink in water, but the dyed woods made in imitation of it except from the woods that are heavier, will swim or float. The other descriptions of box wood are of a specific gravity less than water, and hence will float.



Wood is dyed black, in imitation of ebony, by the usual black dye, composed of green vitriol, logwood and galls. If a portion of this wood be cut in pieces, and digested in sulphuric acid very largely diluted, it will lose its black colour, and assume a yellowish red tinge; and if the acid be examined for iron, previously neutralising it with alkali, by using either tincture of galls, or ferrocyanate of potash, the presence of that metal will be shown. Diluted sulphuric acid digested in the same manner on real ebony, will have no effect; the acid will not produce a black with galls, nor a blue with ferrocyanate of potash. It is difficult, in imitative ebony, to dye the wood thoroughly through; and, therefore, when cut the uniformity of colour will be wanting. Green ebony, if imitated by dyeing wood with a solution of copper, a practice usually adapted for staining or dyeing of that colour, may be examined by digesting it in diluted sulphuric acid, saturating the acid with ammonia, and adding an excess of that alkali. The well known blue colour will appear. The same treatment with the genuine wood will give no indications of copper. Green ebony, we are informed, imparts to alcohol a fine green colour; this would not be the case with the dyed wood, if the colouring ingredient is of copper.

The art of dyeing, and staining wood of different colours, has been much improved, since a variety of experiments have been made on that subject, a short



account of which may be seen in the *Artist's Manual*, article *Dyeing*.\*

## IVORY.

A few remarks respecting this substance, which is intermediate between bone and horn, and is the tusk, or tooth of defence of the male elephant, may be interesting in connection with our observations on ebony.

The tusks weigh from 30 to 130 pounds; and when entire are of a yellowish brown colour on the outside, but white internally. The finest, whitest, and most compact, comes from the island of Ceylon. Hunting the male elephant at the Cape of Good Hope, as many of the hunters are destroyed, meets with great encouragement; for every pound of ivory they receive a guilder.

The tooth of the sea horse, or rather the projecting weapon of the sea-unicorn, furnishes a kind of ivory not of much use, since from their twisted form they cut to great disadvantage, and besides is too hard to be sawed or wrought like ivory. It is used for making artificial teeth.

Ivory is not capable of being softened by fire; but is not altogether so hard and brittle as bone. It

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\* Mr. Hall (*Silliman's Journal* iii, 166,) speaks of a *stain* for some sorts of wood used in the making of cabinet furniture.—It consists of a decoction of walnut or hickory bark, with a small quantity of alum. Wood, of a white colour, receives a beautiful yellow tinge, very little liable to fade. He recommends it in particular for white maple, curly maple, and remarks that it gives the finest appearance to *birds eye maple*, a lustre even to the darkest shades.



is composed of gelatin 24, phosphate of lime 64, and carbonate of lime 0.1 in 100 parts. It is susceptible of receiving a stain or dye like bone; hence is frequently coloured. The coal of ivory is the *true* ivory black. If pieces of ivory be put into a crucible, the crucible filled with sand, and exposed to the action of a strong heat, the ivory will be carbonized, and appear of a perfect black; it is dense, and compact, and is readily recognised from the common bone-black.

The principle uses of ivory are for making mathematical instruments, boxes, combs, dice, and various ornamental utensils.

When bone is substituted for ivory, which is frequently the case, it is easily recognised by its pores, which are not to be seen in ivory, and by its wanting beautiful white veins or marks by which ivory is distinguished.

Ivory when boiled in the usual dye stuffs, as for example, cochineal, muriate of tin, and bitartrate of potash, for red or scarlet, becomes soft in the exterior, and reserves the colouring matter with ease. If digested in muriatic acid, it undergoes the same change as bone, though not so rapidly; the phosphate of lime will be taken up, and the gelatin remain.

### TORTOISE SHELL.

The plates or scales of the Hawk's-bill turtle (*testuda imbricata*,) furnishes that beautifully variegated



and transparent substance called tortoise-shell. It differs from shells in its composition, and approaches the nature of nail. Macerated in nitric acid, it gradually softens, and seems to be composed of membranes laid over each other, having the properties of coagulated albumen. When burnt, it yields phosphate of lime and soda, with a little iron.

When tortoise-shell is steeped in boiling water, it is rendered soft, and is then capable of being moulded into almost any form. The ancient Greek and Romans were very partial to its use, if we may judge by their decorating with it doors, pillars, and even beds. At Rome its consumption was very great.—Velleius Paterculus informs us, that when the city of Alexandria was taken by Julius Cæsar, the warehouses were so full of this article that he proposed to have made it the principal ornament of his triumph.

Tortoise-shell has been imitated with success, although the eye can readily perceive the difference. For this purpose horn is first softened, and pressed into plates; a paste consisting of two parts of quicklime, and 1 part of litharge, made into a proper consistence with soap lie, is applied, leaving those parts bare which are to be transparent. When thoroughly dry, remove the paste, and if the operation has been dexterously performed, the horn will appear variegated, or partly opaque and partly transparent. A great deal of art is required to produce very accurate imitations.



## ROSES.

We notice the rose in consequence of its preparations being adulterated, as the oil or *attar* of roses. White roses are the weakest; but the damask, the *rosa pallida*, or *centifolia* Lin. are the strongest in aroma and essential oil, and are, therefore, principally used. Their odour is imparted to water and spirit, but chiefly to the latter. On distilling large quantities, a small portion of fragrant butyraceous oil, of a yellowish colour, is obtained, which concretes in a slight degree of cold. Both the water and oil are chiefly used in perfumes.

The red rose, *rosa centifolia*, has but little of the fine flavour of the pale sort. They tinge water with a deep red colour, and spirit with a pale one. The extract from a watery infusion is austere and bitter; that from spirit, in a greater degree.

Rose water is the petals of damask roses, the heels being cut off, distilled with water.

The conserve of roses is the red roses gathered before the petals are unfolded, beat up in a mortar with sugar, in the proportion of one to two. Very frequently molasses is used in preparing this conserve, and is sometimes added to soften it. Conserve, containing molasses, is always unusually soft, and in summer becomes so thin as to run, and frequently to spoil by fermentation.

The honey of roses is prepared from the petals, which are infused in boiling water, then strained, and the infusion mixed and boiled with honey.



The sirup of roses is the petals macerated in boiling water, the infusion then strained and evaporated, and sugar added to it to form a sirup.

The infusion of roses is merely an infusion of the petals in boiling water, slightly acidulated with sulphuric acid, with the addition of a small portion of sugar.

The *attar* or essential oil of roses, so highly esteemed as a perfume, is usually prepared in India. Forty pounds of roses with their calyces, are put into a still with sixty pounds of water. The distillation is continued till 30 lbs. of water come over. This water is then poured upon 40 lbs. of roses, and 15 or 20 lbs. more are to be drawn off. It is then poured into tin pans, and exposed to the fresh air for the night. In the morning the attar will be found coagulated, and floating upon the surface of the water.

The roses of India do not appear richer in oil than those of Europe or America. From two to three drachms of oil are procured from one hundred weight. Some have obtained half an ounce, some an ounce, and Hoffman has procured two ounces from the same quantity of leaves. It is adulterated sometimes with the oil of sandal wood; but this oil does not congeal in common cold, and its peculiar smell predominates, sometimes with that of sweet grass. The latter imparts a green colour, and the oil does not easily congeal in a moderate temperature. The colour is no criterion of its genuineness, since the real attar differs considerably in this respect.



The attar of roses should be of a thick consistence, and even retain its solidity in warm weather. If adulterated with fixed oils, as oil of ben, olive oil, &c. and which is frequently the case, the fraud may be discovered like similar adulterations of essential oils, by exposing it to heat; the pure oil will evaporate, and leave the fixed oil. Besides, the attar will leave a stain on paper, after exposure to heat. The pure oil should evaporate entirely, without leaving any residue. Alcohol cannot be used for sophisticating it; it will merely take up a part, and the fluid will be liquid as water. If cheaper essential oils were used, they would change the odour of the oil, and render it at the same time thin.

The attar of roses is an agreeable, but expensive perfume.

We may also mention another sophistication, in order to render it solid, viz. : by melting white wax or spermaceti with the olive or other oil made use of; the presence of wax or spermaceti may be detected by evaporation.

\* \* \* \* \*

Having thus gone through the examination of different substances, it may be useful to enumerate the REAGENTS, which will be generally required in experimental investigations concerning the detection of poisons, and of adulterations in general. The reagents should be *perfectly pure*, and with the exception of test papers and fluxes for the blow pipe, be preserved in well stoppered bottles. The bottles may



be conveniently put into a chest, with divisions between them, and the chest furnished with a drawer for containing the test papers and some other dry substances.

## CHEMICAL REAGENTS.

Sulphuric acid.

Nitric acid.

Muriatic acid.

Dilute sulphuric acid, 1 acid 3 water.

—— nitric acid, do

—— muriatic acid, do

Nitro muriatic acid.

Aqueous chlorine.

—— sulphurous acid.

—— sulphuretted hydrogen.

Acetic acid.

Phosphoric acid.

Tartaric acid.

Solution of potash.

—— soda.

—— ammonia.

—— carbonate of potash.

—— carbonate of soda.

—— carbonate of ammonia.

—— oxalic acid.

—— oxalate of ammonia.

—— barytes.

—— acetate of barytes.

—— nitrate of barytes.

—— muriate of barytes.



_____	phosphate of soda.
_____	sulphate of silver.
_____	muriate of tin.
_____	muriate of platinum.
_____	muriate of gold.
_____	per chloride of mercury.
_____	muriate of ammonia.
_____	nitrate of lead.
_____	nitrate of mercury.
_____	iodine in alcohol.
_____	nitrate of silver.
_____	ferrocyanate of potash.
_____	muriate of lime.
_____	hydrosulphuret of ammonia.
_____	hydriodate of potash.
_____	soap in alcohol.
_____	acetate of silver.
_____	chromate of potash.
_____	ammoniaret of copper.
_____	sulphate of soda.
_____	arsenious acid.
_____	acetate of lead.
_____	succinate of ammonia.

Tincture of galls.

Alcohol.

Chlorate of potash.

Nitrate of ammonia.

Test papers, litmus.

\_\_\_\_\_ do reddened by acid.

\_\_\_\_\_ turmeric.

\_\_\_\_\_ brazil wood.



Black flux.

White flux.

Microcosmic salt.

Cylinders, or plates of copper.

\_\_\_\_\_ tin.

\_\_\_\_\_ zinc.

\_\_\_\_\_ iron.

### OCCASIONAL REAGENTS.

Deuto-acetate of iron.

Tincture of ginger.

Iodide of starch.

Oil of turpentine.

Solution of gelatin.

Dry caustic potash.

Albumen.

Arsenite of potash.

Hahneman's wine test.

Benzoate of soda.

\_\_\_\_\_ of ammonia.

Silicated potash.

Tannin.

Nitrate of potash.

Aqueous carbonic acid.

Muriate of soda.

Supersulphate of alumina and potash.

Subacetate of lead.

Protosulphate of iron.

Infusion of galls.

Infusion of cabbage.



Professor Brande in his *Manual of Chemistry*, has given an engraving of a portable laboratory for the analysis of mineral waters, which may be useful to the experimental enquirer. It consists of a tray sufficiently large to hold the apparatus which he mentions ; and in which is placed, at one end, but raised from the tray, an open box containing the bottles, arranged in the same manner as in a chest.— This arrangement is convenient. The tray should contain the following articles :

Florence flasks.

Wedgwood and glass basins.

Platinum and silver crucibles.

Silver capsule.

Funnels.

Test-glasses and test-tubes.

Glass rods.

Filtering paper.

A spirit and an argand lamp.

A retort and receiver.

Copper basin to serve as a sand bath.

Blow pipe.

Thermometer.

Dr. Wallaston's scale of equivalents.

Dropping bottle.

Watch glasses.

A support for holding glasses over a lamp.

A small brass stand with rings.

A tube, with a bulb in the centre and pointed extremity, for drawing up small portions of liquids.

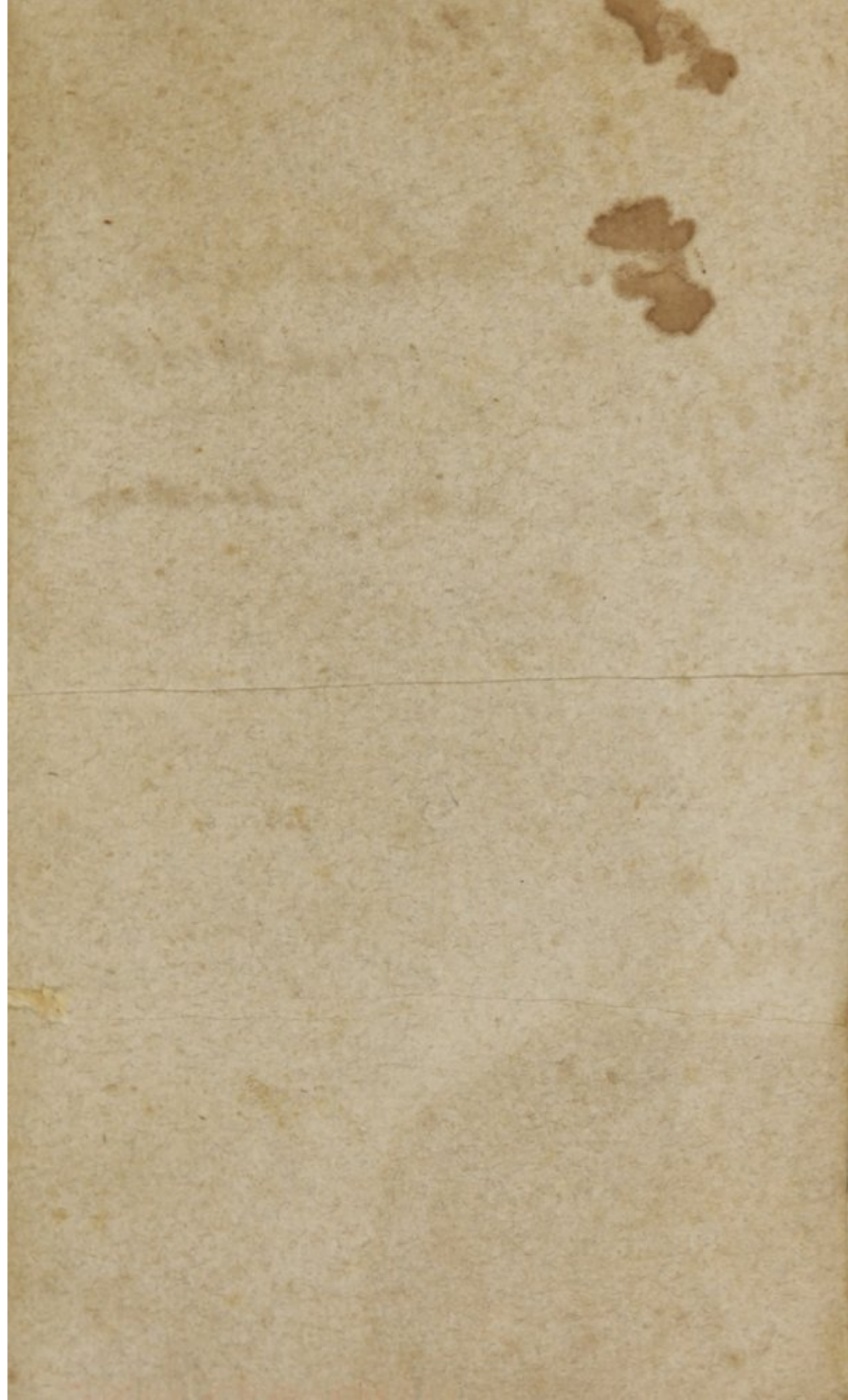


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