scription I shall follow the latest investigations, those of Mall.

As the intestine grows it pushes itself out of the body cavity into the umbilical cord. This extra-embryonic position of the intestine had already been noticed by

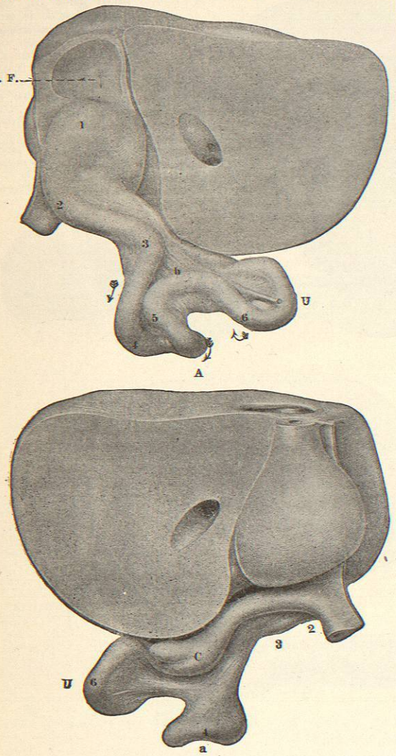

FIG. 76.—Reconstruction of the Liver and Intestine of a Human Embryo, 24 Mm. Vertex-Breech Measurement. (After Mall.) × 10 diameters. A, From the right side; B, from the left side. Letters and numbers as in Fig. 75.

Meckel in 1817. The single loop of which the intestine is composed at this time is shown in the two illustrations forming Fig. 76, which are from a reconstruction of an embryo of about five weeks. It will be noticed that in Mall's figure the relations of the two arms, which make up the intestinal loop, to each other differ from that of Toldt, which is usually given in the text-books. In the figure of Toldt (Fig. 74), there is a ventral and dorsal arm to the loop, while Mall gives a right and left arm. The mesentery between the two lies at right angles to the axis of the embryo in Mall's figures, while in Toldt's it is parallel. His has also described, in his "Anatomie menschlicher Embryonen," similar relations of the intestines. Another point to which Mall calls special attention is that the large intestine lies in the sagittal plane of the embryo, and retains this position until the return of the intestine into the peritoneal cavity.

The right arm of the loop (Fig. 76) has a number of short bends, which have an important relation to the future convolutions of the intestine. The omphalo-mesenteric vessels which lie in the mesentery of the loop in the mid-line serve as a landmark for comparison with older embryos.

The vascular supply of the loop corresponds to that of the adult, since the omphalo-mesenteric artery supplies in

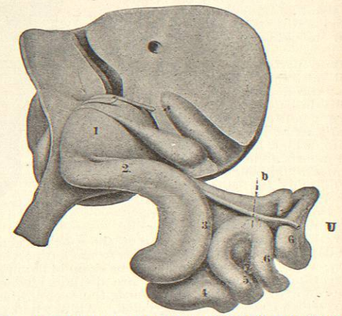

FIG. 77.—Reconstruction of the Liver and Intestine of a Human Embryo of the Same Size as Fig. 76, but Somewhat Older. (After Mall.) × 10 diameters. Viewed from the right side. The growth of each individual coil is easily followed.

the embryo the same portion of the intestine that the superior mesenteric supplies in the adult. The same is true of the large intestine. That part which lies at right angles to the long axis of the body is supplied by the superior mesenteric, and that which lies parallel to the long axis by the inferior mesenteric.

In a somewhat older embryo (Fig. 78), the coils of Figs. 76 and 77 are more sharply defined, and in general it may be said that the coils nearest the cæcum are

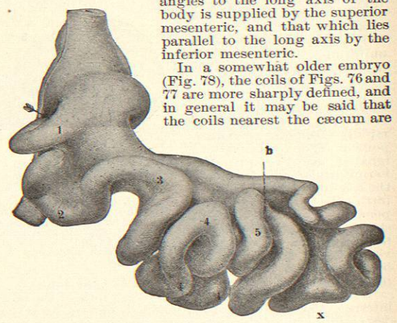

FIG. 78.—Reconstruction of the Stomach and Intestines of a Human Embryo, 28 Mm. Vertex-Breech Measurement. Viewed from the right side. (After Mall.) × 23 diameters.

the strongest developed. The length of the loops has about doubled, while the diameter has increased about

one third. The large size of the liver deserves special notice. I shall refer to this point again.

The next older embryo which Mall figures had a vertex breach measurement of 24 mm. The large intestine occupies the same position; it has increased in length, but not in diameter. A well-defined processus vermiformis is present on the cæcum. A comparison of Figs. 76 and 77 will show the growth of the coils of the intestine. While this growth is rapid, the relations of the coils to one another remain practically the same, and can be followed through successive embryos.

For example, the point *b*, which marks the end of loop 5, occupies in all four embryos (Figs. 76 and 77) the same relation to the cæcum and umbilical vessels. This point seems to be a landmark for determining the loops on the right side of the mesentery, just as *a*, in corresponding views of the left side, is for the intestinal loops on that side of the mesentery (Figs. 75 and 76).

The occasion of the intestine being forced out into the umbilical cord has been previously determined by Mall to be the "great amount of shifting which takes place from the head toward the tail on the ventral side of the embryo during its development." The liver also grows very rapidly and occupies nearly the entire abdominal cavity, thus forcing the intestine into the cœlom of the umbilical cord. That this view is correct, Dexter has demonstrated in his study of the same question in the development of the cat, and I have formed the same opinion in my study of the development of the intestine in the turtle, *C. picta*.

While the forces which compel the intestine to leave the peritoneal cavity and pass into the cœlom of the cord are well established, it is quite difficult to understand why, at a later period, they return into the abdominal cavity. At the time when they leave the abdomen for the cord, the communication between the body cavity and the cœlom of the cord is wide, but at the time of their return into the abdomen it is narrow and offers a seeming impediment to their return.

The return into the body cavity of the intestine is quite rapid, and takes place when the embryo is about 40 mm. long. Up to this time, the lower part of the body has not grown as fast as the upper, but now, owing to its rapid growth, the peritoneal cavity becomes much larger and the intestines are drawn back to fill this place. This seems to be the probable explanation.

While these changes have been taking place in the small intestine, the large intestine from the left flexure of the colon to the rectum has remained quite straight in its course. From the cæcum to this flexure, however, the large intestine has gradually extended itself in a curved direction diagonally across the body cavity from left to right, until the cæcum comes to lie in the right iliac fossa. It is during this change of position that the appendix reaches its full stage of development.

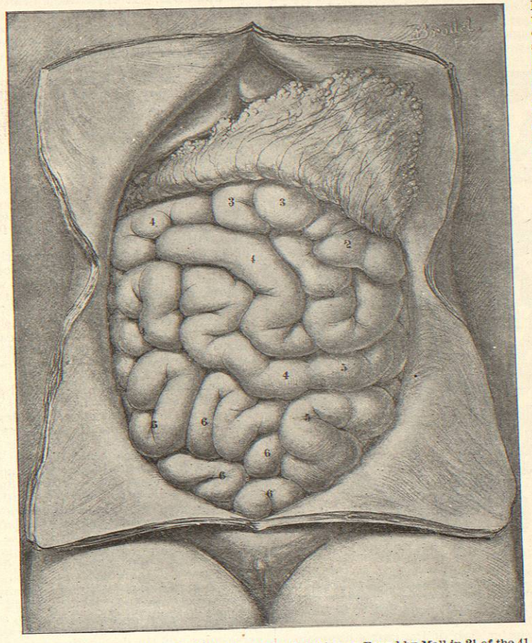

FIG. 79.—This Figure Shows the Position of the Intestine as Found by Mall in 21 of the 41 Bodies Examined by Him. The abdomen was opened by a crucial incision; the great omentum is turned back and to the left. No portion of the large intestine is exposed to view. The figures 2–6 designate the parts of the intestine which are homologous with the coils seen in the preceding figures. The coil 2 is the continuation of the duodenum. (After Mall.)

TOPOGRAPHICAL ANATOMY OF THE INTESTINE.—We have now followed the growth of the intestine, and it remains to describe the position which the coils occupy in the adult. As can be easily inferred, the embryonic condition foreshadows that of the adult.

Mall studied the arrangement of the intestinal coils in the abdomen of forty-one adults. In twenty-one cases the coils were arranged in the same manner. This may be taken as the normal arrangement of the intestine, and the other cases as variations.

In these "normal" cases, the jejunum forms two groups of coils, which occupy the left hypochondriac region. Each of these groups describes more than a complete circle, and both are in contact with the anterior wall of the abdomen (Figs. 79 and 80). The intestine then crosses through the umbilical region to the right side of the body. It then makes a turn and again crosses the median line caudad to the first arm, and forms a loop in the left iliac fossa. From here it passes into the pelvis and the lower portion of the abdomen, between the psoas muscles. Fig. 80 gives the details of the loops as above described.

LARGE INTESTINE.—The large intestine is divided into the *cæcum*, the *ascending*, *transverse*, *descending*, and *sigmoid colon*, and the *rectum*. The various divisions of the colon form a horseshoe-shaped border about the small intestine (Fig. 80).

Cæcum.—The cæcum is situated in the right iliac fossa

and is about 60 mm. in length and 75 mm. in breadth. It includes that part of the large intestine which lies below the entrance of the small intestine, and also its prolongation, the appendix.

The cæcum lies in front of the ilio-psoas muscle, and its relations to the walls of the abdomen and the other divisions of the alimentary tract vary, according as they are distended or collapsed. When the cæcum is somewhat distended and the small intestine nearly empty, it comes into direct contact with the anterior abdominal wall and comes at once into view, together with a portion of the ascending colon, when the abdomen is opened by means of a crucial incision and the flaps drawn back. In this

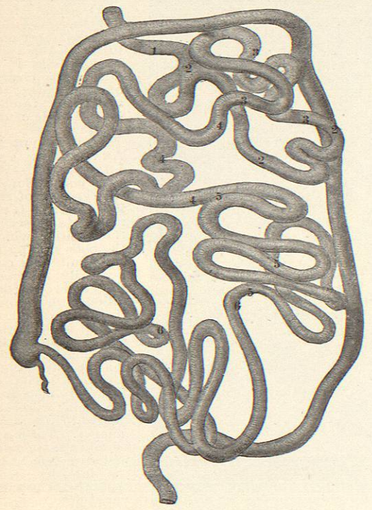

FIG. 80.—The Relation of the Coils of the Small Intestine to One Another and to the Large Intestine. The figures designate, as in the preceding figure, homologous portions of the intestine. The course which this intestine takes is that of the normal type. (After Mall.)

case it lies above the outer half of Poupart's ligament. On the other hand, when the small intestines are distended or when they have been pushed to the right by a distended sigmoid colon, the cæcum is covered by the coils of the small intestine, which are interposed between it and the abdominal wall in front.

Appendix Vermiformis.—The appendix arises from the inner and back part of the cæcum. It varies in size, the extremes being 1 or 2 mm. as the shortest and 23 mm. as the longest. Its average length is 9.2 mm. and its diameter 6 mm. The place where the appendix unites with the cæcum can be found by following any two of the three longitudinal bands of muscle which characterize the large intestine, into the right iliac fossa.

The course which the appendix takes varies greatly. It may be drawn out straight. It may be wound into a spiral. Its position also varies, but it will generally be found passing from behind the cæcum, either upward and to the left behind the ileum and mesentery, in the direction of the spleen, or downward and to the left so as to lie on the brim of the pelvis, or even project into that cavity. Sometimes it is situated entirely behind the cæcum. The appendix is usually hollow throughout its entire extent. The opening into the cæcum is often described as being guarded by a valve. Berry has, however, shown that this valve is inconstant and without any importance.

Ascending Colon.—The ascending colon extends from the cæcum below to the *flexura coli dextra* above. It passes at first obliquely backward to the dorsal wall of the abdomen. It then takes nearly a vertical direction, and in its upper portion bends forward toward the abdominal wall. Its posterior circumference borders, on this median side, upon the psoas muscle. After it has left the right iliac fossa, it lies first upon the quadratus lumborum and then on the lower portion of the right kidney. Laterally, it touches the abdominal wall; above, it is completely covered by the coils of the small intestine. When it is highly distended, it may push the small intestine so far to the left that a small portion is visible on opening the abdomen.

The angle which the ascending colon makes with the transverse colon is quite distinct. In the flexure the large intestine does not pass directly across the abdomen, but bends somewhat toward the anterior wall of the abdomen, on account of the adjoining organs. From the kidney the large intestine must pass toward the ventral side of the abdomen, in order that it may get in front of the duodenum and pancreas.

The Transverse Colon.—In front the flexure is covered by the liver, and below it rests upon the coils of the intestine. In the normal condition, when the abdomen is opened, the transverse colon cannot be seen, being covered by the great omentum (Fig. 79). If one cuts off the omentum or turns it up, the transverse colon is brought into view. In the latter case it appears to run directly from the right to the left. This is, however, a false appearance, due to the fact that the colon is drawn upward out of its normal position. In its normal condition the transverse colon runs in a slight bend, with its convexity below and in front.

The left end of this convexity lies on a higher plane than its right, because the right flexure of the colon is prevented by the liver from rising as high as the left flexure. In front of the transverse colon lies the great omentum, and, since this is a thin membrane, we can say that the transverse colon is in contact with the ventral wall of the abdomen. The left portion of the transverse colon borders upon the great curvature of the stomach in such a manner that the lower convex bend of the intestine nearly corresponds to the line of curvature of the stomach. This close relation between the stomach and the transverse colon makes it often difficult to determine their respective boundaries by percussion.

The left flexure of the colon forms a continuation of the transverse colon. It lies behind the fundus of the stomach, in front of the left kidney, and extends as far as the basal surface of the spleen. The angle which thetransverse colon and the descending colon form with each other in this flexure is much more acute than that which is present in the right flexure. Not infrequently the adjoining portions of the two arms of the flexure lie close beside each other. The relation of the transverse colon to the adjoining viscera, and of the arms of the flexure to each other, may be considerably changed by a distended or collapsed condition of the intestines.

Descending Colon.—The descending colon bears much the same relation to the body wall as does the ascending colon. Above, it rests upon the convex border of the left kidney, and then passes slightly toward the median line. It extends below to the left iliac fossa, where it joins the sigmoid colon. It is overlaid by the small intestine, and in its normal condition is not exposed to view when the abdomen is opened.

Sigmoid Colon.—The sigmoid colon occupies a very considerable portion of the iliac fossa. It is connected above with the descending colon, and below it passes over a brim of the pelvis and joins the rectum. The upper portion of the sigmoid colon is usually firmly fixed in the

fossa; but the lower part is quite movable, in consequence of which it may at times form a loop, which hangs down into the true pelvis.

Rectum.—The rectum is the last division of the large intestine, and is situated entirely within the true pelvis. It extends from the sigmoid colon to about the anus. From the brim of the pelvis, where it joins the sigmoid colon, it passes downward, backward, and to the right in order that it may reach the median line. In general it follows from this point the curve of the sacrum and coccyx, and ends in the anal canal. The anterior wall of the rectum is longer and more curved than the posterior. In children the rectum has a straighter course than in adults, and is of a relatively larger size.

Variations.—The remaining twenty cases examined can be divided into five groups. The first group consists of six cases in which loop 4 (Fig. 80) extended to the left side of the body. The remainder of the small intestine occupied the position given above.

The second group also consisted of six cases. In these cases the loop 4 was also on the left side, and in addition the loops 1 and 2 were pushed to the right side of the abdomen; that is, all the upper portion of the jejunum formed coils which were situated on the right side of the abdomen.

In the third group there were five cases. The variation here was occasioned by a supernumerary coil from that portion of the small intestine which is situated in the hypogastric region, extending up into the umbilical and right lumbar regions. Sernoff has also described similar cases.

The fourth group consisted of two cases in which coil 4 was again carried to the left side, and the space which it should occupy was filled by two coils, one of which came from the upper part of the jejunum, while the other came from the lower portion of the ileum.

The fifth and last variation was found but once. Loop 4 was elongated, and its place was occupied by a large loop which came up from that part of the ileum which is situated in the hypogastric region. A similar case has been described by Henke.

It is interesting to note that in four of these five groups, loop 4 takes some part in the variation.

William S. Miller.

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ALIMENTATION, RECTAL.—Rectal alimentation is employed whenever nutrition in the ordinary way (by the mouth) is either impossible or not desirable. This method of alimentation was already used in the Middle Ages and in ancient times. Aetius[1] occasionally mentions such method of feeding. The value of this way of nourishing a patient, however, was believed to be very slight, until extensive experimental researches with reference to absorption of food from the large bowel had been made. These definitely showed that digestion to a great extent can proceed in the colon if the ingested food is suitably prepared. Among the earliest investigators in this direction were Hood[2] and Steinhäuser.[3] Hood observed that a piece of mutton introduced into the rectum and retained, after some time showed evident signs of digestion. Steinhäuser experimented on a patient with a fistula of the ascending colon, and found that pieces of albumen introduced into the fistula could not be discovered in the fæces. Pieces of smoked beef and apples, on the other hand, were found either slightly altered or entirely unchanged in the stool.

Eichhorst[4] stated in 1871 that absorption of albuminates from the bowel is facilitated, if not made possible, by the addition of common table salt. He experimented principally with egg albumen mixed with the yolk and with milk. Some years later, Ewald[5] observed the very interesting fact that raw eggs were much better absorbed from the large intestine than artificially peptonized foods (Kemmerich's peptone).

Filippi[6] experimented on animals by resecting portions of the intestinal canal. He found that after extirpation of seven-eighths of the small intestine in a dog, there was no appreciable decrease in the absorption of foods consisting of albuminates and carbohydrates, while nineteen per cent. of the ingested fat returned with the fæces. This clearly shows that the colon can vicariously do the work of the small intestine. It further demonstrates that albuminates can be absorbed from the large intestine and enter the lacteals without previous peptonization. These remarkable statements have been confirmed by Aldor.[7] This writer experimented principally with milk, and ascribed the coagulation of the milk in the large bowel to the action of bacteria, not to enzymes. He found that after the injection of from ten to fifteen ounces of milk into the bowel, intestinal lavage, performed one to one and a half hours later, showed only minute particles of milk. The spontaneous evacuation resulting thereafter likewise contained but very small portions of coagulated milk.

Aldor, in his paper, arrived at the following conclusions:

1. A quart of milk, injected by means of a fountain syringe into the bowel, produces no pains either during the injection or afterward. No irritation of the intestine follows, and milk is most suitable for a nutritive enema.

2. The coagulation of the milk, which is due to the action of the bacterium coli commune, is rather detrimental to absorption. This coagulation can be prevented, (*a*) by thorough lavage of the bowel before giving the nutritive enema, (*b*) by adding 1 to 1.5 gm. (gr. xvi–xxiv.) of sodium carbonate to one quart of milk.

3. No digestion takes place in the large bowel.

4. Carbohydrates are absorbed in an excellent manner, albuminates in a great measure, and fats but poorly.

5. After an injection of a quart of milk into the bowel, there was never found either albumin or sugar in the urine.

In America the attention of the medical profession was first directed to rectal alimentation by Austin Flint,[8] who read an extensive and important paper on this subject before the New York Academy of Medicine in December, 1877. Flint mentioned a case in which a woman was almost wholly nourished per rectum for five years. After emphasizing the importance of rectal alimentation in instances in which the usual mode of nutrition fails or is impossible, he gives directions as to the mode of employment of the nutritive enemata. From three to six ounces of fluid or semi-fluid foods may be injected at intervals of from three to six hours. He did not deem it necessary to wash out the rectum prior to each administration of the nutritive enema. Flint, as well as Peasley, Fordyce Barker, A. H. Smith,[10] and G. M. Smith,[9] who took part in the discussion of the above paper, had all practised this method of feeding with best results. A. H. Smith mentioned several instances of gastric ulcer in which nutrition had been successfully maintained by