harmless. Occasionally the pasty contents of the lower bowel block the narrow central opening through the stem of the button and create a serious obstruction to the passage of gas. Nevertheless, for nine out of ten resections

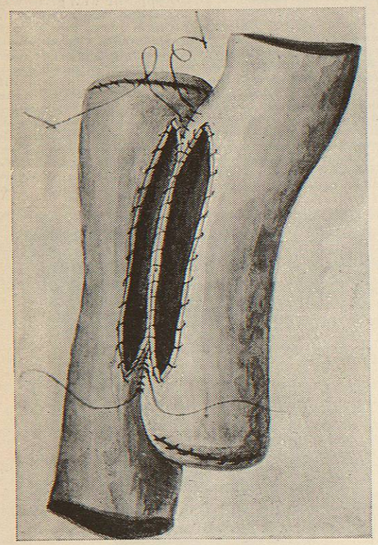

FIG. 2923.—After a Three-Inch Incision and Sewing the Edges.

of bowel the operator will find a Murphy button the most useful, indeed an almost indispensable, aid to his work. Notably in the operation for uniting the gall bladder and intestine it has completely revolutionized the judgment of surgeons as to the feasibility of establishing such a fistula in cases needing permanent drainage of bile—cases in which the common duct is completely obstructed. In this the gall bladder can be as well anastomosed to the small intestine as to the nearest presenting portion of the colon. The author prefers the latter.

The Murphy button consists of two separable halves shaped like mushrooms, the stem of one fitting into the other and secured by a spring catch. These, when joined, allow gas and liquid fæces to pass through. One half button has a separate rim bearing against the opposite one by a spring, which after adjustment confines the two imprisoned layers of bowel which have been tied around the stems, so that an immediate necrosis takes place within the rim, which sloughs away in one week, thus allowing the button to pass away free in the intestinal canal. Meanwhile natural lymph exudate at the margin of pressure has sealed the opposing peritoneal walls tightly, and a narrow line of union borders the most perfect anastomosis, with little or no subsequent tendency to contract.

The application of a strong black silk purse-string suture about the margin of the opening in such a manner that the edges of the wound will be held in close contact with the stem of the button is a detail of some nicety. Too much of the edge must not be included, as thus some excess would squeeze out round the stems when both halves are united, and thus probably lead to fouling of the peritoneum. Special care must be exercised to see that all mucous membrane of the edge must come inside the margin of pressure of the rims. Murphy claims that no suturing outside the line of pressure is needed to secure protection against infection of the peritoneum, but the author advises operators to make careful inspection and apply an extra Halsted or Lembert stitch at any point of apparent weakness or where the possibility of leakage is to be feared when the parts are returned to the cavity of the peritoneum. Indeed the utmost vigilance and carefulness are called for in intestinal surgery if the patient's life is to be saved.

Another very useful device is the bone bobbin of Mayo Robson. It serves perfectly the purpose of a frame over which the divided ends of the intestine may be united by sutures. In the earliest attempts to solve this problem cylinders of dried ox trachea or of some vegetable material were tried, but they were all found to lack durability and strength. Following the device of Senn's decalcified bone plates, Mr. Robson adapted the idea to a cylinder with admirable effect. The suitable-sized bone of an ox is immersed for twenty-four hours in a ten-per-cent. solu-

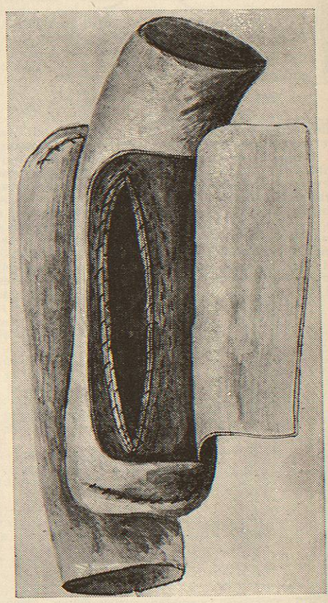

FIG. 2924.—Completed Lateral Anastomosis. (Abbe.)

tion of hydrochloric acid, which completely decalcifies it so that it may be shaped by a pen-knife to the proper form of a cylinder an inch or an inch and a half long with a furrow about its centre into which the sutured edges of the bowel may sink and thus secure the bobbin

from slipping up or down. The ends of the cylinder should taper slightly, in order to prevent necrosis from pressure against the wall of the bowel, and the calibre

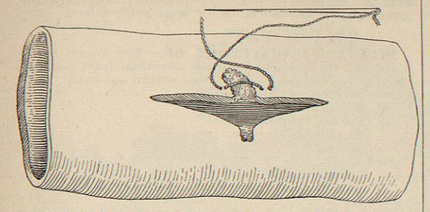

FIG. 2925.—Lengthwise Incision through Gangrenous Opening in Bowel and First Stitch. (Abbe.)

of the tube should be as large as is consistent with the required degree of strength, in order to prevent any blockade of intestinal contents. A brief immersion in

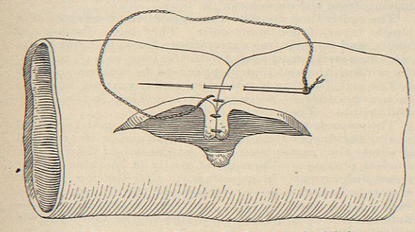

FIG. 2926.—Same. Progressive Inversion by Stitches.

soda solution, just before the time when the cylinder is about to be used, neutralizes the remnant of acid in the bone.

This bone cylinder dissolves by natural digestion in the intestinal fluids in from two to five days; *i.e.*, it re-

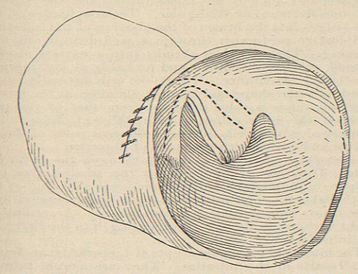

FIG. 2927.—Complete Restoration of Canal by Elbow of Bowel. (Abbe.)

tains its solidity for a sufficient length of time, and then disappears altogether. In gastro-intestinal anastomosis it is digested a little sooner than lower down, but remains firm and useful for a sufficient length of time. The continuous Lembert or Cushing suture of silk is used to join the serous edges, and to confine the bobbin, and the anastomosis can be done quickly.

Recently a device of McGraw has been added to the surgeon's armamentarium. The object of this is to do away with the necessity of making two long incisions in the bowel at points which are opposite to each other. McGraw's plan is based upon the employment of a round india-rubber ligature, 2 mm. in diameter and tapering at the end to such a degree that it may be threaded into a large needle. The latter, when thus threaded with the rubber ligature, is introduced by him through the walls of the intestine and out again at two points, corresponding to the ends of the proposed line of junction. The rubber is drawn after the needle and, through the effect of stretching, its diameter then materially diminishes, but afterward, when the stretching ceases, the cord resumes its full diameter and fills tightly the holes through which it has been passed. The operation is completed by repeating this puncture on the opposite bowel and tying the elastic ligature tightly. Thus the two lines of proposed anastomosis opening are tightly confined in the bite of the elastic ligatures, which cut through in a few days and are cast off into the bowel, but only after a channel between the two portions of the intestine has been completely established. Meanwhile reparative lymph seals the opposite surfaces of the intestinal peritoneum together and no leakage occurs during the process. This is practically the quickest method yet devised, and awaits further indorsement after a fair trial by the profession. Thus far, the few cases in which it has been used have given exceptionally fine results.

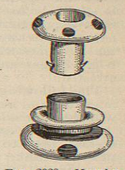

FIG. 2928.—Murphy Button. Lower part larger, as modified by Lilienthal.

In all work of a surgical character upon the intestines it is a cardinal principle that, whenever this is possible, it should be done outside the abdominal cavity; that is, when the involved part is isolated, it must be raised as far as possible and packed about with sterilized hot towels, or gauze pads (about six by twelve inches, each with its tape sewed to it hanging out of the wound with a clamp attached) placed so as to exclude the peritoneal cavity from possible soiling. The author has long been in the habit of having hot folded towels, taken from a steam sterilizer or wrung out of very hot water, frequently placed in the epigastrium during operation, and he regards the sustaining and stimulating effect on the solar plexus as of signal value, and it in no way interferes

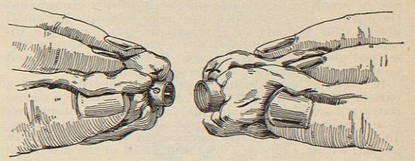

FIG. 2929.—Buttons Tied into Intestine, Ready to be Joined.

with the procedure of work. After the work of repair has been completed the parts are to be rinsed with warm saline solution, the packing is to be removed, and every part restored to its normal relations.

If the operator is satisfied with his work, it is far better to close the abdominal wound after drawing the omentum over the bowel than to place a drain in the cavity with the view of anticipating possible leakage; but if he has reason to believe that leakage may occur, he had best put a rubber or glass drainage tube in the immediate vicinity of the parts operated upon, leaving it there, however, for only two or three days.

It is not wise to apply packing of iodoform gauze over the surface of small intestines, inasmuch as fixation by lymph and the establishment of a blockade by kinking are likely to occur. This principle does not apply to the colon, however, upon which packing may freely be applied.

The after-care of cases of intestinal surgery is important and includes light fluid diet for four days, enemata every day, copious draughts of water or nutritious broths, gentle calomel action (gr. ¼ every quarter of an hour for six doses) on the morning of the third day. The author has made it a rule, in these cases, never to give salts after calomel—or indeed at any time soon after the operation—for the reason that no purgative is so likely to be repelled by the stomach; and if a reverse peristaltic action is initiated in vomiting, any natural downward peristalsis which is proceeding in the intestines will also be reversed and the wholesome relief of gas and intestinal contents will be abruptly arrested.

The following very brief review of the operations on intestines and maladies for which they will be required will aid the reader to comprehend the whole.

Enterotomy, or simple incision into the bowel, may be needed, first, to relieve accumulated gas, confined by stricture, kink, volvulus, or hernia; second, to remove an enterolith or foreign body held in the intestine (usually by stricture, due to the long detention in the bowel). In such an event a linear incision should be made in the intestine, just at the upper part of the foreign body. The latter is then worked back to the opening and removed, after which sutures are more safely applied than if the cut were made at the point of stricture. For gas distention or fæcal accumulation an incision can generally be sewed up tightly after evacuation. The parts are then rinsed and dropped back into the abdominal cavity. If relief is difficult, owing to arrest of peristalsis, there is little to be hoped for from evacuating gas, as the paralysis of the intestinal coats due to septic poison practically disables them from resuming their function.

If a gangrenous loop of bowel is resected and the patient's condition warrants it, anastomosis by Murphy button, thorough cleansing of the neighborhood and of the pelvis by pads wet with salt solution, will give the best results.

If the patient is in bad condition, an artificial anus is temporarily established by simple enterotomy.

Enterostomy, or permanent drainage of the small intestine, is a most undesirable procedure. A lateral anastomosis with a neighboring coil, or with the colon, should be preferred if the malignant growth, for example, cannot be removed safely and one must simply circumvent the obstruction. Simple suture may be ample for small ulcers, stab wounds, or perforations, but for larger ulcers one may be obliged to do the elbow suture, described above, or stitch the rent to a neighboring sound bowel surface, or use a button anastomosis.

In typhoid perforating ulcer the author has tried a variety of operative methods, and is disposed to advise putting a small button into the fistula and anastomosing it to a near-by part of the caput coli or ascending colon. This advice is given, first, because the ulcer is generally located within a foot or a foot and a half of the ileo-cæcal valve, and consequently no serious amount of intestine would be put out of commission. In the next place, there would be easy and certain discharge of gas and intestinal contents into the colon. Third, it leaves the operator the greatest liberty to wash out the abdominal cavity thoroughly with salt solution and close it by strapping without sutures, after drawing the omentum well down over the intestines and laying iodoform gauze between the edges of the wound and upon the omentum. A pelvic drainage tube is advisable but not always essential. Avoidance of abdominal wall sutures diminishes the likelihood of secondary infection cultures around the anæmic areas held tightly by the suture, at which points, in the author's experience, sepsis is apt to reoriginate.

Anastomosis.—"End-to-end" or "lateral" will be required when resection has to be done: first, to remove a malignant or non-malignant stricture; second, to circumvent an inoperable stricture; third, after resection for gangrene, for laceration, or for large perforations.

Robert Abbe.

INTESTINES, HISTOLOGY OF.—The layers recognized in a typical section of the intestinal tract (see Fig. 2934) are as follows, named from within outward:

Mucosa (Mucous Membrane).
  Epithelium.
  Tunica Propria.
  Muscularis Mucosæ.
Submucosa.
Muscularis.
  Circular Layer.
  Longitudinal Layer.
Serosa.
  Subserosa.
  Endothelium.

The *epithelium* lining the intestinal tract and its glands and covering its villi and valves is derived from the entoderm, or inner germ layer. It is the only portion so derived, the much more conspicuous remaining layers arising from the mesoderm.

The epithelium consists throughout the intestines of a single layer of columnar cells. They have distinct cell walls, and on their free extremities a thickened end-plate, with fine striations parallel with the long axis of the cell. In sections the end-plates appear to be continuous from cell to cell, forming a cuticular border, varying in prominence in different sections. It is lacking in the glands and crypts. There are no cilia.

The rounded nucleus of the epithelial cell is placed nearer the deeper than the superficial end of the cell and divides the protoplasm into supranuclear and infranuclear portions. These differ greatly in function, and at times differ greatly in appearance. Cell division (mitosis) occurs only in the deeper portions of the crypts, and the cells here formed move to the more superficial regions and up on to the villi, so that tips of the villi bear the oldest cells.

Mucus appears in the supranuclear portions of the epithelial cells—probably it may appear in any—in the form of small vacuoles, which increase in size or fuse. Further increase of the mucus causes the cell to bulge laterally at the expense of its neighbors, and gives it its characteristic shape and name—"goblet cell." The protoplasm and nucleus are pushed down and the nucleus becomes flattened or triangular. The free border of the cell bulges into the lumen of the gland or of the intestine, and finally perforates through a well-defined, circular opening. The cell then shrinks into a narrow, deeply stained, rod-like structure, and probably at last resumes its original appearance. The goblet cells are easily recognized by their shape and by their staining, as the mucus generally takes a color different from that of the protoplasm, the color differing with different stains. The number of goblet cells differs in different parts of the intestine and varies with the stage of digestion.

Leucocytes are often observed between the epithelial cells. They are recognized by the smaller size and deeper staining of the nucleus compared with that of the epithelial cell. The nucleus is usually surrounded by a pale halo, representing the protoplasm. According to Stöhr they are in the act of wandering into the lumen of the intestine.

The intestinal glands or crypts of Lieberkühn are found in all parts of the intestine. They are simple tubular glands, seldom branching. They extend nearly down to the muscularis mucosæ. Goblet cells are present except in the extreme fundi. Evidences of cell division are present, as has already been said, in their deeper portions, and where it occurs the nuclei move nearer to the exposed ends of the cells and out of the row formed by the other nuclei. They differ but slightly in different regions of the intestines.

Beneath the epithelium there is a basement membrane, upon which the cells rest. Opinions as to its structure and significance differ.

The *tunica propria* throughout the intestines consists of typical reticular tissue containing lymph cells. Mall describes three kinds of fibres found in the various forms of connective tissue—white, fibrillated fibres, yellow elastic fibres, and reticulum fibres. He shows that the mucous membrane of the intestine contains none of the elastic structures, and but few of the white fibrils. The reticulum is, however, unusually well developed. In the tunica propria are found numerous capillaries, some of whose branches make networks about the glands and in the villi; lymph spaces, and smooth muscle fibres derived from the muscularis mucosæ. There are also numerous leucocytes, particularly lymphocytes. These are in some places collected into masses, forming the Peyer's patches and solitary nodules, presently to be described.

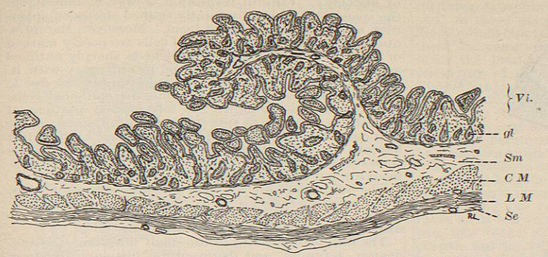

Fig. 2930.—Small Intestine. Longitudinal Section of Wall of Human Jejunum, showing One of the Valvulæ Conniventes. (From author's own drawing.) *Vi*, Villi; *gl*, glands or crypts of Lieberkühn; *Sm*, submucosa; *C M*, circular muscle layer; *L M*, longitudinal muscle layer; *Se*, serosa.

The *muscularis mucosæ* consists of a delicate sheath of non-striated muscle fibres, lying between the tunica propria and the submucosa. The fibres are arranged in two layers like those of the muscularis proper—an inner circular and an outer longitudinal. Fibres branch off from the muscularis mucosæ and run up between the glands and into the villi. The function of this layer is to compress the mucous membrane and thus aid the passage of fluids through it.

The *submucosa* is a wide layer of loose areolar connective tissue. The elastic network is fairly well developed. The layer contains numerous blood-vessels, and through it must also pass nerve fibres and lymphatics. Fat cells are often observed.

The *muscularis* is composed of involuntary or smooth fibres arranged in two compact sheets or layers. The inner layer has its fibres arranged circularly about the lumen of the intestine. The outer layer is composed of fibres running longitudinally. The proportionate thickness of the two layers varies but little. The circular sheath is much the thicker, as the drawings illustrating this article show. The arrangement of the muscular layers is essentially alike throughout the intestine. It is evident that by observing the direction of the fibres we can always tell the direction in which a given section was cut. Thus a section parallel to the long axis of the intestine always cuts the fibres of the outer layer of muscles longitudinally and those of the inner layer across. A section cut across the lumen of the intestinal tube always shows an inner layer of muscle fibres cut longitudinally and an outer layer cut across.

The *serosa* is the outermost layer. In consists of a thin sheet of connective tissue, the subserosa, separating the peritoneal endothelium from the outer muscular layer. The peritoneal endothelium consists of a single layer of greatly flattened cells, so thin that in cross sections under ordinary powers of the microscope they appear like slender lines in which the nuclei are bulging dots. In cross sections it will be seen that where the intestinal tube is attached to the mesentery, the peritoneal later is continued over on to the latter, while the subserous connective tissue is thickened and continuous with the connective tissue of the mesentery and with the adventitia of the vessels entering and leaving the intestine at this point. The peritoneal endothelium is of course lacking over portions of the intestinal tube, where the latter is attached directly to the abdominal wall, without mesentery, as in the ascending and descending colon, the duodenum and the rectum.

The Small Intestine.—This part of the alimentary canal is characterized by the presence of villi. These are found nowhere else in the intestinal tract.

Villi are finger-like projections of the mucous membrane into the lumen of the intestine, involving the epithelium and tunica propria (see Figs. 2930, 2933, and 2931). They are about a millimetre high. The inner surface of the intestinal canal is thickly studded with them all the way from the pylorus to the ileo-cæcal valve. They are so numerous that hardened specimens have the appearance of velvet. Their number has been

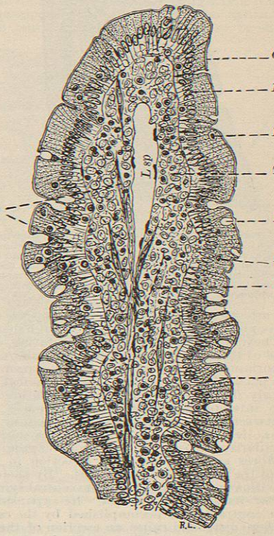

Fig. 2931.—Villus from Small Intestine of Java Monkey, showing Dilated Central Lymph Space (*L sp*). (From author's own drawing.) *Cu*, Cuticular border of epithelial cells; *N e*, nucleus of epithelial cell; *L*, lymphocytes; *T P*, tunica propria; *M*, mucous cells; *Ves*, blood-vessel; *Mus*, smooth muscle fibres; *L sp*, central lymph space.