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A
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WITH
AN HISTORICAL INTRODUCTION.

BY
JONATHAN OSBORNE, M.B. T.C.D.

LICENTIATE OF THE KING'S AND QUEEN'S COLLEGE OF PHYSICIANS IN
IRELAND, &c.

Nulla modo fieri potest ut axiomata per argumentationem constituta ad inventionem novorum operum valeant, quia subtilitas naturæ subtilitatem argumentandi multis partibus superat: sed axiomata à particularibus rite et ordine abstracta nova particularia rursus facile indicant et designant.

Bacon Nov. Org. lib. 1.

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P R E F A C E.

HAVING been particularly induced to observe the urine in some cases of diabetes which fell under my notice, I gradually became interested in its appearances, and, from extending my inquiries, convinced myself of the importance of examining it in several other diseases. The advantages derived from an examination of the alvine discharges are now manifest to every practitioner, although not many years have elapsed since this kind of investigation was almost entirely neglected. The urine, however, seems hitherto to have excited attention only in a chemical point of view, except in a few diseases, wherein it exhibits changes so remarkable, as to strike even the most indifferent observer. As it is obtained without the admixture of food, its numerous variations are perfectly cognizable to the senses, and we have in them a strong inducement to pursue the investigation. They show the delicacy of this test of disease, which appears uncertain, because not as yet under-

stood. By combining and comparing the chemical and physiological observations, which have been made at different times, these variations are simplified, some are easily referred to decomposition of the fluid after its discharge, others to the specific operation of diet or medicines; and thus we arrive at the knowledge of those which depend on the healthy or diseased state of the individual.

I found no modern treatise expressly written on this subject. The observations which lie scattered in a number of medical works of credit I carefully examined, and compared with what I observed. In the following pages I relate those which were found to be correct. As I form no pretensions to originality, I have always endeavoured to get the sanction of some author of note, to what might otherwise have appeared as my own. Thus the following treatise may be regarded as an index of what has been hitherto discovered, concerning the urinary secretion, and is the result of an attempt to frame for any person interested in the subject, such a sketch as I should have been desirous to possess, when I commenced my inquiries.

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HISTORICAL INTRODUCTION.

It is remarkable, that Hippocrates neglected the pulse, and endeavoured to discover the indications which we derive from it by an attentive consideration of the urine. The observations on this subject which are repeated most frequently in his genuine works have been, in general, so well confirmed by subsequent experience, that I cannot refrain from enumerating some of them, as follows. *The sensible qualities of the urine are altered by food and drink^a. In ardent fever, pale urine is connected with oppression of the sensorium, and is unfavourable^b. The appearance of a se-*

^a Aph. 14, sec. 4, De Morbis l. 4.

^b Coac. Prænot. c. 26. Aph. 72, sec. 4. De Victûs Rat. l. 4.

diment denotes a more or less speedy resolution of fever^c. The sediment or cloud is more favourable when it occupies the bottom, than when it floats towards the surface of the fluid^d. Affections of the kidneys and bladder are indicated by the presence of pus or blood in the urine^e. He also observed the connexion between a sandy deposit and calculus of the bladder^f, and remarked the danger of those diseases in which the urine deposits a furfuraceous sediment^g.

There are, however, some observations scattered throughout his writings which do not appear as well founded as the preceding. These may, in some measure, be ascribed to the effects of the climate and mode of living in Greece; but it must be confessed that not a few seem to be owing to a forced analogy which he held between the condition of the urine and that of the pus of an ulcer^h. However, he framed no hypothesis of extensive application. He observed with admirable candour and felicity, generalizing, as far as the

^c Coac. Prænot. c. 26. Aph. 71, sec. 4.

^d Prog. c. 8. Coac. Prænot. c. 26.

^e Aph. 76, 77, 78, 80, 81, sec. 4.

^f Aph. 79, sec. 4.

^g Prog. c. 8.

^h De Crisibus, c. 3.

knowledge of those times led him, according to the method of induction. He opened the extensive field of observation to his successors; and, when we see how lamentably they deserted it, his merits will be more fully appreciated, and we shall not refuse to add our suffrage to that of preceding ages, by which he has been ever honoured as the father of medicine.

Celsus, who flourished in the Augustan age, has repeated several of the aphorisms of Hippocrates, and gives a more detailed account of the symptoms of calculusⁱ. But neither Aretæus Cappadox nor Cælius Aurelianus has left any observations on the urine worthy of relation.

Galen, who lived from the reign of Antoninus Pius to that of Severus, has left numerous remarks on the urine, in his works; but the professed treatise on the subject, which bears his name, is universally rejected as spurious, and is of a much later date^k. His observations, in general, correspond with those of Hippocrates, and he appears to have been the first who consulted the pulse in disease: but, unfortunately, he introduced a theory, the baneful effect of which we shall have to

ⁱ L. 2. c. 7.

^k Freind, Hist. of Physic, vol. i. p. 248.

trace in his numerous followers. Fire, water, air, and earth (the elements of the ancients), are respectively distinguished by the qualities heat, cold, moisture, and dryness. From the preponderance of some of these qualities over others, so as to prevent the action of any of the organs, disease is produced; but when acting in a less degree, the result is merely difference of temperament¹. The humours which, according to him, are most closely connected with those qualities, are: the blood connected with heat; the pituita with cold; the bile with dryness; and the black bile with moisture. From different actions of those humours and of what he calls the faculties and spirits, all diseases, with their symptoms, are explained. This theory, so well adapted to the knowledge of the age, was so embellished by the unrivalled eloquence of its author, that it was universally received, and appears to have extended a pernicious influence over the opinions of almost all the physicians who succeeded him during more than twelve centuries.

The most ancient treatise on urine now extant is that of Theophilus^m. Some suppos-

¹ Le Clerc, *Hist. de la Médecine*, p. 673.

^m Theophilus, *De Urinis*, Græce et Latine, curâ Guidotii, Lug. Bat. 1703.

ed him to be the person who is addressed by St. Luke; but several circumstances prove that he must be referred to some period between the fourth and eighth centuriesⁿ. He transcribes, in some places, from Ætius, and frequently expresses himself in the words of the spurious treatise of Galen. The series of colours which the urine presents is described by comparison with the colours of known objects, and each is furnished with a separate indication, according to the degree of consistence with which it may be connected^o. He divides the deposit into the *nubes*, *enæorema*, and *sediment*, according as it occupies the upper, middle, or lower part of the fluid, and assigns a different indication to each. The *nubes* and *enæorema* are explained in a whimsical manner, by supposing the existence of a *flatus*, elevating them from the bottom of the vessel^p. He distinguishes pus by its odour; derives oily urine from consumption of the fat; and that which abounds with a furfuraceous deposit from consumption of the flesh^q.

ⁿ See Guidot Prolegomena, and Manjeti Bibliotheca. The treatise commences, according to the custom of the age, with a pious invocation: "Χριστῷ ὡ ἀληθινῷ Θεῷ, &c."

• C. 1 and 8.

^p C. 12.

^q C. 15.

In this treatise of Theophilus most of the observations of Hippocrates are repeated. Galen is mentioned with the highest reverence, as one whose authority must not be questioned. It is, however, free from any open developement of his theory; but, from the systematic arrangement of urines according to their colour and consistence, he appears to have opened the way to the hypothetical refinements of Actuarius, whose treatise, although now forgotten, yet was once held in the highest esteem, and is altogether worthy of a more detailed examination.

Actuarius was a physician of Constantinople, most probably archiater^s, flourished in the eleventh or twelfth century^t, and has left seven books on urines: one on the difference of urines; two on the judgment of them; two on their causes; and two on the prognosis to be derived from them. He states that Hippocrates has left scattered and imperfect observations; that Galen only showed the consideration of the urine to be useful; and that Alexander Magnus and Theophilus have left the subject unfinished^u. He informs us, that, hav-

^s Manjēti Bibliotheca Script. Med.

^t Freind, from the purity of his Greek, assigns to him a period before A. D. 1200.

^u Prefat.

ing himself inspected the urine, both of the healthy and diseased, he collected a few general facts, and, by observing and reasoning on them, was enabled to ascertain their causes; that when, in course of time, he had confirmed these discoveries, he proceeded to extend his judgments and prognostics to other cases, in which he was not a little assisted by the pulse, and by fragments left by the older authors^x. He insists on the necessity of examining the urine in connexion with the pulse, for the urine indicates the quantity and quality of the humours, whilst the pulse indicates the degree of heat or coldness; and also in connexion with the alvine discharges, which show the concoction and crudities of the digestive organs^y. He maintains that the knowledge derived from the urine is safer and more ready than that which the pulse affords, because it is exposed to view, whilst the pulse is only perceived by the touch^z, and, according to Galen, requires the term of a man's life to be perfectly understood.

He describes a series of colours and con-

^x De Urin. Judiciis, lib. 2, c. 26.

^y De Urin. Different. c. 7.

^z Ibidem.

sistence both of the urine and of its contents in the manner of Theophilus, but with many refinements^a. The urines of different ages^b and of different seasons^c are evidently described according to the doctrine of moisture and dryness held by Galen and his followers; and he is in one place so much led astray by Galenic notions, as to state that in dropsy the patient passes a greater quantity of urine than usual^d.

In giving a sketch of this performance of Actuarius, I forbear to mention those observations in it which, founded in fact, were confirmed by experience, and rather wish to afford the reader a view of the peculiar notions which he adopted, and which influenced the minds of physicians during a long period afterwards. He thinks that pale white urine is caused by an abundance of crude humours^e; and that a very white deposit is formed by the particles of some phlegmatic humour, or by pus highly concocted, which is secreted by some internal membrane diseased^f. Black urine is salutary only in diseases arising from

^a De Urin. Different. c. 8, et seq.

^b De Urin. Judiciis, lib. 1, c. 5.

^c Id. c. 8.

^d Id. c. 11.

^e Id. c. 12.

^f Id. lib. 2, c. 4.

black bile, as melancholy or quartan intermit-
tents^g. Urine without any sediment is some-
times produced by violent inflammation in the
principal members, and is caused by the spu-
rious heat attracting matter to the part, in the
manner of a cupping-glass^h. The appearance
of the urine differs according to the seat of the
inflammation. In affections of the liver and
lungs from any humour, it is red, bloody, or
of a wine colour, according to the quantity of
heat. There is less alteration in the urine of
those who are affected in the brain or its mem-
branes. In affections of the spleen it is of a
dark colour, from the blackness of the humour
which abounds there. Disease of the uterus,
kidneys, bladder, and colon, alters the urine,
but in a less degree than affections of the
brain and its membranes; and it is a general
rule, that the urine is more affected by those
parts which are near the source of heat, than
by those which are distant from itⁱ.

The two books on the causes of urines are,
as indeed the title imports, completely hypo-
thetical. In those on the prognosis to be de-
rived from urine, the art of uromancy is set
forth. He particularly notices the bubbles

^g De Urin. Judiciis, lib. 1, c. 20. ^h Id. lib. 2, c. 18.

ⁱ Id. c. 25.

which float on the surface^k, and introduces so many refinements, with such subtle explanations, that we can readily believe him, when he says, that no time suffices exactly to comprehend and describe the various complications which are daily seen in the urine, and that, perhaps, the intellect of any person would fall into a *vertigo*, who should endeavour to connect them^l. This treatise of Actuarius was transcribed by many subsequent authors, without however acknowledging their obligation. That it possesses great ingenuity cannot be denied; but most of the observations derived from nature are perverted to complete the theory of Galen. They were repeated with implicit credence for several centuries, afterwards became the fundamental doctrines of uromancy, and at length mainly contributed to bring observations on the urine into total discredit.

From the east we now turn to the west, where the opinions of the Greek physicians were only known through the medium of the Arabians. In the twelfth century, Ægidius, a Benedictine monk, said to be archiater to Philip Augustus King of France^m, wrote in

^k De prævidend. ex Urin. lib. 2, passim.

^l De Urin. Judiciis, lib. 2, c. 9.

^m Manjeti Bib. Scrip. Med.

imitation of the Schola Salernitana, a poem on Urines, in Latin hexameters. This poem, along with others by the same author, was so much admired as to be read in the public schools, and was published repeatedly with commentaries by Gentilis, one of the greatest expositors of his timeⁿ. In it we find absurdities far surpassing those of Actuarius. The urine is divided into four regions, corresponding with the regions of the human body, and the part in which the disease exists is to be determined by the position of the depositor^o. Thus, crude humour occupying the superior portion of the urine, denotes disorder of the thorax and compression of the diaphragm: occupying the middle, it signifies an affection of the stomach and intestines; and when at the bottom, it denotes disease of the kidneys or loins. The bubbles on the surface arise from a *ventosity* in the humours, and are connected with pain in the head from a *fumosity* ascending upwards^p. In short, this trea-

ⁿ Carmina de Urinarum Indiciis edita ab excellentissimo domino Magistro Ægidio, cum expositione Magistri Gentilis de Fulgineo, emendata, &c. per Magistrum Avenantium, de Camerino Artium et Medicinæ professorem.—Bk. Letter.

^o Sub forma cineris corpuscula pressa deorsum,

Infima membra notant morbi languore gravari, &c.

^p Ista ampulla significat dolorem capitis propter fumositatem resolutam et superius ascendentem.—Comment. Gent.

tise is utterly unworthy of notice, except as an historical document, which affords us a view of the medical doctrines of the west of Europe, nearly at the same time that Actuarius wrote in the east.

Towards the end of the fifteenth century, after the taking of Constantinople, the original works of Hippocrates and Galen being produced and disseminated by the newly discovered art of printing, the writings of the Arabians sunk into that universal discredit from which they have never since emerged. The medicine, as well as the philosophy of the Greeks was gradually adopted and assiduously cultivated in all the universities. The opinions, therefore, which have been mentioned respecting the urine in disease, prevailed without any material alteration, till the time of Paracelsus. That extraordinary character first established the distinction between urine of the drink and of the chyle. He also conjectured that calculi are formed of a peculiar matter, which he calls by the name *duelech*, and that they are indurated by means of a petrifying juice¹. Van Helmont first made the observation that calculi are formed

¹ In his works there is a treatise, *de Urinarum Indiciis*, which is almost unintelligible.

in urine, in the same manner as tartar in wine; and although, in his celebrated treatise *De Lithiasi*, he has consulted his imagination much more than experience, yet he appears to have analysed both urine and calculi, with as much success as the chemistry of his time permitted^r, and has the merit of being the first who made any rational experiments towards detecting the constituents of animal substances.

Passing several authors^s who have only repeated the observations of Actuarius, chronological order leads us to the chemical physicians, who excited the great commotion, in which the doctrines of Galen were ultimately overthrown. After Van Helmont, who may be esteemed in some measure the founder of this sect, the most famous supporters of it were, Pr. de la Boe Sylvius, Tackenius, and Willis.

^r Exsectum duelech (calculus) destillavi per se, nec quicquam elicui præter spiritum foetidum urinæ et flavam crystallum simulque oleum quale ex desiccata urina traditur. Quod autem in fundo mihi remansit terra erat nigra friabilis et insipida. *De Lithiasi*, c. 5, s. 9.

^s Peter de Montagnana de Urinarum Judiciis. Patav. 1487. Peter Leo de Urinis. Venet. 1514. Vassæus de Judiciis Urinarum. Paris. 1547. Willichii Urinarum Probationes, cum variis Matularum Delineationibus et genuinis Urinarum Coloribus. Basileæ, 1582, &c. &c.

The last has left a treatise on urine^t. He thinks that the most important information is to be derived from it^u: a sentiment in which chemical physiologists have always been the most ready to participate. He is nearly free from the refinements of Actuarius; but has introduced several notions derived from the supposed constituents of the urine^x. The sect of the chemists, however, was soon to give place to another. On the promulgation of the Cartesian philosophy, a mathematical taste was universally inspired. A number of mechanical principles were introduced into physiology, and the confidence in mechanical reasoning was greatly increased by the success which attended its application to physics by Newton and others. Borelli referred all the actions of muscles to the mechanical powers. Keil and Pitcairn laid the foundation of a system of medical statics, and Bellini, amongst other subjects, wrote a treatise on urine^y, in which I notice nothing new, ex-

^t Willis Opera Omnia, t. 8. Lugd. Bat. 1681.

^u Non certiori fide aut majore diligentia pyxidem nauticam intuentur naucleri quam pro idoneis medendi temporibus et modis urinarum phenomena observare debent medici. De Urinis, c. 6.

^x See c. 4 and 6.

^y Laurent. Bellini de Urinis, Pulsibus, Missione Sanguinis, &c. Bonon. 1683.

cept that the observations of Hippocrates are explained on mechanical principles. Any original observations which may be found in either Bellini or Willis, cannot be received without great suspicion, when we remember the influences under which they wrote. Hence we mention those partisans of the mechanical and chemical sects, merely as connected with our history, without entering into the detail of their peculiar opinions, which are now for the most part deservedly forgotten.

Boerhaave may be styled the *eclectic* of the moderns, who founded his physiology on the principles both of the chemists and mechanics. As a physician he was a most acute observer of symptoms, and in his Aphorisms has not neglected to give the consideration of the urine its due weight. From him originally we hold the opinion on the formation of calculi, which is generally received at the present day. By examining urine with the assistance of a microscope, at different intervals after it was passed, he witnessed the formation of small crystals^z. Connecting this with the deposition of the mucous cloud, and with the concentric layers which calculi present, he concluded

^z Boerhaave Prælect. ab Hallero, t. 3, p. 256. Van Swieten in Aph. 1414.

that their formation is derived from a calculous matter dissolved in urine, gradually depositing itself around a nucleus, which is not unfrequently a particle of blood or mucus delayed in the kidneys or bladder ^a.

We have now to notice a class of men, who justly aroused the indignation of physicians at the commencement of the last century. These were the *uromantes* or *urine-casters*, who never required to see a patient, but prescribed without any hesitation from an inspection of the urine alone ^b. They succeeded in gaining the confidence of the lower orders; and this easy and profitable manner of

^a Boerhaave Aph. 1004.

^b Quæ eorum est dementia qui oblatum domi lotium quasi σελήνης ἐκλειψιν ἀτενίζοντες porrectâ matulâ inspiciunt, et credulo imperitorum vulgo quæ maxime nesciunt scire persuadent. Apage tales istos quibus Vespasiani hoc putidum placet, "Lucri bonus odor ex re qualibet." Vanderlinden Manuduc. ad Medicinam, p. 59. The celebrated Dr. Radcliffe was once applied to by a woman carrying some of the urine of her husband, who was sick and in bed at a considerable distance. The Doctor having inquired his trade, and being answered that he was a shoemaker, took the urinal, emptied it into his chamber-pot, and having filled it with his own water, dismissed her with this advice, "*Take this with you home to your husband; and if he will undertake to fit me with a pair of boots by the sight of my water, I shall make no question of prescribing for his distemper by a view of his.*" Radcliffe's Life and Letters, p. 13.

practising physic, seems to have attracted not a few of the regularly educated physicians of the time. In England it increased to such a degree, that the London College of Physicians at length interfered, and passed an enactment regulating the conduct of its members in this respect^c. *Uromancy* having thus become disreputable, was abandoned by regular practitioners, and gradually fell into the hands of illiterate impostors, who continued for a long time to travel about the country, imposing on the credulity of the ignorant. But the numerous institutions established for affording medical assistance to the sick poor,

^c The enactment of the College quoted in Guidot's *Prolegomena* is as follows: "Ridiculum quidem est et insulsum
 " agunt ex urinarum solummodo inspectione, sive de mor-
 " borum genere atque natura, sive de ægrotantium statu ac
 " conditione aruspicum et conjutorum more velle quicquam
 " certi solidique divinare; monemus itaque omnes medicos
 " ut hac in re multo cautius posthac se gerant quam antehac
 " solitum est a plerisque factitari; et hanc ob causam omni-
 " bus medicinam facientibus interdictum volumus ut idiotis
 " istis et mulierculis ægrotantium matulas circumportantibus
 " nequicquam in medicina præscribant, nisi aut ipsum ægro-
 " tum viderint, aut saltem ab illis qui consilium petunt
 " de toto illo morbo quo laborat æger, morbique circumstan-
 " tiis et plane et plene instructi fuerint. Hac enim ratione
 " et dignitatem medici melius tuebimur, et multo etiam aptius
 " et scientius excogitabimus remedia quæ sint homini periculi
 " tanti maxime profutura."

materially contributed to lessen the sphere of their influence; and their decline was so rapid, that the present generation barely remembers that such persons once existed.

After the fall of uromancy, we have no professed treatise on the urine by any of the English physicians. They seemed to have been ashamed of what had led to so many abuses, and confined themselves to scattered remarks on its appearance in their descriptions of diseases. On the continent, however, the subject was not entirely neglected. Fred. Hoffman has left a tract on it, which abounds with just observations. There is also another by Stahl^d. Both those authors seeing how fallacious and inadequate physiology was when founded on chemical or mechanical principles, assumed the existence of a vital principle, as the existence of gravitation had been assumed in physics, and referred to it the numerous phenomena which could not be otherwise explained. Thus the present epoch of physiology commenced. The observations on our subject, which have been made by medical writers of credit after this period, are noticed in the following pages as far as they appear to be well founded, therefore there is no neces-

^d De Uroscopiæ Usu et Abusu.

sity for mentioning them here. With respect to the chemical examination of urine almost every thing is due to the moderns. For some time after the discovery of phosphorus, all the experiments made on urine were with a view to facilitate the production of that substance; to those, however, we owe the discovery of several of the phosphates. In 1773 urea was discovered by Rouelle junior. In 1775, Scheele discovered uric acid and the phosphate of lime. After the introduction of pneumatic chemistry, putrefaction was explained; and in the paper by Fourcroy and Vauquelin^e, a much more complete analysis of the urine was given than had hitherto appeared. Calculi, before involved in great obscurity, were analyzed by Pearson and Wollaston. Cruikshanks has left a short paper on urine, which contains the most useful remarks on the subject that ever perhaps have been written in the same compass. To enumerate those who have since laboured in this field, is to mention most of the celebrated chemists of our time. Berzelius, Thenard, Henry, Brande, Orfila, Bostock, Marcet, Nysten, and Prout, have each taken important parts, and several others have furnished various illustrations,

^e Annales de Chemie, vol. xxxi.

which being scattered in different publications, are of but little benefit to the medical public. Thus I am led to hope that the following attempt to connect them together, will not be altogether unacceptable.

Many parts of the subject remain unknown, and several others are but imperfectly understood. With respect to these we must remember the old adage, *satius est ignorantiam fateri quam solerter mentiri*. Gravel and calculi having been lately treated in a very ample manner, shall not at present occupy much of our attention. To assist the reader in pursuing his inquiries, a number of quotations are introduced; and perhaps one of the most useful ends which a medical author can propose to himself, is to set forth those topics which have not yet been investigated, to point out the boundaries between what is known and what is unknown, and to direct the attention of future observers where they are most required.

CHEMICAL COMPOSITION OF THE URINE.

THE analysis of animal products, always dubious and difficult from our inability to confirm it by synthesis, is peculiarly so when applied to urine. Its numerous constituents, and the weak affinities by which they are held together, occasion a variety of ambiguities: accordingly, not only has the presence of some substances been assumed without any satisfactory evidence, but products of decomposition have been repeatedly mistaken for constituents of the fluid; it therefore becomes necessary to enumerate those substances whose existence in the healthy urine may be proved by unexceptionable experiments, both in order to render more clear the principles which are afterwards to be advanced, and to show the methods by which examinations of the urine are to be conducted.

The substance which communicates the colour and odour to urine is soluble in water; for, in proportion as water is added, it becomes less high coloured and less odorous. When

an extract of urine, of the consistence of a syrup, has been obtained by evaporation, and is suffered to cool, it gradually concretes into a mass of crystals. If four times its weight of alcohol be poured on this mass, and after the application of moderate heat for some time, it be decanted off, all that is soluble in alcohol is separated from the rest. The alcohol is then to be evaporated slowly to the consistence of a syrup, which, on cooling, presents, in tabular quadrangular crystals, the peculiar substance known by the name *urea*. It may also be detected by pouring into the extract of urine concentrated nitric acid, which is immediately followed by the appearance of a number of white shining crystals resembling boracic acid: these result from the peculiar combination of urea and nitric acid. What has been hitherto regarded as urea, is stated by Berzelius^a to be a compound of the true urea with several deliquescent substances from which he separated it. Urea, according to him, is colourless, and shoots into very distinct prismatic crystals, like those of nitre.

Uric acid is precipitated as the urine cools

^a Sketch of Animal Chemistry in Young Med. Lit. p. 527.

in form of a whitish powder, which gradually assumes a reddish hue. Sometimes the precipitate is hardly perceptible; but if urine is mixed with nitric acid, and left exposed to the air for some time, uric acid will be detected in the form of small red prisms^b.

Lactic acid is procured by the following process. The extract of urine is treated by alcohol; the matter which remains undissolved is acid, and by the addition of ammonia is decomposed, and the lactic acid, combined with the ammonia, is rendered soluble in alcohol. From its solution in alcohol the ammonia is disengaged by quicklime; and from the new salt thus formed, the lime may be separated by oxalic acid, which leaves the lactic acid dissolved in water. By this process a small part only of the lactic acid contained in urine is obtained; the greater part, together with the lactate of ammonia, being carried off by the alcohol^c.

Phosphoric acid may be detected in urine by pouring into it ammonia or lime-water, which, combining with the free acid of the

^b Dr. Egan, Philosophical Mag. vol. xxiii. p. 298. For the properties of uric acid I refer to the head of *Calculi*.

^c Berzelius, Med. Chir. Trans. vol. iii. p. 262.

fluid, precipitate the phosphate of lime, and in some cases the ammoniaco-magnesian phosphate. In the extract of urine also the phosphates of ammonia and soda are found.

The presence of muriatic acid is proved by the muriate of soda and muriate of ammonia which are found in the extract of urine. Both those salts change their crystalline forms: the former, instead of the cube, assumes the octohedron; and the latter, instead of the octohedron, adopts the cube. This remarkable transposition of crystalline forms seems to be entirely owing to the animal constituents of the urine; for, when those salts are dissolved in it, they uniformly undergo this change^d, and do not recover their proper crystallization till after having been subjected to calcination^e.

The phosphoric and muriatic acids are both conveniently detected by the nitrate of lead. With the former it forms an insoluble precipitate, but with the latter it forms one soluble in about 22 parts of cold water. Consequently by this test their proportions may be readily determined.

^d Fourcroy et Vauquelin, *An. de Chimie*, vol. xxxi. p. 68.

^e Orfila, *Recherches sur l'Urine des Ictériques*, Paris, 1811.

Sulphuric acid is detected by the muriate of barytes, which produces an immediate precipitate of sulphate of barytes^f. According to Berzelius, the quantity of sulphuric constantly exceeds that of the phosphoric acid. Cruickshanks overrated the proportion of phosphoric salts, from estimating the insoluble precipitate formed by acetate of lead, as entirely consisting of the phosphate, when a considerable portion of it must have been the sulphate. In pursuing his method, however, the phosphate can be distinguished from the sulphate of lead, for it is decomposed by sulphuric acid, when assisted by heat. Another testimony of the presence of this acid is in the extract of urine; the sulphate of potash is found but in a *mammellated* form^g, corresponding with what has been observed on the muriates.

It had long been suspected that urine contained free carbonic acid, but no method of detecting it without risking the decomposition of the animal constituents, had been devised, till Vogel instituted the following process^h:

^f The urine should be previously acidulated with nitric acid, to prevent the precipitation of the phosphates.

^g Orfila, Recherches.

^h Annals of Philosophy, Jan. 1816.

he put a quantity of fresh urine into a glass flask, to which was luted a bent tube, the mouth of which dipped into a vessel of lime-water. This apparatus being placed under the receiver of an air-pump, the air was slowly exhausted: a large quantity of air-bubbles issued from the urine, and the lime-water became milky. Although this experiment is highly satisfactory, yet it must be observed, that subsequent trials have shown, that the presence of the carbonic acid in the urine is by no means constantⁱ: but what determines its presence or absence, has not yet been ascertained.

The accurate chemistry of the present time has proved the existence of fluoric acid in urine. Berzelius, in his analysis of bones, found that human bones, and those of oxen, contained two per cent. of fluuate of lime. He in consequence conjectured that the same proportion should be retained by the earthy phosphates dissolved in urine, which are chiefly derived from the decomposition and absorption of bone. To ascertain it, he precipitated a large quantity of urine with caustic ammonia, collected and calcined the preci-

ⁱ Marcet on Calculous Disorders, Lond. 1816, p. 160.

pitate, mixed an ounce of it with as much sulphuric acid, and then heated the mixture moderately in a platina crucible, covered with a glass plate prepared for etching. After some hours he removed the glass, took off the graver's wax, and found the lines corroded by the fluoric acid vapour^k.

Potash and soda are proved to exist in urine, by collecting the crystals in the extract; amongst which are the sulphate of potash with the sulphate, phosphate, and muriate of soda. The salts of those two alkalies are distinguished by the solution of platina in nitromuriatic acid.

The presence of lime and magnesia is ascertained by an examination of the insoluble phosphates, which are found in the extract.

Ammonia is detected in the ammoniaco-magnesian phosphate, which is precipitated some time after the urine has been passed, and in the phosphate and muriate of ammonia, which are found in the extract. However, it appears to me as yet doubtful whether the ammonia in those combinations is not derived from decomposition of the urea.

Urine, besides sulphuric acid, contains also

* Med. Chir. Trans. vol. iii. p. 258.

sulphur. When it putrefies, fumes are extricated which blacken paper stained with acetate of lead. Berzelius detected it by a more operose method. He precipitated urine with nitrate of barytes, in order to free it of its sulphuric acid: after filtering he evaporated it to dryness, and burned the residuum with a fresh quantity of nitrate of barytes. The ashes treated with muriatic acid, left a considerable quantity of undissolved sulphate of barytes, which must have been derived from the acidification of sulphur¹.

Silex had been detected in the urine by combustion. Berzelius procured it by treating evaporated urine with alcohol, then with water, and afterwards with muriatic acid. Silex was left in form of a grey powder, which, when fused with soda, produced a transparent glass.

The mucus of the bladder and urinary passages, which is suspended in urine, is separated by filtration.

The proportions of the constituents of urine are thus stated by Berzelius:

¹ Med. Chir. Trans. vol. iii. p. 261.

| | |
|--|-----------------|
| Water | 933 . 00 |
| Urea | 30 . 10 |
| Sulphate of potash | 3 . 71 |
| Sulphate of soda | 3 . 16 |
| Phosphate of soda | 2 . 94 |
| Muriate of soda | 4 . 45 |
| Phosphate of ammonia | 1 . 65 |
| Muriate of ammonia | 1 . 50 |
| Free lactic acid | } 17 . 14 |
| Lactate of ammonia | |
| Animal matter soluble in alcohol, and usually accompanying the lactates . . | |
| Animal matter insoluble in alcohol . . | |
| Urea not separable from the preceding . | |
| Earthy phosphates with a trace of fluuate of lime | 1 . 00 |
| Uric acid | 1 . 00 |
| Mucus of the bladder | 0 . 32 |
| Silex | 0 . 03 |
| | <hr/> 1000 . 00 |

There are great variations from the quantities expressed in this table. The urea, uric acid, mucus, and the earthy phosphates especially, are found to change their proportions; so that daily experience will not permit us to assent to the opinion of Berzelius, that the proportions of the constituents of urine in a state of health, are never very different from the preceding statement.

Fresh healthy urine is always acid. Its

acidity was attributed by Vauquelin, John, and others, to phosphoric, and by Thenard to acetic, acid. The presence of the latter is denied by Berzelius, who thinks that it is a product of decomposition derived from a certain method of operating. According to him the acidity of urine is owing to the lactic, uric, and carbonic acids. As in urine there are a number of acids and alkalies, they must unite with each other in the order of the force of their respective affinities. It follows then, that when the quantity of alkali is insufficient to saturate all the acids present, the weakest acids must be those that will remain uncombined, and communicate to the urine its acid properties. If this reasoning be correct, the old opinion, that the free acid in urine is the phosphoric, must be rejected.

Soon after the urine has been passed, according as it cools it gradually loses its transparency. This is occasioned by the mucus, which after some time collects in a cloud, or separates into distinct flocculi, which remains at the bottom of the vessel. A grayish powder is at the same time precipitated, and is found either at the bottom, or adhering to the mucus. In order to examine the deposit with accuracy, it is necessary to filter the urine whilst warm. Thus it is freed from the

mucus suspended in it ^m; and the precipitate which falls is entirely pulverulent. This pulverulent precipitate is proved to be uric acid ⁿ. By degrees it assumes a reddish hue and a crystalline form; changes which, according to Berzelius, are occasioned by the progressive formation of superurate of ammonia. As by filtration we only separate the mucus which is mechanically suspended, the portion of it which is dissolved in the warm urine unavoidably passes the filter, and seems to favour the formation of the superurate, although in a less degree than when all the mucus is suffered to remain in the urine. The mucous cloud and uric acid precipitate may be almost immediately produced by immersing the vessel of urine into cold water, at any period, however short, after its evacuation; which shows that those appearances are occasioned solely by the cooling of the fluid.

^m The mucus remains on the filter in form of transparent and colourless flocculi. By drying it loses its transparency, becomes red, and sometimes has a crystalline aspect, which is owing to the presence of uric acid, the crystals of which have a diameter exceeding that of the dried mucus. Berz. Med. Chir. Tr. vol. iii.

ⁿ It contains none of the earthy phosphates. Muriatic acid digested with it, and then saturated with ammonia, affords no precipitate. Subject to fire it burns, and leaves at length, and with some difficulty, a very small quantity of a fused ash, which consists of carbonate of soda.

After the deposition just described, the urine gradually loses its aromatic odour, emits a sourish smell, and at length ceases to exhibit acid properties: the precipitation of the earthy phosphates immediately ensues. Those salts having been held in solution by the excess of acid, are precipitated when that excess is removed by the evolution of ammonia derived from the decomposition of the animal constituents. A whitish powder is perceived at the bottom; any scratches which may be in the sides of the glass containing the urine are seen encrusted by the ammoniaco-magnesian phosphate. The mucous cloud is in a measure redissolved, and the fluid for the second time loses its transparency. The time which elapses before these changes occur varies according to the temperature, and also in a great degree according to the proportion of albuminous or gelatinous matter which the urine may contain°. In winter I have sometimes found healthy urine to redden litmus paper for nearly three weeks; but generally it loses its acidity in a few days.

After the two precipitates which urine deposits, the one depending on the reduction of its temperature, the other on the loss of its

° Fourcroy and Vauquelin, *An. de Chimie*, vol. xxxi. p. 61.

free acid, the next process to be noticed is its putrefaction. On the surface are formed globular masses of radiated crystals, being the ammoniaco-magnesian phosphate enveloped in a mucilaginous substance. The extrication of ammonia increases, and the fluid at length loses all its characteristic properties. The pungent and cadaverous odour which putrid urine continues to exhale, however long it may be kept, is readily accounted for, when we remember that from a wine gallon of it between two and three ounces of solid carbonate of ammonia are obtained by distillation. When excluded from the air, the urine putrefies as usual, but acquires a deeper red colour, which seems to be occasioned by combinations formed by ammonia, the escape of which is prevented.

The specific gravity of urine appears by the most accurate experiments to range from 1010^p to 1020^q.

The acrid properties of urine have rendered it useful in several manufactures. It has been employed as a medicine. Pliny^r mentions its use in gout, and in several cutaneous diseases. Dioscorides^s commends it

^p Scudamore on Gout, Lond. 1816, p. 68.

^q Henry, Med. Chir. Trans. vol. ii. p. 120.

^r Lib. 28, c. 5.

^s Lib. 1, c. 74.

as a remedy for the bite of vipers, and it is probable that certain good effects derived from it suggested the use of ammonia in similar cases. Willis^t recommends draughts of urine in some cases of gout; and it continued for a long time to be an officinal in the London Pharmacopœia. According to Zeviani^u it is a brisk purgative, and from the report of the sufferers on board the raft of the Medusa^v, seems to have an immediate diuretic effect. However, as it is not likely ever to become a *popular remedy*, we shall dwell no longer on its medicinal virtues.

CHANGES OCCURRING IN HEALTH.

THE changes effected in healthy urine by various agents relate to its quantity or its qualities.

The absolute quantity of the urine is stated by Haller^a to be about forty-nine ounces daily; that being the medium of a number of estimates made by various au-

^t Opera, Lug. Bat. 1681, t. iii. p. 285.

^u Quoted by Haller, Element. Phys. t. vii.

^v Savigni and Corréard, Voyage to Senegal, p. 120.

^a Element. Phys. t. vii. p. 390.

thors. The great discrepancy which appears in those estimates was evidently owing to the difference in the quantity of drink used by different individuals, which seems to depend in a great measure on habit. The proportion of the urine to the drink may be generally stated to be as three to four ; but varies from the operation of the following causes :

Cutaneous exhalation. The quantity of urine is always increased by the diminution of the cutaneous exhalation, and diminished by its increase. Hence the same individual passes more urine in cold than in hot countries ; and more in winter than in summer. The effect of frosty weather in this respect is well known to every one.

Other evacuations. Nurses in general observe a diminution in their urine. Whether bleeding or purging may not have a similar effect, I have not been able to determine. Dr. Prout^b has related a case of spontaneous ptyalism, accompanied with a remarkable diminution of urine, and in which the saliva appeared to have acquired some of the qualities of urine. On the employment of diuretics, the fluid flowed in its natural quantity, and the ptyalism ceased. If it be ascertained

^b Annals of Philosophy, Dec. 1819.

that ptyalism excited by mercury is accompanied by a diminution of urine, some doubts may justly be excited on the propriety of administering that remedy in certain cases.

Exercise increases the flow of urine, when moderate and in cool air; but has the contrary effect when used so as to excite perspiration. Walking and riding, especially the latter, have a considerable diuretic effect, which perhaps may be in some measure caused by the proximity to the kidneys of the muscles engaged in these actions.

Diuretics. The history of diuretic medicines, though highly interesting and closely connected with our subject, would lead to a more extensive discussion than our limits allow. Several ordinary beverages belong to this class, and their diuretic effect is soon perceived, when their use is succeeded by exercise in cool air.

The effects of exercise and drink in producing a discharge of urine were accurately observed in the case of a man, who, in connexion with a monstrous deformity of the genitals, had no bladder, and whose urine dropped from the extremity of each ureter immediately as it was secreted. When he did not eat nor drink during ten or twelve hours, and remained at rest, six or seven drops pro-

ceeded from the orifice of each ureter in two minutes; but when he walked about a hall, each ureter afforded from ten to twenty-four drops in the same time. About thirty minutes after having drunk half a bottle of white wine the drops increased, and a stream was produced when he coughed. Within an hour and a half he passed first pale urine, with very little odour; but afterwards urine more concocted, and in all, a quantity of fluid amounting to three fourths of what he had taken; but after drinking plain water, an hour and half elapsed before any augmentation was perceived^c.

Changes in the sensible or chemical qualities of the urine are occasioned by the following:

Age. The bladder of the fœtus is found free from colour or odour. The urine of infants is but little coloured, contains no earthy phosphates, and a very small portion of urea with benzoic acid^d. In adults it is as we have described. In old persons the uric acid and the phosphates are much increased, and the fluid is generally more loaded and of a

^c Tenon sur quelques Vices des Voies urinaires. Mém. de l'Acad. des Sciences, 1761.

^d Fourcroy, Système des Connaissances chymiques, Paris, An 9, t. x. p. 166.

higher colour, especially if much wine be used^e.

Drink. The urine has generally been divided into urine of drink and of the blood; that is, into urine passed some short time after drinking, and that which is passed after a considerable interval. The urine of drink differs from digested urine by its materials being disseminated in a greater quantity of water. It appears also to contain proportionably less of the earthy phosphates than of soluble salts^f. The urine passed first in the morning presents the constituents of the fluid dissolved in the smallest quantity of water; hence it most readily deposits its precipitates. It is also the least exposed to disturbing agents, and is, therefore, the best adapted for observation.

Posture. When a person, after remaining a long time either in a standing or sitting posture without exercising, evacuates his urine successively in different vessels, the first portions are found to contain the greatest quantity of mucus; but when a person who has lain a long time on his back, evacuates the urine in the same position, the mucus does

^e Hoffman. Opera, t. i. p. 378.

^f P. H. Nysten, Recherches de Physiologie et de Chemie pathologiques, Paris, 1811.

not pass at first, and it frequently happens that a part of it remains in the bladder. Those occurrences are easily understood, when we remember that the mucus is heavier than the urine, and that consequently it must collect in the lowest part of the bladder^g.

Cutaneous exhalation, whilst it diminishes the quantity of the urine, appears also to diminish its acidity. The urine passed during the day, although not so concocted, yet is more acid than the morning's urine^h. In very cold weather there is not only an additional quantity of the fluid secreted; but the bladder is more frequently stimulated to evacuate it, which is most probably in consequence of its increased acidity.

Fasting is said to render the urine turbidⁱ, and a long abstinence from drink renders it acrid and scanty.

Various articles of diet and medicine affect its sensible qualities. The following have been particularly observed. Asparagus^k, olives,

^g Berzelius, Med. Chir. Trans. vol. iii. p. 264.

^h See Mr. Wilson's paper, quoted in Marcet on Calculous Diseases, p. 176.

ⁱ Plenck's Hygology.

^k Although asparagus communicates a very strong odour to the urine, yet it cannot be perceived in the blood. Boerhaave Prælect. ab Hallero, Amstel. 1742. t. iii. p. 280.

nutmeg, mace, cloves, parsley, carrots, and parsnips communicate to it peculiar odours¹; a similar effect is produced by turpentine, not only when taken internally, but when its fumes are inhaled. Red beet^m, and the fruit of the opuntiaⁿ, tinge it with a red colour. Tamarinds are said to communicate a green tint^o. Rhubarb taken in sufficient quantity imparts a yellowish colour^p, and it has been observed to become green from the use of *uva ursi*^p.

Nitre, the prussiate of potash^r, and some other salts taken internally, are afterwards detected in the urine.

The use of preparations of iron communicates to it the property of forming a dark-coloured precipitate with infusion of nutgalls; and the use of astringents causes it to form a similar precipitate with sulphate of iron^s.

¹ Haller. Element. Phy. t. vii. p.

^m Fourcroy, Syst. des Connaiss. t. x. p. 170.

ⁿ Dampier's Voyages, vol. i. p. 223.

^o Boerhaave Prælect. Acad. t. iii. p. 280.

^p Sir Ev. Home, Phil. Trans. 1808, p. 52.

^q Heberden, Comment. p. 368. R. Bourne's Cases of pulmonary Consumption treated with Uva Ursi, Oxf. 1805, passim.

^r Wollaston, Phil. Trans. 1811. It is found in the urine in four hours; but cannot be detected in the blood.

^s Nysten, Recherches, p. 235.

Alkalies have very generally the effect of rendering the urine alkaline. Dr. Bostock^t relates the case of a young lady who laboured under symptoms which threatened pulmonary consumption. She took two ounces and a half of soda daily for a considerable time. The urine was examined, with the following results. It was decidedly alkaline, and probably contained carbonated alkali, as the nitric and muriatic acids produced effervescence. It had a strong tendency to putrefaction. The muriatic and phosphoric salts were in about the usual proportion, though the presence of the phosphate of lime is inconsistent with that of an uncombined alkali; this, however, may be explained by the close attachment which appeared to subsist between the urea and the alkali, which could not be separated. The proportions of the solid contents were ascertained to be as follows :

| | |
|---|-----|
| Urea united to a fixed alkali with muriate of ammonia | 57 |
| Phosphate and muriate of soda | 37 |
| Phosphate of lime and albumen | 5.5 |

Mr. Brande^v found, that after soda was taken, the urine deposited a cloud of the phos-

^t Medico-Chirurg. Trans. vol. v. p. 80.

^v Phil. Trans. 1810.

phates ; but that this effect ceased in less than two hours. When taken in water highly impregnated with carbonic acid, the separation of the phosphates was less distinct and less rapid. In two hours after being passed, the urine formed a deposit, consisting principally of the phosphate of lime, and exhibited on its surface a pellicle, consisting of the ammoniaco-magnesian phosphate. This pellicle, which is not unfrequently seen in perfectly healthy urine, is stated by Mr. Brande to be uniformly produced, after taking alkalies in water highly impregnated with carbonic acid, and is, according to him, to be ascribed to the escape of the carbonic acid from the surface of the fluid. Similar results followed the experiments on potash. Magnesia produced neither so rapid nor so copious a precipitate as the other alkalies; but seemed to be decidedly superior to them in permanently diminishing the quantity of uric acid. Its effect, in producing a white sediment in the urine, is frequently observed, and has been erroneously attributed to the magnesia passing off by the kidneys.

The use of acids affects the urine, but not with the same certainty as the use of alkalies. Berzelius^u had a gouty patient, whose urine was

^u Medico-Chir. Trans. vol. iii.

turbid and alkaline, containing the earthy phosphates in suspension. He ineffectually gave him sulphuric acid, and afterwards administered phosphoric acid, till the dose was increased so as to produce a cathartic effect. The urine then became acid, and deposited uric acid as long as the catharsis continued, but resumed its morbid state when that ceased. He also tried vinegar, but without effect. In Mr. Brande's experiments, however, the carbonic acid appears to have reached the kidneys. Mr. A. Phillip^x found that the uric acid contained in his urine, which, whilst living as usual on animal and vegetable food, amounted to one grain and a half, was increased to three grains and a half upon eating twenty-four lemons in twenty-four hours. This effect of the citric acid, however, is not equal to the contrary effect produced by the fixed alkalies, as Sir G. Blane^y found that the common effervescing draught deprived the urine of its acid properties. Turbid and alkaline urine has been observed in connexion with great irritation of the urinary passages, caused, apparently, by the mucus being dissolved by the free alkali of

^x Quoted by Dr. Egan, Trans. Roy. Irish Acad. vol. x. p. 309.

^y Medical and Chirurgical Trans. vol. iii. p. 339.

the urine. This was inferred from the transparent gelatinous matter, which was thrown up on adding to the fluid some distilled vinegar; but, after the use of nitric acid, the urine became clear, and the irritation ceased^y. The contents of the stomach and intestinal canal being generally acid, they appear to be in a measure insensible to the effects of acids: the natural state of the urine also being acid, any increase of acidity produced in it must be difficult to determine, whilst the effect of alkalies can be easily perceived: hence we may explain the uncertain state of the evidence concerning the former, and the satisfactory observations which have been made respecting the latter.

The use of animal food seems to have an important share in the formation of uric acid, and in the general acidity of the urine. M. Majendie^z fed a dog for a considerable time on sugar and distilled water: his urine became sensibly alkaline, and ceased to afford any traces of uric acid or of the phosphates. In serpents^a and some species of birds which

^y Dr. Wood, on a certain State of the Urine producing Micturitis frequens, &c.—*Lon. Med. and Phys. Jour.* 1818, p. 455.

^z *Researches on Gravel*, *Lon.* 1818, p. 12.

^a Davy, *Phil. Trans.* 1818.

live exclusively on animal food, the urine is almost entirely formed of it; whereas it is scarcely, if ever, found in the urine of herbivorous animals.

A singular change in the urine has been observed, independent of any cause with which we are acquainted. Dr. Jurine, of Paris, in 1810, passed his urine in the evening, at the corner of a public promenade. He observed with astonishment that it was phosphorescent, so that the pannels of the door against which it fell shone in different places with a soft light, and the leaves of the trees shaken in this corner by the wind were covered with luminous points, rendered visible by the undulation of the liquid. This light continued in all its force for about thirty seconds, when it became weak, and soon entirely disappeared. In 1813, Dr. Jurine again observed the same appearance, and was informed, by Professor Pictet, of Geneva, that he also had passed phosphorescent urine, a short time before; and, in the same year, Dr. Guyton, of Autun, observed a similar fact. The subject of phosphorescent urine has been treated in a chemical point of view by Guyton Morveau, who concludes that the luminous appearance is caused by the presence of the gaseous oxide of phosphorus, which, at a low temperature, under-

goes a slow combustion. It is stated by Dr. Jurine that he never saw urine become phosphorescent from the use of phosphorus, although eight grains of that substance were taken daily; and that the phosphoric acid, taken to the extent of two ounces *per diem*, produced no more effect^b.

There are several spontaneous alterations of the urine mentioned by the older authors, but being for the most part founded on mistaken notions, and not confirmed by modern observations, they are not worthy of repetition.

METHOD OF EXAMINING THE URINE.

BEFORE we commence the description of urine in disease, it is necessary to make a few observations on the method of examining it. Much uncertainty and consequent mistrust of observations on the urine have arisen from the carelessness with which those observations

^b An. de Chemie, Fev. 1814.

were made. The physician one day sees urine which has been just passed, the next he sees that which has lain by for several hours. At one time he sees the morning's urine, at another, that which has been produced by drink: the necessary result of which is, that the examination of the fluid presents no satisfactory information, and is at last neglected. In order to ascertain the changes which depend on the disease, separately from those which are produced by other causes, it is requisite that every day the urine shall be examined, as far as possible, under the same circumstances. The morning's urine should always be preferred, for the reasons mentioned before. It should also be examined after it has cooled, as it is from the deposition which takes place on its cooling that the most important information is derived. If, however, the examination is delayed till the fluid loses its acidity, a new source of confusion is produced, for then the mucous cloud is in a great measure redissolved, and the fluid becomes turbid from the precipitation of the earthy phosphates.

It sometimes happens that the urine is turbid when evacuated. This is, 1st, when it is alkaline; 2d, when, although not alkaline, it yet contains the earthy phosphates, both in solution and suspension; and, 3d, when the

urinary passages, from any irritation, secrete an unusual quantity of thick and coloured mucus. In the first case, the urine remains always more or less turbid; but in the second a copious sediment is deposited in a short time. By the aid of litmus paper they are readily distinguished. Mucous urine is a frequent attendant on calculus, and thus is often found combined with either of the former cases of turbid urine.

The pulverulent sediment of the urine may be generally determined by its appearance. When it remains white, it is principally composed of the earthy phosphates; but if it has, or speedily assumes, a reddish or pink colour, it contains the animal acids, and that generally in proportion to the depth of the colour. Besides the uric acid, the *rosacic* acid of Proust^c, the *erythric* acid of Brugnatelli^d, and the *purpuric* acid of Prout^e, are severally obtained from this sediment by peculiar modes of operating. It has also afforded to Dr. Prout traces of nitric acid. The subject, however, being as yet under investigation, may be passed over for the present.

Much obscurity has arisen from a vague

^c Ann. de Chimie, tom. xxxvi.

^d Phil. Mag. 1818.

^e Phil. Trans. 1818.

manner of describing the urine. Every product of organization may be described with as much accuracy as the objects of mineralogy. Thus, the series of colours usually observed in urine may be expressed by this series of terms: watery, straw yellow, citron yellow, Madeira, deep Madeira, and hyacinth red, passing into blood red. With respect to degrees of transparency, the urine is clear, misty, or turbid. The situation of the mucous cloud is to be noted. For this purpose the accurate use of the ancient names, *nubes*, *enæorema*, and *sediment*, will be sufficient: the first denoting a cloud towards the surface; the second, a cloud suspended in the middle of the fluid; and the last, a cloud at the bottom, along with the pulverulent deposit.

The specific gravity of the urine in some diseases affords highly important information. The most convenient manner of ascertaining it is to weigh the urine in a bottle, which holds 1000 grains of distilled water up to a mark on its neck. This method requires no calculation, and is practised with the utmost facility.

The chemical tests which are of the most frequent use in the examination of morbid urine are the following.

Heat. Some urines, exposed to a temperature of about 160, coagulate. The coagula

appear, in some cases, like curds in whey; but most commonly a turbid whiteness alone is produced. By this test the presence of albumen is determined.

Nitric acid is another test of albumen, and produces coagulation when heat has no effect. Hence it is to be preferred, as a more delicate test.

A solution of oxymuriate of mercury, in certain cases, produces a whitish cloudy precipitate, which is generally stated to be caused by the presence of albumen. Some observations^f, however, tend to show that this test sometimes forms a precipitate distinct from that which it produces with albumen. As this test is of very extensive application in inflammatory disorders, it is necessary to mention the following precautions in using it, without a due attention to which it ceases to be of value.

1st. The urine to be tried by it should be cool; as almost all urine, even in health, contains a small portion of albuminous matter, which is coagulated when exposed to both heat and the solution at the same time.

2d. It should be used before the urine has lost its acidity: otherwise, the insoluble muriate of ammonia and mercury will be precipi-

^f See the article on Dropsical Urine.

tated. For the same reason, the application of this test is inadmissible in the case of alkaline urine.

Distillation is employed to ascertain the presence of urea, when in such a small quantity as not to be perceptible in the extract of urine on employing nitric acid. By distillation this substance is decomposed, and its quantity may be computed from the quantity of carbonate of ammonia which passes over.

Infusion of nutgalls I found to produce a precipitate, very frequently, in healthy urine; consequently it cannot be relied on. The other tests used in examining morbid urine are mentioned under their respective heads.

URINE IN DISEASE.

IN all febrile diseases the urine presents general characteristics, which, however modified in different cases, are yet sufficiently distinct to admit of a general description. These are: 1st, a greater specific gravity and higher colour than usual; 2d, the mucous cloud floating towards the surface of the fluid, or else being entirely absent; 3d, the formation of a

precipitate with the oxymuriate of mercury; and, 4th, a tendency to become scanty.

The increased specific gravity depends on the great proportion of salts held in solution, and the high colour is owing to the urea (or, rather, to the oily matter) which accompanies it. We are indebted to M. Nysten^a for an analysis of inflammatory urine, which explains most of its properties. It came from a young man labouring under acute peritoneal inflammation, was of a deep red colour, but perfectly transparent; had the usual odour of urine; and reddened the tincture of turnsol. He passed a very small quantity of it. Delirium and death shortly supervened. On examination it was found to contain:

1. One third more urea than in healthy digested urine.
2. More soluble saline substances, and especially more sulphates and phosphates, than in healthy digested urine.
3. A great quantity of albuminous matter, which is not in healthy urine.

This red and acrid urine forms no immediate deposit, and is more or less transparent. It is almost constantly met with when there is a great increase of temperature in the system,

^a Nysten, Recherches, p. 252.

with a strong and rapid pulse. When a mucous cloud is present, it ascends and descends in the fluid according to the specific gravity, thus serving the purpose of an hydrometer. The deposition of a sediment and the diminution of the saline soluble contents, as indicated by a paler colour and by the descent of the mucous cloud, are generally either accompanied or speedily followed by favourable symptoms. In some cases of fever, when the urine is scanty, it is accompanied by *ardor urinæ* and *dysuria*, occasioned by the deficient secretion of mucus in the bladder and urethra corresponding with what is observed in the mouth and fauces. This seldom occurs, except in cases of great irritation; but in general it is to be observed that a diminution in the quantity of the urine in inflammatory diseases is always, more or less, accompanied by an exacerbation of the febrile symptoms.

Having made a great number of trials with the solution of oxymuriate of mercury, I may be permitted (although in opposition to a late authority^b) to state my opinion, that the precipitation caused by this test is a characteristic property of inflammatory urine. In dropsies alone, where it frequently occurs, its nature

^b Dr. Scudamore on Gout, Lond. 1819, p. 281.

seems to be not so well marked, unless we recollect the close connexion between dropsy and inflammation, which is becoming every day more evident. It appears to have some analogy with the buffy coat of the blood. In every case (except some dropsies in which the urine was modified in a peculiar manner) I found the buffy coat to be accompanied by urine affording this precipitate. In two chronic inflammations, indeed, there was no precipitate; but in these the blood had not the true buffy coat, but was covered with a whitish coat, more than half an inch thick, which passed imperceptibly into the red portion of the crassamentum. The diseases which furnished most of my observations, were continued fevers, hepatitis, phthisis pulmonalis, nephritis, rheumatism, and pneumonia: in the last, when the blood was not buffed till after the second venæsection, the urine answered to this test from the commencement.

We are now to consider the peculiar appearances which the urine presents in each febrile disease.

In intermittent fevers there is a greater discharge of urine, both in the cold and sweating stages, than in the hot^c: and in

^c L. Beauvais Semeiotique, Paris, 1813, p. 223.

tertians and quartans, Hoffman^d states, that extensive observation convinced him, that great danger is to be apprehended, if the urine is not turbid at the end of the paroxysms.

In continued fevers the crisis is commonly announced by a copious lateritious or pink-coloured sediment; and in general the more perfect the crisis, the more rapid and lasting is the deposit^e. When the transparent and high-coloured urine, which is almost always seen in the course of those fevers, becomes pale and limpid, with a sediment, and unaccompanied by any signs of a crisis, it has constantly been regarded as an unfavourable occurrence^f. Peculiar stress was laid on it by those who adopted the theory of spasm; and Hoffman^g states that the urine becoming of a thicker consistence with the deposition of a sediment, is a certain proof that the spastic stricture is resolved. In some instances, however, I have seen the favourable change announced by the colour of the urine becoming gradually paler without depositing any sediment: so

^d Opera omnia, t. i. p. 378.

^e De Haen, Ratio Medendi, t. i. p. 75.

^f Hippocratis Aph. 72; sec. 4. Baglivi Opera, Lug. Bat. 1704, pp. 72, 102.

^g Loc. cit.

that this secretion affords no more proof of the theory of spasm than the skin, which we often see covered with perspiration, whilst there is no abatement of the febrile symptoms. It may, however, be stated with confidence, that a fever never terminates without a change of some sort taking place in the urine, and that which occurs by far the most frequently consists in the deposition of a sediment, the diminution of the colour, and the formation of a mucous cloud towards the bottom of the fluid.

In typhus, when attended by great prostration of the vital forces, the urine is commonly pale, and often limpid, or like vapid small beer, in which there is either no sediment, or a kind of loose matter scattered like bran^h. In the fevers of this type, which are commonly called putrid or malignant, the urine is alkaline when passed, contains a great quantity of free ammonia, and less urea than healthy urineⁱ. At first it is high-coloured, without sediment or cloud, and so continues for some days; but as the disease advances it grows darker, with a strong ammoniacal odour, and in some cases becomes black with

^h Huxham on the Slow Nervous Fever, Lon. 1750, p. 77.

ⁱ Orfila, *Chémie Medicale*, t. ii. p. 337.

a black sediment. This urine, when accompanied by livid petechiæ, and other symptoms of a like nature, generally denotes the speedy approach of death^k. It must, however, be confessed, that in fevers of this description, the urine taken by itself affords but little positive information; it sometimes deposits a sediment without a crisis^l, and is very frequently more or less turbid, becoming clear as the fever abates^m.

In the plague, small-pox, and other diseases of a similar tendency, the appearance of bloody urine has always been esteemed as an almost fatal signⁿ. It should, however, be kept in view, that this may sometimes be produced by the action of cantharides.

In inflammations of the thoracic viscera the urine is almost invariably high-coloured. The appearance of a sediment is favourable; but is not to be depended on, unless accompanied by other signs of amendment^o. When

^k Huxham on Putrid Malignant Fever, p. 95.

^l Sydenham. Opera, Lug. Bat. 1726. Febris Annor. 1667, 8, 9, p. 163.

^m Dr. James Johnstone of Kidderminster, in Medical Museum, vol. i. p. 511.

ⁿ Etmiller. Opera, Lond. 1688, t. i. p. 379. Boerhaave Prælect. Academ. t. i. p. 313. Huxham on the Small Pox, p. 152.

^o Van Swieten Comment. t. iii. p. 25.

a vomica was formed in the lungs, the urine has been observed red, scanty, turbid, emitting a disagreeable odour, and with a copious furfuraceous deposit^p. Hippocrates^q remarked the danger attending pleurisy, when the urine was turbid, or with a mutable or indistinct sediment. I was once able to see his unfavourable prognostic verified in a man labouring under pneumonia, which was suffered to run to suppuration without any medical interference. For some days before death, his urine, which was high-coloured and transparent, became permanently turbid in a few minutes after it was evacuated. Whether this usually takes place is hard to determine, for the active practice, which so happily prevails in these countries in cases of pulmonic inflammation, deprives us of the opportunity of often witnessing similar events.

Hectic fever is well distinguished by the appearance of the urine, which is high-coloured, and continues to deposit a lateritious sediment, without any abatement of the febrile symptoms. The approach of hectic, in any disease, is generally well marked by

^p Avenbrugger, *Nouvelle Méthode pour reconnaître les Maladies internes de la Poitrine*, Paris, 1808, p. 325.

^q Coac. Prænot. c. 26.

the urine assuming this character^r. In phthisis pulmonalis the sediment is generally deposited after the sweats, and is absent during the hot fit^s. Some variations in this respect, however, have been observed^t; but whatever irregularities may occur in the deposition of the sediment, the urine is almost invariably scanty and high-coloured in proportion to the degree of fever which prevails.

The examination of the urine in hepatitis has produced an unexpected result. Mr. Rose first found it to be destitute of urea. Dr. Henry^u analysed the urine of a female labouring under chronic hepatitis, which was nearly free from colour and odour; and although he employed distillation, which is the nicest test of urea, a mere trace of it was discernible; but as the patient recovered the urea was gradually restored. From my experience I cannot confirm these observations.

^r Hoffman. Opera, t. i. p. 379. Juncker, Conspectus Therapeiæ, &c. Hallæ, 1750, p. 714.

^s Dr. Young on Consumptive Diseases, Lond. 1815, p. 8. Mead, Monita et Præcepta medica, à Cl. Wintringham, Lond. 1773, vol. i. p. 53.

^t Heberden Comment. Lond. 1807, p. 164. Morton states that pale urine sometimes occurs in phthisis from nervous affections, or from the use of diuretics. Phthisiologia, Lond. 1681, p. 125.

^u Annals of Philosophy, vol. vi. p. 339.

In the hepatic patients which I have seen, the urine had a high colour, proportionate to the degree of fever which existed ; and I rather suspect that the urine described by Dr. Henry, must have been occasioned by the inflammation having extended to the kidneys. However, this subject must remain undecided till more numerous and decisive observations are obtained.

In nephritis the urine presents a peculiar modification, as the secreting organ is the immediate subject of the disease. It is evident, from numerous observations, that glands in a state of inflammation, cannot well perform their office. Hence, if both kidneys are inflamed, we should, *à priori*, expect the urine to be scanty and pale : and thus it is described to be, in the height of the disease, by some of the systematic authors^x. If only one kidney labours under inflammation, whilst it secretes the urine now described, the other secretes urine possessing the febrile characteristics in a high degree, as well from the general fever which exists, as from a load probably thrown on it. In nephritis, however, we seldom see the urine, as it has been secreted. Most frequently it ap-

^x Boerhaave Aph. 995. Van Swieten, t. iii. p. 223. Cullen, First Lines, Edinburgh, 1812, vol. i. p. 254.

pears red, and more or less turbid, from small quantities of blood emitted by the renal capillaries. Sometimes this hemorrhage is so considerable, that a coagulum is formed in the bladder, which occasions very remarkable appearances in the urine. We owe to Sir Everard Home^y a case of this kind, which is so well illustrated by his experiments, that I take the liberty of transcribing it.

Hemorrhage from the kidneys, with suppression of urine, commenced on the third of April. On the 5th, four ounces of a bloody fluid were, with difficulty, drawn off by the catheter, which coagulated on exposure. On the 7th the urine was less tinged with blood. 13th. Had a darker colour, and was passed in smaller quantity. 16th. Was of a light brown colour, and deposited a whitish powder. The sediment now passed only with the latter portion of the urine. 19th. It was passed tolerably clear. The white sediment was more completely separated, and in greater quantity. On the 5th of May the sediment began to diminish, and gradually disappeared. With a view to discover the process which had taken place, separate portions of blood were mixed and repeatedly washed with water and urine. What was washed with water soon

^y Philosoph. Trans. 1797.

putrefied; but that which was washed with urine, so as to imitate what occurs in the bladder, formed a coagulum with a quantity of urine equal to itself, in which the red globules were not dissolved. This did not putrefy; but the coagulating lymph broke down into parts almost resembling a soft powder. The following coincidences between the case and the experiments were observed: 1st, The coagulum out of the body was reduced in twenty-five days to a very small size, and in four days more was completely dissolved. In the case the white sediment began to diminish in a month. 2dly, In both the white sediment was first observed about the twelfth day. 3dly, The patient's urine became darker, from the red globules mixing in it, in nine days: in the experiment this took place in five days." This case and experiment are worthy of being recorded, as extravasations of blood frequently occur from the irritation of renal calculi, whilst the urine is secreted nearly as usual.

When nephritis has proceeded to suppuration, there is a purulent discharge along with the urine. The fluid is then turbid, emits a peculiar foetor, and deposits a milky sediment, which is rapidly disseminated on being shaken; but in a short time collects

again at the bottom^z. When gangrene has taken place, the urine has been observed of a high colour and turbid^a; but the different terminations of nephritis cannot be determined by the urine alone, nor indeed is it at all requisite that they should. The appearances of this fluid, however, taken in connexion with the symptoms, will be found to furnish important information, although attended with more complexity than in other diseases, arising from the frequent mixtures of blood or pus, which can be well judged of by none but an experienced eye.

It has been established by numerous experiments, that during a paroxysm of gout, the urine contains considerably more phosphoric acid than usual^b. Its specific gravity is much increased, ranging from 1025 to 1035, or even 1040^c: the urea also is usually augmented in the same proportion. This urine is of a deeper colour, and more scantily secreted than natural, and on cooling, deposits a pink or brickdust sediment, which is observed, not only at the termination, but also com-

^z Gruner, *Semeiotice*, Halæ, 1775, p. 417.

^a Portal, *Anatomie Medicale*, Paris, 1803, t. v. p. 381.

^b Berthollet in Double, p. 239. Scudamore on Gout, Lond. 1819, p. 120 et seq.

^c Scudamore, p. 96.

monly more or less throughout the continuance of the paroxysm^d.

Gouty patients frequently observe a diminution in their urine previous to the occurrence of a paroxysm. Berthollet stated, that it does not contain as much phosphoric acid as usual, except during the paroxysm: however this may be, it is certain that gouty habits have been always remarked as being more or less subject to gravel, and I am at present acquainted with a gentleman, who labours under an hereditary irregular gout, whose urine, at times, exhibits on its surface beautiful crystals of uric acid. This connexion between gout and gravel should not be lost sight of, as it assists in ascertaining the pathology of both diseases.

Dropsical urine sometimes presents a coagulation on the application of heat or nitric acid. This circumstance, which seems first to have attracted the attention of Cruickshank, has received a particular consideration from Dr. Blackhall^e, who in his treatise divides dropsies into those which are accompanied by coagulable urine, and those in which the urine is uncoagulable. Coagulable

^d Scudamore, p. 37.

^e Blackhall on Dropsies, Lond. 1814, passim.

urine, according to him, attends universal dropsy, and is not unfrequently superadded to great visceral unsoundness. He states, that when the urine is most loaded, it coagulates by the lowest heat, and with the greatest firmness; the blood is always found most buffy, and the whole system exhibits the greatest marks of inflammation. He has, also, collected a number of facts to prove, that this kind of dropsy is not generally caused by debility or relaxation, but by inflammation, and remarks that there is no sign more delusive than the subsidence of the swellings, and an increased flow of urine, if the character of it be not improved.

Dr. Blackhall's enumeration of cases of uncoagulable urine, unfortunately affords no positive information on the subject, as the urine appears not to have been tried by nitric acid as well as by heat. It frequently happens that urine is coagulated by nitric acid, after heat has been applied in vain. This is attributed by Dr. Wells^f to a deficiency of salts in the urine, since, if to serum coagulable only by nitric acid, any neutral salts are added, a coagulation will be formed on the application of heat. Whether this opinion,

^f Trans. of the Medical Society, 1819

however, be correct or not, it is certain that no satisfactory results have been obtained on the subject of uncoagulable urine in dropsy, when the trials have been made by heat alone^g.

We owe to Dr. Wells an account of the urine of 130 persons affected with dropsy from other causes than scarlatina. Amongst 29 cases of anasarca not symptomatic were 23 with coagulable urine. Of 9 cases of anasarca, preceded by some debilitating disease, as dysentery or ague, the urine of 2 alone was coagulable. Of 37 cases of anasarca, preceded by cough and dyspnœa, the urine of 24 was coagulable. Of 20 cases of hydrothorax, the urine of 14 was slightly coagulable, in one case considerably. In 4 encysted dropsies, 3 of which were attended by anasarca, the urine contained no serum. Of 21 cases of ascites, not preceded by anasarca, the urine of 7 was slightly coagulable; and in 8 cases of ascites, preceded by diffused dropsy, the urine was highly coagulable. This statement shows, that diffused dropsy, when not preceded by some debilitating disease, is very generally accompanied by coagulable urine,

^g On this head see the Report of Dropsies, by Dr. Cramp-ton, Trans. of the Association of the College of Physicians in Ireland, vol. ii.

and that encysted dropsies and ascites are most frequently not thus accompanied; and it also tends to confirm the assertion of Cruickshank, that in the dropsy proceeding from unsound viscera, the urine is usually uncoagulable. M. Nysten^h analyzed the urine of a young man labouring under ascites. His abdomen was of an enormous size; paracentesis had been twice resorted to. The urine was of a deep red colour, turbid when passed, and had an ammoniacal odour. It was alkaline, and the turbid appearance was caused by the suspension of the earthy phosphates. It contained albumen and a much greater proportion of the oily colouring matter than healthy urine, but the ammonia appeared to have been produced from an extensive decomposition of the urea. M. Nysten remarks, that in general, when dropsical patients pass a quantity of urine nearly equal to that of their drink, and when diuretics begin to take effect, it then differs very little from natural urine. Two dropsical urines were examined by Mr. Brandeⁱ. One presented a considerable coagulation on the addition of sulphuric acid, was found to contain hardly any urea, and deposit-

^h Recherches, p. 256.

ⁱ Transactions of the Medical Society, 1812.

ed a lateritious sediment: the other afforded no signs of albumen, but was copiously precipitated by tannin, and contained a much larger portion of urea. In four of the dropsical urines which I examined, and which were not attended by any peculiar circumstance (except I may be permitted to mention that the patients were all young, or under the middle age), although decisive coagulation was produced by heat and nitric acid, there was no precipitate caused by the solution of the oxy-muriate of mercury. Unfortunately, at the time of meeting these cases, I had not an opportunity of making farther experiments; but if we compare this fact with Dr. Bostock's experiments on albumen^k, it will appear that that substance was in these instances modified in a manner not hitherto described.

The reader sees, that with respect to dropsical urine, the results hitherto obtained, have been only approximating, and that different appearances of the urine cannot be referred to the different modifications of the disease, unless in a very general way, and admitting numerous exceptions. The fluids effused in dropsy differ considerably in the proportions of their constituents, according to the cavity

^k Medico-Chirurg. Trans. vol. iv.

in which they are found. Thus Dr. Marcet¹ ascertained the fluid in hydrothorax to contain 18.8 of animal matter, whilst that of ascites contained 25.1: the fluid of hydrocele also, contained of it, 71.5; and that of hydrocephalus only 1.12, the serum of the blood being proved by the same process to contain 90.8. M. Nysten also has found the peculiar oily colouring matter of urine in dropsical fluids. Hence we see how the composition of the urine may be altered, not only by the very nature of the disease, and by those diseases which produce it, but by the principles of the urine being delayed in the different cavities of the body. Examinations of the urine in dropsy should be accompanied by that of the dropsical fluid, when it can be obtained; and from a number of comparative views in this way, it is probable that some general principle might be discovered, on which the course of the disease depends.

It is almost needless to remark, that in dropsy the increased flow of urine is highly favourable. When patients are under a course of diuretic medicines, it is necessary, in order to form an accurate judgment of their effects, to measure the urine daily, and compare its

¹ Med. Chirurg. Trans. vol. ii.

quantity with that of the drink. Before the fatal termination of the disease, the urine is generally diminished in a remarkable manner, and from its acrimony causes very troublesome excoriations.

In hydrocephalus the urine has not been examined with the attention it merits. It is most probable that it possesses the properties of inflammatory urine. In the commencement of the disease some have observed milky urine, such as is more particularly described as belonging to worms. It is stated by Dr. Coindet^m, that in the second stage, a micaceous deposition occurs, resembling the crystals of boracic acid, which he believes to be urea, and regards as an appearance peculiar to the disease. In general it is observed, that an increased flow of urine may afford hopes of recovery, when there is no other symptom in a case on which to relyⁿ.

Diabetic urine, from the remarkable constituent which distinguishes it in general, attracts particular attention. It is passed in great quantities, is most frequently of a light straw-colour, and is characterized by a sweet taste. When it is evaporated, a syrup, like

^m Mémoire sur l'Hydrencephale, Genève, 1818, passim.

ⁿ See the cases in Dr. Cheyne's Treatise on Hydrocephalus acutus, Dublin, 1819.

molasses, is obtained, which is proved to be truly saccharine, not only by its sensible qualities, by the effects produced on it by nitric acid and other reagents, but in a more decisive manner, by the production of alcohol from it, in almost an equal proportion as from sugar on the application of fermentation and distillation°. Its specific gravity generally ranges from 1028 to 1040; but remains more stationary during the day than healthy urine. As there is considerable trouble and difficulty in evaporating different portions of urine, so as to obtain a comparative view of the quantity of saccharine extract contained in them; and as such a view is highly important in comparing the cases of different individuals, or the state of the same individual at different times; I take the liberty of transcribing the following table, which we owe to Dr. Henry; from which we can estimate the quantity of solid extract in this urine when its specific gravity is between 1020 and 1050. It was formed from evaporating different diabetic urines by a steam heat, till they ceased to lose weight, and left an extract which became quite solid on cooling^p.

° Ann. de Chimie, 44, c. 59.

^p Medico-Chirurg. Trans. vol. ii.

| Specific Gravity. | Quantity of solid Extract in a Wine Pint, in Grains and Tenths. | Specific Gravity. | Quantity of solid Extract in a Wine Pint. |
|-------------------|--|-------------------|---|
| 1020 . . . | 382.4 | 1033 . . . | 632. |
| 1021 . . . | 401.6 | 1034 . . . | 651.2 |
| 1022 . . . | 420.8 | 1035 . . . | 670.4 |
| 1023 . . . | 440.0 | 1036 . . . | 689.6 |
| 1024 . . . | 459.2 | 1037 . . . | 708.8 |
| 1025 . . . | 478.4 | 1038 . . . | 728. |
| 1026 . . . | 497.6 | 1039 . . . | 747.2 |
| 1027 . . . | 516.8 | 1040 . . . | 766.4 |
| 1028 . . . | 536. | 1042 . . . | 804.8 |
| 1029 . . . | 555.2 | 1044 . . . | 843.2 |
| 1030 . . . | 574.4 | 1046 . . . | 881.6 |
| 1031 . . . | 593.6 | 1048 . . . | 920. |
| 1032 . . . | 612.8 | 1050 . . . | 958.4 |

The formation of sugar in diabetic urine supersedes that of urea, and, indeed, may be considered as a depraved and morbid secretion of that substance. However, although the quantity of urea in diabetic urine is reduced to less than $\frac{1}{40}$ or $\frac{1}{60}$ of that which exists in health, yet it is not entirely absent. This is proved by distillation, and also by the phenomena attending its spontaneous decomposition; for, at a temperature exceeding 60° , it passes rapidly to the acetous state; but if attentively watched, it will be found that, before it becomes acid, there is a point at which it

exhibits, to sufficiently delicate tests, distinct alkaline properties^q. The extract of diabetic urine and that of healthy urine were analyzed by Dr. Prout^r. The results were, that the latter yielded from 35 to 40 parts of azote, whilst the former afforded only 6.5 parts of the same principle; but, except the formation of sugar and deficiency of urea, the different salts exist in diabetic urine in the same proportion to each other as in the healthy state^s.

The quantity of urine in this disease is, in some cases, increased to a degree that appears hardly credible. An excess of the urine above the drink, however the patient may be tormented by thirst, is almost constantly observed. Though the flow of urine is thus increased, yet in some instances we find diabetes accompanied by dropsical effusions and serous urine. This, for the most part, occurs in infirm persons; and, according to Dr. Heberden, is peculiarly unfavourable; the patient, if recovering of the one disease, commonly falling into the other.

When the use of animal food is exclusively persevered in, the urine is generally not only diminished in quantity, but also recovers some

^q Dr. Henry. ^r Medico-Chir. Trans. vol. viii.

^s Dr. Henry.

portion of urea. Hence a diet of animal food was recommended by Dr. Rollo and others, as the chief means of curing the disease; and various cases are recorded, in which this treatment was successful. A more extensive experience, however, has shown that, in some instances, animal food fails in producing this effect^t; and, from the general average of cases, we learn that, although the change in the urine is effected, yet the general disease remains unsubdued^u, or the favourable effects are only transitory, which is, indeed, by far the most frequent occurrence. A consideration of the other means which have been proposed for the cure of this disease would lead to too long a discussion, and the effects of animal food have been noticed only because they are principally confined to the urine.

The species of diabetes named *D. insipidus* is a disease so rare, that Dr. Cullen hesitated whether he should admit its existence. Profuse discharges of urine may occur, accompanied by great thirst; but we cannot admit them to be of the same nature as diabetes, unless they are connected with the peculiar dryness of the skin, the increased appetite for

^t Dr. Ferriar, Med. Hist. vol. i. p. 144.

^u Dr. Henry, before cited, p. 133.

food, and the other peculiar symptoms of that singular disease. Dr. Bostock^x analyzed the urine of a lady who laboured under this affliction. She passed, in the twenty-four hours, five quarts of pale urine, of 1034 specific gravity. It contained no saccharine matter, but urea and the salts of urine were in such excess, that she must have passed daily six ounces of urea, and above an ounce and a half of salts, more than the natural quantity. Dr. Bostock directed his curative means to the digestive organs, and also endeavoured to restore the skin to a healthy state by warm baths. These efforts were completely successful: the urine was reduced to the natural standard, and the constitutional symptoms disappeared.

The same physician has recorded another case of diabetes, in which the urine, at first, was apparently free from saccharine matter, but afterwards afforded a small quantity of it, united to a large quantity of urea. This is the converse of what usually occurs.

NERVOUS URINE.—The urine experiences a singular change during the access of hysteria. It loses most of its colouring matter, contains more urea and uric acid than urine emitted soon after drink, but not so much as digested

^x Medico-Chir. Trans. vol. iii.

urine. It also loses a considerable portion of its salts, except the phosphate of lime, of which it contains more than the urine after drink^y. It is colourless, flows in a great quantity, often in a sudden manner, and appears not only during the paroxysm, but also, frequently, some days before^z. Similar urine is also passed in hypochondriasis^a, and in spasmodic diseases; and in many cases, wherein the pulse is a very fallacious guide, it may enable the practitioner to determine whether an affection is spasmodic or inflammatory.

In asthma the urine is very pale and copious before the fit; and, when the fit disappears, it presents no remarkable deposit, but is then generally passed in less quantity than is natural^b. There is the closest analogy between it and hysterical urine. I had a patient affected apparently by angina pectoris, who passed, at stated intervals, urine of this description, without any alleviation of the symptoms; and it was probably the appearance of this urine which induced Sauvages to frame an analogy between asthma and diabetes.

In jaundice the urine is of a yellow or

^y Nysten, *Recherches*, p. 251.

^z Hoffman, tome i. p. 377.

^a Sydenham. *Opera*, Lug. Bat. 1726, p. 392.

^b Bree on *Disordered Respiration*, Lond. 1815, p. 135.

greenish yellow colour, and generally imparts a brilliant yellowish hue to linen. The presence of bile in it was denied by Fourcroy, but has been most satisfactorily proved by Orfila^c and others. In the green jaundice the urine is commonly much loaded with bile; but sometimes in slighter forms of the disease, though of a deep colour, it will not impart a yellow tinge to linen^d. Dr. Heberden^e mentions a case of jaundice, in which the urine was of a deep yellow colour when passed, but in a few hours became green, as yellow bile is sometimes changed to green after it has been vomited. The urine becoming more light in its colour, with other favourable symptoms, shows that the disease is on the decline. Muriatic acid is an excellent test of the presence of bile in the urine; for, with a very small portion, it produces in a short time a green colour. When, therefore, muriatic acid ceases to produce this effect in the urine, we may infer that the obstruction to the bile is removed, and that consequently

^c *Nouvelles Recherches sur l'Urine des Ictériques*, Paris, 1811.

^d Dr. Baillie's *Observations on the Green Jaundice*, Trans. Coll. Physicians, vol. v. p. 143.

^e *Comment.* p. 206.

the bilious colour of the skin will soon disappear^f.

The urine of children affected with worms is very generally observed to become more or less milky a short time after it has been passed. In Fourcroy's work^g we have the first and only chemical account of it; from which it appears that its sediment exhibits all the properties of the oxalate of lime.

The urine in the rickets has been repeatedly analyzed, and proved to contain much phosphate of lime, although it was found to be deficient in the bones of those whose urine was examined^h.

In various dyspeptic complaints I have observed the urine to be covered with an oily film, which appears to be derived from a depraved secretion of mucus, and also to deposit a great quantity of the earthy phosphates. Those appearances, however, in general cease immediately after the use of purgative medicines, and seem to be closely connected with the state of the bowels.

^f Cruickshank in Rollo, p. 449.

^g *Système des Connaiss.* t. x. p. 117.

^h Orfila *Chémie Med.* t. ii. p. 335.

URINARY CALCULI.

THE next table is designed to represent, in a compendious manner, the principal distinctions of urinary calculi, with a view to facilitate and extend the examination of them. When taken in connexion with some of the statements made in the preceding pages, it also exhibits the facts on which the chemical treatment of calculous disorders is founded; but on this subject I must beg to refer to the ample and satisfactory work of Dr. Marcet.

Simple calculi (to which the table is confined) are seldom found pure. Like minerals, they pass gradually into each other, and therefore must be named from the predominating characteristic. The numbers denoting the frequency of occurrence of each, were obtained from examinations of 181 calculi preserved at Norwich; of 87 in Guy's Hospital, London; and of four collections in Newcastle, Leeds, and Manchester, examined by Dr. Henry, which, with his own, amounted to 187. The numbers belonging to those collections, are severally distinguished by the letters, N, G, and H; and the sum of them

presents us with the comparative frequency of each calculus, as ascertained in 455 cases.

The compound calculi amounted to 115. Of those, 98 were in layers, and the remainder were confusedly aggregated. The layers consisted of uric acid, the oxalate of lime, and the earthy phosphates, alternating with each other. It is evident, that, in order to examine such, it is necessary to saw them asunder, and to ascertain the nature of each layer separately. The most frequent nuclei are small calculi formed in the kidney. Of 58 cases of kidney calculi, it was ascertained by Mr. Brande, that 51 were uric, 6 oxalic, and 1 cystic; and from a variety of observations, it appears that the formation of the phosphates is almost exclusively confined to the bladder.

Three new calculi have been described, two consisting of xanthic oxyd and fibrine, by Dr. Marcet, and one of urate of ammonia, by Dr. Proutⁱ; but as only one of each has hitherto been discovered, the reader is referred to those authors for their description.

ⁱ Med. Chirurg. Trans. vol. x.



TABLE OF URINARY CALCULI.

| | SENSIBLE PROPERTIES AND SOLUBILITY IN WATER. | COMPARATIVE FREQUENCY. | EFFECTS OF THE BLOWPIPE. | CHEMICAL PROPERTIES. |
|--|---|--|--|---|
| URIC ACID. | Hard, inodorous. Brownish or fawn colour. Sol. in 1720 parts water, at 60°; in 1150, at 212°. | N 66 G 22 H 71 — 159 | Blackens, emits a peculiar animal smell, and gradually evaporates, leaving, generally, a small quantity of a white alkaline ash. Sometimes crackles, from the presence of oxalate of lime, or from a rapid evolution of ammonia. | Soluble in nitric acid. On evaporating this solution a residue is obtained, of a bright pink colour, which disappears on adding either an acid or an alkali. |
| PHOSPHATE OF LIME. | Surface generally palish brown, and smooth as if polished. On being sawed through, it appears regularly laminated. Insol. | Rarely found in a state of purity. | At first blackens, owing to the charring of the animal matter, but soon becomes perfectly white, and remains unaltered, unless the heat be most intensely urged, when it may at length be fused. | When pulverized, is easily soluble in muriatic or nitric acid. |
| AMMONIACO-MAGNESIAN PHOSPHATE. | Calculi in which this salt prevails are generally whiter and less compact than the preceding. It is frequently found in minute sparkling crystals, diffused between the interstices of other calculous laminæ. Insol. | Rarely found pure. This and the preceding are included in the numbers of the fusible calculus. | An ammoniacal smell is perceived. The size of the fragment diminishes, and, if the heat be strongly urged, it ultimately undergoes an imperfect fusion, being reduced to the phosphate of magnesia. | |
| FUSIBLE CALCULUS. | Commonly whiter and more friable than any other. Like chalk, leaving a white dust on the fingers, and separable into laminæ; or spongy, and not laminated. Often of a great size. Insol. | N 53 G 29 H 22 — 104 | Easily runs into a vitreous globe. | Readily dissolved by acids, particularly by the dilute muriatic acid. Proved to be composed of the two former phosphates. |
| OXALATE OF LIME, OR MULBERRY CALCULUS. | Tuberculated, whence its name; or smooth and pale-coloured, and sometimes assuming a flat, octohedral form. Insol. | N 41 G 22 H 11 — 74 | Expands into a white alkaline efflorescence. Sometimes crackles and decrepitates, from the mixture of some other substances. | When finely pulverized, is dissolved, with the assistance of heat, in the muriatic and nitric acids. Not decomposed by the pure alkalies; but, when digested with alkaline carbonates, the alkali combines with the oxalic acid, and the carbonic acid with the lime. |
| CYSTIC OXYD. | Confusedly crystallized. Semi-transparent; yellowish colour; peculiar glistening lustre, like that of wax. Insol. | N 0 G 1 H 2 — 3 | Emits a peculiar fetid smell. | Abundantly dissolved by muriatic, nitric, sulphuric, phosphoric, and oxalic acids; by potash, soda, ammonia, and lime-water; and by the neutral carbonate of soda. Scarcely soluble in alcohol, acetic, tartaric, and citric acids. |

THE END.

TABLE I

| Soluble Properties and Solubility in Water | |
|--|--|
| Hard, translucent, brownish or blackish. Sol. in 100 parts water at 60°; in 1100 at 212°. | URIC ACID |
| Glaucous, generally gelatinous, and somewhat as if pedicled. On being raised through it appears regularly laminated. Insol. | PHOSPHATE OF LIME |
| Colorless in which the salts are generally white and less common than the preceding. It is frequently found in minute sparkling crystals, enclosed between the laminae of other calcareous laminae. Insol. | AMMONIACO-MAGNESIAN PHOSPHATE |
| Commonly white and more friable than any other. Like chalk, leaving a white stain on the fingers, and separable into laminae, or spores, and not laminated. Often of a green stain. Insol. | FUSIBLE CALCULUS |
| Tuberculated, when in mass; or smooth and pale-colored, and sometimes assuming a flat, conical form. Insol. | OXALATE OF LIME or MULBERRY CALCULUS |
| Commonly crystallized, though transparent; yellowish color; peculiar itching feeling like that of wax. Insol. | CYSTIC OXYD |



