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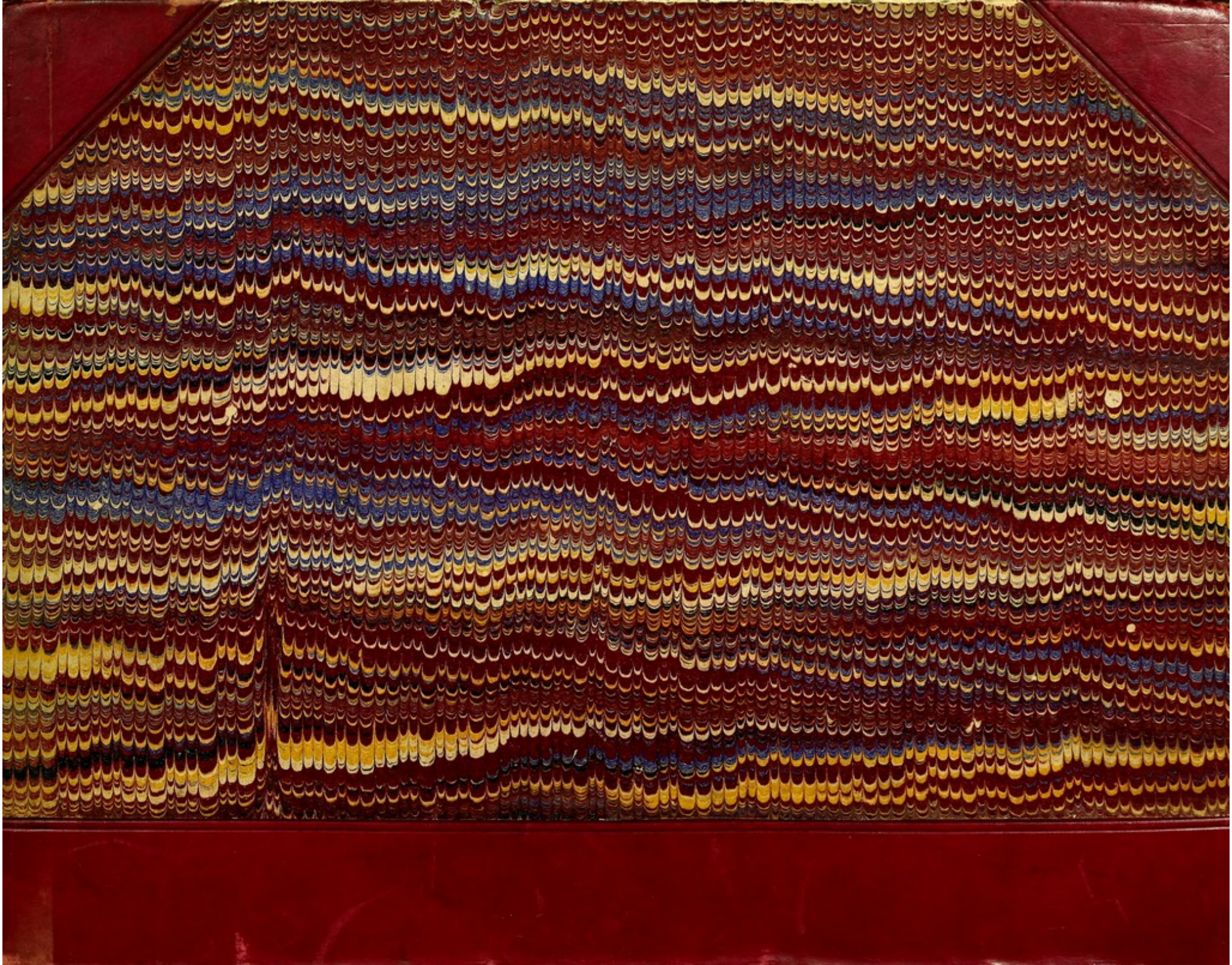

ATLAS

OF

PHYSIOLOGICAL CHEMISTRY.

BEING A SUPPLEMENT TO

LEHMANN'S PHYSIOLOGICAL CHEMISTRY.

By DR. OTTO FUNKE,

OF THE UNIVERSITY OF LEIPSIC.

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MDCCCLIII.

PREFACE.

In submitting this "Atlas of Physiological Chemistry" to the notice of the scientific world, I believe I am fairly entitled to attach to it the announcement now borne by almost every literary production which issues from the press, that it is intended to supply some sensible want. Even although there should be no difficulty in the present instance in proving the existence of such a want, after I have explained what is to be understood by the title selected; still, the precise mode in which it is attempted to meet the want in question, demands some degree of explanation and apology, which will not permit me merely to let the drawings speak for themselves.

It is unnecessary to enter into any long argument to prove that the use of the microscope is now quite as indispensable in investigations appertaining to physiological chemistry as in general physiology, of which the former is merely a section. Without the microscope, both sciences would be only unconnected fragments; no branch or doctrine of either could, as in other natural sciences, be prosecuted with productive and comprehensive results; no theories could be constructed upon a solid basis of experimental evidence, as they really may at the present time, and as we hope they will be in a still greater degree for the future. A physiological laboratory without a microscope is as great an anomaly as a chemical laboratory without a balance. Those who may be inclined to regard these assertions as too bold, as perhaps the result of that prejudiced opinion which men not unfrequently entertain of

the importance of their own particular pursuits, or even as quackish puffs of the publication, will find, in almost every page of Lehmann's excellent work, (which is certainly beyond the reach of any such criticism,) a "ceterum censeo," acknowledging the high place which the microscope holds as an instrument of zoo-chemical investigation. It is difficult to state, in a concise form, all that is to be anticipated from its use, or the particular points on which it is capable of affording information; I could wish that my drawings might themselves serve as the index of this.

I shall now at once proceed to offer a short programme of the principles, in accordance with which I have selected objects for representation. If the necessity of microscopic examination in animal chemistry is an indisputable fact, the beginner, when he enters the zoo-chemical laboratory, is justified in seeking for some guide by means of which he may learn to "*see*," just as in addition to a general elementary work on the science, a special manual of the chemical analysis of animal substances is indispensable to him. The actual use of the microscope, under the direction of a teacher, is certainly the best means of attaining this end; but next to that, and even together with it, there is no doubt that the graphic representation of objects, as seen with the microscope, is very desirable; serving the beginner as a grammar of the language of the microscope, and presenting it to him in an intelligible and systematically arranged form. It is indeed by no means an easy matter to learn to see with the microscope, as its history, unfortunately, too clearly proves; even the most lucid, detailed, and accurate descriptions of microscopic objects are frequently inadequate to enable an inexperienced person to form such ideal pictures of them as would guide him in his observation of the microscopic field of vision without other assistance. All writers on histology have perceived this difficulty, and have therefore given with their descriptions either diagrams or drawings, in some cases accurately copied from nature, though frequently too much idealized; no one would recommend to the beginner an histological manual with-

out plates. This is equally the case with regard to the use of the microscope in physiological chemistry; and I am far from supposing that I am the first who has recognised the necessity of drawings of the microscopic objects with which the science is concerned. We already possess many excellent works on general zoo-chemistry, or particular branches of it, in which the authors have given drawings of, at least, the most important and characteristic microscopic objects. I may, for example, mention C. Schmidt's "Entwurf einer Untersuchungsmethode der thierischen Säfte," Donné's "Atlas," Golding Bird's "Urinary Deposits," Hoefle's "Chemie und Microscop am Krankenbett," and v., Gorup Besanez's "Anleitung zur zoochemische Analyse." Still, none has, as yet, attained the desired object in a complete or by any means satisfactory manner. I believe I shall not be doing any one an injustice in asserting that all the plates of the kind in question which have hitherto appeared, have two considerable faults: in the first place, the partial and very limited range of the object selected; and, secondly, the inaccuracy, want of resemblance, and more or less injurious and even false idealization of the drawings. Many of these drawings are mere diagrams, principally crystalographic. I do not at all question the value and use of such representations, and am well aware that Schmidt and others have done much for science by means of them. But crystalographic diagrams alone cannot constitute an "Atlas of Physiological Chemistry;" and they are frequently even insufficient to enable the beginner to recognise the bodies which they represent. There are indeed hundreds of instances in which it is not the crystaline form which characterises bodies, but precisely the deviations from the perfect figure, and other circumstances, such as the kind and degree of refraction, the mode of grouping, &c. Moreover, it can scarcely be questioned that crystals are not the sole, or even the most important objects of microscopic zoochemistry. Very little attention has, however, been paid to other objects. The uncrystaline morphological elements of animal fluids and tissues, together with the changes which, by the aid of the microscope, are observed in them, when treated

with various chemical reagents, and which especially entitle them to a place in an Atlas of Physiological Chemistry: these have met with little consideration, and are represented only here and there by a few imperfect drawings. Attention has been confined, almost solely, to the most important constituents of urinary deposits; and besides hone or tub-shaped particles of uric acid, and a few crystals of triple phosphate, &c., the utmost furnished has been a figure of a tubular cast from the kidney, leaving the rich and valuable material presented by other animal fluids, and especially the objects of histo-chemistry, to histologists. The alterations produced in the form of blood-corpuscles by chemical reagents, the changes which may be observed in food while undergoing the process of digestion, the microscopic chemistry of milk, mucus, pus, &c., undoubtedly come as much within the province of physiological chemistry as any of the substances mentioned above: it appears to me that their graphic representation is a matter of far greater importance to the student than that of crystals, since it is much easier to recognise a crystal of uric acid or of cholesterin, by the aid of verbal description, than the delicate characters of objects, such as blood-cells, pus-corpuscles, muscular fibre, &c., whose investigation presents most formidable difficulties.

One fault of previous microscopic drawings is, then, that they do not represent a sufficient range of objects; the other, and, unfortunately, far greater fault, is in the technical execution of the delineations. At the risk of exposing myself to the charge of self-laudation, I must confess that in most of the zoo-chemical figures with which I am acquainted, both draughtsman and lithographer have done their utmost to disguise the natural object in such a manner as to render its recognition impossible. I could mention hundreds of drawings, with regard to which it might reasonably be doubted whether any impartial observer could tell what they were intended to represent. I could point out cholesterin plates, with angles of 50°; urate of soda, (sic,) in the form of a spider; casts of tubes of the kidney which have a greater resem-

blance to an accidental spot of dirt upon the object-glass, &c. I hope that every unprejudiced judge will exonerate me from the slightest imputation of disrespect in making these statements.

Three circumstances may be pointed out which explain the imperfect character of former delineations. The first, which is indeed unpardonable, is, that most authors have copied certain objects from others, instead of from nature; there are drawings of this kind which have already migrated to the tenth hand, and have become a little worse at each step, until at last they completely belie their name; in the case of figures even of such objects as oxalate of lime, it is not unfrequent to meet with the addition "copied from G. Bird," and this is indeed a *testimonium paupertatis*. Secondly, there has been a reluctance to incur any great expense in the execution, and this is the fault of the publishers, who have imagined that a cheap woodcut, or a rough lithograph would do well enough. The third circumstance is, that the xylographers or lithographers have generally executed their part of the work in a very inferior manner, and perhaps even gone so far as to correct at hazard any supposed fault.

In this criticism of my predecessors I have had no other object in view than to prove the necessity for an Atlas of Physiological Chemistry. I now proceed to give a sketch of my own work,—to describe my aim and plans, the mode in which I have attempted to carry them out, the success or failure of which I cheerfully leave to be decided by as severe a criticism as that which I have just exercised.

The task which I have undertaken is the graphic representation of all those substances whose microscopic and micro-chemical investigation is of importance to physiological chemistry, comprehending in this term all that has received the sanction of Lehmann's work,—that is, excluding special phyto-chemistry, and including, so-called, pathological chemistry, which it is altogether impossible to separate from purely physiological chemistry. In such an undertaking there

were certainly no very definite limits for the extent of the "Atlas;" and, I confess, the selection of appropriate objects for representation was by no means easy. With regard to many substances, I was in considerable doubt, which was not entirely removed even by referring to Lehmann's Lehrbuch, for the purpose of availing myself of his clear statement of the relative degree of importance attached to the microscopic study of the objects in question. The selection of substances from among those treated of in the first volume, was particularly difficult. For instance, which crystaline substances were sufficiently characteristic under the microscope, in point of form, general aspect, optical peculiarities, grouping, &c., to be of service for diagnostic purposes? Which, among the manifold chemical compounds of any given body were to be selected as most characteristic?—Which, among the frequently innumerable modifications of a fundamental form, were to be represented?—These and similar questions repeatedly forced themselves upon my notice; and although there could be no doubt that the several forms of uric acid ought to be represented, still some consideration was necessary in deciding whether this was likewise requisite with regard to allantoin or guanine; which of the salts of lactic acid should be chosen, &c. Less uncertainty prevailed with regard to the animal liquids and tissues treated of in the second and third volumes of Lehmann's work. I must leave it to others to decide how far my selection has been successful, judicious, and satisfactory; and I hope rather that I have given too much in some instances, than that I have overlooked anything of importance.

In the second place, I have attempted to reproduce the natural object in its minutest details, and even with pedantic accuracy, as far as pencil and graver would permit; above all things prohibiting the slighest idealization, either by myself or the lithographer. This is indeed a very bold project, and one which it is impossible to carry out completely, although I consider it was my imperative duty to endeavour to fulfil it. It will consequently be understood, that among all my drawings there is not a single one which has been borrowed.

And I can moreover conscientiously affirm, that not only are the drawings in general taken from actual microscopic objects, but likewise every single crystal or cell, &c., and indeed, exactly as they appear under the microscope; not according to ideal models, such as science constructs from the microscopic appearances and experimental facts derived from other sources. I have therefore copied even the optical deceptions which are owing to the different refractive powers of crystaline substances, as for instance, the apparent displacement of the under planes and edges of a crystal when seen through its substance. I have faithfully copied the shadows produced by the illumination of microscopic objects from beneath or from the side, and have represented the various aspects of certain objects dependent upon the focal adjustment of the lenses. Every object has been represented in the most various positions; and I believe that by this means I have lessened the labour of observation, and rendered it possible for the student to combine together the several optical impressions, thus forming as adequate and correct an idea of the true form of bodies as from actual observation with the microscope. I have not only accurately represented the individuals of the various morphological elements, but have also endeavoured, wherever it was of any importance, to give their natural mutual relations, their grouping, quantitative proportions, &c.,—in short, true reflections of the microscopic field of vision, whether comprising a drop with crystals, blood, a fragment of muscular fibre, or whatever else it might be. It must of course be understood that only in very few instances I have portrayed but a single part of a preparation in the field of view, because it scarcely ever happens that all the forms and modes of grouping in which any object presents itself, are united in the same field. I was therefore compelled not only to examine innumerable preparations before I could find one which was appropriate, but likewise to select from them, and from different sections of the microscopic field, especially characteristic spots, and then to compile these together into one drawing. I must leave it for

others to decide how far I have succeeded in this attempt to represent the general characters.

All the drawings have been made with one of Oberhäuser's large microscopes of excellent quality. With regard to the magnifying power, I must observe that I have used one and the same, and that not too strong a power, for the greater number of the drawings; and I have adopted this course because beginners are generally unable to command any very high magnifying powers, and because, for well-known reasons, it is a general principle that the lowest powers applicable should always be used, and further, in order that a comparison might be made between the drawings, especially in those of organized substances, with reference to the relative magnitude of the different elementary forms, without any special data of measurement, which have no connection with the objects I had in view. The magnifying powers used for crystaline bodies are less uniform, since their magnitude is subject to variation of considerable amount, and is not of any great importance; it is therefore only for those crystals which occur as such in the organism, whose magnitudes are more definite and constant, and generally have a certain relation to those of the other elements, that I have employed the same magnifying power used for all the organized structures—cells, vesicles, fibres, &c.: this power is about 180 to 200 fold. Only a very small number of objects, such as the intestinal villi (Plate viii., fig. 1 and 2), have been drawn with lower powers.

With regard to the technical execution of the plates, I can of course give an opinion only on that part which belongs to the lithographer; of my own labours I will merely say, that I have in all cases delivered the drawings to the lithographer in a perfectly finished state, and have not left him to add a single line to them. At the same time I cannot sufficiently acknowledge the extraordinary fidelity and care with which Herr Wilhelmi has copied my drawings, I may say, point for point, and the trouble which he has taken to adapt certain

technical modes of operation to the representation of pencil-work. I may therefore venture to term the execution of the lithographs perfect in the highest possible sense, and whatever deficiency there may be in them is attributable either to my original drawings, or to the insurmountable difficulties attending some parts of the lithographic process. I need only mention, that the delicate and uniform shadow tints, which, with the pencil and stump are so extremely easy, can never be perfectly rendered upon stone even by the finest diamond shading; that all the outlines, and especially those which are faint, as is the case with so many organic structures, as seen by the microscope, must necessarily appear somewhat more harsh and distinct upon the stone. The extreme practical difficulties connected with printing in colour, will be a sufficient excuse for the circumstance that here and there a tint, the determination of which is moreover to some extent dependent upon subjective conditions, may not perfectly harmonise with that of the natural objects; as regards the congruity of the various colours with the black, the utmost has been achieved.

In the text accompanying the Plates I have endeavoured to give the greatest amount of information in the briefest form. To have given a perfect description of the objects represented, I should have had to write a work on physiological chemistry, histology, and crystalography. I have therefore adhered to only two points of view in the explanations. I have, in the first place, always given a statement respecting the source of the objects under notice, and their mode of preparation, both which appeared to me as necessary adjuncts to the mere name. Secondly, I have described in every instance only the purely optical part of the subject, and given a short comprehensive analysis of the separate constituents as far as it appeared to me indispensable in the frequently very variegated field of vision. Data of magnitude, or crystalographic and histological descriptions, beyond what the plates themselves afford, I regarded as remote from my purpose.

In conclusion, I must offer my warmest thanks to many who

have rendered me their assistance; in the first place, to my highly respected teacher, Professor Lehmann, for having granted me the honour of entitling my work a supplement to his Manual; and secondly, to those who have contributed rare and difficultly procurable objects. I could not have given an original drawing of cystine, had it not been for the kindness of Dr. Bence Jones, and should with difficulty have obtained such fine crystals of hæmatoidine had I not received them as a present from Professor Virchow. Dr. Zeuker has, with indefatigable labour, and more than friendly zeal, furnished me with an extensive collection of pathological objects from the abundant sources of the Dresden Hospital; Professors Lehmann and Erdmann have saved me the trouble and expense of preparing many crystaline bodies, by presenting them from their cabinets. A special enumeration of all the aids which I have received would occupy too much space, and I must therefore limit myself to the expression of my most cordial thanks to Professor E. H. Weber, Drs. Uhle, Hamberg, Theirfelder, Panum, and Walther.

THE AUTHOR.

Leipzig, October 18th, 1852.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. Oxalate of Lime, prepared from normal human urine, by the addition of oxalate of ammonia.

Most of the crystals present the usual form, resembling a letter envelope; the edges of the octohedral planes turned towards the eye appear partly as sharply defined lines, partly as brilliant intersecting streaks, according to the position of the microscope; some crystals appear distinctly as acute quadratic octohedrons.

Fig. 2. Carbonate of Lime, in dumb-bell or drumstick-shaped crystals, accidentally obtained in the course of a chemical examination of normal human urine.

I have placed these crystals beside those of oxalate of lime, because the latter are sometimes met with in precisely similar forms; I have not as yet seen dumb-bell crystals of oxalate of lime. An extensive series of modifications of this crystaline form of carbonate of lime is given in Plate xiv., Fig. 5.

Fig. 3. Butyrate of Baryta, crystalized from water.

When this salt is rapidly separated from solution, in films with a fatty lustre, upon the surface of the mother liquor, it generally happens that it appears under the microscope only in the form of dense heaps of pale crystaline plates, which cannot be well distinguished from one another. When it separates slowly, stellar druses are generally formed, such as are shown on the left of the drawing. The individual crystals are seldom perfectly developed, and some of them are so thin and translucent that their outlines are scarcely recognisable.

Fig. 4. Succinic Acid, crystalized from hot water.

Fig. 5. Sebacic Acid, crystalized under the microscope from a hot aqueous solution.

Fig. 6. Benzoic Acid, crystalized from a hot aqueous solution.

The irregular compound scales, with numerous retreating angles, are particularly characteristic.

PLATE II.

Fig. 1. Lactate of Lime, prepared from chemically pure lactic acid and carbonate of lime, crystalized from a hot aqueous solution.

The double groups of delicate needles, resembling two brushes joined at their bases, are characteristic; groups likewise are constantly met with in which the individual needles extend more or less parallel towards two sides, such as are represented in the centre of the drawing: stellar druses also occur.

Fig. 2. Lactate of Zinc, crystalized from hot water.

The crystals, while forming, frequently present the club shape, and curved surfaces, as represented near the lower part of the figure.

Fig. 3. Lactate of Copper, deposited from an aqueous solution.

Fig. 4. Urea, prepared from human urine, and crystalized from an aqueous solution by slow evaporation.

Fig. 5. Nitrate of Urea, separated from very concentrated human urine by nitric acid.

Fig. 6. Oxalate of Urea, prepared from chemically pure urea and oxalic acid.

PLATE III.

Fig. 1. Creatine, prepared from beef according to Liebig's method, and crystalized from hot water.

Fig. 2. Creatinine, prepared from creatine by digestion with hydrochloric acid, and separated by means of hydrated oxide of lead; crystalized from a hot aqueous solution.

Fig. 3. Creatinine-Chloride of Zinc, prepared from human urine according to Liebig's method, and crystalized from hot water.

This compound is very rarely obtained from urine in perfectly developed regular crystals, but generally in the irregular forms represented, and frequently with curved surfaces.

Fig. 4. Taurine, prepared from ox-gall, recrystalized from hot water.

It crystalizes very readily in the highly refracting regular prisms represented; if, however, it is present in the extract of an organic liquid only in very minute quantities, it often separates on the addition of alcohol in the form of small rhombic laminæ, such as are represented near the right margin of the drawing, two plates frequently lying one above the other.

Fig. 5. Glycine, prepared from gelatine by digestion with caustic potash, crystalized from water.

Fig. 6. Leucine, prepared from albumen by digestion with concentrated sulphuric acid, recrystalized from caustic ammonia.

Leucine generally crystalizes from all solvents in druses of laminæ, the outlines of which are difficult to distinguish with accuracy; in most instances single edges alone are observed as sharp black lines, which disappear when the focus is altered, while others become visible; consequently at first sight many of the crystals appear only as very delicate dark needles terminating in two points.

PLATE IV.

Fig. 1. Hippuric Acid, prepared from normal human urine, recrystalized from water.

Besides the usual prisms, hippuric acid frequently crystalizes in a form exactly similar to that of the triple phosphate, especially when the crystalization is slow; such crystals are represented in the left lower quarter of the drawing.

Fig. 2. Uric Acid, in various forms, prepared partly by solution and recrystalization of chemically pure uric acid

partly by treating urinary deposits, consisting of urates, with acids, and partly by the spontaneous formation of sediment from urine.

The great variety of forms which uric acid assumes, from the most frequently occurring, simple, rhombic plates with truncated, obtuse angles, to the more rare modifications, may easily be recognised in the drawing. The dumb-bell crystals, represented in the upper and left part, occurring sometimes even in spontaneous urinary deposits, were artificially prepared by myself; I have obtained them, in almost every instance, on dissolving chemically pure uric acid in concentrated potash, and precipitating it under the microscope by means of concentrated hydrochloric acid.

Fig. 3. Uric Acid, in various other forms, especially "hone" and "tub-shaped" crystals, which are met with, generally tinged by the colouring matter of urine, in the spontaneous sediment, and are likewise obtained by treating the ordinary sediment of urate of soda with acids.

Fig. 4. Urate of Soda, artificially prepared by digesting chemically pure uric acid with ordinary phosphate of soda.

Fig. 5. Urate of Ammonia, prepared from the last mentioned salt by treatment with chloride of ammonium.

Fig. 6. Glycocholic Acid, prepared from glycocholate of soda, by means of sulphuric acid, and crystalized from an alcoholic solution by the addition of ether.

PLATE V.

Fig. 1. Glycocholate of Soda, prepared from ox-gall, and crystalized from an alcoholic solution by the addition of ether (the crystals brought under the microscope in the etherial liquid between two large glass plates.)

Fig. 2. Cholic Acid (of Demargay and Lehmann), Cholalic Acid of Strecher, prepared by various methods from glycotaurocholate of soda by treatment with caustic potash or caustic baryta, &c.

It is remarkable that, notwithstanding numerous attempts, I have never been able to obtain cholic acid in tetrahedrons

(*Strecker*). I have tried all modes of preparation, procured choleic acid prepared in other laboratories, repeatedly recrystalized it from its various solvents, especially from ether, and constantly obtained it in the prismatic forms represented. It must, of course, be understood that with regard to every preparation I have taken care to convince myself, as far as was possible without an elementary analysis, that the substance operated upon was really free cholic acid.

Fig. 3. Pulmonic Acid, (*Lungensäure*) (*Verdeil*), prepared according to Verdeil's directions from calves' lungs, and recrystalized from alcohol.

Fig. 4. Allantoine, prepared from calves' urine and recrystalized from hot alcohol.

Fig. 5. Hydrochlorate of Guanine, neutral.

When this is treated with a large quantity of water, colourless acicular crystals of guanine separate from the solution of the yellow salt, generally grouped in rounded clusters, as represented near the right margin of the drawing.

Fig. 6. Cystine, obtained from a urinary calculus and recrystalized from caustic ammonia.

PLATE VI.

Fig. 1. Cholesterin, in large regular plates obtained from an apoplectic cyst of the thyroid gland.

The tenacious mass contained, besides the crystals, a great number of shrivelled, irregularly serrated blood-corpuscles, generally of a deep yellow-red colour, but in some instances perfectly colourless, together with larger, yellowish red coloured granular globules.

Fig. 2. Cholesterin, from the contents of an hydatid cyst in the liver in a state of progressive obliteration and into which bile was at the same time effused.

The cholesterin consists of masses of variously sized plates, some of them with retreating angles; at the upper edge of the drawing there is a heap of small, irregular and imperfectly developed plates, such as are always formed from hot alcoholic

solutions of cholesterin. Together with these crystals are a few crystals of margaric acid, united in the form of bunches of grass, small, roundish granules of a dark brownish red pigment, among which small, regular crystals of the form and colour of hæmatoidine may be recognised; from the behaviour of these granules and crystals with reagents, they proved to be really hæmatoidine. The microscopic field is moreover covered with a great quantity of variously sized globules of fat, and yellow, amorphous clusters (remains of bile).

Fig. 3. Hæmatoidine, from the subcutaneous fatty tissue of an amputation flap, partly in large, separate, regular crystals, partly in clusters of small crystals.

The bunches of radiating acicular crystals consist of fats, which crystalized under the microscope on the evaporation of the ether with which the preparation had been treated, for the purpose of better exposing the crystals of hæmatoidine originally enveloped in masses of fat.

Fig. 4. Bilifulvine Crystals (*Virchow*), with a few laminæ of cholesterin, from the bile of a person who had died of typhus fever, in whom no pathological alteration of the gall-badder itself could be detected.

The separate masses consist of several small crystals, generally joined with each other at an angle.

Fig. 5. Uroglaucine Crystals *(Heller)*, obtained by evaporating human urine with concentrated nitric acid.

Violet-coloured crystals of the form represented are obtained from almost every normal urine, on treating it in the above manner; whether they are to be regarded as colouring matter is, however, more than doubtful. The crystals are difficultly dissolved by ether, but crystalize again, from the violet solution, *colourless;* they are merely different products of the decomposition of uric acid coloured by some pigment.

Fig. 6. Inosite, prepared from ox-heart, and crystalized partly from alcohol, and partly from water.

The laminæ resembling cholesterin, with retreating angles, represented near the right upper margin of the drawing, are formed from an alcoholic solution.

PLATE VII.

Fig. 1. Normal Human Saliva, its morphological constituents.

1. Large polygonal squamous *epithelium-cells* of a pale colour and with distinct, round nuclei. 2. *Mucus-corpuscles* with dull, granulated surfaces, and generally with simple, eccentric nuclei visible without any further treatment.

Fig. 2. Gastric Glands and Gastric Cells, from the mucous membrane of the pig's stomach.

Besides the perfectly developed, round, oval, or polygonal, *gastric cells* with nuclei, which are partly detached, partly enclosed in the membrane of the glands, there are *clusters of granules* enveloping single nuclei without cellular membrane, as shown near the upper and left margin of the drawing, and likewise free, naked *nuclei*, and a few *epithelial cells* of the mucous membrane of the stomach.

Fig. 3. Vomit of a dog four hours after feeding.

Its constituents are: 1. *Transversely striated muscular fibres*, more or less altered by the gastric juice, some with tolerably distinct, transverse striæ, and torn in places in the direction of these striæ; others presenting an indistinct transverse striation, recognisable only in parts, but with a distinct, longitudinal striation (at the upper margin of the drawing); in others, which are still further altered (the right margin), the longitudinal striæ are indicated only by specks arranged in lines; all round the edges, the fibre-elements are broken up into molecular substance. 2. *Starch-granules* in various shapes, the central cavity generally very distinct, the concentric layers abruptly separated from each other in places. 3. *Fat-globules* of various sizes and a few delicate bunches of acicular crystals of margarine. 4. *Vegetable cells containing chlorophylle* (at the upper margin). 5. A few *fermentation fungi*, sometimes two joined together.

Fig. 4. Vomit with Sarcina (*Goodsir*), from an hysterical girl, who had been subject to habitual vomiting for several years.

The Sarcina-cells separated into four sections by two

intersecting constrictions, are partly separate and partly united together into plates of various size; in some of the sections of these cells it is possible to recognise the incipient, secondary constriction by means of which each section is converted into a new quadripartite cell. Together with the Sarcina, are starch-granules and globules of fat.

Fig. 5. Cholera stool.

The whitish "rice water" evacuations, in Asiatic cholera, contain almost exclusively, quantities of *intestinal epithelium particles* generally still cohering in strings or plates; the top of each cell generally protruding like a watch-glass, as is usually the case in watery liquids. At the upper margin of the drawing, a cluster of these cells is represented as seen from above, when it presents a honeycomb-like appearance. Isolated crystals of *phosphate of ammonia and magnesia* (triple phosphate) are distributed among the epithelium-cells.

Fig. 6. Typhus stool.

This object is from an extremely characteristic yellow-coloured watery evacuation mixed with white granules, and separating upon standing into two layers. It contains: 1. A few distorted, pie-dish-shaped *blood-corpuscles* (*e.g.*, at the middle of the right margin); 2. Large, round, faintly-granulated *mucus* or *pus-corpuscles*, some with distinct nuclei (the centre); 3. Oblong *intestinal epithelial-cells*; 4. Roundish or angular *nuclei*, associated with fine *molecular matter*, and partly suspended singly in the liquid, partly aggregated together in large, compact, dark-coloured *clusters*, frequently round, but also of irregular form; some of the clusters consist merely of fine, amorphous, molecular substance. The white granules in typhus stools are probably exudations from the ulcerated Peyer's patches, and consist of such nuclear and molecular masses. 5. Remains of *vegetable cells* and a fragment of *spiral fibre* (at the right, upper margin); 6. Large quantities of *triple phosphate crystals* in various forms; 7. A mass of biscuit-shaped (dumb-bells) bodies which dissolve in acetic acid with evolution of gas, and are consequently small dumb-bells of *carbonate of lime*. I have repeatedly found the latter in typhus stools, although rarely of such large size as represented on the left at the lower margin of the drawing.

PLATE VIII.

Fig. 1. VESSELS FILLED WITH CHYLE IN THE VILLI OF THE SMALL INTESTINE, from the body of a healthy suicide.

As it frequently happens that food is taken immediately before the commission of suicide, the chyle vessels of the small intestine are generally found to be filled in the most beautiful manner. The first two subjects which I examined for the purpose in the Leipzig Anatomical School, both furnished most perfect preparations of the kind represented. The epithelial covering of the villi has been detached: the middle of each villus is traversed by a larger-sized chyle vessel, generally single, sometimes (as in the lower one) double, completely filled with small, dark and powerfully refracting chyle-granules, whose greenish brown colour is owing to the absorption after death, and through the whole mucous membrane, of biliary liquids present in the contents of the intestinal canal. These larger branches of the chyle vessels are not always of uniform width, frequently expanding in places and dividing, so that isolated parts appear. Very often the contents are not uniformly distributed throughout the entire vessel, the chyle-granules lying in separate masses and clumps, partly also scattered singly, so that vacant spaces are left, as is distinctly shown in the next figure. Numerous branches run out from these principal vessels of the villi, continuing to ramify until they ultimately form a perfect *capillary network* of chyle vessels, as was first pointed out by E. H. Weber. In the preparations represented, these capillaries are perfectly and densely filled, appearing consequently as actually continuous vessels; where they are not so completely filled, and the granules are unconnected, the latter appear uniformly distributed throughout the parenchyma. A defined vascular membrane can only be detected in the larger chyle vessels, and not in the capillary branches; and it is possible that such capillary vessels may be formed at any point of the villus by the opening out of the elementary tissue.

Fig. 2. HUMAN INTESTINAL VILLI WITH FILLED CHYLE VESSELS, AND THE DOUBLE VESICLES DESCRIBED BY E. H. WEBER, AT THEIR APICES, ONE FILLED WITH TRANSPARENT OLEAGINOUS

LIQUID, AND ONE WITH OPAQUE CRUMBLY SUBSTANCE; from the body of a healthy person who committed suicide while digestion was going on.

The chyle vessels here are not so perfectly filled as in the previous specimen; however, the presence of chyle capillaries may be especially recognised at the left of the figure, where a villus separates into two points, into both of which the vessel sends a capillary network. The other villi present the peculiar vesicles observed by Weber; they are in all instances in pairs, one transparent, the other opaque; sometimes a villus has two such pairs (as in the centre). The size of the vesicles is various, but they are generally so large that they occupy from a third to one-half of the entire breadth of the villus. The epithelial covering is entirely wanting in these villi; a proof that the vesicles are not distended epithelial cells.

Fig. 3. EPITHELIA OF THE VILLI, FILLED WITH GLOBULES OF FAT; from the duodenum of a rabbit, two hours after feeding with melted butter.

The cylindrical epithelia are partly isolated, and partly separated from the villi by pressure, and aggregated together in rows: near the lower and left part of the drawing, the free border of a villus, still covered with epithelium, is seen. The epithelial cells are densely filled with fat-globules of various sizes, especially at the basis turned towards the intestinal canal, still the light cell-nucleus is conspicuous in most of them; at the pointed extremity of the cells the fat-globules exist but sparingly; the entire cell is distended, and the cover closing its basis bulges out in form of a watch-glass, so that in the connected rows of cells, a narrow transparent border is formed. Besides the cylindrical epithelial cells, there are numbers of variously sized, round cells, which, as they roll under the microscope, prove to be spherical, and are undoubtedly derived from the cellular layer, shown by E. H. Weber to exist beneath the epithelial envelope. When the specimen is cautiously washed with water, before bringing it under the microscope, no fat unenclosed in cells can be detected, or, at the utmost, only a few globules from cells burst by pressure.

Fig. 4. LIVER CELLS, from human fatty liver.

The polygonal cells, partly united in rows and small plates,

contain, besides the pale granular substance which surrounds the faint, round nuclei, two different elements, namely, small, round, brilliant globules of fat, and round, or angular granules of a dark greenish brown colour; both are met with together in some cells. The green granules evidently consist of biliary matter, very probably formed within the liver cells.

Fig. 5. Chyle from the Thoracic Duct of a rabbit.

The drop surrounded by air-bubbles, contains, besides the fine molecular matter which uniformly covers the entire field of view, the following structural elements:—1. Large and small nuclei, partly round and granulated, partly composed of molecular matter, and containing nucleoli. 2. Larger, round, and faintly granulated corpuscles—chyle-corpuscles—in some of which a simple, round eccentric nucleus is distinctly visible, a few others presenting a bipartite, tripartite, or quadripartite nucleus. 3. Isolated red blood-corpuscles; and, 4, small fat-globules in very small quantity.

Fig. 6. Colourless (white) Blood-Corpuscles, from leucæmic blood, obtained by venesection from a man suffering from an enormous splenic tumour.

The colourless corpuscles amount in this case to more than one-half of the entire structural constituents of the blood, as may be perceived from the drawing; they are of very different sizes, bounded by regular round outlines, for the most part faintly, but the smaller ones rather more darkly granulated. In the fresh state a simple, round nucleus is recognisable only in very few, but on the addition of acetic acid (as at the lower part of drawing), the corpuscles swell up, become extremely pale and hyaline, so that their outlines cannot be recognised without some trouble, and nuclei in various number and form become visible, partly simple, round, oblong, biscuit or horse-shoe shaped, and partly duplicate, triplicate, and quadruplicate, in the various forms and groupings represented, as produced by the breaking up of simple ones. The red corpuscles (see following plate), part of which are arranged in rolls like coin, generally appear annular; the central depression is very sharply marked and bounded, being either dark while the surrounding border is bright, or bright with the border dark, according to the adjustment of the microscope, so as to produce the deceptive appearance of nucleated cells.

PLATE IX.*

Fig. 1. Normal Human Blood-Corpuscles, from whipped blood obtained by venesection.

The *red blood-cells* appear partly separate and partly united in rolls like pieces of money. The former lie partly upon their flat side, partly upon the edge; in the former case they appear as circular discs with sharp outlines, in which by a right adjustment of the focus the central depression appears as a faint shadow, somewhat darker upon the edge of the hollow; if they are not quite at the right focal distance, the central depression appears light and the edge of the disc dark. The oval figures represent those corpuscles which when rolled turn their sides obliquely upwards, and downwards; if they turn their edge upwards, they appear oblong, slightly biscuit-shaped. The rolls appear, therefore, to be composed of such figures. If a roll stands upright, only the top surface of the uppermost corpuscle is seen; the edges and shadows are, however, more marked and darker, on account of the underlying corpuscles. If two corpuscles lie one above the other, but in such a way that one only partially covers the other, the outline of the covered part of the under one is faintly perceptible through the other; the separate cells appear of a very pale yellowish red; the more of them lie above each other, the darker is their colour. At the right, lower side, blood-corpuscles are represented which are drying, and therefore appear distorted, spotted, and jagged with edges; when perfectly dry, they appear like sharply defined rings. Among the red blood-cells, *colourless cells* are here and there visible, as round pale corpuscles, faintly granulated upon the surface.

Fig. 2. Coagulation of Normal Human Blood under the Microscope.

If a drop of blood is placed between two glass plates immediately upon being drawn from a vessel, and allowed to remain for about two hours under an air-tight bell-glass, it presents, under the microscope, the appearance represented.

* On account of the technical difficulties of printing such small bodies as blood-corpuscles in colour, they have been represented colourless.

The red blood-cells are partly detached, partly united in rolls, and partly in irregular clusters. In the vacant spaces between them a compact network of extremely delicate threads of *fibrin*, intersecting in all directions, may be recognised at various parts; the outlines of the blood-cells, heaped above each other, appear in many instances indistinct on account of the web of fibrin above them.

Fig. 3. HUMAN BLOOD-CORPUSCLES, TREATED WITH A CONCENTRATED SOLUTION OF SULPHATE OF SODA.

The great contraction of the blood-cells caused by this and similar salts, manifests itself under the microscope principally in the greater prominence of the central depression; the shadow which indicates it is more intense and extends further towards the edge of disc than in the unaltered corpuscles; if they lie somewhat upon their sides, the edge of the depression appears as a sharp line; lying upon their edges they appear much smaller than unaltered corpuscles, and have a marked biscuit or drumstick shape. The edges are not always circular, but generally somewhat distorted, oblong, angular, and generally not smooth, but serrated.

Fig. 4. HUMAN BLOOD-CORPUSCLES TREATED WITH WATER.

The gradual alteration of the blood-cell by water is represented at the left side of the drawing, as commencing; towards the right side, in a more advanced stage. The first consequence of this action is the distention of the cells; they become more lens-shaped, and finally spherical, inasmuch as the central depression is obliterated and then bulges out; a change which is necessarily attended with a diminution of the transverse diameter of the discs. They appear, therefore, smaller; the shadow in the centre fades and disappears, while a sphere-shadow becomes more prominent at the edge; in the few cells lying upon the edges the lens-form appears distinctly. By further action of water they become gradually duller and paler, and less easily distinguishable from the surrounding liquid, since in consequence of the absorption of water, their contents acquire a refractive power equal to that of the external liquid; they then appear only as extremely delicate, hyaline vesicles, and finally become entirely imperceptible. If a concentrated solution of a neutral salt is then added, they appear again in the dis-

torted, angular and serrated forms represented at the right hand and lower part of the drawing.

Fig. 5. HUMAN BLOOD FROM THE HEPATIC VEIN, taken from the body of an old woman five hours after death, by opening one of the larger hepatic veins immediately at its point of exit from the liver.

This hepatic-venous blood presents the same characters which Lehmann has described as belonging to that from the horse. The red corpuscles are rather smaller than in other blood, the central depressions are generally but faintly marked, in many instances not at all visible. The coloured cells at the edge appear either rod-shaped or lenticular; very few are biscuit-shaped. Rarely two, and never more than three, are seen with the surfaces united in rolls. Besides the coloured cells, there are numerous colourless ones of various sizes—some few remarkably large—partly detached, partly, and especially the smaller ones, lying together in twos, threes, or whole clusters. These are for the chief part very pale, bounded by faint round outlines, only dimly granulated on the surface, as if breathed upon; a few of them resemble perfectly transparent vesicles, in which a round eccentric nucleus is distinctly visible; minute, dark and powerfully refracting spots may be detected in a tolerably large number of them.

Fig. 6. HUMAN BLOOD FROM THE SPLENIC VEIN, included in ligatures, taken from the same subject as the last-mentioned blood.

This blood presents exactly the same general characters first pointed out by me as belonging to the blood from the splenic vein of the horse, and the same elements: small and almost always strongly lenticular, coloured cells, only here and there presenting indications of a central depression, seldom lying upon the edges, never joined together in rolls; among them are numbers of colourless-blood corpuscles of various dimensions, generally small, partly detached, but chiefly aggregated in large, round or irregular clusters by means of a delicate molecular substance. They are mostly pale, but distinctly granulated; nuclei are seldom to be seen without further treatment, but the addition of acetic acid renders a simple one visible in the greater number of corpuscles. Among the above-named

elements, bodies are frequently seen which appear as free nuclei. I have not unfrequently observed in the blood of the human splenic vein, as in that of the horse, large, round, or oblong bodies, with distinct, sharp outlines, presenting the appearance of a coagulum, and containing in their interior colourless blood-corpuscles and nuclei, in some few instances likewise coloured blood-corpuscles; such bodies are represented in the right upper quarter of the drawing. Whether these are to be regarded as "cells containing blood-corpuscles" I cannot decide, although I am inclined to doubt it, as I have never, with certainty, observed that they had a cell-membrane. Among the colourless blood-corpuscles are a few colourless "granular cells," that is, large, round cells, which contain, in their interior, a number of small, round, powerfully refractive granules soluble in acetic acid.

PLATE X.

Fig. 1. BLOOD-CRYSTALS, FROM NORMAL HUMAN VENOUS BLOOD, obtained by venesection from an elderly man.

After I had discovered the peculiar crystalization of the *albuminous* contents of red blood-corpuscles in combination with their colouring matter, in the first instance in blood from the splenic vein of the horse, I also succeeded in effecting the crystalization of human blood. Kunde had at the same time followed up my previous observations, and had likewise remarked the crystalization of human blood; further, Kunde and myself have proved, by means of an extended investigation of the blood of various animals, the correctness of the principle first put forward by myself, that all blood is capable of crystalization, whatever animal or organ it may be taken from. The following is the simplest mode of observing this phenomenon, and essentially the same method may be used with all kinds of blood.

A drop of human blood (it is better to use blood which has been kept a day, although freshly drawn blood will sometimes answer) is allowed to evaporate upon a glass plate, a drop of distilled water is then added, and the whole covered with a bit of thin glass; after a time, when the water has to some extent evaporated, regular, red-coloured crystals, such as those represented, are observed, of various sizes and forms, some larger,

rod-shaped and columnar, some smaller, distinctly prismatic, and others resembling rhombic plates.

Fig. 2. Blood Crystals, from the heart-blood of a young cat.

The crystals were obtained by the addition of water to blood which had been kept a day, as above described. Some of the crystals are very large, perfectly regular, more or less intensely cherry-red coloured and columnar, grouped together in places in the form of bru hes, others appear as a compact network of acicular crystals, mostly delicate, long, and violet-coloured (at the right, lower margin). At the upper part of the drawing the crystals are covered by clusters of distorted, corrugated, and empty blood-corpuscle envelopes, such as are observed after evaporation at those points of the preparation where the most dense layers of blood-cells had been situated. At the left, lower side, detached crystals are seen in a more yellow coloured mother liquor, with small spherical blood-corpuscles. Such spots are frequent at the edges of the preparation, where the atmospheric air has freer access; the entire object is often surrounded, parallel to the borders of the covering plate, with a yellowish-red streak, where the blood-corpuscles always appear much reduced in size, pale yellowish red, often spotted, and partially mixed with irregular, scaly, incipient crystals.

Fig. 3. Blood-Crystals, from blood taken from the jugular vein of the guinea pig.

These regular tetrahedrons, described by Lehmann and Kunde, and certainly identical with the "albuminous crystals" previously described by Reichert, as obtained from the uterus of pregnant guinea pigs, are formed with remarkable readiness from the blood taken from any vessel of this animal, even on spontaneous evaporation without the addition of water. It generally happens that all the blood-corpuscles are converted into crystals, which when rapidly formed, are small, pale, yellowish-red tetrahedrons, and when the evaporation is more gradual, are larger and of an intense, purple-red colour. Besides, the tetrahedrons, derivative forms are sometimes produced.

Fig. 4. Blood-Crystals, from blood taken from the jugular vein of the squirrel. (*Kunde, Lehmann.*)

They appear principally as large heaps of regular, six-sided

plates, together with which are prismatic crystals, oftentimes grouped in stellar druses and lying upon the plates.

Fig. 5. Blood-Crystals, from blood taken from the heart of a fish. (*Leuciscus Dobula*).

The small scaly crystals, represented on the left margin of the drawing are, according to my observations, formed within the envelopes of the blood-corpuscles; the nucleus of the cells may be distinctly recognised in some instances as a hemispherical convexity upon the lateral edge. When water is added to such preparations, the scales are immediately converted into nucleated blood-discs, the crystal within the envelope dissolving and filling it; such regenerated blood-corpuscles are represented in the lower left corner. Besides these, very compact reticular masses of small and large acicular crystals and columns are formed. At the margin of the preparation, dense palisade-like patches of larger prisms are generally formed, such as are represented at the lower part of the drawing.

Fig. 6. Blood-Crystals, from normal human blood of the splenic vein.

Here, as in blood from the splenic vein of the horse, together with the prismatic crystals which are here also arranged like palisades at the upper margin of the figure, there are *rhombic plates* of two kinds, distinguishable from each other by their angles; the one very pale, delicate, and almost rectangular plates (the acute angle, 88° 30′) lying in heaps like cholesterin; the other more detached darker-coloured plates, with more acute angles (the acute angle, 73° 23′); they frequently appear as if full of cavities, and their edges seem as if broken in some places.

PLATE XI.

Fig. 1. Human milk from a healthy lying-in woman eight days after delivery.

The round, brilliant milk-globules are of various sizes; however, the larger ones are on the average more rare, as may be seen in the drawing. When a drop of milk is treated with dilute acetic acid, under the microscope, the albuminous envelopes of the globules are dissolved. The enclosed fat escapes,

and the adjoining drops partially run together, giving rise to the forms represented at the upper and left part of the drawing.

Fig. 2. HUMAN MILK, COLOSTRUM, from a healthy lying-in woman twelve hours after delivery.

Besides the true milk-globules, which are less abundant, but larger in the first milk than in that of later periods, it contains the so-called *colostrum-corpuscles*, that is, variously sized, round conglomerates of fine fat-molecules, aggregated together by means of a hyaline (albuminous) substance. They are generally bounded by distinct, round outlines, without, however, a separate enveloping membrane being recognisable. They frequently lie in large clusters, mixed with variously sized milk-globules, as in the upper part of the drawing. The true milk-globules are likewise frequently met with in colostrum, aggregated into clusters, as is shown somewhat to the left of the centre of the drawing.

Fig. 3. PUS, from an acute abscess of the forearm, resulting from a bruise.

The lower half of the drawing shows the normal *pus-corpuscles* as pale, round, faintly granulated vesicles of various size, in a good many of which, a simple, round, eccentric nucleus may be seen through the envelope, while some present a nucleus separated into several divisions. As is shown in the drawing, some of the cell-like bodies are distinctly bounded by sharp lines, while others present only indistinct, and, as it were, blended outlines; the surface likewise is in some instances darkly, in others faintly granulated. The upper half of the drawing shows the action of acetic acid upon the pus-corpuscles. They swell up, their surface becomes smooth, and so translucent that the outlines are scarcely to be distinguished; the nuclei, on the other hand, become distinctly perceptible, the various formations of which are represented in the drawing, and to which the description already given of the colourless blood-cells, with which they are morphologically identical, will apply.

Fig. 4. PUS-CORPUSCLES, treated partly with water, and partly with a concentrated solution of sulphate of soda.

The left half of the drawing shows pus-corpuscles from a simple pustule of the skin, greatly distended in consequence of

the addition of water, extremely pale, and with very delicate edges; their nuclei, generally simple and eccentric, are distinctly visible; in some instances small, dark, speck-like molecules are likewise perceptible. The right half of the drawing shows pus-corpuscles from the same source, greatly contracted by means of a solution of sulphate of soda; they are angular, uneven, jagged, distinctly granulated as if covered with grains, and present no visible nucleus.

Fig. 5. Pus in a state of acid fermentation. Pus from a large spontaneous abscess, after having been kept for two months in an air-tight vessel containing one-third its volume of air.

Numerous white specks and granules were formed in this pus, which had an acid reaction; when examined by the microscope, they proved to be crystals of fat and fatty acids. Besides a few small and partially broken plates of cholesterin, variously sized grass-like bunches of ensiform or lily-leaf-shaped crystals of margaric acid, long, and generally isolated, lozenge-shaped laminæ of stearic acid, and delicate needles of magarine, in large, dense tufts, partly united at their bases, forming double tufts (like the lactate of lime,) and partly arranged in stellar groups. The pus-corpuscles are, for the most part, still present, but have very faint outlines; many are filled with small, dark, brilliant granules (fat), besides which, numbers of free nuclei, along with fine molecular substance, present themselves.

Fig. 6. Mucus, (sputa from inveterate bronchial catarrh,) treated with dilute acetic acid.

The precipitation of mucus, in whitish threads and shreds, on the addition of this acid to gelatinous sputa, presents, under the microscope, the appearance represented. The coagulum consists of delicate, punctiform, molecular granules, which, in consequence of their linear arrangement, present the appearance of pale granulated threads and fibres, running parallel to each other, or, as at the left side, form sharply-bounded, granulated, and longitudinally striated membranes. Similar threads, which have frequently been confounded with other structures, are often formed in sputa, even on simple treatment with water (saliva) or with alcohol and dilute mineral acids.

Upon the threads and membranes, partly also imbedded in them, lie the manifold nuclei of the mucus-corpuscles, exposed by means of the acetic acid.

PLATE XII.

Fig. 1. SPUTA, FROM CHRONIC LARYNGITIS.

The slate grey-coloured sputa, consisting of small, pearl-shaped globules, present an enormous quantity of the so-called *inflammation-globules*, (granular cells, corps granuleux,) precisely analogous to the colostrum-corpuscles. They are of various sizes, round or oblong; some appear as extremely dense, almost opaque, dark conglomerates, of fine, mixed with somewhat larger, elementary granules, with dark outlines (lower part of the figure); others contain such granules in a more isolated manner, and imbedded in an apparently hyaline medium. The larger of these granules appear distinctly as globules of fat. Others again of the above conglomerates present only very fine, pale granules, or large, dark grains, which appear as if they contained colouring matter (left side). They do not all present distinct, sharply defined outlines. They are mixed with a tolerable number of mucus-corpuscles of various sizes, pale, but with distinct outlines, further a few free nuclei, some oblong granules with faint concentric striæ (Hassal's?) and detached drops of fat.

Fig. 2. SPUTA (RUST-COLOURED) OF SEVERE RECENT PNEUMONIA.

The most remarkable constituents are the yellow blood-corpuscles, which communicate the rust colour. They appear as flat, round, oblong, angular, and variously distorted discs or lenses without any central depression, forming rows of various length by junction at the *edges*,—an almost constant character in pneumonia; the cells never adhere together by their surfaces. Besides these, there are numerous mucus- or pus-corpuscles of different kinds, aggregated together in clusters by means of a pale, finely-granulated, molecular mass, resembling a coagulum; some of them present distinctly visible nuclei, and among them are a few larger, very granular, round bodies, resembling the inflammation-globules (upper part of plate) and detached bodies.

Fig. 3. SPUTA OF A SUBSEQUENT STAGE OF A PROLONGED PNEUMONIA.

Beautiful detached granule-cells and clusters of granules similar to those described in Fig. 1., but generally containing large, brilliant granules of fat; also numerous forms of pus-corpuscles and a few globules of fat, which require no further explanation. The threads projecting inwards from the right margin, and the structures with rows of nuclei, visible in the middle towards the bottom, are confervæ in a state of development, such as are frequently produced in sputa exposed for some time to the air.

Fig. 4. URINARY DEPOSIT, CONSISTING OF CRYSTALS OF URIC ACID, FROM THE URINE OF A MENSTRUATING GIRL SUFFERING FROM ACUTE RHEUMATISM.

Besides the yellowish-brown coloured, rhombic plates, as well as the tub and hone-shaped crystals of uric acid, which are mostly arranged in groups and druses, and represent the most usual forms of uric acid sediment, so often presenting the aspect of a granular sand of a golden lustre—a great number of distinctly yellow-coloured vesicular-shaped and distended blood-corpuscules, of very different sizes, are perceptible.

Fig. 5. URINARY DEPOSIT, CONSISTING OF URIC ACID.

Fan-shaped aggregates of tabular crystals of uric acid, rather less often met with in urinary deposits.

Fig. 6. URINARY DEPOSIT, CONSISTING OF URIC ACID, URATE OF SODA, AND OXALATE OF LIME, FROM THE URINE OF A PATIENT RECOVERING FROM TYPHUS FEVER.

The large, dense tufts, united in pairs at their bases, and composed of innumerable, long, narrow, hone-shaped crystals, generally colourless, represent a mode of occurrence of uric acid in sediments, which is not very unfrequent. The fine, brilliant crystals of oxalate of lime, in the shape of letter envelopes, have already been explained. (Plate I. Fig. 1.) The small, roundish, and angular, dark granules, partly detached and partly lying together in irregular groups and clusters, consist of urate of soda, which always presents itself in this molecular form in urine. (See following Plate).

PLATE XIII.

Fig. 1. URINARY DEPOSIT OF URATE OF SODA FROM THE MORNING URINE PASSED BEFORE TAKING FOOD BY A PERSON AFFECTED WITH TUBERCULES.

The ordinary whitish, yellowish, or brick-coloured deposit which is formed in concentrated acid urine upon cooling (especially in febrile states), consists almost exclusively of urate of soda in molecular granules. When rapidly separated, these granules are very fine and generally arranged in the moss-like groups represented. Mixed with these, a few epithelial cells from the bladder sometimes present themselves, generally much granulated or wrinkled, and when the urine has been kept for some time, a few fermentation fungi. (See Fig. 4.)

Fig. 2. URINARY DEPOSIT, CONSISTING OF URATE OF SODA, PHOSPHATES, AND COAGULATED MUCUS, EXAMINED AFTER THE URINE HAD BEEN KEPT FOR THREE DAYS.

The urate of soda is here deposited in far larger, dark granules and larger clusters than in the previous instance. The uniformly granulated, membranous structures represented in the centre of the drawing are fragments of the film of amorphous earthy phosphates, with which decomposing urine frequently becomes covered when exposed to the air. The narrow and broad waving streaks, consisting of extremely fine specks and granules, arranged in rows, are mucus-coagulum; they are not unfrequently met with in acid urine, and might easily be confounded with the casts from the tubules of the kidney to be mentioned hereafter. Besides these, fermentation-fungi are likewise present, partly united in rows and plates (as at the lower side), and a few granulated mucus-corpuscles.

Fig. 3. URINARY DEPOSIT, CONSISTING OF TRIPLE PHOSPHATE CRYSTALS AND NUMEROUS MUCOUS CORPUSCLES, FORMED IN RECENTLY EVACUATED, TURBID URINE WITH AN ALKALINE REACTION, FROM A PERSON AFFECTED WITH CATARRH OF THE BLADDER.

The crystals of ammonio-magnesian phosphate present various forms, but may always be recognised without the aid of crystalographic or chemical analysis. The mucous-corpuscles are rather small, much contracted and granulated, generally united by their edges into large mail-like groups.

Fig. 4. URINARY DEPOSIT, CONSISTING OF URATE OF SODA, URIC ACID, AND FERMENTATION FUNGI, FROM URINE WHICH HAD PASSED INTO A STATE OF ACID FERMENTATION.

Every normal urine, and almost every abnormal acid urine, suffers the acid fermentation when kept for a sufficient time. As the acid reaction becomes stronger, small, nucleated, fermentatation fungi are formed in the liquid; these propagate by budding, and thus give rise to simple and branched rows of cells, such as are represented. Meanwhile the uric acid is gradually separated in yellow-coloured crystals of the various, simple shapes represented, from the urate of soda present in its usual form. Small octohedral crystals of oxalate of lime are not unfrequently met with, as at the upper and right side of the drawing.

Fig. 5. URINARY DEPOSIT, CONSISTING OF TRIPLE PHOSPHATE CRYSTALS AND URATE OF AMMONIA, FORMED IN URINE IN A STATE OF ALKALINE FERMENTATION, FROM A PERSON WITH PARALYSIS OF THE LOWER EXTREMITIES, IN CONSEQUENCE OF A SPINAL AFFECTION.

The crystals of triple phosphate present the most usual forms met with in decomposed urine. The urate of ammonia separates at first in the form of fine molecules, from which dark-coloured, strongly refractive spherules are gradually formed, which afterwards become covered with acicular points, resembling thorn-apples.

Fig. 6. URINARY DEPOSIT, CONSISTING OF TRIPLE PHOSPHATE CRYSTALS AND URATE OF AMMONIA, FORMED IN URINE PERFECTLY DECOMPOSED BY LONG EXPOSURE TO THE AIR.

The large, finely-developed crystals of ammonio-magnesian phosphate require no explanation. The large, drusy conglomerates, composed of small, club-shaped, curved bodies, are an unfrequent form of urate of ammonia, resulting from very gradual formation.

PLATE XIV.

Fig. 1. URINARY DEPOSIT, WITH EPITHELIAL CASTS AND NUMEROUS EPITHELIAL CELLS, TAKEN, BY MEANS OF THE CATHETER, FROM THE BLADDER OF A TYPHOID PATIENT AFTER DEATH.

The cylindrical casts consist of the epithelial lining of the tubes of Bellini, the round, nucleated cells of which are distinctly

visible through a delicate molecular mass. The detached, club-shaped, caudate, fusiform, and nucleated, epithelial cells come from the ureters, the pelvis, and calices of the kidney.

Fig. 2. URINARY DEPOSIT, WITH TRANSLUCENT TUBULAR BODIES, CYSTIC EPITHELIUM, AND MUCOUS CORPUSCLES, FROM A PERSON SUFFERING FROM ACUTE, MILIARY TUBERCLES.

These cylindrical casts, somewhat less frequently met with than the former, are so translucent and homogenous that they are with difficulty distinguishable from the surrounding liquid. In the present instance they are more evident in places, from being filled with small granules of urate of soda (?); the ends of some are distended in the shape of a flask. Roundish, oblong, or polygonal cells of tesselated epithelium, from the bladder, most of them distinctly nucleated, are likewise present, together with strongly granular mucous corpuscles.

Fig. 3. URINARY DEPOSIT, CONSISTING OF FIBRIN CYLINDERS, BLOOD- AND PUS-CORPUSCLES AND EPITHELIAL CELLS, FROM THE ALBUMINOUS URINE OF A TYPHOID PATIENT.—The post-mortem examination showed the existence of considerable inflammatory infiltration of the cortical substance of the kidneys.

The cylindrical bodies, consisting of an apparently granulated molecular mass, are fibrin coagula (croupy exudations) from the tubes of Bellini, of which they represent moulds. A few contain blood- and pus-corpuscles within their mass; these are also present in tolerable quantity in a detached state: the blood-corpuscles are mostly distended into a vesicular shape, though some present distinctly visible central depressions. The bipolar epithelial cells have already been described. (Fig. 1.)

Fig. 4. URINARY DEPOSIT, CONSISTING OF YEAST FUNGI AND CONFERVÆ FORMED IN THE URINE OF DIABETES MELLITUS AFTER EXPOSURE TO THE AIR FOR EIGHT DAYS.

The large yeast-fungi, in a state of abundant propagation by means of off-shoots, are identical with the mycoderma cerevisiæ, but differ in size from the small fermentation-fungi formed in the acid fermentation of urine. (Plate XII. Fig. 1—4.) They are constantly generated during the alcoholic fermentation of saccharine urine. Their form is somewhat oblong, sometimes round, their size variable; all possess a distinct round nucleus,

frequently appearing like a hole. The bifurcating threads of confervæ, containing spores, often form so dense a mass as to hide the entire field of view.

Fig. 5. URINARY DEPOSIT OF CARBONATE OF LIME, FORMED IN THE ALKALINE URINE OF A RABBIT, ON EXPOSURE TO THE AIR.

The carbonate of lime always separates from the urine of the rabbit in the various modifications of the so-called dumb-bell shape represented in the drawing. Shortly after evacuation only the small, biscuit or drum-stick shaped shining bodies, such as are represented especially at the right and left sides of the drawing, are seen; some of them still distinctly show their formation from two rhombohedrons placed vertically above each other (as at the lower margin); many are arranged in rosette-shaped groups. The longer the urine is kept, the larger and more complicated are the forms which make their appearance, resulting mostly from secondary deposition upon the originally formed dumb-bells. Siegmund has given a special crystalographic analysis of these crystaline formations. (*Arch. f. path. Anat.* iv., 505.)

Fig. 6. CONTRACTILE FIBRE CELLS (SMOOTH MUSCULAR FIBRE) FROM THE MUSCULAR COAT OF A PIG'S STOMACH, TREATED WITH VERY DILUTE HYDROCHLORIC ACID AND NITRIC ACID.

The action of extremely dilute hydrochloric acid upon portions of organic muscular tissue teased out as finely as possible, is represented at the lower and left side of the drawing. The substance of the fibre swells up, and becomes so translucent that it can only be recognised by means of a few faint longitudinal striæ and rows of specks in connected fibres, and scarcely at all in such as are quite detached. On the other hand, the long, fusiform, mostly crescentic, or even slightly S-shaped nuclei become distinctly prominent. Nitric acid causes the fibres to contract and gives them a yellow colour (right and upper part of the figure). Connected groups present sharp, dark longitudinal lines, variously curved, the boundaries of the individual fibre-cells, and a granulated appearance in some places as if creased. Isolated fibre-cells acquire very marked outlines under the influence of nitric acid, frequently a spiral or zigzag curvature at their ends, and a granulated surface without any perceptible nucleus.

PLATE XV.

Fig. 1. Striated Muscular Fibre (from the adductor muscles of the rabbit), treated with acetic acid.

The primitive bundles (*fibres*) swell up considerably in acetic acid, become so pale and translucent that their transverse striæ often appear only as indistinct shadows; the latter diverge in consequence of the distention, and run continuously from one edge to the other, in some places crossing those on the lower surface which are seen through the substance of the fibres; at some of these transverse striæ the fibres split across; sometimes the envelope of the bundle bursts at some point, and the superimposed transverse discs protrude (upper part of plate). No traces of longitudinal striation are seen. The nuclei of the fibres are distinctly evident; they are partly round, more frequently oblong, spindle-shaped, with distinct nucleoli, and are situated mostly in longitudinal rows at both sides of the fibre, although likewise in the middle and without invariable uniformity.

Fig. 2. Striated Muscular Fibre (from the same source), treated with concentrated nitric acid for seven hours.

The intensely lemon-yellow coloured primitive bundles (*fibres*) present different appearances. Most of them, like that projecting inwards from the lower margin of the figure, have remarkably sharp, dark, transverse striæ extending continuously over the fibres, no perceptible longitudinal striation, and divide at these transverse striæ into paralleopipeds, which appear to be composed of a variable number of discs or bands placed one above the other (left side); besides these fragments, a single detached disc is often met with in the liquid, as shown in the centre of the drawing. In some fibres, however, the transverse striæ are less prominent, while a distinct, delicate, and in some places well marked, longitudinal striation is perceptible; thus, for instance, the fibre projecting inwards from the right margin appears as a bundle of parallel, curled or wavy fibres, perfectly homogeneous, and only towards the lower part crossed by a delicate and apparently superficial, transverse striation.

On the other hand, in the bundle situated next below this, the unconnected end has distinct transverse striæ, and at the right margin is even split or torn transversely in places; towards the lower part, however, these transverse striæ become finer, and less distinct, and disappear at last, while evident longitudinal fibres become visible, crossed at the right margin by the transverse lines. When the action of the nitric acid is continued for a longer time, both the transverse and longitudinal striæ disappear in some of the fragments, or are indicated only by points arranged in rows; the edges likewise become indistinct, as is shown near the right, upper margin and above the centre of the drawing.

Fig. 3. STRIATED MUSCULAR FIBRE (FROM THE SAME SOURCE), TREATED WITH HYDROCHLORIC ACID FOR FOUR HOURS.

The primitive bundles, which in a normal condition, are rather flat, swell up like a jelly, and assume a more cylindrical form, as may be distinctly seen at the free ends. They all split up transversely into variously sized fragments; the fibre running upwards from the lower margin of the figure shows fissures passing inwards from the right edge at regular distances, and is in a state of progressive disintegration. At the right side of the drawing, fibres are represented which split up at their ends into discs, corresponding to the transverse striæ, in a manner precisely similar to those treated with nitric acid. With regard to the transverse and longitudinal striæ, the former are distinct and sharp in some fibres, (as at the left upper margin) and more particularly marked in some places. However, I found the greater number of fibres always shaded by an extremely delicate, pale, longitudinal striation, while the transverse striæ were more or less imperceptible. The longitudinal striæ generally do not form continuous lines, but appear as pale, delicate rows of points, resembling granules, and coarser in some parts, as is particularly shown in the middle lower fibre. A few detached parallelopipeds appear quite homogenous, and shaded only at the edges.

Fig. 4. STRIATED MUSCULAR FIBRE (FROM THE SAME SOURCE), DIGESTED FOR FOURTEEN DAYS WITH A SOLUTION OF NITRATE OF POTASH (10 PER CENT.).

In these fibres transverse and longitudinal striæ are com-

bined in the following manner. In some fibres (as that projecting inwards from above) the transverse striæ are distinct and tolerably dark; the striæ, however, do not form continuous, but interrupted lines. This interruption is very frequent and regular, (in the lower fibres,) while at the same time distinct longitudinal lines present themselves, so that the bundles appear composed of several longitudinal fibres, each of which is transversely striated. In some places, transverse striation can no longer be detected, but only transverse rows of points, which are situated so exactly above each other in the longitudinal direction, that the fibres also appear to be composed of longitudinal rows of points. The transition of the continuous transverse striæ into this latter appearance is most distinctly visible in the primitive bundle projecting inwards from the right margin. The free ends of the lower fibres explain these optical appearances; they are obviously split up into their primitive fibrils, each of which presents an independent transverse striation, as is the case with perfectly fresh muscular fibre, although less distinctly visible. A breaking up of the free ends into transverse discs is very rarely observed in muscular fibre treated in this way. The fibre at the left side of the drawing presents a few irregularly curved lines, which result from rents in the sarcolemma.

Fig. 5. Nervous Fibres from the sciatic nerve of a recently killed rabbit; treated with water.

The originally homogenous nerve-cylinders present, on the addition of water, distinct, sharply-defined, double outlines; the contents present a faintly granulated appearance, and in the middle, the cylinder-axis appears as a pale streak with parallel edges, in the most evident manner. At the free, compressed ends, and at some torn places elsewhere, the nervous pulp escapes in variously shaped drops (in which the cylindrical axis is sometimes continued), as is shown in the centre of the drawing.

Fig. 6. Nervous Fibres (from the same source), partly boiled with absolute alcohol alone; partly with alcohol, and then with acetic acid; and partly with alcohol and nitric acid.

The fibres represented upon the left half of the drawing have

been boiled with alcohol alone. The sheath appears in most instances as a distinct membrane detached from the contents and swelling out in places. The contents present the appearance of numerous larger and smaller granules more or less dark, through which the cylinder-axis is here and there distinctly visible. In some of the fibres the latter projects from the ends, and frequently appears perfectly isolated between the fibres. The fibres projecting inwards from above have been treated with alcohol and acetic acid; they appear as if plicated, wrinkled, or granulated, the cylinder is likewise, in some instances, evident in the fibres, in others it projects from their ends. The fibres at the left margin of the drawing have been treated with cold concentrated nitric acid after being boiled with alcohol. By this method I frequently observed the sheaths with very faint outlines, but distinctly separated from the coagulated, yellowish-coloured, albuminous contents.

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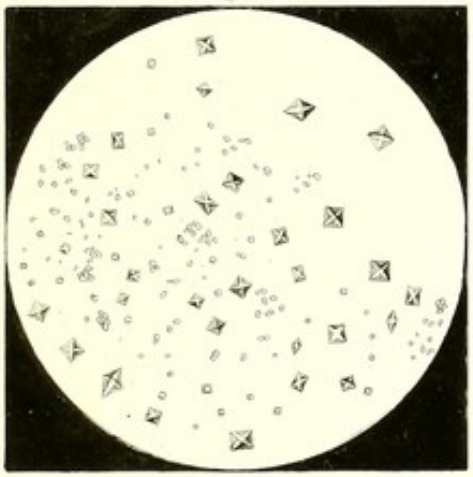

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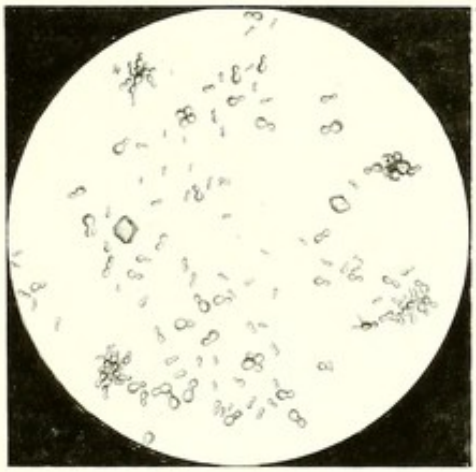

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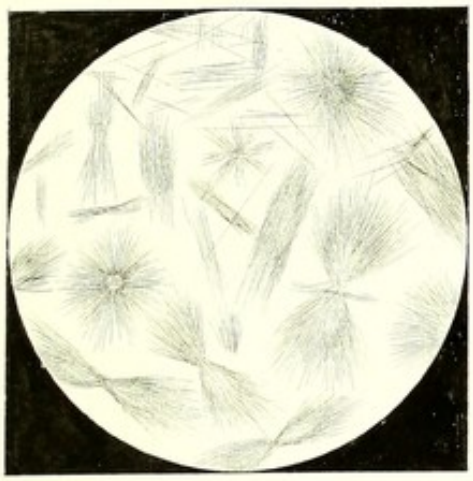

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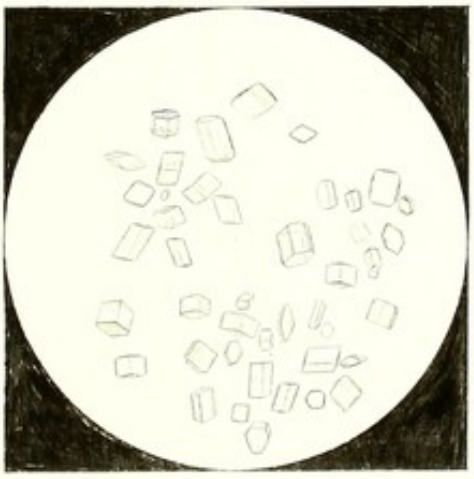

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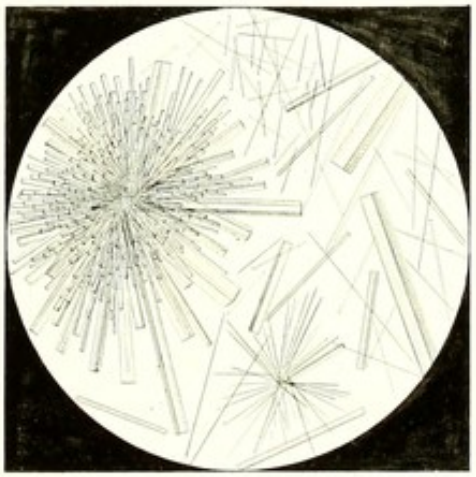

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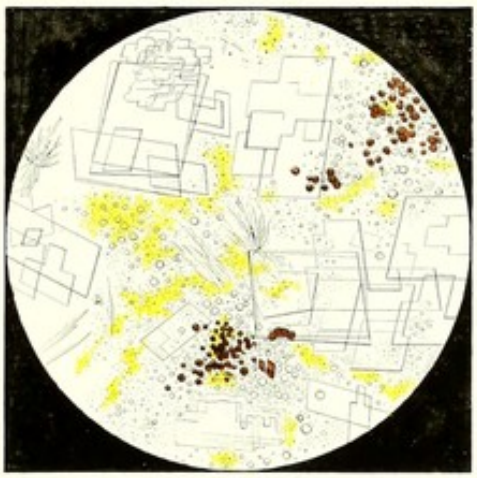

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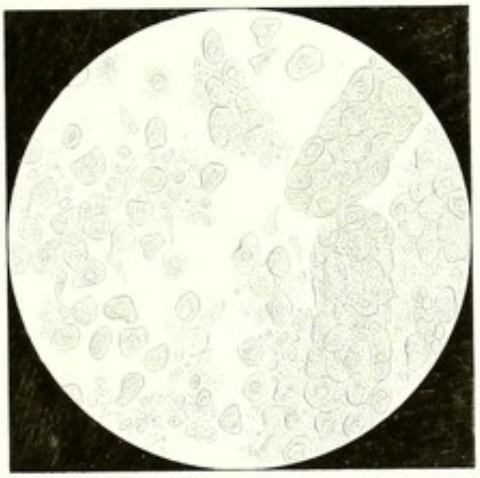

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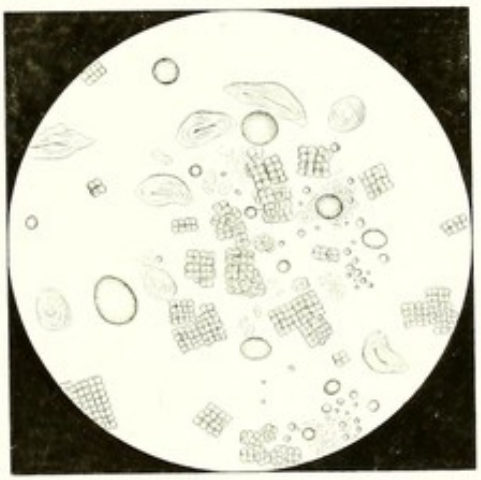

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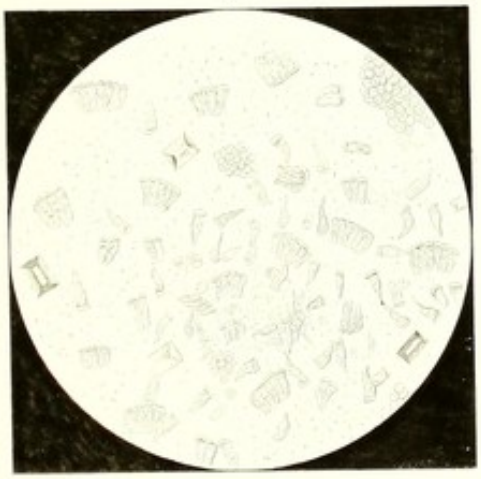

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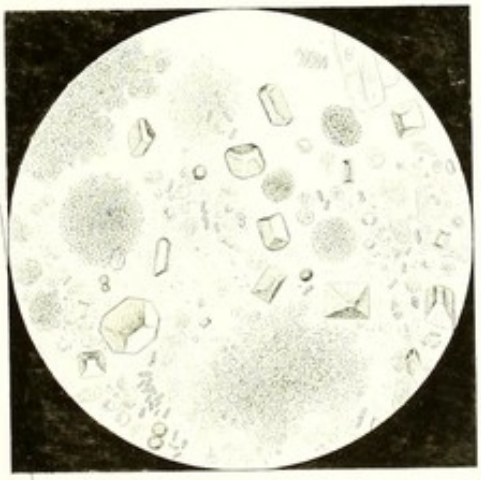

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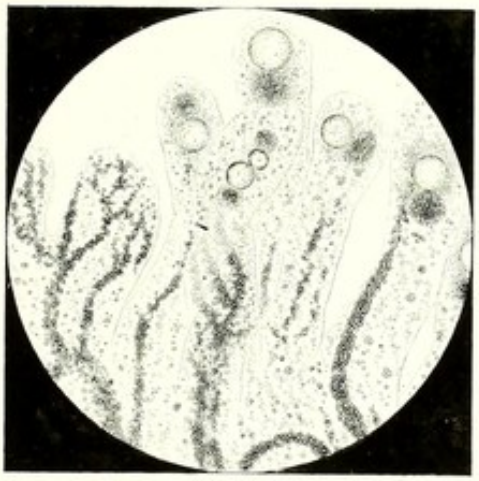

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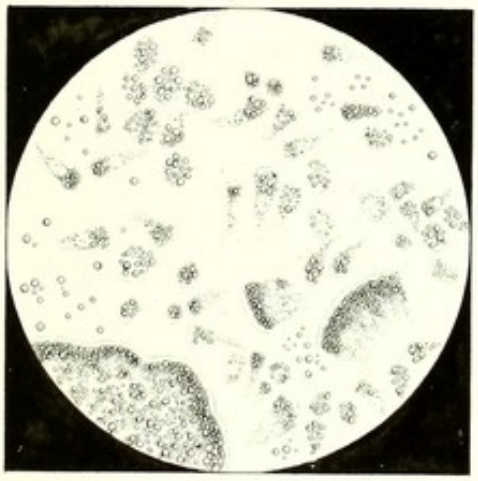

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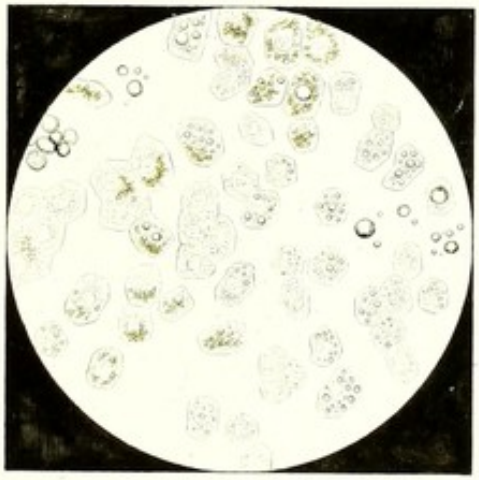

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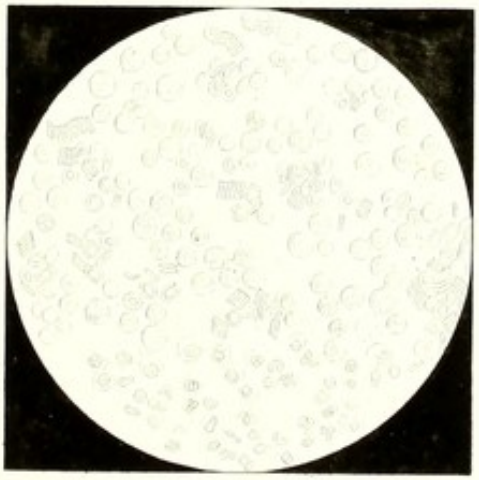

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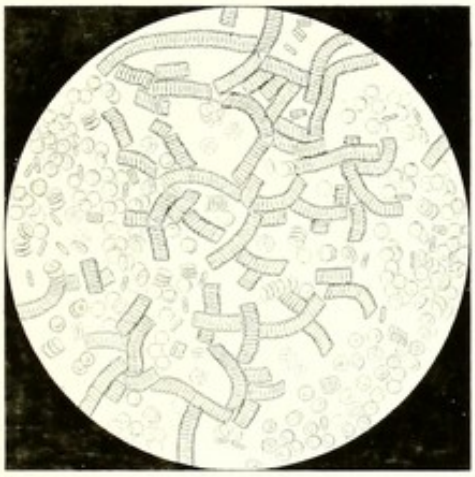

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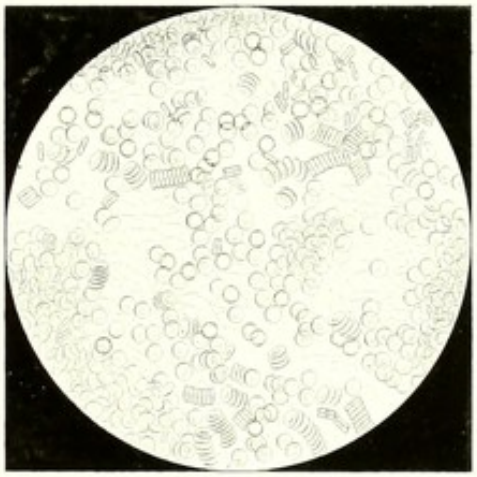

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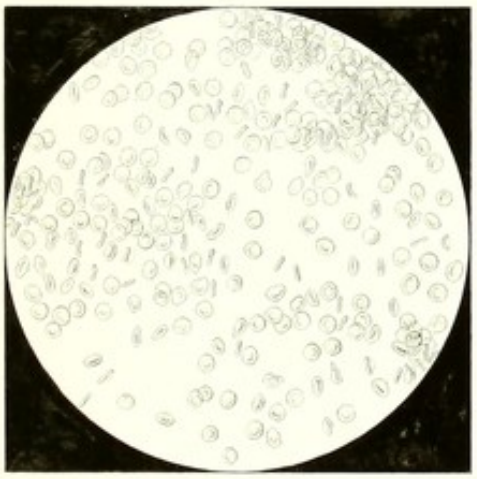

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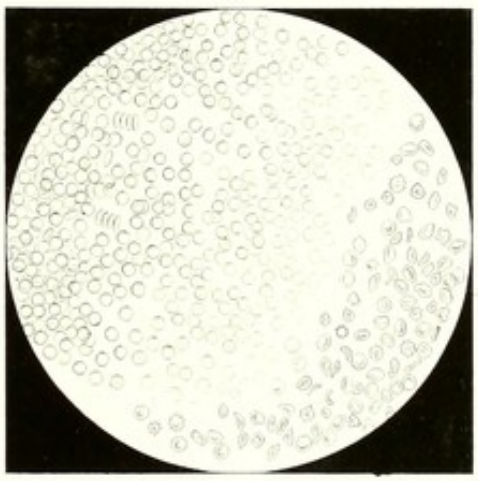

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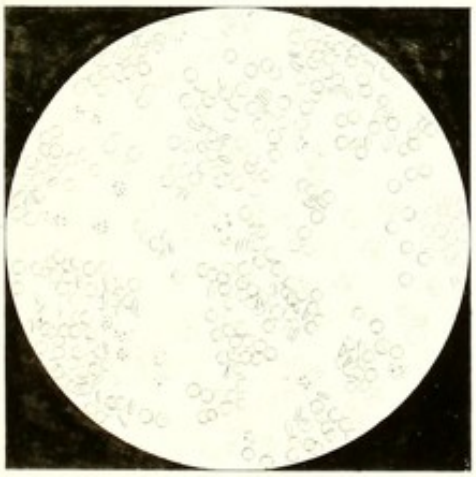

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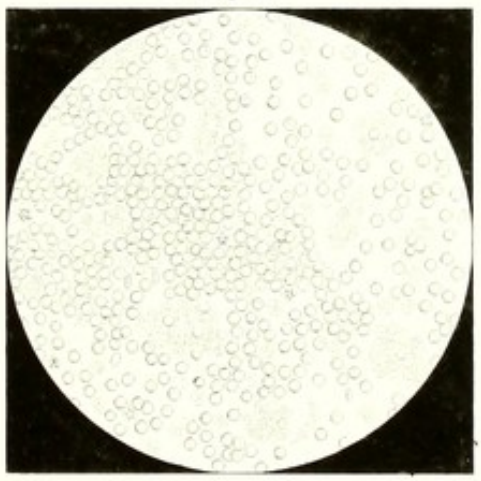

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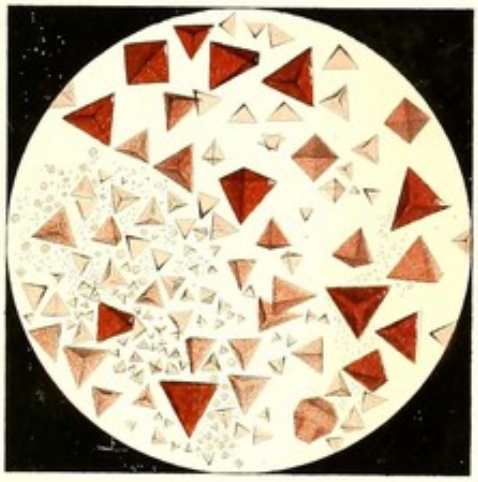

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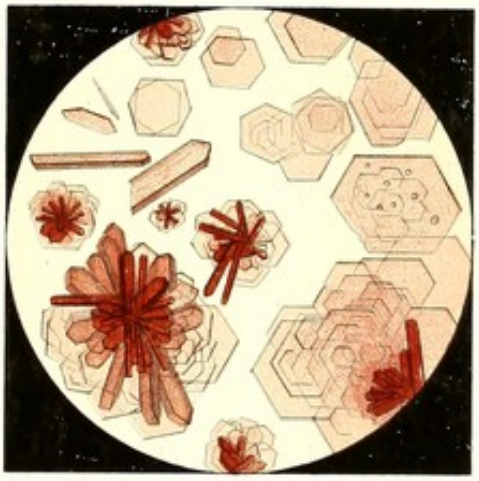

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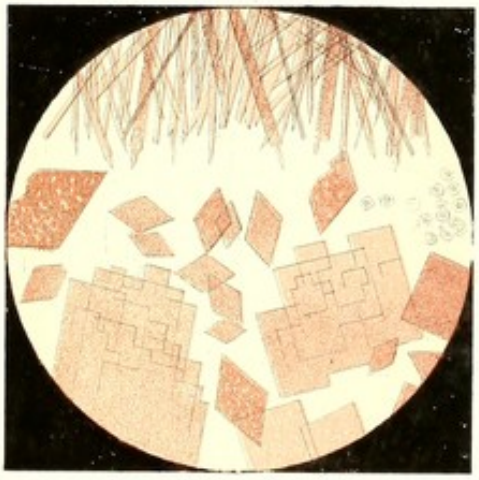

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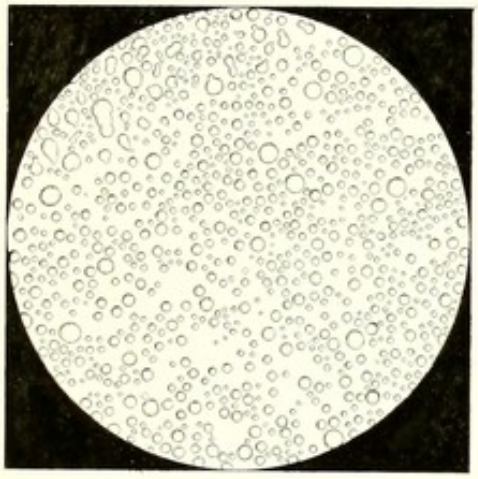

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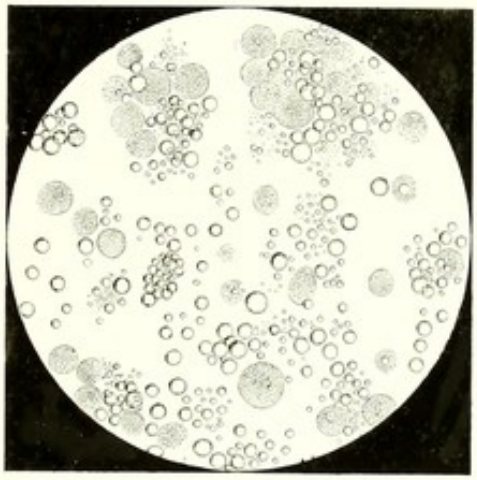

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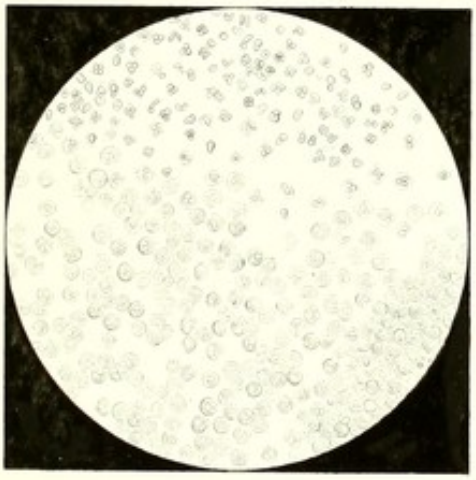

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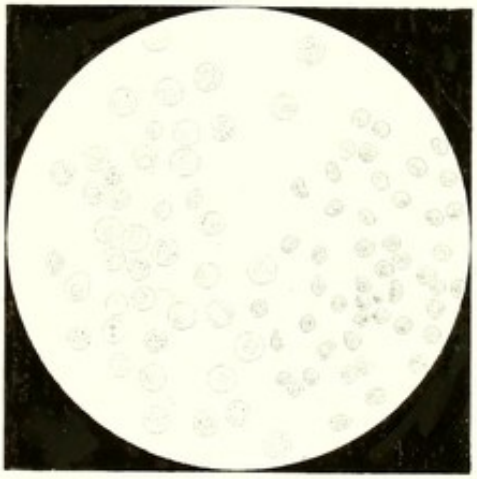

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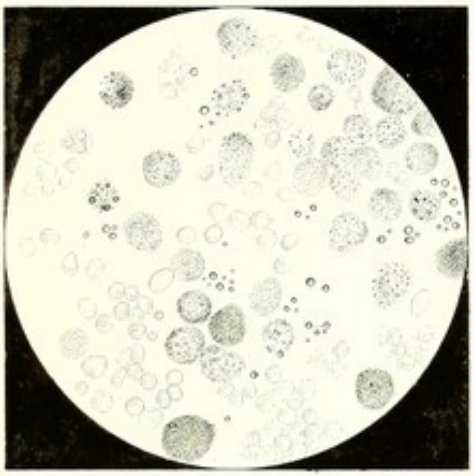

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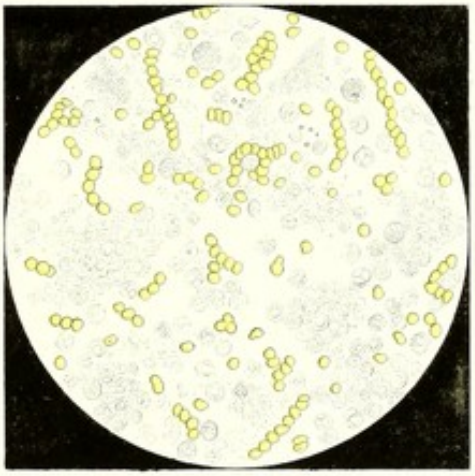

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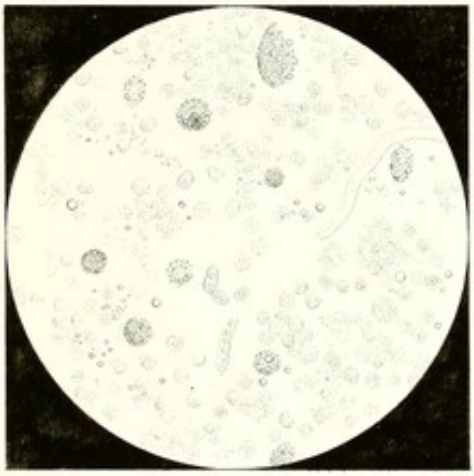

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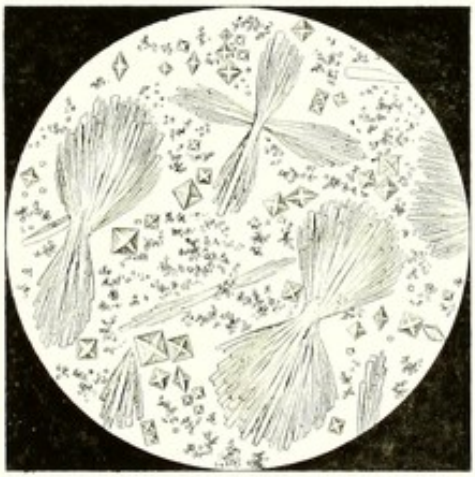

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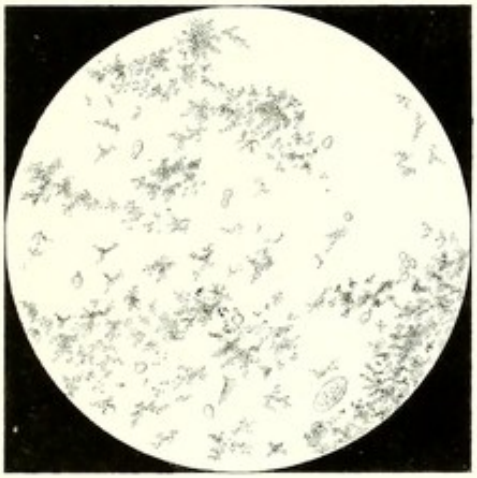

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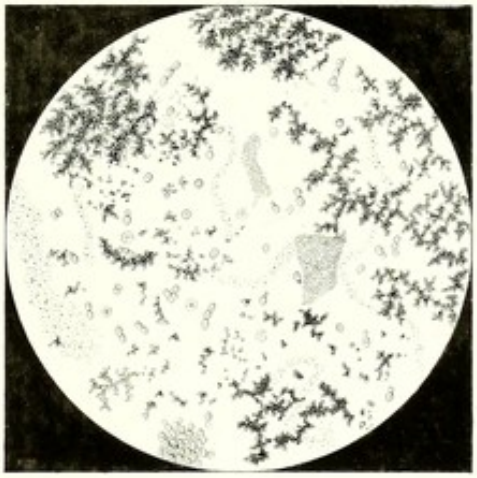

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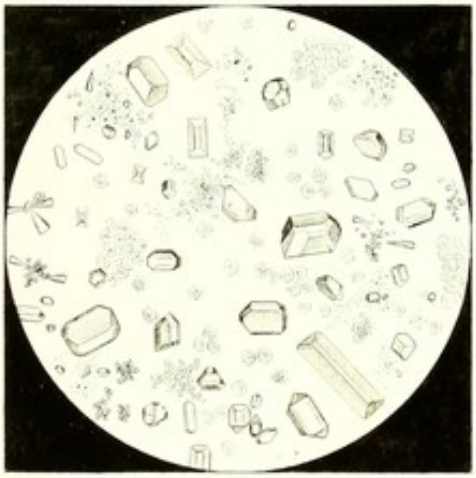

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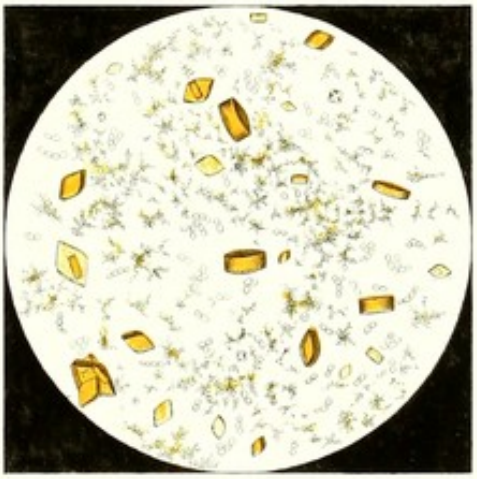

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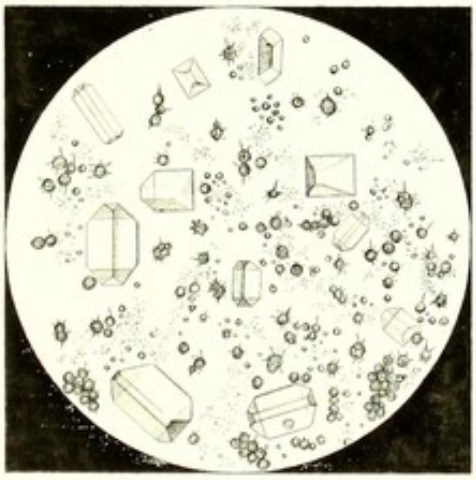

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Fig. 1.

Fig. 2.

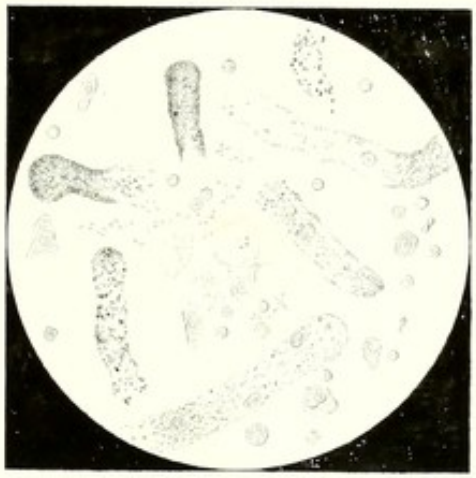

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

a d. Nat. gez. v. D^r O. Funke.

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Lith. Anst. v. Emil Wilhelmi in Leipzig.

Fig. 1.

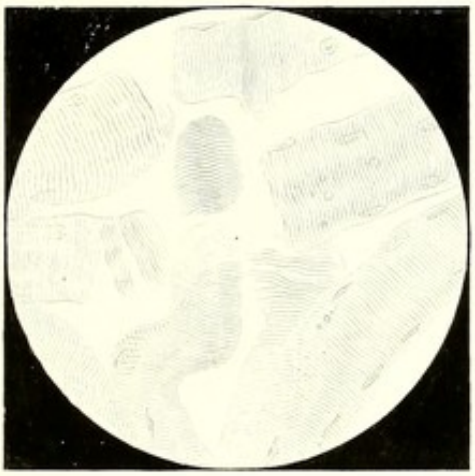

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

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