called *frænum linguæ*, is prolonged to the middle line of the under surface of the tongue.

In its structure the mucous lining of the mouth consists of a stratified pavement epithelium, and a sub-epithelial fibro-vascular corium, possessing numerous vascular papillæ. The mucous membrane of the gum is characterized by its density and toughness, due to the numerous strongly developed bundles of connective tissue in the corium, many of which are continued into the fibrous tissue of the periosteum, which covers the alveolar surface of the jaw. The free surface of the corium of the gum possesses numerous broad papillæ, and is covered by a stratified pavement epithelium similar to that in the lips and cheeks. The mucous membrane of the hard palate is also tense and tough, though not so much so as the gum; and the fibrous fasciculi of its corium blend with the connective tissue of the subjacent periosteum. The mucous lining of the mouth is a sensitive membrane, and receives its nervous supply from the fifth cranial nerve.

The mucous membrane of the mouth is specially modified on the dorsum of the tongue, in the interval between the circumvallate papillæ and the epiglottis, and in the substance of the tonsils, by the development of collections of lymphoid tissue in the sub-epithelial connective tissue.

Tonsils.

The *Tonsils* are two almond-shaped bodies, situated, one on each side of the posterior orifice of the mouth, in the fossa between the anterior and posterior pillars of the soft palate. Their normal size is not bigger than a hazel nut, but they are very apt to enlarge, grow inwards across the posterior aperture of the mouth, and diminish the size of that opening. The free surface is marked by several rounded holes, leading into shallow pits or crypts, which may be either simple or branched, in the substance of the tonsil. The pits are lined by the epithelial covering of the mucous membrane, into which minute papillæ project. In the sub-epithelial connective tissue of the walls of the crypts numerous follicles of lymphoid tissue are situated, and lymph cells are infiltrated in great numbers in the connective tissue between the follicles. Interspersed amidst the crypts are small racemose mucous glands. The tonsils are very vascular, and capillary blood-vessels are distributed in connection with the papillæ, the lymphoid tissue, and the racemose glands. The tonsillar veins form a plexus in relation to the attached surface of the tonsil.

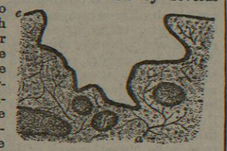

FIG. 1.—Vertical section through one of the tonsils, to show a pit vertically divided. *e*, its epithelial lining; *f, f*, lymph follicles; *l, l, l*, lymph cells diffused in the connective tissue; *a*, small artery ending in capillary blood-vessels. Slightly magnified.

Glands of the mouth.

Mucous and Salivary Glands of the Mouth.—The ducts of numerous glands, engaged in secreting mucus and saliva, open on the free surface of the mucous membrane of the mouth. Their secretion not only keeps the mouth moist, and aids therefore in articulation, but by mingling with the food assists in mastication, deglutition, and the digestive process. Each gland is characterized by being divided into small lobules, and by possessing a duct or ducts, which branch off in an arborescent manner in the substance of the gland, and finally end in the minute lobules. They all belong to the compound racemose group of glands.

The mucous glands of the mouth are situated beneath its mucous lining in the following localities:—(*a*) *labial* glands, in the upper and lower lips, but absent at the angles of the mouth; (*b*) *buccal* glands, scattered on the inner surface of the cheek from the lips to the opening of the parotid duct; (*c*) *palatine* glands, on the oral surface of the hard palate, in the uvula, on both surfaces of the soft palate, and in the tonsils; (*d*) *molar* glands, close to the last lower molar tooth on each side; (*e*) *lingual* glands, extending backwards from the tip of the tongue along its margin, and also on its dorsum between the circumvallate papillæ and epiglottis. The ducts of these mucous glands consist of a delicate membrane lined by a single layer of columnar epithelial cells. The terminal branches of the ducts which enter the lobules end in a series of saccular dilatations, the *acini*, *alveoli*, or *gland-vesicles*, which contain rounded or polygonal secreting cells. A collection of such vesicles forms a lobule. The lobules are bound together by intermediate connective tissue, in which the blood-vessels divide into a capillary network, that ramifies on the outer surface of the delicate membrane forming the wall of the gland-vesicles.

The salivary glands of the mouth are the parotid, submaxillary, and sublingual glands. The *parotid gland* is the largest salivary gland, and occupies the parotid hollow between the lower jaw and the external ear. Its anterior border overlaps the masseter muscle, and the excretory duct emerges out of this border. A prolongation of gland substance, the *socia parotidis*, frequently accompanies the duct for a short distance. The excretory duct of the gland, called *Stenson's duct*, passes forwards superficial to the masseter muscle, then pierces the cheek, and opens on its inner surface opposite the second upper molar tooth. The duct is between 2 and 3 inches long, and about the thickness of a crow-quill. The *submaxillary gland* is situated immediately below the lower jaw. The excretory duct of the gland, called *Wharton's duct*, runs forwards and opens on the floor of the mouth by the side of the frænum linguæ. The *sublingual* is the smallest of the salivary glands, and lies under the mucous membrane of the floor of the mouth, close to the frænum linguæ. It possesses from ten to twenty small excretory ducts, the *ducts of Rivinus*, some of which join Wharton's duct, though the greater number open directly on the floor of the mouth near the frænum linguæ.

Structure.—The ducts of the salivary glands branch and terminate in the lobules,—each terminal duct ending in a series of saccular dilatations, the *acini*, *alveoli*, or *gland-vesicles*, the wall of which, formed apparently of a membrana propria, is continuous with the simple membranous wall of the terminal duct. The terminal ducts are lined by a layer of squamous epithelium, and the gland-vesicles contain the secreting cells.

The blood-vessels are distributed in the interlobular connective tissue, and form a capillary network on the wall of the gland-ducts, and on the wall of the gland vesicles.

The *Pharynx* is an irregularly dilated canal, which forms a common passage, connecting the mouth with the œsophagus, and the nose with the larynx, so as to be subservient to the processes both of deglutition and respiration. Its position and connections have been described under the heading ANATOMY.

The wall of the pharynx consists of three coats—an external muscular and an internal mucous coat, and an intermediate fibrous membrane, which blends with the submucous coat. The *muscular coat* consists of three pairs of circularly arranged muscles, the constrictors of the pharynx; and of two pairs of longitudinally-arranged muscles, the stylo-pharyngei and plato-pharyngei, with occasionally a third pair, the salpingo-pharyngei. The constrictor muscles extend from the lateral wall to the middle line of the posterior wall of the pharynx, and are named from below upwards the inferior, middle, and superior constrictors; they lie on three different planes, so that the inferior constrictor overlaps the middle, and the middle the superior.

The *mucous coat* of the pharynx lines the canal, and is continuous through the several openings with the mucous membrane lining the Eustachian tubes, nose, mouth, larynx, and œsophagus.

The epithelium covering the mucous membrane of the nasal part of the pharynx is columnar and ciliated over a considerable surface, but elsewhere the pharyngeal epithelium is tesselated and stratified; and in the latter localities, vascular papillæ project into the epithelial layers. Small racemose glands lie beneath the mucous membrane, which is pierced by their ducts to open on the surface (fig. 2); they are most numerous in the nasal part of the pharynx. Collections of lymphoid tissue are found in the sub-epithelial connective tissue, more especially in the nasal part of the pharynx, where it forms a mass, extending across the posterior and upper wall, between the openings of the two Eustachian tubes, which Luschka has called the *pharyngeal tonsil*. The arteries of the pharynx are derived from the external carotid or some of its branches. The motor, sensory, and sympathetic nerves unite to form the pharyngeal plexus situated behind the middle constrictor muscle.

FIG. 2.—Vertical section through the mucous membrane of the pharynx, to show the racemose glands. *e*, the epithelium; *cf*, subjacent connective tissue; *g*, racemose gland; *d*, its duct; *a*, artery ending in a capillary plexus on the gland vesicles. × 40.

The *Soft Palate* forms an inclined plane, which projects, downwards and backwards into the pharynx, from the posterior border of the hard palate. It is less dependent at the sides than in the mesial plane, where it forms an elongated body, the *uvula*. Its anterior or oral surface is smooth, and gives origin on each side to a fold, which curves downwards to the side of the root of the tongue, to form the *anterior pillars of the palate or fauces*. Its posterior or pharyngeal surface, also smooth, gives origin on each side to a fold, which, springing from the base of the uvula, curves downwards and backwards to be lost in the side-walls of the pharynx; this pair of folds forms the *posterior pillars of the palate or fauces*. The soft palate is complex in structure, and consists of muscles, mucous membrane, glands, blood and lymph vessels, and nerves. The muscles of the soft palate are arranged in two groups, those which elevate and make it tense and those which constrict the fauces.

The mucous membrane of the soft palate is continuous with that of the mouth and pharynx. The epithelium covering the anterior or oral surface is a stratified pavement epithelium. That on the posterior or pharyngeal surface is in infancy a laminated cylindrical and ciliated epithelium, with isolated areas of pavement epithelium, but in adults it is a laminated pavement epithelium. Numerous racemose mucous glands lie beneath the mucous membrane, but much more abundantly on the oral than on the pharyngeal aspect. Collections of lymphoid tissue, similar to those found in the tonsils, are also met with. The arteries are branches of the internal maxillary, facial, and ascending pharyngeal. The veins of the soft palate often assume a dilated character, and are continuous with the pharyngeal veins. Lymphatics are also distributed beneath the mucous membrane.

The *Œsophagus*, or *Gullet*, is an almost cylindrical tube, about 9 or 10 inches long, which transmits the food from the pharynx to the stomach. It commences in the neck opposite the body of the sixth cervical vertebra, where it is continuous with the pharynx. It passes down the lower part of the neck, traverses the cavity of the thorax, pierces the diaphragm at the œsophageal opening, enters the abdomen, and becomes continuous with the cardiac end of the stomach close to that opening.

Structure.—The wall of the œsophagus consists of three coats, named, from without inwards, muscular, submucous, and mucous coats.

The *muscular* or *external coat* is divided into two layers, an external and an internal. The *external* layer is composed of fibres arranged longitudinally in the wall. The *internal* layer consists of fibres arranged in a series of rings around the tube, which lie sometimes horizontally, at others obliquely. The muscular coat in the upper fourth of the œsophagus is red, and its fibres are transversely striped; in the second fourth numerous non-striped fibres are mingled with the striped; whilst in the lower half the coat consists exclusively of non-striped fibres. By the contraction of the fibres of the muscular coat the food is propelled downwards into the stomach.

The *submucous coat* connects the muscular and mucous coats with each other. It consists of bundles of white fibrous tissue intermingled with elastic fibres, and the nerves and blood-vessels passing to the mucous coat ramify in it.

The *mucous* or *internal coat* lines the interior of the tube, and is continuous above with the mucous lining of the pharynx, and below with that of the stomach. When the œsophagus is empty it is thrown into longitudinal folds. Its free surface is covered by a thick layer of stratified squamous epithelium, which terminates abruptly at the cardiac orifice of the stomach in an irregular line. Projecting into the epithelium are multitudes of minute conical papillæ. Opening on the surface of the membrane are the ducts of numerous small racemose glands similar to those in the pharynx (fig. 2). Collections of lymphoid tissue, forming solitary follicles, are also found in the mucous membrane. The deep surface of the mucous membrane consists of a layer of non-striped muscular tissue, the bundles of which run longitudinally; it forms the muscular layer of the mucous coat, or *muscularis mucosæ*.

The œsophagus is supplied with blood by the inferior thyroid artery, the œsophageal branches of the thoracic aorta, and the ascending branch of the coronary artery of the stomach. The nerves are derived from the pneumo-gastrics, which form plexuses containing nerve-cells, not only in the muscular coat, but in the muscularis mucosæ. A network of lymphatic vessels also occurs in both the mucous and submucous coats.

ABDOMINAL CAVITY AND PERITONEUM.—As the remaining portions of the alimentary canal are situated in the abdominal cavity, it will be advisable, before describing their anatomy, to give an account of the form and boundaries of that cavity, of its division into regions, and of the general arrangement of the peritoneum, which constitutes its lining membrane.

The *Abdominal Cavity*, *Abdomen*, or *Belly*, is the largest of the three great cavities of the body. It occupies about the lower two-thirds of the trunk, and extends from the diaphragm above to the pelvic floor below. As its walls, except in the pelvic region, are chiefly formed of muscles and of fibrous membrane, they are much more distensible than those of the thorax, and permit considerable modifications to occur in the size of the viscera contained within the cavity. The abdomen is elongated in form: its vertical diameter is greater than either the transverse or the antero-posterior diameter. The superior boundary is formed by the concave vault of the diaphragm, and by the seven lower pairs of ribs and costal cartilages; in this boundary occur the opening through which the œsophagus passes into the abdomen, and also the apertures for the transmission of the great blood-vessels, the nerves, and the thoracic duct. The inferior boundary is formed by the levatores ani and coccygei muscles, and the pelvic fascia; in relation to this boundary are the termination of the rectum and anal orifice, the termination

of the urethra, and in the female that of the vagina also. The anterior boundary is formed above by the muscles of the anterior abdominal wall and the fascia transversalis; the linea alba occupies its middle line, and about the middle of the linea alba is the umbilicus or navel; the anterior wall below is formed by the two pubic bones with the symphysis. The lateral walls, or flanks, are formed above by the flat muscles of the abdominal wall and the fascia transversalis, and below on each side by the ilium and ischium with the muscles attached to them. The posterior wall is formed by the lumbar spine, sacrum, and coccyx, and by the muscles attached to these bones with their accompanying fasciæ. The abdomen is primarily divided into the *pelvis* and *abdomen proper*. The *pelvis* is subdivided into the *false pelvis*, or the part above the pelvic brim, and *true pelvis*, or part below the pelvic brim.

The *Peritoneum* is the largest and most complicated serous membrane in the body. Like the other serous membranes, it not only lines the walls of the cavity in which it is situated, but gives a more or less complete investment to the contained viscera. It is arranged, therefore, so as to form a *parietal* and a *visceral* part, which are continuous with each other in the various regions where the part lining the wall is reflected as a covering upon the viscera. A space or cavity, called the *peritoneal cavity*, is inclosed between the parietal and visceral layers. This cavity, as in other serous membranes, is a closed or shut sac, without any communication externally, except in the female, where the two Fallopian tubes open into it.

Through these openings the mucous membrane lining the tubes becomes continuous with the serous membrane, and a communication is established between the lumen of each tube and the peritoneal cavity. That surface of both the parietal and visceral portion of the peritoneum which lies next the cavity is free, smooth, covered by an endothelium, and lubricated by a little serous fluid, which under some pathological conditions may be greatly increased in quantity, so as to cause abdominal dropsy. The moistening of the two free surfaces by the serum permits them to glide smoothly on each other, during the movements of the viscera, and the changes which take place in their size and position. The opposite surface of the peritoneum is attached—that of the parietal part to the fasciæ situated internal to the abdominal muscles, that of the visceral part to the subjacent coat of the several organs.

Special names are applied to the folds or duplicatures of the peritoneum, which pass from the wall of the abdomen to the viscera. In the case of the liver, spleen, bladder, and uterus, these folds are named *ligaments*, whilst the corresponding folds which pass to the intestine have received the name of *mesenteries*. Folds of peritoneum also pass between certain of the viscera themselves, and these are called *omenta*.

The *Stomach* is the bag-like dilatation of the alimentary canal, connecting the œsophagus with the duodenum, in which the food is mingled with the gastric juice, and converted into a pulpy substance—the chyme. The stomach is situated in the costal zone of the abdominal cavity; three-fourths of its volume being contained in the left hypochondrium, whilst the remaining fourth extends into the epigastrium. About five-sixths of the organ lies to the left of the mesial plane, and one-sixth to the right. The stomach varies in size, shape, and somewhat in position, according as it is empty or full of food. When moderately full it is about 1 foot in length, whilst its greatest transverse diameter is 4 to 5 inches. Its general shape is pyriform, and it may be described as possessing two extremities, two surfaces, and two borders. The larger extremity, called the *fundus*, *cardiac extremity*, or *great cul-de-sac*, is directed upwards so as to be in contact with the under surface of the diaphragm, whilst the smaller end, the *pyloric* or *duodenal extremity*, is directed downwards, curves to the right, and becomes continuous with the duodenum. The *surfaces* form the *anterior* and *posterior walls* of the stomach. When the organ is empty, the walls are flattened, and in apposition with each other by their inner surfaces; but when it is distended they are convex. The *borders* of the stomach are curved and unequal in size; one is convex, about three times as long as the other, and is named the *greater curvature*; the other is concave, and forms the *lesser curvature*. The curvatures are so arranged that the greater has its convexity directed downwards and to the left, where it lies in relation to the transverse colon and the splenic flexure of the colon. The lesser curvature has its concavity directed upwards and to the right, and the œsophagus opens into the stomach at the upper end of the lesser curvature. Above this orifice the stomach expands into the fundus, which is situated in the highest part of the left hypochondrium, and occupies therefore the summit of the vault of the left half of the diaphragm. At the lower and right end the two curvatures lie almost horizontally in the epigastrium and terminate at the pylorus, where the stomach becomes continuous with the duodenum. The pylorus, or gate of the stomach, is situated in the epigastrium about three fingers' breadth below the ensiform cartilage, and immediately to the right of the mesial plane. The junction of the stomach with the duodenum is marked by a circular constriction externally, called the *pyloric constriction*, and by a valve internally, the *pyloric valve*. At its pyloric end the stomach presents a small bulging, the *lesser cul-de-sac*, or *antrum pylori*.

The stomach is retained in position, partly by its connections with the œsophagus and duodenum, partly by the pressure of the surrounding abdominal walls and viscera, and partly by folds of peritoneum which pass from it to the adjacent structures. These folds are as follows:—The *gastro-phrenic ligament* extends from the diaphragm to the stomach in the angle between the œsophagus and the cardiac extremity; the *gastro-hepatic* or *small omentum* passes from the lesser curvature of the stomach to the lips of the transverse fissure of the liver; the *gastro-splenic omentum* from the cardiac end of the stomach to the spleen; the *gastro-colic* or *great omentum* descends from the greater curvature of the stomach in front of the coils of the small intestine, and then ascends to inclose the transverse colon.

Structure of the Stomach.—The wall of the stomach consists of four coats, named, from without inwards, serous, muscular, submucous, and mucous coats.

The *external* or *serous coat* is that part of the peritoneal membrane which incloses the stomach,—one layer covering the anterior, the other the posterior surface. It leaves the stomach at the curvatures, where it forms the great and small omenta, and along these borders the two layers inclose between them the blood-vessels and nerves which supply the organ.

The *muscular coat* consists of non-striped fibres arranged in three layers from without inwards. The outer layer consists of *longitudinal* fasciculi, which are continuous with the external longitudinal layer of the œsophagus. They form scattered fasciculi extending longitudinally over the surface of the stomach from cardia to pylorus; but along the two curvatures, more especially the lesser, they are collected into stronger bundles, and at the pylorus they become continuous with the longitudinal fibres of the duodenum. The middle layer consists of *circular* fasciculi, which form a ring-like arrangement transversely to the long axis of the stomach. These fasciculi are comparatively thin and scattered at the cardiac end, but as they approach the pylorus they become more closely aggregated, so as to form a thick layer, which at the pylorus extends into the pyloric valve, and forms the *sphincter pylori* muscle. The circular fibres of the stomach are in the same morphological plane as the circular fibres of the œsophagus and duodenum. The inner layer consists of *oblique* fasciculi, which are not found over the entire organ; the greater number spring from the left side of the cardiac orifice, and radiate on the anterior and posterior surfaces towards the pylorus and greater curvature. These oblique fibres by their contraction approximate the cardia to the pylorus, the great curvature to the smaller, and the anterior to the posterior wall; they are thus the true grinding muscles of the stomach, and have been compared to the muscular gizzard of the bird. From the relation of the two groups of oblique fibres to the cardiac orifice they probably close that opening during gastric digestion. The longitudinal and circular fibres

occasion a longitudinal shortening and transverse constriction of the stomach. By the action of the muscular coat the food is churned about in the stomach, so as to become thoroughly intermingled with the gastric juice. The contraction of the sphincter pylori closes the pyloric orifice, and prevents the passage of the food into the duodenum, before it is converted into chyme.

The *submucous coat* consists of the areolar variety of connective tissue, and lies immediately subjacent to the oblique layer of the muscular coat.

The *mucous* or *internal coat* lines the cavity of the stomach, and is continuous with the mucous membrane of the œsophagus and duodenum. It is a soft, pulpy membrane, of a pink colour, which becomes redder during digestion, owing to turgescence of the blood-vessels. At the pyloric end it is often stained yellow or green with bile, and in old people it has a brown colour, from formation of pigment. In the empty stomach it is thrown into folds or *rugæ*, which have usually a longitudinal direction, but when distended the rugæ are obliterated, and the surface of the mucous membrane is smooth. This membrane is commonly said to be thicker at the pyloric end than in the fundus; but Brinton, who had opportunities of examining the stomach of healthy young adults immediately after death, found the cardiac mucous membrane to be more than twice as thick as the pyloric. He ascribes the thinning of the cardiac mucous membrane to the effects of post-mortem digestion, owing to the gravitation of the gastric juice, in the recumbent position of the dead body, into the fundus of the stomach.

If the free surface of the gastric mucous membrane be examined with a pocket lens it will be seen to be pitted with shallow depressions or alveoli, polygonal in form, and varying from $\frac{1}{100}$th to $\frac{1}{200}$th inch in diameter. In the sides and bottom of each of these pits numerous rounded orifices may be seen, which are the mouths of the gastric secreting glands. If vertical sections be now made through the mucous membrane, these glands will be seen to be tubular in form.

In the human stomach the tubular glands are, for the most part, simple, almost straight cylinders, and possess an average length of $\frac{1}{12}$th inch, and a breadth of about $\frac{1}{350}$th inch. They are somewhat dilated at their orifices, and at their closed ends give rise to cœcal pouches. For about the upper fourth or fifth of their length the tubes are lined by a single layer of columnar epithelium, continuous with the columnar epithelium covering the free surface of the gastric mucous membrane. In the rest of the gland-tube Brinton found two kinds of cells. The one, the so-called *peptic cells*, about $\frac{1}{1000}$th inch in diameter, and of an ovoid or somewhat polygonal form, lay next to the wall of the gland. The other kind, somewhat cubical in form, lined the very narrow central canal of the gland, and formed an *axial layer*, which was continuous above with the columnar epithelium lining the upper end of the tube.

It is in the dog and cat, however, that the structure of the gastric mucous membrane has especially been studied, and two kinds of glands have been described. The one, situated especially in the region of the pylorus, consists for the most part of simple tubes, which may, however, branch at their deeper end; they have been called the *mucus glands*. They are lined by a columnar epithelium, the cells of which at the deeper end of the gland are more cubical in form, and have a clouded granular appearance. The other kind of gland is situated in the remaining part of the gastric mucous membrane, and consists of tubes which divide usually into four branches; they have been named the *peptic glands*. The cellular lining of these peptic glands closely corresponds with the dimorphous arrangement in the human stomach already referred to. Heidenhain states that in a fasting dog the glands are shrunken, and the axial cells are transparent, whilst during digestion the peptic glands are swollen out and the cells are clouded and granular.

The gastric glands are separated from each other by slender prolongations of the muscularis mucosæ, and by the vascular interglandular connective tissue, which is soft and delicate, and contains a small proportion of lymphoid corpuscles diffused in it. In some localities the lymphoid tissue may be collected into solitary follicles, forming the *lenticular* glands of the stomach. Beneath the glands is a well-defined *muscularis mucosæ*, arranged in two layers, which gives off bundles that pass between the gastric glands.

Fig. 3.—Vertical section through the gastric mucous membrane of a cat, to show the tubular peptic glands. *c*, columnar epithelium near the gland mouth; *p*, peptic cells; *m*, interglandular muscular band; *v*, vessels surrounding tubular gland; *mm*, muscularis mucosæ; *sm* submucous coat.

The gastric mucous membrane is highly vascular; small arteries enter it from the submucous coat, and terminate in a capillary plexus, situated in the interglandular connective tissue surrounding the gastric glands; a vascular capillary ring surrounds the orifice of each gland.

The *pyloric valve* is the name given to the circular fold, situated at the junction of the stomach and duodenum, which surrounds the pyloric orifice. This fold is covered on its free surface by mucous membrane, which incloses the submucous coat and the circular layer of the muscular coat, but not the longitudinal layer, or the serous coat. That portion of the mucous membrane which covers the gastric surface of the valve possesses the structure of the mucous membrane of the stomach; whilst that which covers the duodenal surface is studded with villi, and possesses the structure of the intestinal mucous membrane.

The arteries of the stomach form arches along the greater and lesser curvatures, and anastomose in the anterior and posterior walls of the stomach. The veins of the stomach are rootlets of the portal vein. The lymphatics are numerous, and form a superficial and a deep set. The nerves of the stomach are derived from the epigastric plexus of the sympathetic and from the pneumogastric nerves.

The *Intestinal Canal*, *Intestine*, *Gut*, or *Bowel*, is situated in the abdominal cavity, and extends from the pyloric opening, or gate, of the stomach to the orifice of the anus. In it the chyme becomes mingled with the bile, the pancreatic fluid, and the secretions of the intestinal glands, and is converted into chyle. In it also the absorption of the chyle takes place, and the insoluble part of the food is passed onwards to be excreted in the form of fæces. The intestine is the longest division of the alimentary canal, and measures on an average about 25 feet. It is primarily divided into two parts, called small intestine and large intestine; the length of the small is about 20 feet, that of the large about 5 feet.

Intestinal canal.

The *Small Intestine* is the upper of the two divisions of the canal, and consists of a convoluted, almost cylindrical tube, which reaches from the pylorus to the cœcum, or commencement of the large intestine. It is subdivided into three portions, named duodenum, jejunum, and ileum.

The *Duodenum* is the commencement of the small intestine, and has received its name from its length being regarded as about equal to the breadth of twelve fingers. It forms the shortest and widest of the three sub-divisions of the small bowel; it curves, in the form of a horse-shoe, from the pylorus to opposite the left side of the body of

the second lumbar vertebra, where it becomes continuous with the jejunum. The duodenum is distinguished from the rest of the small intestine by having the ducts of the liver and pancreas opening into its canal, by containing in its wall a collection of compound racemose glands, named the glands of Brunner, and by being developed from the primitive fore-gut, and not, like the jejunum and ileum, from the primitive middle gut. Like the stomach, it should be regarded as a distinct segment of the alimentary canal.

The *Jejunum* and *Ileum* form by far the longest part of the small intestine, and are not separated from each other by any sharp line of demarcation —the upper two-fifths being called jejunum, on account of its being usually empty after death, the lower three-fifths being termed ileum, from its convoluted arrangement. They occupy the umbilical, hypogastric, right and left iliac regions of the abdomen, in which they are arranged in a series of coils or convolutions; one or two coils of the ileum sometimes lie in the cavity of the pelvis, between the bladder and rectum. The coils are attached to the posterior wall of the abdomen, along a line from the body of the first lumbar vertebra to the right sacro-iliac joint, by the fold of peritoneum called the *mesentery*. Owing to the extent of the mesentery, the coils of the jejunum and ileum can be freely moved about in the abdominal cavity, so that they are apt to be displaced from their natural position, and, when a rupture occurs, to become the most usual contents of the hernial sac. The lower end of the ileum passes into the right iliac fossa, where it becomes continuous with the large intestine, at the junction of the cæcum and ascending colon. Though the line of demarcation between jejunum and ileum is an arbitrary one, yet the upper end of the jejunum may be distinguished from the lower end of the ileum by being wider, and having a thicker mucous membrane, in which the folds called *valvulæ conniventes* are larger and more numerous.

Structure of the Small Intestine.—The wall of the small intestine consists in the greater part of its extent of four coats, named, from without inwards, serous, muscular, submucous, and mucous coats.

The *serous* or *external coat*, derived from the peritoneum, forms a complete investment for the jejunum and ileum, and is continuous with the mesentery along a line of attachment, named the mesenteric border of the intestine: but the serous covering of the duodenum is incomplete.

The *muscular coat* consists of non-striped fibres arranged in two layers from without inwards. The outer layer consists of *longitudinal* fasciculi, which form a thin layer parallel to the long axis of the intestine. The inner layer consists of *circular* fasciculi arranged around the gut transverse to its long axis; this layer is thicker, stronger, and more highly coloured than the longitudinal layer. By the contraction of the muscular coat, the peristaltic or vermicular movement is produced, which propels the ingested materials along the intestine.

The *submucous coat* lies immediately subjacent to the circular layer of the muscular coat, and consists of areolar connective tissue; in it the blood-vessels ramify before they pass into the mucous membrane.

The *mucous* or *internal coat* is a soft, velvety-looking membrane, which lines the wall of the small intestine, and possesses a complex appearance and structure. The inner surface is not smooth, but is thrown into strongly-marked, transverse folds, the valvulæ conniventes, which are not obliterated during distension of the gut. They are very numerous in the duodenum and jejunum, but then decrease in size and numbers, until at the lower end of the ileum they have disappeared. Each valvula consists of a fold of the mucous membrane with its submucous coat. Owing to their presence, the extent of the mucous surface is much greater than if it were a plane-surfaced membrane.

In its more minute structure the mucous coat may be regarded as composed of numerous projecting bodies, a glandular layer, and a muscular layer.

The projecting bodies are the intestinal *Villi*, which jut out into the lumen of the intestine from the free surface of the mucous membrane, not only of the valvulæ, but of the intermediate surface. They are delicate, minute processes, varying in length from a fourth to half a line, and in number amount to several millions.

They are best examined when the mucous surface is placed in water or spirit, when they may be seen with the naked eye, or, still better, with a pocket lens; when the chyle-vessels or blood-vessels are injected, they become erected, and stand out more prominently from the surface. They vary in form, being filiform, or cylindrical, or conical, or club-shaped, or leaf-shaped. They are more numerous in the duodenum and jejunum than in the ileum, and to their presence is due the velvety appearance of the mucous surface. They are not found elsewhere than in the small intestine.

As they are the parts of the mucous membrane directly concerned in the absorption of the chyle, their structure is interesting and important. Each villus is invested by a cap of epithelium continuous with the general epithelial covering of the mucous membrane. The epithelium consists of a single layer of *columnar cells*, compactly arranged side by side. Scattered amidst the columnar cells are cells which possess the form of microscopic goblets, and are named *goblet cells*. The free end of each goblet cell appears to have an open mouth on the surface of the villus, through which a mucus-like substance exudes. Various opinions have been expressed as to the nature of these goblet cells. Some regard them as special structures engaged either in the absorption of chyle, or the secretion of mucus; others look upon them as merely modifications of the columnar epithelium; whilst others again consider them to be *post-mortem* productions, due to the swelling out of the columnar epithelium by the imbibition of fluid. There can be no doubt, however, that they are not specially concerned in the absorption of chyle, as cells of the same character are found in the respiratory mucous membrane, and on other surfaces, where the absorption of chyle does not take place.

The sub-epithelial tissue of a villus forms its matrix or basis substance, and consists of the sub-epithelial connective tissue of the mucous membrane. When thin sections through a villus are examined, the matrix is seen to be

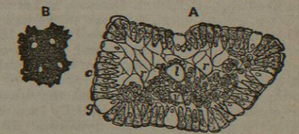

Fig. 4.—A, transverse section through an intestinal villus, showing its epithelial investment and the matrix of lymphoid tissue; *c*, columnar epithelium; *g*, goblet-shaped cell; *l*, lacteal; *r*, *r*, lymphoid retiform tissue; *v*, *v*, transversely divided blood-vessels. B, free ends of columnar epithelium, with mouths of four goblet-shaped cells. × 300.

composed of a delicate retiform tissue, which forms a network, in the meshes of which numbers of colourless lymphoid corpuscles are imbedded. These cells were described and figured by Goodsir, as the absorbing cells or vesicles of the villus. In the axis of the villus one, or perhaps two, minute lacteals or chyle vessels are situated, which serve as rootlets of origin of the lacteal division of the lymphy-ascular system. The lacteal is a capillary tube-

which ends near the apex of the villus, as a dilated microscopic *cul-de-sac*. By its opposite extremity it becomes continuous with a plexus of lacteals in the submucous coat. In the matrix substance, around the lacteal vessel of the villus, is a layer of non-striped muscular fibre-cells, which is continuous with the general muscular layer of the mucous coat, and extends as far as the apex of the villus. By the contraction of this layer the chyle during absorption is propelled along the lacteal vessel. The villus also contains blood-vessels; a small artery enters at its attached base, and terminates in a capillary plexus, situated in the peripheral part of the matrix, close to the cap of epithelium; from the plexus a vein arises, which leaves the villus at its base, and joins the veins in the submucous coat.

Various theories have been put forward to account for the mode of passage of the chyle, during digestion, from the lumen of the intestine into the lacteal vessels of the villi; but the question cannot even yet be regarded as definitely settled. The appearance of a network of minute tubules within the matrix, extending from the epithelial investment to the lacteal, which Letzerich supposed to be the channels along which the chyle flowed, is doubtless produced by the arrangement of the strands of the retiform tissue. There seems little doubt that both the cells of the epithelial investment and those of the retiform tissue of the matrix become distended with the particles of chyle previous to its passage into the lacteal. The view advanced by Schäfer, that the corpuscles in the meshes of the retiform tissue may serve as carriers of the fatty particles of the chyle into the lacteals, is but another mode of expressing the function of these cells advocated thirty years ago by Goodsir.

The mucous membrane of the small intestine is abundantly provided with secreting glands, named the glands of Brunner and of Lieberkühn.

Brunner's glands are confined to the duodenum; they belong to the compound racemose group of glands, and resemble generally in structure the mucous and salivary glands. The minute lobules of these glands lie in the submucous coat, and the excretory duct pierces the mucous membrane to open on the surface. The wall of the duct is formed of connective tissue lined by columnar epithelium. The finest branches of the duct are continuous with the acini or gland-vesicles, and the gland-vesicles contain the secreting cells, which are columnar in form. A plexus of capillary blood-vessels is distributed outside the membrana propria of the gland-vesicles, and lymphatic vessels lie around the lobules. Into the duodenum, about the junction of its descending and horizontal portions, the duct of the pancreas, and the bile duct from the liver, open by a common orifice. These glands may be regarded, therefore, as accessory glands to this portion of the small intestine.

Fig. 5.—Vertical section through the wall of the duodenum, showing the glands of Brunner. V, intestinal villi; L, layer of glands of Lieberkühn; *m m*, muscularis mucosæ; B, a Brunner's gland, *d*, its excretory duct; SM, submucous coat; M, muscular coat; *v*, a small artery. × 40.

The *glands of Lieberkühn* are distributed throughout the whole length of the mucous coat of the small intestine. They are simple tubular glands, in shape like test tubes, which lie vertically in the mucous membrane, and form its proper glandular layer (figs. 5 and 6). The tubes are microscopic in size, vary in length from $\frac{1}{10}$th to $\frac{1}{30}$th of a line, and are sometimes closely set together, but in the localities where the solitary and Peyer's glands occur they are more widely separated. The glands open on the surface of the mucous membrane between the villi; and the opposite end of the tubes is closed and rounded, and reaches close to the muscular layer of the mucous coat. They are lined by a layer of columnar epithelium cells, continuous with the epithelial investment of the villi. The glands are separated from each other by retiform connective tissue, in the meshes of which colourless lymphoid corpuscles exist in considerable numbers, the plexus of capillary blood-vessels, which is distributed outside the membrana propria of the gland tube, lies in this connective tissue.

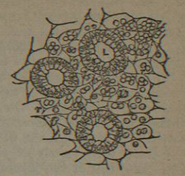

Fig. 6.—Horizontal section through the mucosa of the small intestine, to show the glands of Lieberkühn L, and the interglandular retiform lymphoid tissue *r*, *r*. *v*, *v*, transversely-divided blood-vessels. × 300.

The connective tissue of the mucous coat is characterized generally by its retiform character, and by the diffusion of colourless lymphoid corpuscles in the meshwork. But in some parts of the mucosa these corpuscles, with their supporting framework of retiform tissue, are collected into distinct masses or follicles, visible to the naked eye, and known as the solitary and Peyer's glands or follicles.

The *solitary glands* are scattered throughout the whole length of the intestinal mucous membrane. They are about the size of millet seeds, and vary in number and distinctness in different individuals. They are globular or ovoid in form, and occasion a slight elevation of the mucous membrane. One pole of the gland lies next the free surface of the mucous membrane, and is in relation to the columnar epithelium covering the mucosa, whilst the opposite pole rests on the submucous coat.

Peyer's glands, or the *agminated glands*, consist of an aggregation of solitary glands or follicles, which are crowded together, so as to form distinct elongated patches, which may vary in length from ½ inch to 3 or 4 inches. The long axis of each patch corresponds to the long axis of the intestine, and the patches are placed opposite to the mesenteric attachment of the bowel. Villi either may

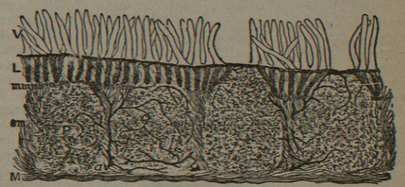

Fig. 7.—Vertical section through a Peyer's patch in the wall of the small intestine. V, the intestinal villi; L, the layer of Lieberkühn's glands; *mm*, the muscularis mucosæ; *sm*, the connective tissue of the submucous coat; P, the follicles of a Peyer's patch (the two to the right are completely divided from the cupola to the base; the two to the left are cut through to one side of the apex); *aa*, small arteries in the submucous coat, which enter the follicles of Peyer, and form *c*, a capillary network; M, muscular coat. Slightly magnified.

or may not be situated on the surface of the patch, in the intervals between the individual follicles, but Lieberkühnian glands are always found opening on the surface, and frequently forming a ring of orifices around each follicle. Peyer's patches are most abundant in the lower end of the

ileum, but diminish in size and numbers in its upper end and in the jejunum, and are absent in the duodenum.

These follicles are lymphoid organs, and are composed of lymphoid or adenoid tissue. The solitary and Peyer's glands, as is the case generally with the lymphoid organs, are more distinct and perfect in structure in infancy and childhood, than in adults or in advanced age.

The *muscular layer* of the mucous membrane lies next to the submucous coat, and consists of non-striped fibres which lie parallel to the surface of the membrane. It passes into the substance of the villi, and lies around the closed end of the glands of Lieberkühn.

Of the *blood-vessels* of the small intestine, the arteries enter the wall of the jejunum and ileum at its attached or mesenteric border, and are branches from the arcades of the superior mesenteric artery. They run in the sub-serous tissue around the wall of the intestine; then pierce the muscular coat and supply it; they then enter the submucous coat, where they are very abundant; from this submucous layer offshoots pass through the retiform tissue, which lies between the Lieberkühnian glands, into the villi. Where the solitary and Peyer's glands are situated, the lacteals, as Frey has pointed out, form a system of anastomosing vessels around the base and mesial part of each follicle.

The *nerves* are derived from the plexuses of the sympathetic, which accompany the branches of the superior mesenteric artery. They form between the two layers of the muscular coat an important plexus, named, after its discoverer, Auerbach's plexus, in which large stellate nerve-cells are intermingled with nerve-fibres, and a similar nervous plexus is found in the muscular coat of the other divisions of the alimentary canal. It supplies and regulates the movements of the muscular coat.

Large intestine.

The *Large Intestine*, though not nearly so long as the small intestine, is of much greater diameter. It reaches from the end of the ileum to the orifice of the anus, and is divided into the cœcum with the appendix vermiformis, the colon, and the rectum; whilst the colon is subdivided into the ascending colon, the hepatic flexure, the transverse colon, the splenic flexure, the descending colon, and the sigmoid flexure.

The *Cæcum*, the dilated commencement of the large intestine, lies below the ileum, and occupies the right iliac fossa. It forms a large *cul-de-sac*, closed in below, but communicating freely above with the ascending colon. Opening on the inner and posterior wall of the cæcum is the *appendix vermiformis*, which is a slender hollow prolongation of the bowel, varying in length from 3 to 6 inches. It has the calibre of the stem of a common tobacco pipe, and ends in a free closed extremity, so that, like the cæcum, it is a *cul-de-sac*. It is not generally found in mammals, but is present in man, the orang, certain lemurs, and the marsupial wombat.

The *Colon* extends from the cæcum to the rectum, and forms the longest part of the large intestine. The transverse part of the colon lies immediately below the great curvature of the stomach, but owing to the length of the *transverse meso-colon*, which forms its peritoneal attachment, it not unfrequently undergoes some change in its position, and may hang downwards towards the pelvis, or be elevated in front of the stomach or thrown to the right or left side.

The sigmoid flexure of the colon is situated in the left iliac fossa, but as the *sigmoid meso-colon*, which forms its peritoneal attachment, is of some length, it is freely movable, and not unfrequently hangs into the pelvis, or even extends across into the right iliac fossa.

The *Rectum* is the terminal segment of the large intestine, and extends from the sigmoid flexure to the orifice of the anus. It lies in the cavity of the pelvis. It commences opposite the left sacro-iliac joint, and passes at first obliquely downwards and to the right until it reaches the middle line of the sacrum; secondly, it closely follows the curvature of the sacrum and coccyx, lying in relation to their anterior surface; thirdly, when it reaches the tip of the coccyx its terminal or third part inclines downwards and backwards for about 1½ inch to the anal orifice. The anus opens on the surface of the middle line of the perineum, midway between the two ischial tuberosities, and the skin surrounding the orifice is thin, and wrinkled when the opening is closed. Immediately beneath the skin is the *sphincter ani externus muscle*, which forms a thin layer of fasciculi, arranged in a series of ellipses around the orifice. The sphincter in its normal condition of contraction simply closes the opening, but, under the influence of the will, a more powerful contraction can be induced, so as to resist the entrance of foreign bodies into the rectum.

The large intestine is arranged in the abdominal cavity in the form of an arch, the summit of which is the transverse colon, whilst the cæcum and rectum are the right and left piers. Within the concavity of this arch the coils of the jejunum and ileum are situated. The large intestine is not, except in the rectum, a cylindriform tube, but is dilated into three parallel and longitudinal rows of sacculi, which rows are divided from each other by longitudinal muscular bands, whilst the sacculi in each row are separated externally by intermediate constrictions. In the rectum the sacculi have disappeared, and the intestine assumes a cylindrical form, but at its lower end it dilates into a reservoir, in which the fæces accumulate prior to being excreted.

At the junction of the large with the small intestine a valvular arrangement, termed the *ileo-cæcal* or *ileo-colic valve*, is found. This valve is due to the peculiar manner in which the ileum opens into the large intestine.

The opening is bounded by two semi-lunar folds, which project into the large bowel. These folds are the two segments of the valve; one situated above the opening is the *ileo-colic segment*, the other, below the opening, the *ileo-cæcal*. The two segments become continuous with each other at the ends of the elongated opening, and are prolonged for some distance around the inner wall of the large intestine as two prominent ridges, named the *frœna* of the valve. The use of the ileo-cæcal valve is to impede or prevent the reflux of the contents of the large into the small intestine. When the cæcum and colon are distended the frœna of the valve are put on the stretch, and the two segments are approximated, so that the opening is reduced to a mere slit, or even closed, if there is great distension of the bowel.

Structure of the Large Intestine.—The wall of the large intestine consists in the greater part of its extent of four coats, named, from without inwards, serous, muscular, sub mucous, and mucous coats.

The *serous* or *external coat*, derived from the peritoneum, forms a complete investment for the flexures of the colon, the transverse colon, and the first part of the rectum, but not for the cæcum, or the ascending and descending colon. The second part of the rectum has only a partial serous investment, and the third part has no serous coat. Numerous pedunculated processes invested by the serous membrane, and containing lobules of fat, named *appendices epiploicæ*, are attached to the large intestine.

The *muscular coat* consists of non-striped fibres arranged in two layers from without inwards. The outer layer consists of *longitudinal* fasciculi, which are not as a rule distributed uniformly in the wall, but in the cæcum and colon are collected into three longitudinal bands, which start from the cæcum, where it is joined by the appendix vermiformis, and extend along the colon to the rectum. As these bands are not so long as the colon itself, they occasion the puckerings which separate the sacculi, so that when the bands are cut through the sacculi disappear. The colon then becomes more elongated and cylindriform.

In the appendix vermiformis the longitudinal layer is not collected into bands, but arranged uniformly along the wall. In the rectum, also, the longitudinal layer is spread uniformly along the wall, and forms a well-defined red-coloured layer.

The inner layer of the muscular coat consists of *circular* fasciculi distributed around the wall of the large intestine. In the rectum this layer increases in thickness, and in proximity to the anus forms a circular muscle, the *sphincter ani internus*, which is a strong band, about half an inch broad, around the lower end of the rectum. In the large, as in the small intestine, the muscular coat occasions the peristaltic movements, and its increased thickness in the rectum is for the purpose of expelling the fæces.

The *submucous coat* has similar relations and structure to the corresponding coat in the small intestine.

The *mucous* or *internal coat* is not thrown into valvulæ conniventes, but presents a series of well-marked permanent ridges, lying transversely or somewhat obliquely to the long axis of the gut, and corresponding internally to the constrictions, which, on the outer surface of the colon, separate the sacculi from each other. The mucous membrane of the large intestine is covered by a layer of columnar epithelium. It is devoid of villi, and consists of a glandular and a muscular layer. The secreting glands of the glandular layer have the form and structure of the Lieberkühnian glands of the small intestine (fig. 7); they open on the free surface of the mucous coat, and, owing to the absence of villi, their mouths are more closely set together than is the case with the corresponding glands in the small intestine; the tubular glands are separated by a retiform tissue with lymphoid corpuscles. Solitary glands, similar to those in the small intestine, are also present, but no Peyer's patches. The muscularis mucosæ resembles generally that of the small intestine.

Of the *blood-vessels* of the large intestine, the arteries are principally derived from branches of the superior and inferior mesenteric arteries, but the lower end of the rectum receives the hæmorrhoidal branches of the internal iliac and the pudic. The veins which correspond to these arteries for the most part join the superior and inferior mesenteric veins, and are consequently rootlets of the portal. But the veins which belong to the middle and inferior hæmorrhoidal arteries form a plexus about the anal orifice, which partly joins the superior hæmorrhoidal vein, and through it the portal vein, and is partly connected through the middle and inferior hæmorrhoidal veins with the internal iliac vein, and through it with the inferior vena cava. The veins about the anus are very apt to become varicose, and to form the excrescences termed hæmorrhoids or piles. The *lymph vessels* are arranged as in the small intestine, except that they are not prolonged into villi. Nervous plexuses with ganglion cells are found in both the muscular and submucous coats. They proceed from the superior and inferior mesenteric plexuses, but the rectum receives branches from the hypogastric plexus, and from the third and fourth sacral spinal nerves.

The Liver is the biggest of the abdominal viscera, and the largest gland in the body. It is the organ in which the secretion of bile takes place, and is the chief seat in the body of the formation of glycogen, a substance like dextrin, which readily undergoes conversion into sugar. It lies in the costal zone of the abdomen, fills up the greater part of the right hypochondrium, and extends, through the epigastrium, into the left hypochondrium. In its long or transverse diameter it averages about 12 inches, in its antero-posterior diameter about 6 inches, in the vertical diameter of its thickest part about 3 inches. Relatively to the size of the body the liver is bigger and heavier in the fœtus than in the adult; soon after birth the relative weight declines, and that of the left lobe diminishes much more rapidly than the right lobe. Frerichs states that the relative weight of the healthy liver fluctuates in adults between $\frac{1}{14}$th and $\frac{1}{19}$th of that of the body, and the absolute weight varies from 1·8 to 4·6 pounds avoird. During the digestion of the food the liver increases both in size and weight, partly from the greater quantity of blood flowing through it, and partly from the new material in the secreting cells; whilst after a long fast it becomes smaller and lighter.

For descriptive purposes the liver may be regarded as having two surfaces, two borders, and two extremities.

The *superior* or *diaphragmatic surface* is smooth and convex, and attached to the diaphragm by the falciform ligament.

The *posterior* or *vertebral border* is comparatively thick, and attached by the coronary ligament to the diaphragm. The *anterior border* of the liver is unattached, thin, and attenuated, and is marked by a deep notch, opposite the anterior edge of the falciform ligament, which lodges the *round ligament* of the liver.

Of the two *extremities* of the liver the *right* is thick and massive, and lies deep in the right hypochondrium, in contact with the diaphragm; the *left* is thin and attenuated, and overlaps the œsophageal opening and fundus of the stomach.

The *inferior* or *visceral surface* of the liver is much more complex in form than the upper. The *longitudinal* or *umbilical fissure*, continuous with the notch in the anterior border of the liver, and much nearer to the left than the right extremity of the gland, divides it into a large right

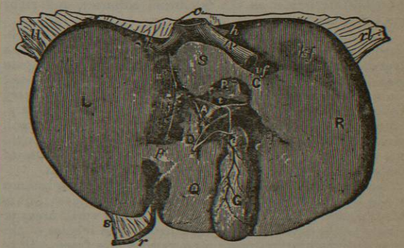

Fig. 8.—Under surface of the liver. R, right lobe; L, left lobe; Q, lobus quadratus; S, lobus Spigelii; C, lobus caudatus; P, pons hepatis; *f*, longitudinal fissure; *t*, transverse fissure; *cf*, caudate fissure; *vf*, fossa for vena cava; *kf*, fossa for right kidney; G, gall bladder in its fossa; *u*, obliterated umbilical vein; *v*, obliterated ductus venosus; IV, inferior vena cava; A, A, hepatic veins; P, portal vein; A, hepatic artery; D, bile duct; *c*, coronary ligament; *ll* and *rl*, left and right lateral ligaments; *s*, suspensory ligament; *r*, round ligament.

and a small left lobe. In the anterior part of the fissure the *round ligament*, formed by the obliteration of the *umbilical vein* of the fœtus, is lodged; whilst the posterior part contains a slender fibrous cord formed by the obliteration of a vein of the fœtus, named *ductus venosus*. The longitudinal fissure is often bridged across by a band of