ART. IV.—*On the Cause of the Milky and Whey-like appearances sometimes observed in the Blood.* By ROBERT CHRISTISON, M. D., Professor of Medical Jurisprudence and Police in the University of Edinburgh, &c.

IN our present state of ignorance as to the chemical pathology of the human fluids, every addition to our knowledge, more especially of the pathological states of the blood, must be a subject of interest, although its precise bearings on physiology and medical practice may not at first be apparent. Within these few years several interesting additions have been made to this department of medical knowledge, which have admitted of very direct and important practical applications. No one who is acquainted with the researches of Drs Marcet, Prout, Bright, and Bostock, will be inclined to doubt the practical utility of pathological chemistry. On the contrary, he will rather regret that so few physicians carry with them from the schools the knowledge of the details of organic chemistry, which is requisite for carrying on this kind of investigation.

It is not easy to say what are the relations which the addition to be made in the present paper to the pathological history of the blood may have to physiology or the practice of medicine. The state of the serum which I propose to investigate is, in its minor degrees, not uncommon. But the circumstances in which it occurs have not hitherto been often enough observed to justify any pathological or physiological inferences. The facts, however, appear to me too interesting not to deserve being recorded. I must therefore be content with simply making them public, and directing the physician's notice to an easy method of chemical investigation in all cases of the kind.

In the last number of the Edinburgh Medical and Surgical Journal, some observations have been made for the purpose of illustrating a case communicated by a correspondent, where the serum of human blood presented, when recently drawn, the appearance of milk. The author of the observations appended to the case has quoted several parallel instances from the experience of *Hewson*, and extracted from the same writer copious references to other sources of information in earlier works. From these particulars, from the more accurate researches of later experimentalists, which will presently be mentioned, and likewise from the facts which have come under my own notice, or been communicated to me by my friends,—it would appear that a milky-like state of the serum of human blood is not a very uncommon occurrence.

Various opinions have been formed as to its cause. The most recent conjecture is that of the correspondent whose case appears in the last number of the Medical and Surgical Journal, and who takes it for granted that the milky-like serum is nothing else but milk. *Mr Hewson*, after stating that he was at first led to imagine the milkiness depended on a portion of the chyle not being converted into blood, acknowledges that this idea was not borne out by facts. He afterwards observed, that on evaporating milky serum to dryness, the residuum made a greasy stain on paper; from which he infers that the cause of the milkiness is oily matter diffused throughout the blood; and he considers that this oil is in all probability formed by the mouths of the absorbents from the fat of the adipose cells.* The late *Dr Gregory* observes explicitly, but without specifying any grounds for the statement, that the milkiness depends on the absorption of fat and its non-conversion into gluten or fibrin.†—The only person, however, who has hitherto carefully analyzed milky serum, and been thus enabled to assign a substantial reason for the opinion he espouses, is *Dr Traill* of Liverpool. His researches may be seen in various numbers of the Medical and Surgical Journal for the years 1821 and 1823. He analyzed with care three specimens of milky serum, two of which were taken from the same person in two different illnesses. The specific gravity was under the healthy standard in all, being 1018.7 in one case, and 1025 and 1018 in the two specimens from the other. The former serum contained 21.1 parts per cent. of solid matter, a most unusually high proportion; and of this 15.7 were albumen, 4.5 an oily matter, 0.9 saline substances. Of the two specimens in the latter case the lighter gave 16.4 per cent. of solid matter, 13.3 being albumen, 2.5 oil, 0.6 saline substances; while the denser specimen gave 15.2 of solid matter, of which a considerable proportion was oil. From these analyses *Mr Traill* concludes, that oil exists in all kinds of milky serum, and that the milkiness is partly perhaps owing to this oil, but chiefly in all probability to an excess of albumen.‡ Since his researches, notice has again been taken of the occurrence of milky serum in two numbers of the London Medical Repository for 1824. One of the editors of that Journal says he has four times witnessed a milky or whey-coloured appearance in serum; and (apparently under the impression that he was the first to notice it, and attempt to explain it,) puts the question, whe-

* On the Blood, 141, 148, 149.
† Conspectus Medicinæ Theoreticæ.
‡ Edin. Med. and Surg. Journal, xvii. 236. *Ibid*, 637, and xix. 321.

ther the appearance arises from the presence of oil. * In a subsequent Number, *Mr Venables*, a correspondent of the Journal, also mentions his having seen the appearance in question, but denies that it depends on the presence of oil, though without assigning any reason.†

My own experiments, which will now be detailed, have furnished results in many respects the same with those of *Dr Traill*. They differ, however, in some subordinate particulars, and likewise in leading to the conclusion (which I trust the sequel will satisfactorily establish,) that the cause of the milkiness is simply the fat of the human body contained in the blood in the form of emulsion.

I am indebted for the milky serum which I examined to *Mr Ziegler*, a surgeon of this city, who had the kindness to submit to my inspection two specimens taken from the same patient, with an interval of a week between them. The blood which yielded them had a whitish appearance before it coagulated, so that *Mr Ziegler* at first imagined milk had been accidentally left in the cup. The blood each time coagulated in the customary way. In appearance both specimens of serum were quite undistinguishable from new milk, being at least as white and opaque, especially the serum of the first-drawn blood.

The specific gravity of both was much under the healthy standard, that from the first drawn blood being 1018.7, that of the last drawn 1021.8; while that of a specimen of healthy serum examined at the same time was 1030.8, which is rather above than below the average. The quantity of solid matter was above the healthy standard in the lighter milky serum, and about the healthy standard in the heavier. The solid contents of the healthy serum dried at 212° till they ceased to lose weight amounted to 10.22 per cent., which is about the average assigned by chemists; that of the lighter milky serum was 13.77; and that of the denser serum 9.81. It is worthy of remark, that, neither in relation to healthy serum, nor to one another, was there in these specimens of milky serum any direct proportion between the density and the solid contents; the proportion was rather an inverse ratio. The same fact results from the experiments of *Dr Traill*.

The solid contents of both varieties of milky serum were obviously greasy on the surface, so as to stain glass and impart an oleaginous appearance to filtering paper. This was also remarked by both *Mr Hewson* and *Dr Traill*. The oleaginous or rather adipose matter, however, may easily be separated in a state of pu-

* Lond. Med. Repos. xxv. 191. † *Ibidem*, xxv. 257.

rity from the original serum by means of sulphuric ether. As ether does not coagulate serum, and possesses the power of dissolving most oily and fatty substances, I expected, by agitating the milky serum with a larger quantity of ether than the water of the serum can dissolve, that the adipose substance would after repose rise to the top with the undissolved ether in the form of a pure ethereal solution. Accordingly, when the milky serum was agitated with half its volume of ether in a small, narrow, precipitating glass, the milkiness in a few seconds disappeared entirely; and a nearly transparent fluid was formed, which, when left at rest for a minute or two, divided into three layers. The uppermost was colourless and transparent;—the second greenish, translucent, opaline, and apparently formed of little irregular masses, not unlike the granules of orange pulp;—and the lowest greenish and nearly transparent. The upper layer was a pure ethereal solution of adipose matter; which, as the ether evaporated away in a watch-glass, collected in oily-like globules on the glass. The second was a mixture of much ether, a good deal of albumen, and a little adipose matter. For, when left exposed to the air, the adipose matter, as the ether evaporated, gradually collected on the margin of the mass; and the remainder of the residuum, composing its greater part, was evidently albumen with its original properties nearly entire, especially its coagulability under the application of heat. The lowest layer was pure serum containing a little ether in solution, but quite free from any greasy impregnation. When exposed to the air till the ether evaporated, a faintly-gelatinous mass was left, which presented all the chief properties of uncoagulated albumen.

The effect of agitation with ether in the preceding experiment shows, that the milky state of the serum is owing solely to some oily or fatty substance in a state of intimate suspension or emulsion; for the milkiness is at once and entirely removed by a fluid which possesses the property of dissolving the fatty matter. That an excess of albumen has nothing to do with the phenomenon, as *Dr Traill* conceived it had, is evident from the fact, that the milky serum of the second-drawn blood did not contain more solid matter than usual. Besides, it is well known, that white of egg, which contains much more albumen than was present in any of *Dr Traill's* specimens of serum, is colourless and transparent when uncoagulated; and it is not easy to conceive how an excess of albumen should impart whiteness and opacity to one fluid, and not to the other.

I have now to consider what is the exact nature of the fatty or oily matter thus separated from the blood. In the first drawn specimen of serum, the fatty matter formed about 5 per cent of the whole; and in the second specimen 3 per cent.; that is 36 and 32 per cent. of the whole dry residuum pro-

cured by evaporating the serum at 212°. In the former it was translucent and nearly colourless, when solid; in the latter it had a yellowish tint. Both had a faint, peculiar, heavy, oleaginous odour. Both were concrete at 60° F.; at 70° they began to soften, but remained opaque; at higher temperatures their fluidity increased, but they were not sufficiently fluid to flow easily till about the temperature of 96°. Both were inflammable, and burnt entirely away with a clear white flame. This property is best ascertained, as *Dr Traill* suggests, by kindling the substance under trial on a small parcel of asbestus fibres. Both contained two adipose principles,—one fluid at ordinary temperatures, the other concrete; and these principles were easily separated by cooling the compound substance down to 40°, and placing it between folds of filtering paper. The paper became impregnated with an oil, fluid at 40°; while a solid fat was left behind, which was concrete at 100° F., and liquid at 115°. The former was therefore obviously the *oleïne*, and the latter the *stearine* of *Chevreul*. The quantity of the compound matter at my disposal was too small to allow me to ascertain whether any other fatty principle was also present. But the properties I have enumerated are sufficient to show that the composition of the fatty matter procured from the two specimens of serum corresponds in every essential respect with the account given by *Chevreul* * of the composition of human fat, which consists of stearine and oleïne alone in various proportions, and one specimen of which, taken from the neighbourhood of the kidneys, he found to have nearly the same point of liquefaction as the compound now under consideration.

It hence appears that the opinion of *Dr Gregory* regarding the cause of the milkiness of serum is correct, and that it depends on the absorption of fat.

Hitherto I have considered only the milky state of the serum, or that state in which the serum does not differ in appearance from milk. But there is another condition of much more frequent occurrence, and which is often, though incorrectly called milky, where the serum has the appearance of whey,—being translucent, and grayish by reflected, but yellowish by transmitted light. This appearance is not unfrequently seen in cases of dropsy with coagulable urine, and also in acute rheumatism. So far as I know, its nature has never been particularly examined.

I have analyzed four specimens of this whey-like serum, all taken from persons labouring under dropsy with coagulable urine, and whose blood formed in every instance a buffy coat on coagulating. My attention was chiefly turned to the possi-

* Recherches sur les Corps Gras d'origine Animale. 1823. P. 249.

bility of discovering fatty matter in them; and in each I was successful. By means of pure sulphuric ether, used as formerly related, I separated a fatty matter, exactly agreeing in properties with that procured from the milky serum of *Mr Ziegler's* patient. One of these specimens of serum, which was put into my hands the other day by *Dr Alison*, appears to contain fully one per cent. of fat.

I may farther add, that the serum, even when not whey-like, but perfectly transparent, occasionally contains a trace of fatty matter. I have examined some specimens of serum, where I could not detect any fat; but in two instances, where that fluid did not appear to differ from the healthy state, a distinct trace of the same fatty impregnation was discovered. It is hence extremely probable, that in the natural state of the blood there is generally, if not always, contained in it a greater or less proportion of a fatty matter, exactly corresponding with the fat of the adipose cells. If this be afterwards proved to be the case it will be an additional circumstance to be placed along with the facts already discovered, which show that various principles found throughout the body and in its secretions, exist in the blood, and are therefore secreted from it simply by a process of elective percolation.

It would be premature to attempt to connect the existence of a considerable proportion of fat in the blood with other more palpable pathological phenomena, as a sufficient number of facts have not hitherto been collected on the subject. Meanwhile, however, it may be stated, that it appears to be connected in general with an excited state of the circulation, or with that state of the blood in which the buffy coat is formed.

In *Mr Ziegler's* case the patient was bled on account of muscular pains in the left side, accompanied with fever; but the blood was not buffy. In two of *Dr Traill's* cases the disease was hepatitis, which in one was acute. In his third case it was nephritis. The case mentioned in the last number of the Medical and Surgical Journal was an acute inflammation of a doubtful nature, probably pleurodyne or pericarditis. Of *Mr Hewson's* four cases one was acute rheumatism, another active epistaxis, a third slight asthma, and the fourth an anomalous case of suppressed menses, with pain in the left side and a frequent pulse. The whey-like state of the serum, which I have often seen before my attention was particularly turned to its cause, has, so far as I remember, occurred to me most distinctly in cases of acute inflammation, or in cases of dropsy with coagulable urine, where there is a strong inflammatory tendency in the body and very often buffiness of the blood.

As the milky appearance has occurred chiefly in persons

abruptly seized with an acute disease, it occurred to me that it might simply arise from the absorbents acting powerfully on the fat of the body on the person being suddenly restricted to low diet. *Mr Ziegler's* case, I conceived at one time, favoured this notion. She was a corpulent female, twenty-seven years of age, and had been for some days on low diet before she lost blood. I am informed, however, that she has been since bled more than once for acute complaints, without any such appearance being witnessed in the blood as that observed on the former occasion.

The most convenient method of searching for fatty matter in the serum, is to agitate in a long narrow phial, half an ounce, or a whole ounce of the serum, with about a third of its volume of ether for one minute; and to leave the mixture at rest for a few minutes or half an hour, according to the rapidity with which it divides itself. The uppermost clear stratum is then decanted off or removed with a pipette, and evaporated in a little glass vessel or other cup at a gentle heat, such as before a common fire.

ART. V.—*Memoir on the Developement of the Organs of Respiration in Birds and Mammiferous Animals.* By PROFESSOR RATHKE. Published by G. Breschet; abridged and translated from the Répertoire Génerale d'Anatomie et de Physiologie Pathologiques, Tome vii. Part I.

THE subject of the present memoir, though not much attended to in this country, is one which, for several years past, has excited much interest and inquiry on the Continent. In Germany especially it has been successively studied by Wolff, Oken, Meckel, and Tiedemann, and more recently by Baer, Huschké, and Rathké. The results obtained by the three latter inquirers have been so far satisfactory that the knowledge of the embryal developement of the different organs may be now said to assume the shape of ascertained facts; and Charles Frederic Burdach, an eminent German author, has attempted to reduce them to the shape of a generalized system.* Though this work, therefore, contains the general results of the inquiry, and exhibits the successive stages through which it has passed, and may therefore come under notice on a future occasion, we believe that the subject is too important to be presented in that form only; and we doubt not that our anatomical readers will be pleased with seeing a short view of the researches of Professor

* Die Physiologie als Erfahrungs wissenschaft Zwey Banden. Bearbeitet Von Karl Friedrich Burdach. Mit Beitragen, von Karl Ernst von Baer, Heinrich Rathké und Ernst H. F. Meyer. Leipzig, 1828.