Actiniochrome is generally confined to the tentacles, and is not respiratory, actiniohæmatin occurs in the ectoderm and endoderm, and is respiratory.

(3.) A special colouring matter is found in *Sagartia parasitica*, different from either of the above, and this too exists in different states of oxidation. It is not apparently identical with that obtained by Heider from *Cerianthus membranaceus*.

(4.) In the mesoderm and elsewhere in *Actinia mesembryanthemum* and other species, a green pigment occurs which alone and in solution gives all the reactions of biliverdin.

(5.) *Anthea cereus*, *Bunodes ballii*, and *Sagartia bellis*, yield to solvents a colouring matter resembling chlorofucin, and all the colouring matter, which in them shows this spectrum, is derived from the "yellow cells," which are abundantly present in their tentacles and elsewhere. It is not identical with any animal or plant chlorophyll, as is proved by adding reagents to its alcoholic solution.

(6.) When "yellow cells" are present, there appears to be a suppression of those colouring matters which in other species are of respiratory use.

All readings are reduced to wave-lengths, and the spectra described illustrated by means of sixty-five maps of spectra. The "yellow cells" are also drawn alone and stained with iodine in iodide of potassium, and with Schultze's fluid.

II. "On the Origin of the Proteids of the Chyle and the Transference of Food Materials from the Intestine into the Lacteals." By E. A. Schäfer, F.R.S. From the Physiological Laboratory, University College, London. Received January 12, 1885.

In consequence of the discovery that in many of the lower Metazoa the ingestion of food particles is the result of an amœboid activity of individual cells of the organism, and that digestion and assimilation may also occur within the protoplasm of cells thus endowed with amœboid activity, attention has of late been directed to the part which such cells may play in promoting absorption from the alimentary canal of Vertebrates.

It is well known that lymph-cells occur in large numbers in the mucous membrane of the intestine, which is everywhere beset with them; besides which they form the nodular masses of the solitary and agminated glands. It is also known that they are found extending between the columnar epithelium-cells which line the intestine, sometimes in considerable number. Since this is the case, and since,

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moreover, they are amœboid and capable of altering their shape and position, and of taking up particles with which they may come in contact, I was long since led to infer that they might probably be regarded as active agents in effecting the transference of fat-particles from the columnar epithelium to the lacteals. This inference was based upon the following experiment, which I have often repeated. An animal is killed during digestion of food containing fat and whilst absorption is freely proceeding. On examining the small intestine it is found that the columnar epithelium-cells, the lymph-cells of the mucous membrane, and the lacteal vessels, are all occupied by particles of fatty matter. This fact can be readily substantiated by the mere examination of the fresh tissue, but it becomes strikingly manifest if a piece of the mucous membrane is placed in a 1 per cent. solution of osmic acid for a few hours, and after subsequently macerating in water for two or three days, is broken up with needles in a drop of glycerine. The fat-particles being now stained black are very conspicuous, and it is easy to recognise their presence in the epithelium-cells, where they are often of considerable size, and in the lymph-cells, where they are generally small.

Sections of the intestinal mucous membrane, and especially longitudinal sections of the villi, also show the fat-particles in the epithelium-cells, in the lymph-cells, and in the lacteals, but none in any other structures. The inference seems, therefore, unavoidable that the amœboid lymph-cells are the carriers of the fat-particles.

Nor is this view in itself an improbable one or without analogy. For the intussusception of particles is one of the most characteristic phenomena exhibited by amœboid cells, which will carry such incepted matters along with them in their slow movements from place to place. When vermilion is injected into the blood-vessels, the particles of pigment are taken in by the white corpuscles of the blood, and when these emigrate from the vessels the particles are carried with them, and may thus reach the radicles of the lymphatics. In the alveoli of the lung and in the smaller bronchial tubes, amœboid cells are constantly to be found filled with inhaled carbon particles which they have taken up from the mucus by which these particles have been intercepted. These cells are seemingly white corpuscles which have emigrated from the blood-vessels, and they pass back again into the lung-tissue between the epithelium-cells of the alveoli, carrying with them the fine particles of carbon, and eventually also reach the radicles of the lymphatics in which the carbon is deposited. Nevertheless, the view in question has not until lately met with any general acceptance, probably partly owing to the fact that contrary statements regarding the path of fat-absorption have been made by distinguished authorities, partly because it seemed to be an isolated instance of the participation of amœboid cells in absorption.

But this is no longer the case. In very numerous instances it has now been shown that amœboid cells are actively concerned in the transference and assimilation of nutriment. Observations on this point have chiefly been made upon animals low down in the scale of organisation, but have not been confined to these. For it has been demonstrated that a similar process occurs also in some fishes, whilst, as regards both normal and pathological tissue-absorption, strong evidence has been adduced in favour of the active agency of lymph- or white blood-corpuscles in the production of these changes.

The views of physiologists upon the subject of absorption would seem, in fact, to have taken a fresh direction, and the importance of the part played in the process by amœboid cells is coming to be very generally recognised. This being the case, I have been led again to turn my attention to the question of intestinal absorption in Vertebrates, considering it with reference not only to the mode of passage of fat into the lacteals, but also to the possibility of other alimentary substances being conveyed in a similar manner. With this object I have devoted a considerable amount of time at intervals during the last two or three years to a renewed investigation of the subject, with the assistance of a grant derived from the Government Grant Fund. The principal results arrived at in this investigation I propose now briefly to lay before the Society.

By far the most important of these results is the establishment of the fact that during absorption of food from the intestine the lymph corpuscles migrate in large numbers into the lacteals, and these for the most part become disintegrated and dissolved in the chyle. This is the case not only after a meal containing fat, but also after feeding with substances devoid of that alimentary principle; it is, therefore a phenomenon of general occurrence during absorption, and the carrying of fatty particles into the lacteals after a meal containing fat by the immigrating leucocytes, must be regarded as merely incidental to a more general function.

The number of leucocytes which thus pass from the tissue of a villus into its lacteal, is often so great that the blind end of the villus may be almost blocked by them. Lower down, however, *i.e.*, nearer the attachment of the villus, there are only very few to be seen, and some of these are only the more persistent nuclei of corpuscles, the protoplasm of which is already dissolved. Others are seen swollen and partially disintegrated, and, indeed, in preparations in which the cells have been fixed by the action of osmic acid, every stage of disintegration may be traced.

This immigration and solution of numerous leucocytes in the contents of the lacteals must be the means of conveying a large amount of proteid material, derived from their dissolved protoplasm and nuclei, into the chyle. And any other material which may be mechanically

or otherwise incorporated with their protoplasm must also be set free. In this way the fatty particles which they contain during absorption of a meal containing fat become released and suspended in the chyle, and it is probable that amyloid matters are also in part thus conveyed to that fluid.

The cause of the solution of the immigrated leucocytes in the chyle of the commencing lacteals is not easily discovered, but it is not difficult to imagine more than one way in which it might be brought about. It is known that a solution of peptones when added to the blood or lymph, produces disintegration and solution of many of the white corpuscles. And it is by no means unlikely that peptones which have passed by diffusion into the lacteals may produce a similar effect upon the immigrated amœboid cells. Moreover, after the blood is drawn many of the white corpuscles undergo solution in the plasma in consequence of changes in its physical or chemical condition which are inappreciable to the most delicate tests. And an increase of alkalinity in the blood which fails to produce any change whatever in the easily influenced coloured corpuscles will speedily produce the disintegration of most of the colourless cells.

As to the origin of these immigrant cells, it may be regarded as certain that they have passed inwards from the epithelium. Leucocytes are constantly seen, often in considerable number, between the epithelium-cells of the villi (where they may even lie close to the free surface), and also between the fixed ends of the epithelium-cells and the basement membrane, as well as in the tissue of the mucous membrane itself. In fat-absorption all these leucocytes, as well as those which have passed into the lacteals, contain fatty particles, and these particles are not found elsewhere in the tissue of the mucous membrane. Since there is no continuity of the protoplasm of the lymph-cells one with another, the fat-particles in those which are more deeply seated must have been carried along by the amœboid movements of the cells which contain the fat. In this case, then, it seems scarcely possible to come to any other conclusion than that the fatty particles are taken up by the leucocytes from the epithelium-cells, and perhaps in part directly from the intestinal cavity, are conveyed to the lacteal, and there become set free by the breaking down of the carrying cell.

The presence of the fat thus serves to trace the course of the leucocytes in the villi. But there is no reason to believe that their course is at all different even in the absence of fat, for they are still seen between the epithelium-cells, and they still pass into the lacteals. It is fair, therefore, to assume that they play precisely the same part whatever the nature of the aliment.

A further question as to the origin of the leucocytes involves the explanation of the production of a constant succession to take the

place of those which have passed into the lacteal. With regard to this, it may safely be affirmed that they are continually undergoing multiplication by division. No one has, so far as I am aware, ever doubted that the lymph-corpuscles are thus capable of renewal, although it has been generally believed that their mode of division is *direct*, *i.e.*, unaccompanied by those peculiar changes in the nucleus which have been termed karyokinetic or karyomitoic. This has, however, been settled by Fleming, who has shown that the cells of lymphoid tissue multiply abundantly by karyomitosis. This multiplication by division will apply to the leucocytes which lie between the epithelium-cells as well as to those in the mucous membrane proper. It is doubtful whether there is any addition caused by emigration of white corpuscles from the blood-vessels; certainly it is not by any means considerable.

It is a most important question whether any amœboid cells are produced by division of the columnar epithelium-cells. That these cells do divide is certain; in confirmation of other observers I have seen abundant evidence of the occurence of karyomitoic figures in them; but I am not yet able to say what is the result of such division, although I am strongly disposed to think that they may give origin to amœboid cells. Several instances can be cited of the origin of mesoblastic amœboid cells from hypoblastic epithelial cells in the embryo, which seem to favour this view.

Taking for granted that the leucocytes multiply by division, the newly produced daughter cells will naturally be relatively small with scanty protoplasm. Being freely supplied with nutrient material during the absorption of aliment, either directly from the intestine or indirectly from the columnar epithelium-cells (which are probably the primary agents in effecting absorption from the intestinal cavity), their protoplasm probably in part assimilates, and in part stores up this material and rapidly grows. Wandering now towards the centre of the villus (urged it may be by the stream of fluid which is passing at this time in that direction) the cells enter the lacteal, and there become dissolved, and again set free not only the proteid matters which they have assimilated and converted into protoplasm, but also all other material, whether in the form of definite particles or not, which may have been taken up in addition and carried by them into the lymphatic vessel.

The preparations upon which the observations and inferences which are here briefly recorded are based have been made chiefly from mammals, especially from the rat, in which the shape of the villi and the size of their lacteals render it relatively easy to obtain successful sections. Many, however, are from the frog, in which the facts can be very clearly made out on account of the size of the elements, and in which also the comparative slowness of the process of absorption

enables one more readily to study it in its different stages; although, on the other hand, the number of leucocytes which are passing into the lacteals and there undergoing disintegration is much less at any one period than in the mammal.

A fuller account of the subject, furnished with illustrations, and containing the necessary references to other articles dealing with the same question, will appear in the forthcoming number of the "Monthly International Journal of Anatomy and Histology."

January 29, 1885.

THE TREASURER in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

The following Papers were read:—

I. "On some Physical Properties of Ice and on the Motion of Glaciers, with special reference to the late Canon Moseley's objections to Gravitation Theories." By the Rev. COUTTS TROTTER, M.A., Fellow of Trinity College, Cambridge. Communicated by Professor STOKES, Sec. R.S. Received December 22, 1884.

I. *Introductory.*

It will be remembered that in a paper "On the Descent of Glaciers," read to the Royal Society on the 19th of April, 1855 ("Proc. Roy. Soc.," vol. 7, pp. 333—342; "Phil. Mag.," vol. x, pp. 60—67), Canon Moseley proposed a new theory to account for the phenomena of glacier motion. The theory was suggested, as is well known, by the observation of the gradual descent of a sheet of lead resting on a roof of moderate slope, and exposed to considerable diurnal variations of temperature. According to it the descent of a glacier is due to the alternate expansion and contraction of the ice in the direction of the length of the glacier under the influence of varying temperature; gravity assisting the downward and opposing the upward movement of the mass.

This paper was effectively answered by Forbes ("Proc. Roy. Soc.," vol. 7, p. 412), and the theory has never been accepted by persons