

gall bladder. The succeeding part of the liver is the quadrate lobe, lying in front of the lesser omentum. Finally, the under surface of the left lobe overlaps the lesser curvature and upper part of the anterior surface of the stomach.

The right surface lies internal to the seventh, eighth, ninth, tenth, and eleventh ribs, being separated from them by the diaphragm, and being overlapped above by the lung. Many clinical facts of importance can be learned by a close study of these relations. In gunshot and stab wounds of the lower part of the thoracic wall, lung, pleura, diaphragm, peritoneum, and liver may all be involved. The end of a fractured rib may penetrate the liver. Abscesses of the liver may extend through the diaphragm and open into the pleural cavity or when this is obliterated by adhesions, into the lung, and a bronchus. Behcet, an enlargement of the liver may retard the circulation in the aorta, the vena cava, or the thoracic duct. Below, the close relations of the stomach, duodenum, and colon explain the ease with which adhesions develop between these organs, and disease spreads from one to the others.

During inspiration, the liver descends about the breadth of one intercostal space. The lower border is more easily palpable in the erect posture than in the recumbent, as in the latter it rests somewhat behind the costal arch. These changes in position, especially the first, may serve to distinguish a tumor or swelling of the liver from one of the stomach, kidney, adrenal gland, or pancreas. The peritoneal relations of the liver are extensive and important. For the most part its surface looks into the general peritoneal cavity, and the reflections of the peritoneum from the abdominal wall and diaphragm are the principal agents in supporting, or rather suspending, the organ. A small part of its posterior surface is not visible from the greater cavity, as it looks into the lesser. This corresponds in extent to the Spiegelian lobe. A second area of the posterior surface, between the layers of the right coronary ligaments, is not covered by peritoneum; it lies in contact with the diaphragm. This locality is the favorite seat of subphrenic abscesses, and here they most easily spread to the pleura and lung.

The artery of the liver is the hepatic branch of the coeliac axis. It reaches the organ between the layers of the lesser omentum, and entering at the transverse fissure its branches accompany those of the portal vein.

The portal vein, formed behind the head of the pancreas by the union of the superior mesenteric, splenic, inferior mesenteric, and the veins of the stomach, also ascends in the lesser omentum to the transverse fissure. In the substance of the liver its branches are situated within the portal spaces, *i. e.*, outside the lobules, before

entering the intralobular capillaries. They are distinguished by their relatively thick walls and collapsed state on cross section. An infective thrombo-phlebitis in a distant part of the abdomen or pelvis may be followed by a metastatic abscess or abscesses in the liver, a phenomenon explained by the anatomy of the portal circulation.

The hepatic veins are remarkable for their thin walls, which, closely connected with the surrounding liver substance, stand widely open on section. Consequently a rupture or incised wound of the liver bleeds with great freedom and the bleeding has little tendency to cease spontaneously. The hepatic veins emerge on the posterior surface of the liver, entering immediately the inferior vena

cava within half an inch to an inch from its termination in the right auricle. They have no valves; consequently the circulation in them is easily impeded. In some forms of valvular heart lesions, — *e. g.*, tricuspid insufficiency, — the pulsation of the heart may be transmitted through them to the liver.

The excretory apparatus of the liver consists of the hepatic duct, the cystic duct and gall bladder, and the common duct. The gall bladder, three or four inches in length and with a capacity of from one to two ounces, is held in position on the under surface of the liver by the peritoneum. As a rule, it is closely applied to the liver substance, lying in a distinct fossa; but it may hang free, completely invested by peritoneum and suspended by a mesentery. Its fundus projects beyond the lower border of the liver opposite the ninth costal cartilage. It is directed downward, forward, and to the right, while the neck is in the opposite direction. Immediately below it are the transverse colon, duodenum, and sometimes the pylorus of the stomach. The relation to the colon is most constant and important. An artificial opening is sometimes formed between the two organs, and

through it the feces may be passed. The ducts are all situated between the layers of the lesser omentum and can be readily exposed by removal of its anterior lamina. The gastric vein, hepatic artery, and hepatic nerves are found in the same space, but the ducts are anterior to them, and among the right free edge of the omentum. In making a dissection, or in an operation, the position of Wislizenus's duct first be located, and with the fingers of the left hand to it for a guide an exposure can be easily accomplished. The cystic duct, arising at the neck of the gall bladder, is an inch and a half in length. It is directed downward, backward, and to the left, to join the hepatic duct at an acute angle. The hepatic duct, about two inches in length, is directed downward, backward, and to the right. It arises at the liver by two main branches. The common bile duct, formed by the union of these two, continues the direction

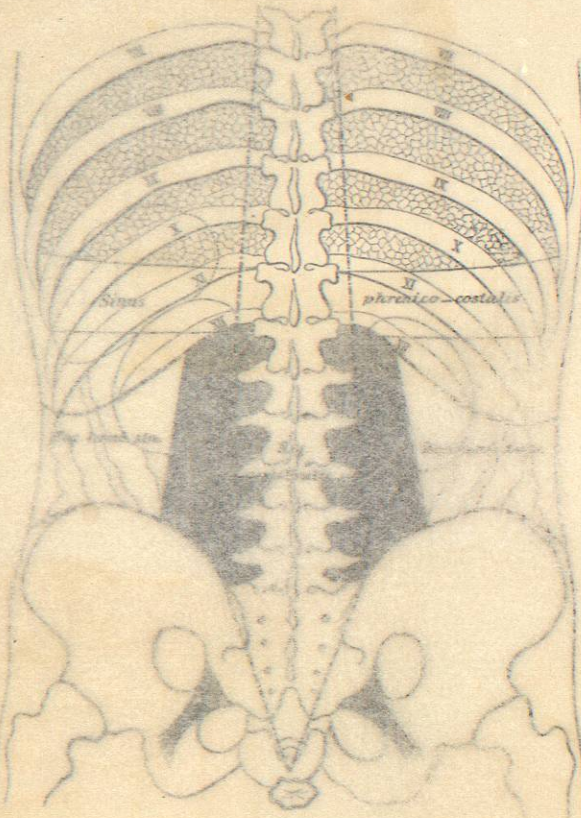
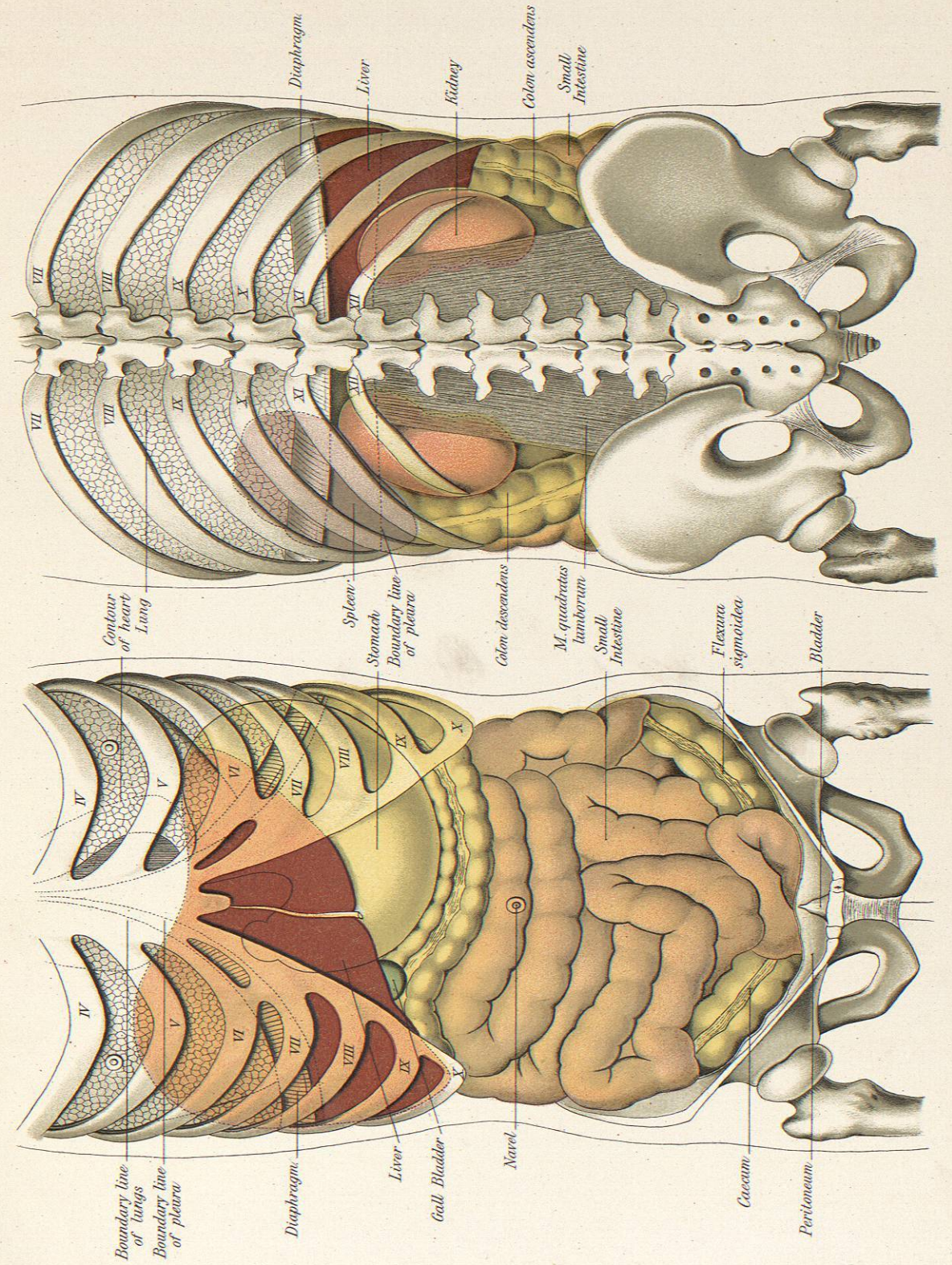


FIG. 9.—Regions of the Abdomen. Posterior view.



of the hepatic along the right free edge of the lesser omentum on the anterior surface of the portal vein, and to the right of the hepatic artery. Approaching the duodenum, the vein tends to the left, the duct to the right. This relation of the vein to the duct is remarkably constant, but the hepatic artery and its branches are subject to frequent variations which should be guarded against. As the common duct reaches the duodenum, it passes behind its first portion, then downward, between the second portion and the head of the pancreas; or it is embedded in the latter, from which point onward it accompanies the pancreatic duct into the lower part of the second portion of the duodenum. The duodenal orifice is markedly constricted, but just proximal to it the duct is dilated, forming a well-marked diverticulum. Consequently a calculus may successfully pass the entire duct, to be arrested at the terminal orifice. To cause a jaundice, calculi must be situated in either the hepatic or the common duct, for any number may occupy the gall bladder or the cystic duct, yet give rise to few or no symptoms as long as they remain there and the gall-bladder is not infected. Not all cases of jaundice are due to gall stones. Enlarged lymphatic glands in the lesser omentum, tumors of adjacent organs, especially of the head of the pancreas, hydatids, ascariis, adhesions producing flexures of the ducts, and many other causes have been noted.

The stomach varies in position and relations according to the degree of distention. When empty, it lies in the left hypochondrium and left half of the epigastrium, the cardiac orifice being four or five inches posterior to the interval between the seventh left costal cartilage and the ensiform process, on a level with the eleventh or twelfth dorsal vertebra. This is the most fixed portion of the stomach, and participates only slightly in any changes of position. The pylorus is in or near the mid-line, at the level of the last dorsal or first lumbar vertebra. It looks toward the right, and is the most movable portion of the stomach. Thus a tumor of the pylorus may be found in the central or lower part of the abdomen. The anterior and posterior surfaces are separated by sharp borders, and the entire viscus recedes from the anterior abdominal wall behind the liver.

When distended, the fundus fills the left cupola of the diaphragm, impinging upon the liver and heart. The great curvature comes in contact with the anterior abdominal wall in the subcostal angle, and may enter the left lumbar and umbilical regions. Immediately below it is the transverse colon. The pylorus moves to the right as much as two or three inches, and rotates so that it is directed backward, being concealed from in front by the dilated lesser cul-de-sac.

Relations. The anterior surface is divisible into two regions: the upper and right region, which includes the pylorus and cardia, and is overlapped by the right and left lobes of the liver; and the lower and left region, which may be subdivided into two, viz., the small triangular portion in contact with the anterior abdominal wall, and above this the portion lying behind the costal arch and diaphragm. The fundus is also overlapped by the lung and pleura in the fifth and sixth intercostal spaces. Here, again, a wound may involve both thoracic and abdominal viscera. Posteriorly, the stomach is in relation with the diaphragm, spleen, left kidney and capsule, pancreas and the splenic flexure of the colon, all of which taken together form for it a concave bed. The peritoneal relations of the stomach are complicated. Its anterior surface faces the greater peritoneal cavity, but the posterior surface is concealed behind the great omentum, which hangs from its greater curvature. Furthermore, joined to the posterior surface of the omentum are the transverse colon and the mesocolon. When the omentum is raised these structures are carried with it. Only by passing the finger through the foramen of Winslow can the posterior surface of the stomach be reached. In a dissection, however, one of two routes may be chosen. The first lies between the greater curvature and the transverse colon; the second passes through the transverse mesocolon. Surgeons choose the former. A peritonitis arising from perforation of the posterior wall

of the stomach, whether due to trauma or to disease, will at first involve the lesser cavity only and may be limited entirely to it. In operating for wounds of the stomach, the posterior surface should always be examined in the manner indicated. The lesser omentum is attached to the entire lesser curvature, while the gastro-splenic and greater omenta are continued from the greater curvature.

The arteries of the stomach are derived from the three branches of the coeliac axis, and reach the organ between the layers of the omenta. On the lesser curvature an arch is formed by the gastric and pyloric branches of the hepatic; on the greater, a similar arch is formed by the gastro-epiploic dextra and sinistra. From these arches transversely directed branches arise which anastomose near the centre of the surfaces. Incisions in the stomach wall are best made in the direction of the transverse branches, with the exception of the central region where the sets anastomose.

Small Intestines.—With the exception of the duodenum, the small intestines are surrounded throughout by peritoneum, and are suspended from the posterior abdominal wall by a mesentery.

The line of attachment of the mesentery extends from the left side of the second lumbar vertebra obliquely across the vertebral column, aorta, vena cava, and third portion of the duodenum to the right sacro-iliac articulation. Although this line is only six or eight inches in length, and the average width of the mesentery is eight or ten inches, it reaches at its convex intestinal edge a length of some twenty feet. The middle or lower intestinal loops have the widest mesentery and are therefore most likely to enter a hernia. Between its layers are the blood-vessels, lymphatics, and nerves of the intestine.

The duodenum is for the most part situated behind the peritoneum, a position which it acquired when the large intestine of the embryo crossed the small. Up to this time it possessed a mesentery, which then fused with the posterior body wall. The first portion of the duodenum is movable except at its distal end. With an empty stomach it is directed transversely; with a distended stomach, antero-posteriorly. Above, it is in relation with the liver and gall bladder; below, with the pancreas; behind, with the portal vein and common bile duct. Beneath the neck of the gall bladder, at a point opposite the first lumbar vertebra, it turns downward as far as the fourth vertebra, in front of the right kidney and vena cava, being crossed anteriorly by the meso-colon, above and below which it is covered by visceral peritoneum. Internally is the head of the pancreas, whose duct opens with the bile duct into the lower portion of the intestine. This constitutes the second portion, at the end of which the duodenum turns to the left across the spinal column and great vessels to ascend a short distance and end in the jejunum opposite the first or second lumbar vertebra. Note its relations to surrounding organs in connection with the spread of disease. It may be involved and the peritoneal cavity may escape. Wounds are serious because of its inaccessibility and its fixed position. With the exception of the first part, it cannot be raised into a laparotomy wound. Its arteries, forming an arch within the concavity, may be opened in a duodenal ulcer and may allow a fatal hemorrhage.

The jejunum and ileum include the remainder of the small intestines—two-fifths jejunum, three-fifths ileum. Although there is no distinct line separating them, each has distinctive characteristics. The walls of the jejunum are thicker and more vascular, the valvulae conniventes are numerous and perfectly developed, and the calibre is greater. Peyer's patches are larger and more numerous in the ileum. The coils of the small intestines have no fixed position, but one may expect to find jejunum in the umbilical, left lumbar, and left iliac regions, while the ileum tends more to the right side, toward the hypogastric region and toward the pelvis.

Because of their wide extent and exposed position the small intestines are frequently injured. The degree of injury may vary from slight contusion to complete rupture, and is greater the nearer it approaches the stomach and the more distended the coils happen to be.

The extent to which the abdominal wall is injured does not indicate the severity of the visceral injury, for the most extensive laceration may follow a blow which scarcely leaves a mark upon the skin. The great dangers are hemorrhage and fecal extravasation, especially the latter. It occurs more rapidly from distended coils, and they are the ones most frequently injured. A longitudinal wound gapes more widely than a transverse, the edges being separated by the strong circular muscular fibres. A small penetrating wound may be plugged by everted mucous membrane. A wound in the mesenteric border is most difficult to repair. A gunshot wound in the lower left quarter of the abdomen will certainly inflict multiple intestinal injuries. As a rule, however, they will be found in a comparatively short loop of intestine, with a few scattered in distant coils.

Large Intestine.—Of this there are the following divisions: cæcum, ascending, transverse, and descending colon, sigmoid flexure, and rectum.

It is distinguished from the small intestines by its larger size, by its more fixed position, and by the appendices epiploicæ. Furthermore, the longitudinal muscular fibres which are spread in an even layer over the small intestines are gathered into three well-marked bundles on the surface of the colon. These are about one-half the length of the remaining colon layers, and so throw it into sacculations separated by transverse constrictions, which project into the lumen of the bowel as plicæ or valvulæ sigmoïdæ. The length of the large intestine is five or six feet; its capacity is about one gallon. The cæcum—that part of the large intestine below the ileo-colic opening—is situated in the right iliac fossa, upon the ilio-psoas muscle. Anteriorly, it is in contact with the anterior abdominal wall above the outer half of Poupart's ligament, except when the omentum is interposed. Its exact position depends upon its peritoneal relations. As a rule, it is completely invested by peritoneum, though it has no meso-cæcum. In a small percentage of cases the upper part of the posterior surface is not covered by peritoneum, and so comes in contact with the areolar tissue of the posterior abdominal wall. It may be long and movable, its free extremity hanging into the pelvis or projecting across the mid-line to the opposite side of the body. Or it may be situated at any point between the iliac fossa and a position immediately beneath the liver, this being its location in the embryo of three months. The later variation occurs in consequence of an arrest of its normal descent into the false pelvis.

When the posterior wall of the cæcum is not entirely covered by peritoneum, an infection readily travels from it to the areolar tissue about the right kidney. The *appendix vermiformis* originally arose from the apex of the cæcum, but, as the right half of the latter exceeds the left in development, the adult appendix arises from its inner and posterior surface a little below the ileo-colic opening. Its average length is between three and four inches, but it may vary from one to nine. Its cavity, lined by mucous membrane continuous with that of the cæcum, tends to undergo obliteration with advancing age. The lumen is narrowest at the orifice, which is guarded by a valve of mucous membrane. It is enveloped by peritoneum throughout, and is provided with a triangular mesentery derived from that of the small intestines. The mesentery is rarely complete, allowing the end to hang free. Within the mesentery is a branch of the ileo-colic artery, furnishing its blood supply. The exact position of the appendix is variable, but it will always be found by following one of the longitudinal bands of muscular fibres seen on the surface of the colon. Two main positions are observed. In one, the appendix is truly an intraperitoneal organ hanging free from the cæcum. It may be directed inward and upward, or downward; it may be curled on the brim of the pelvis or may hang into the pelvic cavity; or it may occupy one of the fossæ about the cæcum. In the second position the appendix is practically an extraperitoneal organ, lying between the posterior surface of the cæcum and the colon. The base of the appendix, as indicated by McBurney's point, lies two inches from the

spine of the ilium on a line drawn from the spine to the umbilicus.

The ascending colon reaches from the cæcum to the under surface of the liver, passing through the right lumbar region into the hypochondrium. Here it turns to the left and becomes the transverse colon. As a rule, it has no mesentery, being held in position by the peritoneum which covers its anterior surface and sides. Behind, it is separated by loose areolar tissue from the quadratus lumborum and transversalis muscles and the lower and inner part of the right kidney. In front it is in contact with the anterior abdominal wall, omentum, and a few coils of the small intestines. The relation to the anterior surface of the kidney is most important. An abscess of the kidney or a perinephritic abscess may open into it without involving the peritoneum. A kidney enlarged from infection or a tumor carries the colon forward on its anterior surface. This may be determined by inflation of the colon. The transverse colon suspended by a meso-colon is deeply placed at its ends, but comes in close contact with the anterior abdominal wall in the remainder of its course. As a rule, it lies along the sub-costal line, but may descend as far as the pelvis. Above, it is first close to the fundus of the gall bladder; adhesions between the two are common, and calculi may ulcerate into it from this viscus. The greater curvature of the stomach and the lower end of the spleen lie above in the remainder of its course.

The descending colon begins at the splenic flexure, at which point it is situated deeply in the left hypochondrium. From here it descends through the left lumbar region along the outer border of the kidney. Its peritoneal relations resemble those of the ascending colon. A relation worthy of notice is that to the kidney. The left kidney lies more internal to the descending colon than the right does to the ascending colon. Anteriorly, the descending colon is more constantly covered by omentum and small intestine than is the ascending.

Fæcal matter may accumulate in the colon in any part to such an extent as to simulate a true tumor; consequently colonic flushing is always a wise procedure in the examination of an intra-abdominal growth.

The sigmoid colon, continuing the descending colon, extends from the iliac crest to the third sacral vertebra, at which point it becomes the rectum.

It is provided with a mesentery attached transversely in front of the psoas muscle. Its length and position are variable. It may form a perfect loop occupying the pelvis, or, when the bladder and rectum are distended, lying near the umbilicus. At times it rests in the left iliac fossa. It is this loop which surgeons open in a left inguinal colostomy. In the descending colon, the opening may be made through the posterior abdominal wall without exposing the peritoneal cavity, but as the position of the artificial anus is an awkward one for the patient the operation has been abandoned. The remaining portion of the large intestine is the rectum, situated within the true pelvis, with which it is usually described.

The *spleen* is situated obliquely behind the stomach in the epigastric and left hypochondriac regions. It lies beneath the eighth, ninth, tenth, and eleventh ribs; its long axis, measuring five or six inches, corresponds in direction with the tenth rib. It is separated from these ribs above by the lower border of the lung and pleura, and throughout by the peritoneum and diaphragm. A normal spleen cannot be palpated. The enlarged spleen appears beneath the costal arch at the level of the tenth and eleventh ribs. It may be distinguished by the notches, one or two, in its anterior border and by its respiratory movement. Unlike the movement of the liver, which is vertical, the movement of the spleen is oblique, that is, toward the umbilicus. The dullness of the spleen as outlined by percussion is an oval area extending from the ninth to the eleventh rib in the posterior axillary line. Four surfaces are described on the organ, each indicating a relation to a neighboring viscus. The phrenic surface is in contact with the diaphragm. The renal surface, directed downward and inward, is in contact

with the left kidney. The gastric surface faces forward and inward and is in contact with the posterior surface of the stomach; on this surface is the hilum. Finally, the lower blunt end is the basal surface resting upon the splenic flexure of the colon and the tail of the pancreas.

The peritoneal relations of the spleen are extensive. With the exception of the small region corresponding to the hilum it is covered by the visceral peritoneum of the greater sac. The blood-vessels and nerves reach the organ between the layers of the gastro-splenic omentum.

Wounds of the spleen are accompanied by severe hemorrhage. When it is extreme it may become necessary to remove the organ for this reason.

The *pancreas*, situated behind the stomach, in front of the first and second lumbar vertebrae, reaches from the concavity of the duodenum on the right to the spleen on the left. On the surface of the abdomen its position is from two and one-half to five inches above the umbilicus. To expose the pancreas the lesser peritoneal cavity must be opened. It is then seen lying behind the posterior layer of this cavity. It can be palpated only when pathologically enlarged, as by a carcinoma or cyst. The organ does not move with respiration.

The anterior surface of the pancreas is in contact with the posterior surface of the stomach, while the posterior surface lies in front of the aorta, the superior mesenteric artery, the splenic vein, and the left kidney with its vessels. The head is encircled by the duodenum. The pancreatic duct crosses the gland from left to right, and is buried in its substance close to the posterior surface. Its course is straight until it reaches the head, at which point it turns obliquely downward to enter the second portion of the duodenum, close to or in common with the bile duct. Retention cysts of the duct or of some of its smaller branches occur, and may attain a large size. In general appearance such a cyst resembles a solid or a cystic tumor of the kidney, the differential diagnosis being at times impossible.

Kidneys.—For the greater part the kidneys are situated deeply in the hypochondriac regions, their lower ends, however, extending into the adjacent lumbar and umbilical regions. In consequence of the position of the liver on the right side, the right kidney is somewhat lower than the left. As regards the vertebral column, the kidneys are opposite the twelfth dorsal, the first and second, and sometimes the third lumbar vertebrae. The upper end of the right kidney reaches a line drawn transversely outward from the tip of the spine of the eleventh dorsal vertebra. Its lower border reaches a similar line drawn from the lower edge of the spine of the second lumbar vertebra. This line is usually about an inch and a half above the iliac crest. Its upper end is nearer the spinal column than the lower. The pelvis of the organ is opposite the transverse process of the second lumbar vertebra.

Relations. The posterior surfaces are similar, but the anterior surfaces differ on the two sides. Posteriorly, the kidneys are not covered by peritoneum, being connected by areolar tissue with the diaphragm, the anterior layer of the lumbar aponeurosis covering the quadratus lumborum, and, more internally, the psoas magnus muscles. Above, the relation to the diaphragm is important, as this structure separates the kidney from the twelfth rib, and sometimes, on the left side, from the eleventh. An inspection of Plate I. will show that the pleura descends over the inner ends of these ribs, and so lies between the upper ends of the kidneys and the surface of the body. Notice especially that the pleura does not descend below the angle formed by the lower border of the twelfth rib and the outer edge of the quadratus lumborum muscle. However, the development of the twelfth rib is not constant, it being incompletely developed or entirely absent in many cases. The individual cases can be recognized only by counting the ribs. On the other hand, the lower limit of the pleura and its relation to the kidney are constant, and in a case of anomalous twelfth rib the pleura will lie unprotected by rib in this locality. The importance of this condition will be appreciated later.

Anteriorly, the right kidney has the following relations:

At the extreme upper end is a small non-peritoneal surface in contact with the suprarenal capsule, below and external to which is a large peritoneal surface in contact with the liver. The area about the hilum is non-peritoneal and is in contact with the descending portion of the duodenum. Below this region and internal to the liver area are two regions: an outer non-peritoneal covered by the colon, and an inner peritoneal covered by coils of small intestines.

The anterior surface of the left kidney is crossed just above its centre by the pancreas, no peritoneum intervening. Above the pancreatic surface three organs are in relation with the kidney: the suprarenal capsule, the stomach, and the spleen—the first being the only organ not separated by peritoneum. Below the pancreas the surface is largely covered by peritoneum and small intestines, the exception being the outer border, which lies behind the colon. From the description of the situation and relations of the kidney a number of practical points are evident. As a general rule, it is safe to say that a palpable kidney is enlarged. Only in very favorable subjects, especially thin women, in whom the organ is frequently lower than normal, can we certainly feel the normal kidney, and then only the lower third, as the upper two-thirds lie behind the lower ribs. Bimanual palpation should be used, the hand placed in the loin being depended upon to lift the kidney against its fellow which presses upon the abdomen. In this connection note the position of the colon; it is nearly over the centre of the right kidney, but to the left of or outside the left kidney. The kidney has no respiratory movement. It is recognized by its characteristic shape, and, when possible, by the large artery which enters the hilum. The kidney may be reached through the loin or by way of the peritoneal cavity. In the former method various incisions are employed. The most important landmarks are the outer edge of the quadratus lumborum muscle and the twelfth rib. In all incisions it should be remembered that the pleural cavity is near, and it should be avoided. As indicated above, when the twelfth rib is of normal development, an incision may be carried closely into the angle between this muscle and the ribs. When the rib is short or absent, which is to be determined only by careful examination, then the location of the normal rib should be borne in mind, and the incision should be carried no farther than the normal angle. The attachment of the quadratus to the eleventh rib in these cases should not mislead one. The ureters occupy a position in the hilum posterior to the artery and vein. Their average length is seventeen inches. Beginning as a well-marked dilatation, called the pelvis of the kidney, the ureter passes downward on the psoas magnus as far as the brim of the true pelvis, which it enters by crossing either the common or the external iliac artery. It is accompanied by the spermatic vessels in the male, and by the ovarian in the female. This portion of the ureter may be reached through the post-peritoneal space. In searching for it the operator must raise the parietal layer of the peritoneum, to which structure it will be found adherent.

The *peritoneum* is a closed serous sac with the exception of the tubal openings in the female. It appears as though placed within the abdominal cavity in front of the viscera, the anterior or parietal layer of the sac lining the posterior surface of the antero-lateral wall, while the posterior or visceral layer is tucked about the viscera, enclosing them more or less completely, and attaching them to the abdominal walls. The exact relations of the membrane to the individual viscera have been noted in the descriptions of them, and are of importance in the spread of disease from viscera to peritoneum. Many injuries and diseases of the abdominal viscera are dangerous only as they involve the peritoneum. It is a well-known fact that an infection approaching the membrane from its outer surface is of much less danger than one approaching from the inner. The former is soon localized and results in the formation of an abscess; absorption of toxins is slight. When the inner surface is infected, the tendency of the disease is to spread rapidly, and the absorption of septic toxins is intense. These phenomena are explained by the microscopical structure of the peri-