XI. *Observations on the functions of the Intestinal canal and Liver of the human Fœtus.* *By* ROBERT LEE, *M.D., Physician to the British Lying-in-Hospital. Communicated by Dr.* PROUT, *F.R.S.*

Read June 19, 1828.

WHILE investigating the mode of developement of the organs in the human fœtus, at the different periods of utero-gestation, I was struck with the appearances which were uniformly met with in the contents of the intestinal canal. As these appearances have only been vaguely noticed by physiologists, and as they seem to throw light on some obscure processes of the fœtal œconomy, I have been induced to offer the following account of my observations on this subject to the consideration of the Royal Society.

It has not yet been determined what are the organs which are first developed in the human fœtus, but it is certain that the liver and intestines are visible at a very early period, that these organs are copiously supplied with blood, and that, during the whole period of gestation, they occupy a large portion of the abdominal cavity. The pancreas and spleen can also be distinctly perceived between the second and third month after conception, but, unlike the liver and intestines, they are very sparingly supplied with blood, and remain small and imperfectly developed during the existence of the child in utero. In all the intermediate periods, from the fourth to the end of the ninth month, the small intestines are much more vascular than the stomach and great intestines. The mucous membrane of the upper portion of the small intestines, is of a bright rose-red colour; while that of the ileum and colon is comparatively pale and bloodless. In a fœtus of eight months, the length of whose body was eighteen inches, the small intestines, when fully extended, measured nine feet six inches, and the great intestines two feet; and from other examinations I have been led to estimate the entire length of the intestinal canal of the fœtus, at the full period, at about eleven feet; the relative proportion to the length of the body being much greater than in the adult.

I have now examined, in upwards of twenty fœtuses of different ages, the contents of the different portions of this extensive tube; and from their appearance, as well as chemical composition, as determined by Dr. PROUT, to whom numerous specimens were submitted for analysis, it will be perceived that they bear a striking analogy to the contents of the alimentary canal of the adult, where the processes of assimilation and absorption are performed.

The stomach of the fœtus I usually found, in these cases, distended, with a semitransparent, ropy, mucous, and occasionally ascescent fluid, without any sensible admixture of albuminous or other apparently nutritious matter.

In the duodenum, and part of the remaining portion of the small intestines, there was uniformly present, adhering closely to the mucous membrane, a semi-fluid matter, found upon examination to possess properties decidedly of an albuminous character, and to have an orange or pink colour. This matter has always been found in greatest abundance around the papillary projection, through which the common duct of the liver opens into the duodenum.

In the lower half of the small intestines the quantity of this albuminous matter was greatly diminished, and near the colon it almost entirely disappeared. The colour also of the contents of this lower portion of the small intestines was different from that noticed in the contents of the duodenum, being of a greenish tint, and assuming more and more the characters of the meconium as the distance from the origin of the colon diminished. These different substances were generally found slightly ascescent.

The great intestines were much more distended than the small intestines, and contained throughout a dark green, homogeneous, generally neutral or slightly alkaline fluid, in which no albuminous matter could be detected, and which was consequently excrementitious.

The absence of albuminous matter in the stomach of the fœtus, its invariable presence in the upper half of the small intestines, its gradual diminution as we proceed downwards, and its disappearance in the colon, are circumstances, which, viewed in connection with the great length of the small intestines already noticed, seem to prove that the absorption of some nutritious substance takes place from the intestinal canal in the latter months of gestation, in like manner as it does after birth.

The observation, that the lacteals contain a similar fluid, is sufficient to

render the preceding physiological view a matter of demonstration. In no instance, however, have I succeeded in detecting these vessels in the mesentery of the human fœtus, though I have perceived them distinctly in a calf of seven months. A case has been however recorded by Mons. ADELON, in his work on Physiology, where the lacteals were observed in a child at the period of birth distended with chyle. His words are: "En examinant les vaisseaux du mesentère, dans un enfant qui venait de naitre avec l'abdomen ouvert, on a trouvé ces vaisseaux pleins de chyle*."

My attention was next directed to discover the source of this albuminous matter in the intestines, which I conceived could only be derived from the pancreas, the liver, or the duodenum itself. With respect to the pancreas, that organ remains so small during the whole of the fœtal state, that it would appear incapable of forming so large a quantity of matter as exists in the intestinal canal. On the other hand, the duodenum presents still greater difficulties to the solution of this question; for it seems improbable that this portion of the alimentary canal can perform simultaneously the office of secreting and absorbing the same matter; to say nothing of the anomaly which in this case would take place, of a mucous membrane forming albumen. From having observed in every instance the same orange-coloured fluid, in the small intestines, collected in great abundance near the orifice of the ductus communis choledochus, and taking into consideration the magnitude of the fœtal liver, and the large supply of blood which it receives from the umbilical vein, it appeared to me reasonable to infer that this viscus must be the source of the matter in question. Additional weight was given to this conclusion by having detected, in two instances, in the hepatic duct, the presence of a fluid possessing, not only some of the sensible, but also the chemical properties of that which was found in the duodenum. In general, the hepatic and common ducts of the liver have been found empty, or have contained too minute a quantity of fluid to be collected for chemical investigation; but in the two instances above mentioned it existed in unusual abundance, and was pressed out upon a plate of glass without mixing with the bile of the gall-bladder, a ligature having previously been applied around the cystic duct. This fluid of the hepatic duct was of a light straw-colour, and much less viscid than that

* ADELON, Physiologie de l'Homme. Tom. iv. p. 476.

coating the inner surface of the duodenum; and its properties were, if possible, still more decidedly albuminous than those of the intestines.

I have been led to conclude from these facts, that the function of the fœtal liver is not, as has generally been supposed, that of separating from the blood an excrementitious fluid injurious to the œconomy of the child; at least that such is not its only use, but that it also performs some other important office destined to assist in the nutrition of the fœtus.

It would be superfluous here to enumerate the various opinions which have been entertained by physiologists on the subject of the nutrition of the fœtus in utero; but that of HIPPOCRATES as adopted by HARVEY in his great work de Generatione Animalium, requires to be noticed. He observes, "Quinetiam certum est, intra pulli ingluviem (talisque prorsus in omnium embryonum ventriculus cernitur) substantiam quandam, colore, sapore, et consistentia dicto jam liquori persimilem reperiri; eandemque, in ventriculo aliquantulum coctam, lac coagulatum referre; quam etiam, chyli specie, in primis intestinis deprehendimus, inferiora autem intestina excrementis stercoraceis referta sunt. Similiter in viviparorum in fœtibus intestina crassiora consimili excremento replentur, quali eadem, cum lacte vescuntur, abundare cernimus. In ovibus etiam, aliisque bisulcis, manifesta sunt scybala.

"Quid dubitemus igitur affirmare fœtum in utero sugere; et in eo fieri chylificationem, cum ejus manifesta adsint tum principia, tum rejectamenta?"

The fallacy of the opinion of HARVEY, and of later physiologists with regard to the source of the nutritious fluid found in the intestinal canal of the fœtus, is demonstrated by the fact, that acephalous children*, and those born with the œsophagus impervious, have not only been perfectly nourished, but in their

* MECKEL's Manuel d'Anatomie Generale, &c. Tom. iii. p. 792.

The translators of MECKEL's work, Messrs. JOURDAN and BRESCHET, have stated the opinion of GEOFFROY ST. HILAIRE on this subject in the following note:—"GEOFFROY ST. HILAIRE (Monstruosités Humaines, p. 279.) ayant rencontré dans le canal intestinal d'un anomocephale de veritables matières fecales moulées même, et reunies en crottins dans l'intestin post-cæcal, s'est trouvé conduit par ce phenomène à examiner la nutrition propre du fœtus. Il pense que le mucus secrété dans les voies alimentaires, et qui est trop abondant pour ne jouer que le role de fluide lubrifacteur, est l'aliment sur lequel agit d'abord la digestion; que pris d'abord par l'appareil digestif, ensuite par les voies chylifères, il est la source du fluide nutritif, qui afflue ainsi sans cesse dans l'appareil circulatoire, et qui, à chaque passage, eprouve une animalization graduelle. Considerée de la sorte, la nutrition du fœtus

intestines substances have been found similar in character to those contained in the intestines of children, in whom no such malformation had existed

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Note by Dr. PROUT.

The principal chemical facts ascertained by me having been introduced by Dr. LEE in the preceding paper, it only remains that I should briefly state the manner in which these facts were determined.

The most unequivocal test of the presence of albuminous matter that I am acquainted with, is the prussiate of potash assisted by dilute acetic acid, as first recommended by BERZELIUS; and this accordingly was the test on which the chief reliance was placed in my experiments. But the presence of albuminous matter was also satisfactorily indicated by other means; as by heat, by the oxymuriate of mercury, &c. Besides the albuminous matters, however, it may be proper to mention that others were present, to which this term, even in its most extended sense, could not be strictly applied, and for which in the present state of animal chemistry, it was difficult to find a precise term; a large proportion of them appeared to be nearly allied to mucus and bile, though they did not exactly agree with these principles as they occur in the adult state.

I cannot close this note without observing how forcibly I was struck by the close resemblance between the phænomena, as above described, and those presented by the intestinal canal, when the processes of digestion and assimilation are known to be going on; and that I cannot at present conceive any other source from whence the matters in question can be derived, than the hepatic system as supposed by Dr. LEE.

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se rapprocherait de celle de l'adulte. Cette hypothèse, d'apres laquelle l'ecoulement du mucus serait du à l'irritation des membranes muqueuses par la bile, est ingenieuse, mais peu probable. Elle obligerait, en effêt, à admettre que le tube alimentaire exerce deux actions totalement differentes à l'égard du mucus, l'une en vertu de laquelle ce mucus est formé, et l'autre qui a pour but de le transformer ensuite et de le convertir en chyle."