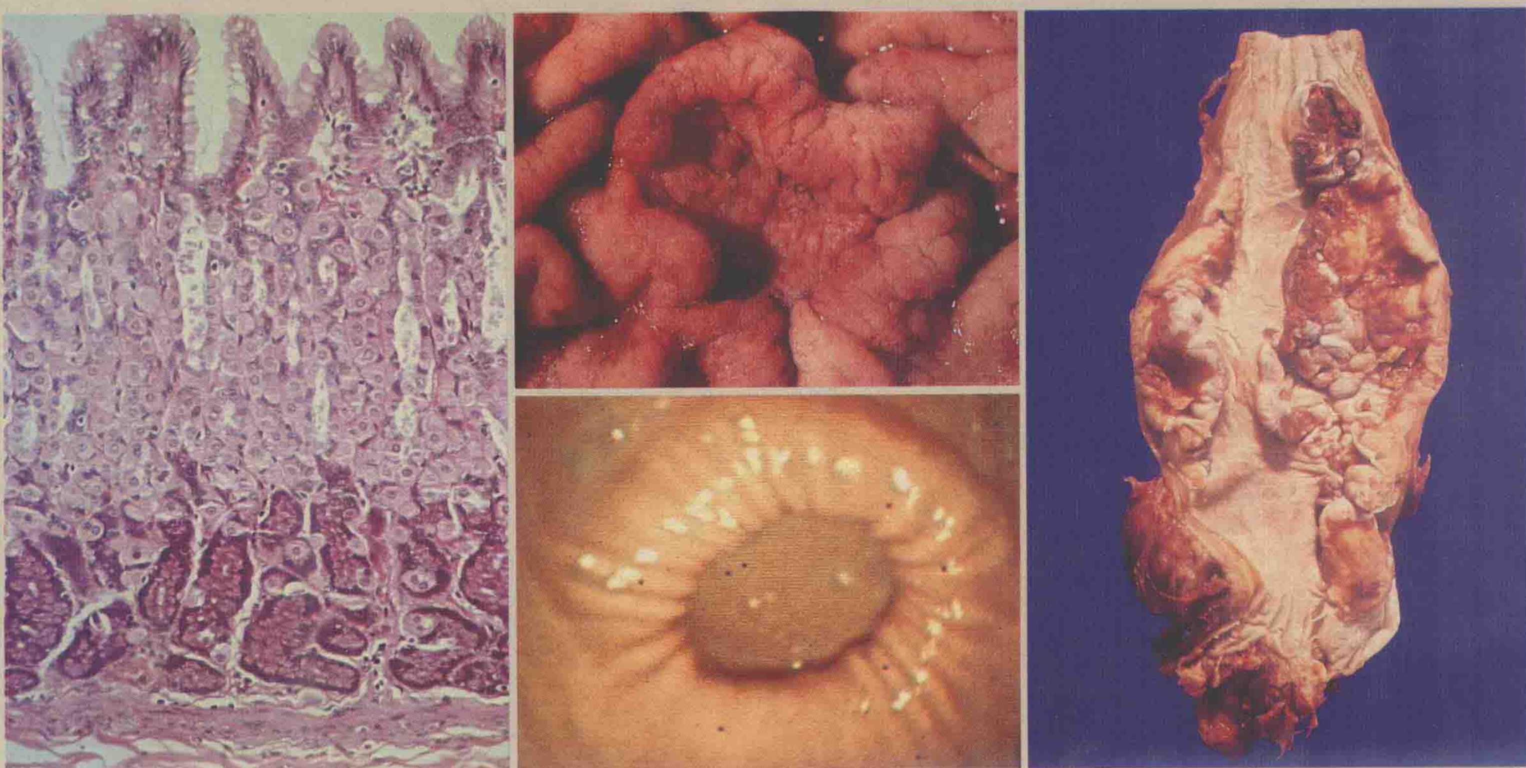
Atlas of Clinical

Gastroenterology

Volume 1



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Gastroenterology

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Preface

The text and the illustrations contained in this book provide extensive visual documentation of the normal and abnormal anatomy, histology, radiology, etc., of the alimentary tract with supporting text. The text and illustrations in this volume, therefore, were not intended to form a textbook of gastrointestinal disease and should not be used, or judged, as such. Instead, the notes and illustrations can form a convenient aide memoire to remind the reader of various aspects of normal and abnormal gastrointestinal function and anatomy.

Gastroenterology is progressing and developing rapidly, and technological advances in imaging techniques and in the methods used to display the lesions of the alimentary tract have played an important part in the advance of the subject. The physician and the surgeon have a duty to keep up-to-date in their areas and I hope that this atlas will aid this aim. Diagnostic procedures and methods are indicated, and histopathological diagnosis is treated in some detail, reflecting the importance of histopathological evaluation in alimentary disease, for example, in the area of pre-cancerous conditions. It is hoped that the contents of this volume will serve as a useful revision course for those active in gastroenterology and that it will stimulate others to become involved in this very dynamic area of medicine.

It has been a great pleasure to join with my fellow editors in the production of this book, which I hope will prove useful to many of our colleagues.

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Acknowledgements

Figs. 5.4 and 5.5 were reprinted from Proceedings of the Symposium on Electron Micrography of the G.I. Tract by Dr. M.N. Marsh from the Scandinavian Journal of Gastroenterology Supplement (1981) by permission of Universtetsforlaget, Oslo.

Contents

1. The Normal Esophagus and Stomach

Normal Esophagus

The esophagus is a muscular tube connecting the oropharynx to the stomach. It begins at the lower margin of the cricopharyngeus muscle and is approximately 25cm in length. It is composed of striated muscle in its upper third, smooth muscle in the lower two thirds and is lined by squamous epithelium.

In the mediastinum the esophagus is closely related to the two trunks of the vagus nerve, the trachea, aorta and the heart (Figs.1.1 & 1.2) so that both bronchial and aortic impressions can be seen during a barium swallow examination (Fig.1.3). In addition to demonstrating the normal mucosal pattern of the esophagus (Fig.1.4), a barium swallow may show a slight constriction approximately 2cm above the diaphragm, below which is an area of dilatation known as the vestibule, or phrenic ampulla (Fig.1.5). This area of dilatation should not be confused with the radiological appearances of a hiatus hernia. The esophagus enters the stomach at an oblique angle just below the diaphragmatic crura approximately 40cm from the incisor teeth (Fig.1.6).

Food is transported from the pharynx to the stomach by the coordinated contraction of the muscular layers of the body of the esophagus. This peristaltic contraction wave is relatively slow and moves down the esophagus at a rate of 2-6cm sec^{-1}. When initiated by swallowing, it is known as primary peristalsis. Secondary peristalsis originates below the hypopharynx with no antecedent swallowing movement.

The barrier functions of the esophagus are accomplished by the upper cricopharyngeal and lower esophageal sphincters (LOS). The LOS is a zone of high pressure extending over the lower 3-4cm of the esophagus with no definite anatomical counterpart. The normal resting LOS pressure is between 15 and 35mm Hg.

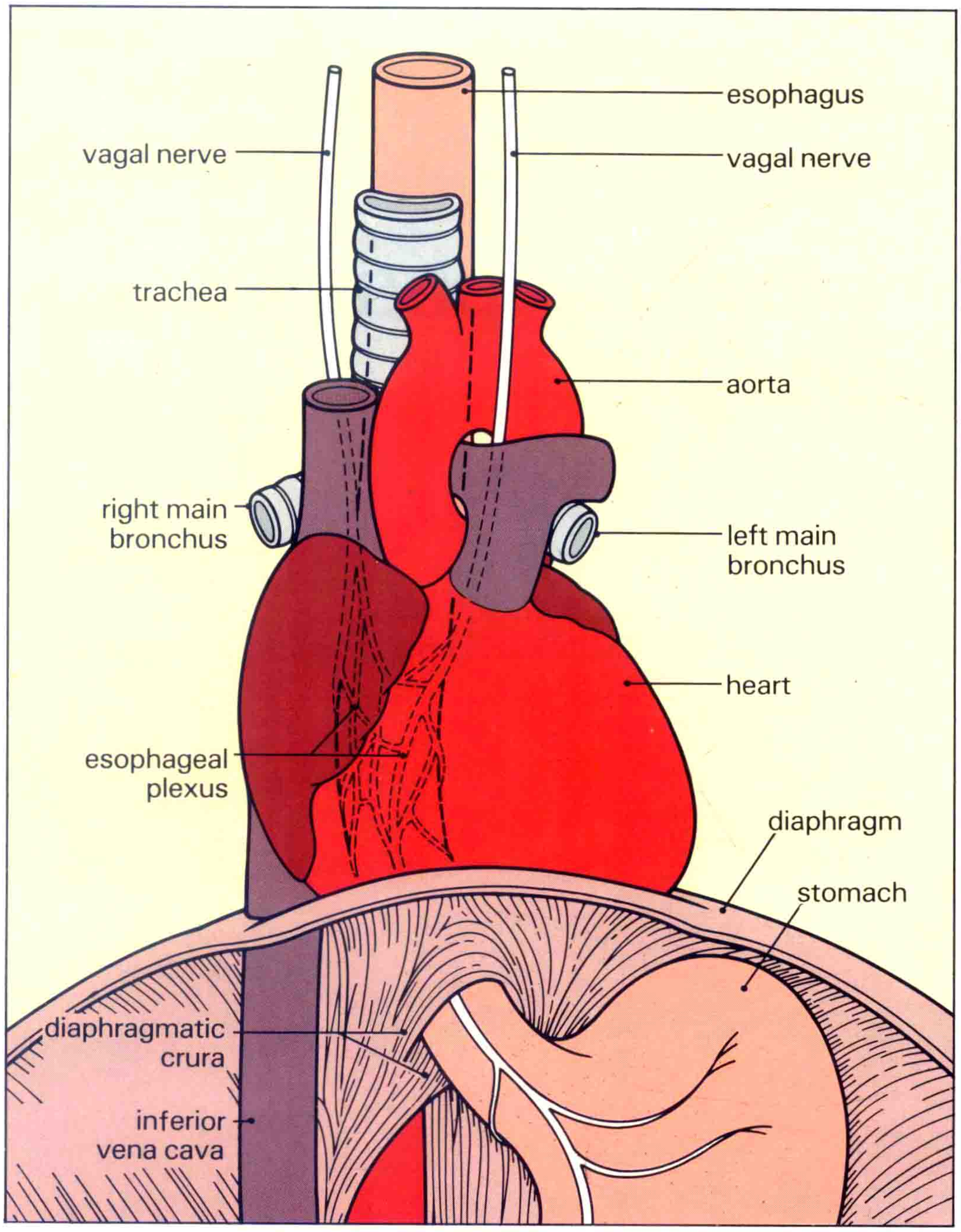


Fig.1.1 Diagram showing the anatomical relations of the esophagus.

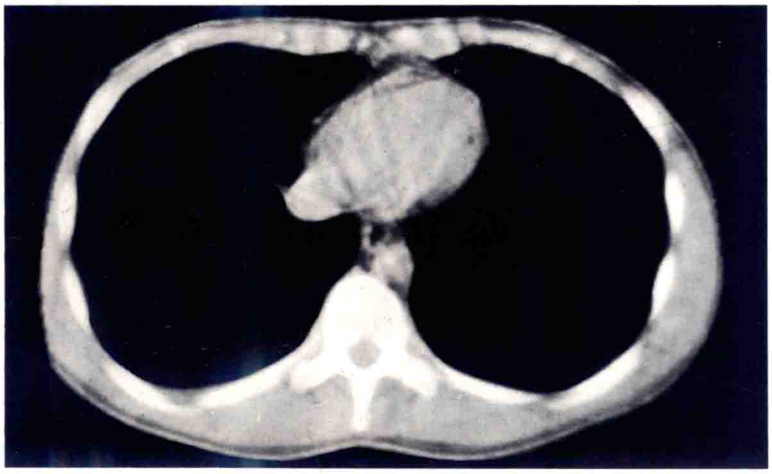


Fig.1.2 Transverse computerized tomographic (CT) scan of the thorax at the level of T4.

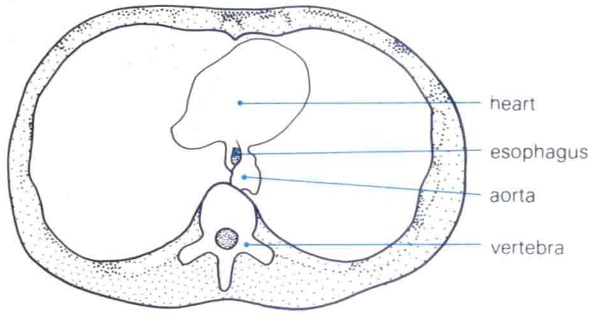
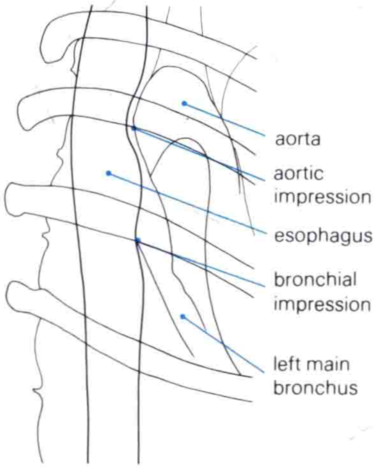


Fig.1.3 Barium swallow showing normal indentations due to the bronchus and aorta.



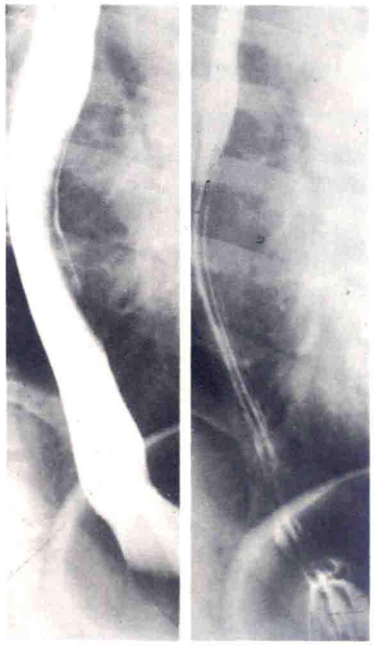


Fig.1.4 Barium swallow showing the pattern of esophageal mucosa in the distended (left) and contracted (right) states. There are normally three to five parallel lines of barium lying within the crenated mucosal folds.

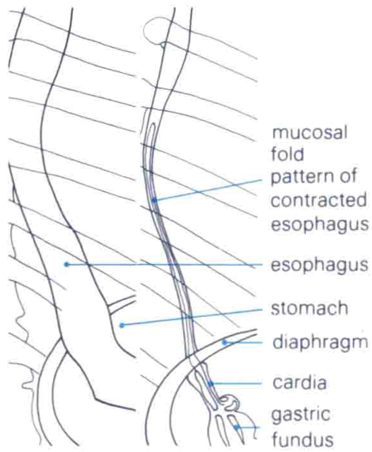


Fig.1.5 Barium swallow showing the phrenic ampulla at the lower end of the esophagus.

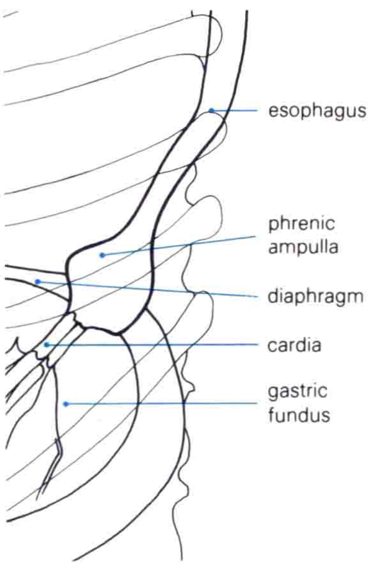
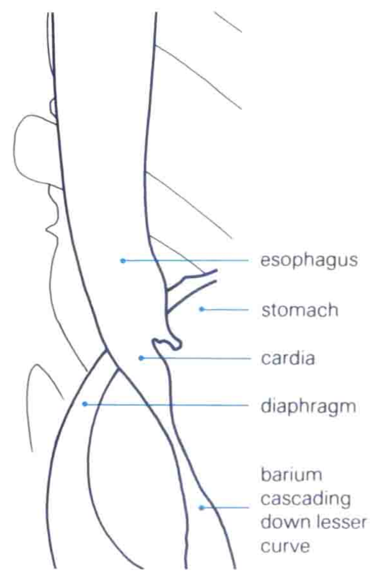


Fig.1.6 Barium swallow showing the entry of the esophagus into the fundus of the stomach, with barium cascading down the lesser gastric curve.



A manometric pressure trace of normal peristalsis and sphincter relaxation shows that on swallowing the upper sphincter relaxes before passage of the bolus, after which it contracts. Swallowing is followed by a peristaltic contraction along the body of the esophagus and the lower esophageal sphincter relaxes just prior to the contraction wave reaching it, thus allowing passage of the bolus into the stomach (Fig.1.7).

The lower esophageal sphincter alone is not sufficient to prevent gastro-esophageal reflux and compression of the subdiaphragmatic portion of the esophagus by a rise in intra-gastric or intra-abdominal pressure and the acute angle of entry of the esophagus into the stomach are factors that help to prevent reflux.

The pH within the esophagus is usually 5-7, unless there is a reflux of acid gastric contents. A pH recording from the lower esophagus (Fig.1.8) may therefore show the presence of reflux and serial pH measurements can be used to determine the time taken for the esophagus to be cleared of acid.

Endoscopically the esophageal body appears as a smooth featureless pink tube without prominent blood vessels (Fig.1.9). At the gastro-esophageal junction transition from esophageal to gastric mucosa is easily seen as an irregular circumferential line known as the ora serrata, gastric rosette or Z line (Fig.1.10). Histological examination of the esophagus shows it to be lined by non-keratinized squamous epithelium.

Papillae, extensions of the lamina propria, penetrate for a short distance into the epithelium. The lamina propria is separated from the underlying submucosa by a thin layer of smooth muscle, the muscularis mucosae. Deep to the submucosa is a circular and longitudinal muscle coat (Figs.1.11-1.13).

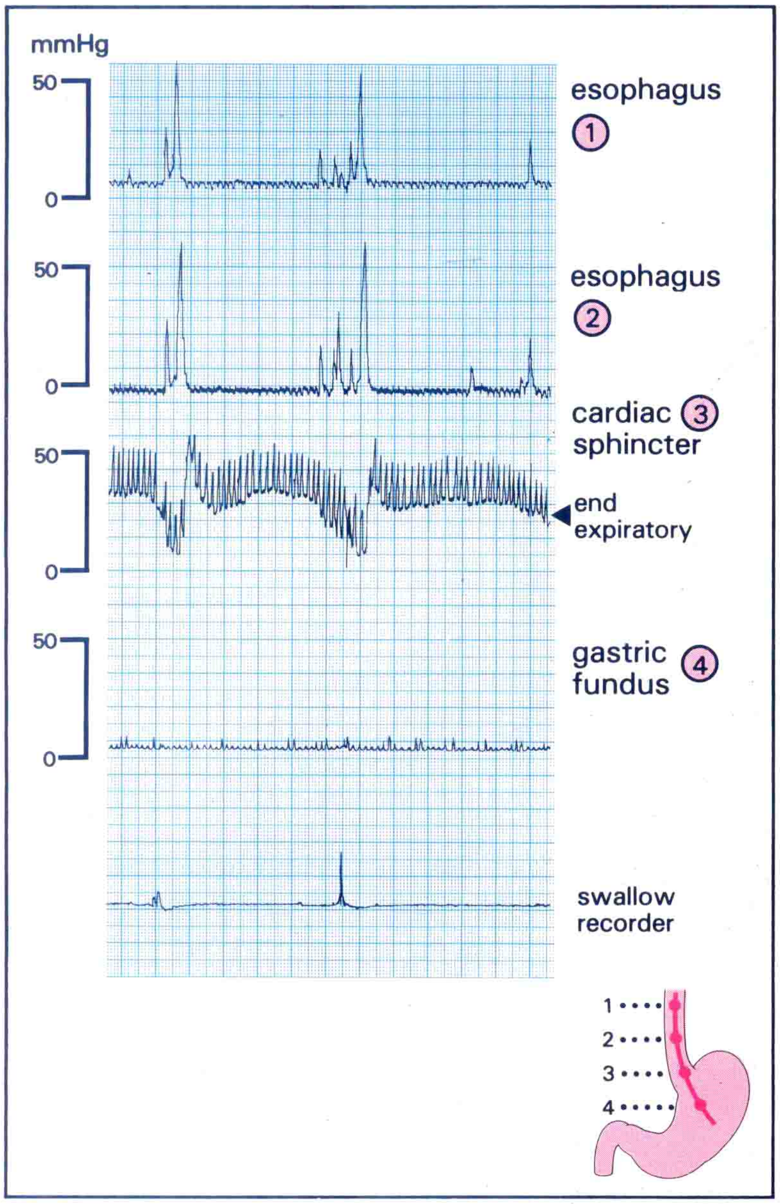


Fig.1.7. Manometric pressure trace from the body of the esophagus, from the lower esophageal sphincter and from the gastric fundus. Swallowing (bottom trace) is followed by progressive contractions of the esophageal body and relaxation of the cardiac sphincter. Sphincter pressure trace shows marked respiratory excursions; positivity of these shows that the pressure is recorded from the subdiaphragmatic part of the cardiac sphincter.

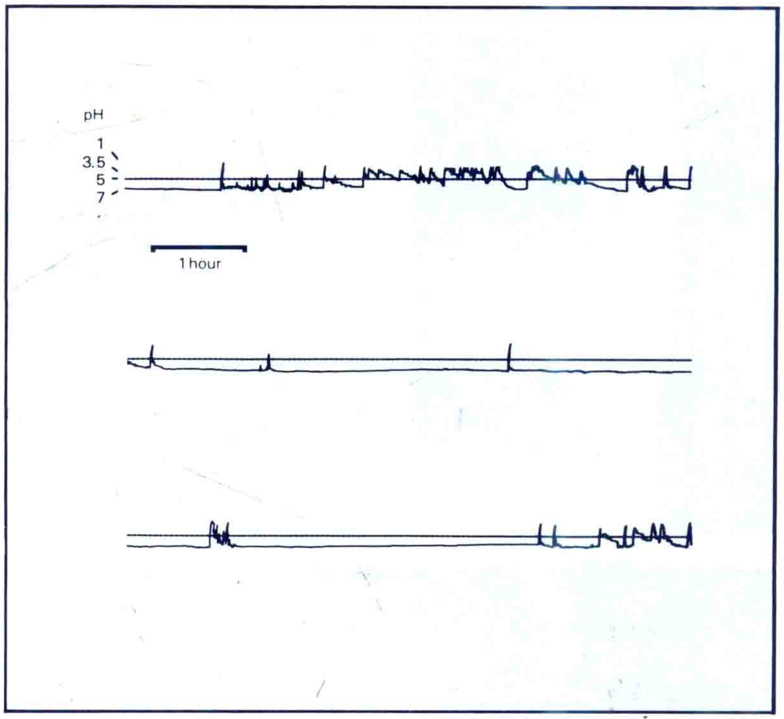


Fig.1.8 pH recording at the lower esophagus demonstrating frequent episodes of reflux which lower the esophageal pH below 3.5. Courtesy of Dr. J. Bennett.

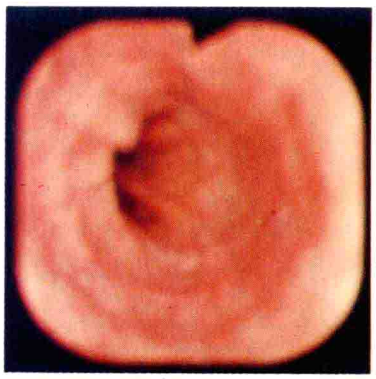


Fig.1.9 Endoscopic view of the esophageal body showing pale pink squamous mucosa and distal deeper pink of the columnar, epithelial-lined gastric rosette.

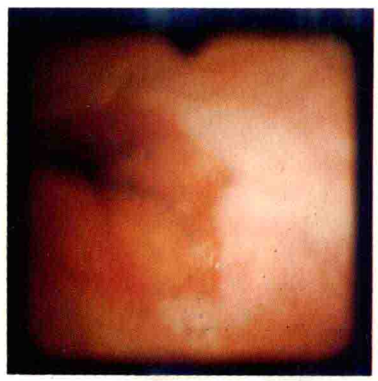


Fig. 1.10 Endoscopic view of the esophago-gastric junction showing sharp demarcation between the pale pink squamous epithelium of the esophageal body and darker pink of the columnar gastric epithelium.

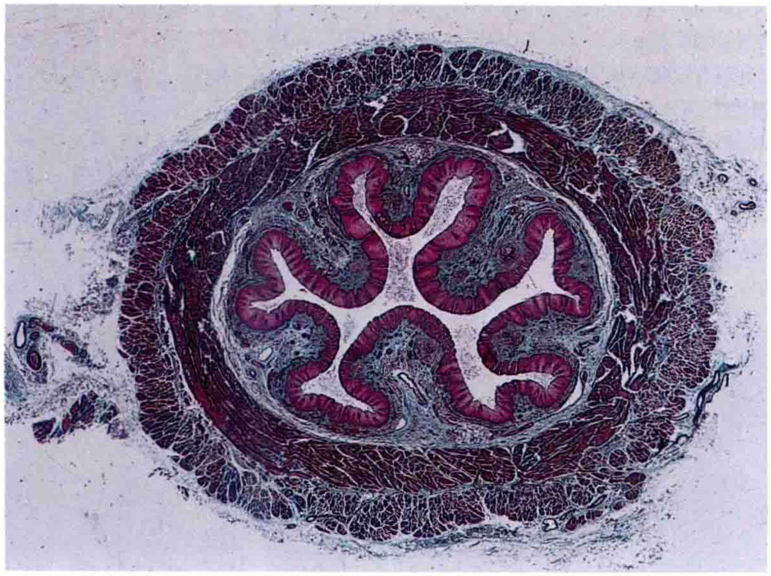
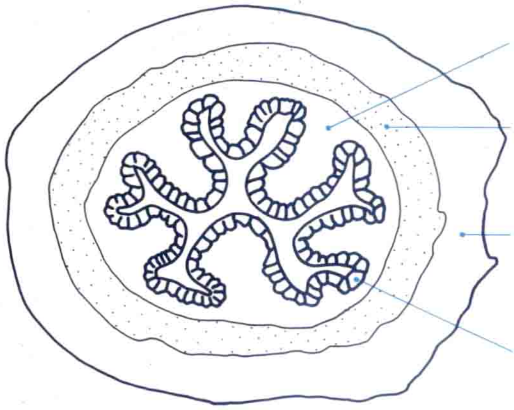


Fig. 1.11 Cross-section through the esophagus showing the convoluted lumen, squamous epithelial lining, the submucosa and the two outer layers of muscle. Trichrome stain, x 6. Courtesy of Dr. P. Wheater.



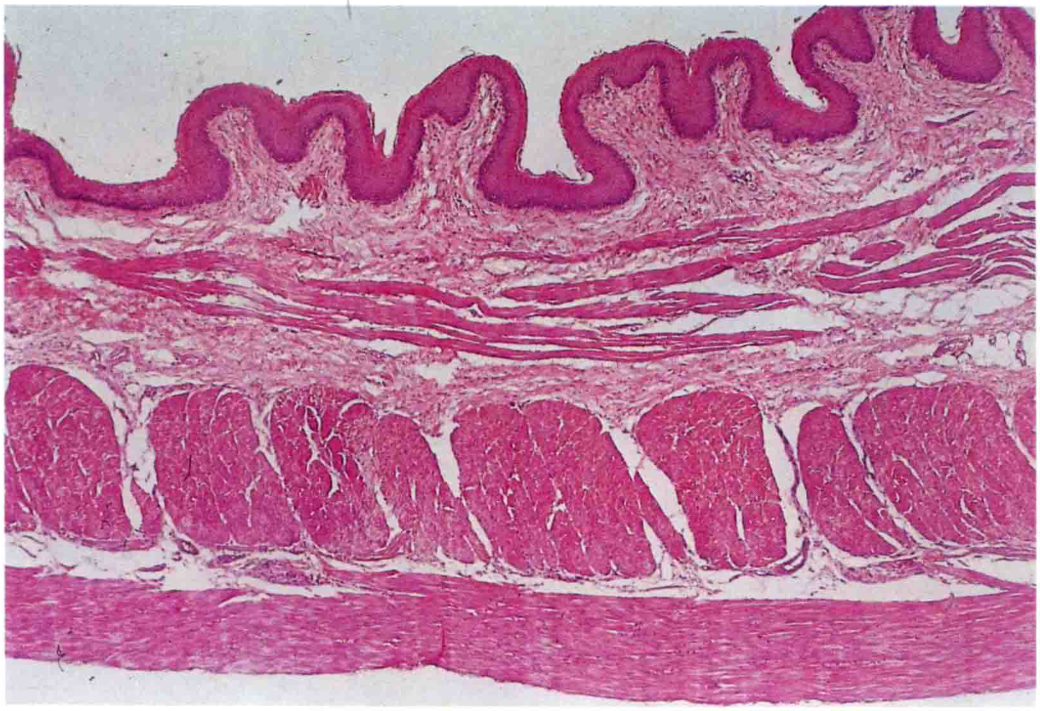


Fig. 1.12 Histology of a longitudinal section of the esophagus. H & E stain, x 40. Courtesy of Dr. P. Wheater.

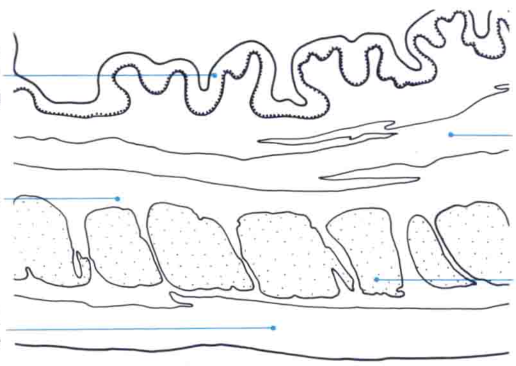
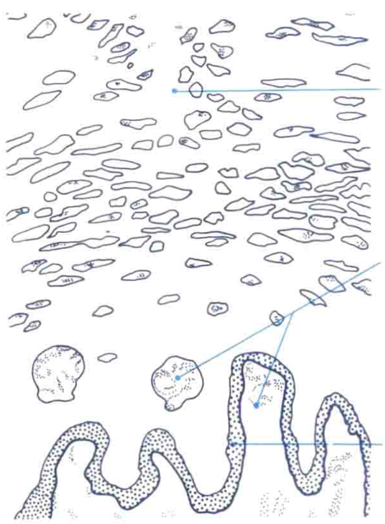


Fig. 1.13 Histology of normal esophageal squamous epithelium showing the shallow papillary projections of the lamina propria. H & E stain, x 190.



Normal Stomach

The stomach connects the esophagus to the duodenum (Figs.1.14 & 1.15). Anatomically it is divided into several portions (Fig.1.16).

The cardia (Fig.1.17) is situated just below the entrance of the esophagus whilst the fundus of the stomach is that part which lies above the esophago-gastric junction. The main part of the stomach is the body which has a shorter, lesser curve and longer, dependent greater curve (Fig.1.18). The mucosa of the body of the stomach is thrown into folds known as rugae. The antrum represents approximately the distal third of the stomach (Fig.1.19). It is smooth with no rugae and is demarcated by the incisura angularis proximally (Fig.1.20) and the pylorus distally. The exit from the stomach into the first part of the duodenum is the pylorus represented by a greatly thickened layer of circular muscle.

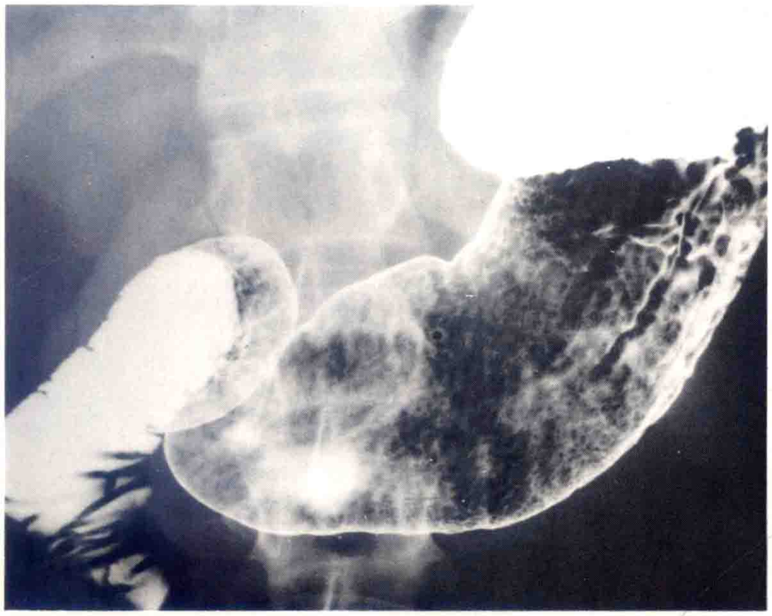
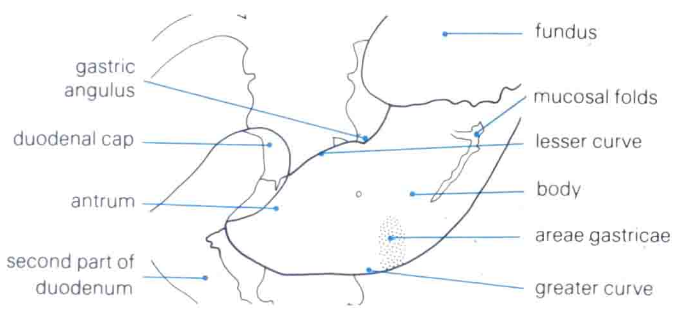
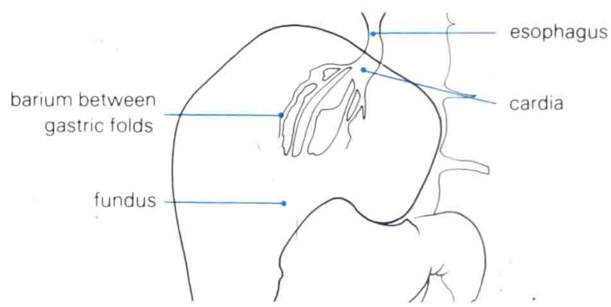


Fig.1.14 Barium meal (anteroposterior view) showing the normal anatomy of the stomach.

Fig.1.15 Barium meal (oblique view) showing the fundus and the cardia.





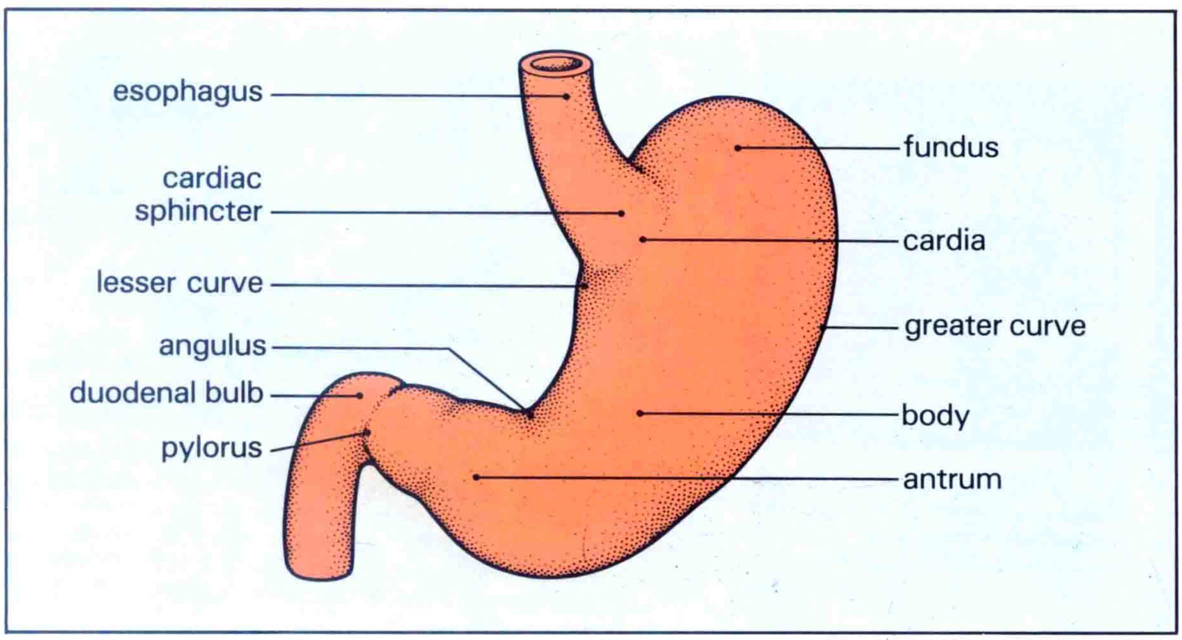


Fig.1.16 Diagram showing the normal anatomy of the stomach.

The stomach is innervated by parasympathetic nerves supplied by the vagus and sympathetic nerves which originate in the coeliac plexus. The vagus is divided into anterior and posterior trunks. The anterior trunk is further subdivided into an anterior gastric division that supplies the anterior wall of the stomach and a hepatic division that supplies the proximal duodenum (Fig.1.21). Part of the posterior gastric division of the posterior vagal trunk supplies the posterior gastric wall. In addition to afferent fibres, the vagus contains 3 types of efferent fibre – cholinergic stimulatory, adrenergic inhibitory and non-adrenergic inhibitory. The cholinergic fibres play an important part in gastric secretion and motility.

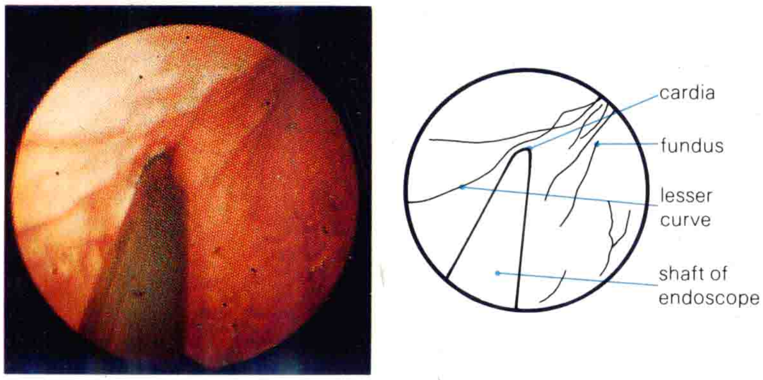


Fig.1.17 The cardia viewed from below. Retroflexion of the endoscope shows the instrument entering through the cardia into the body of the stomach.

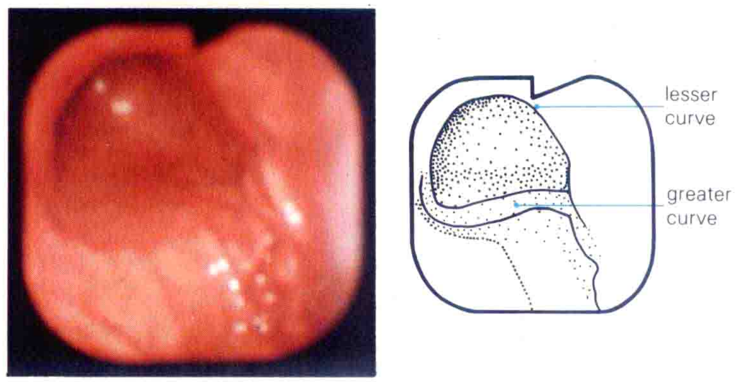


Fig.1.18 Endoscopic view of the greater and lesser curves of the stomach.

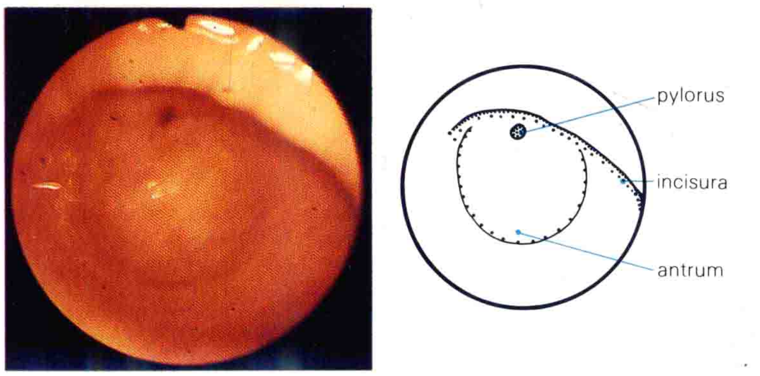


Fig.1.19 Endoscopic view of the gastric antrum and pylorus.

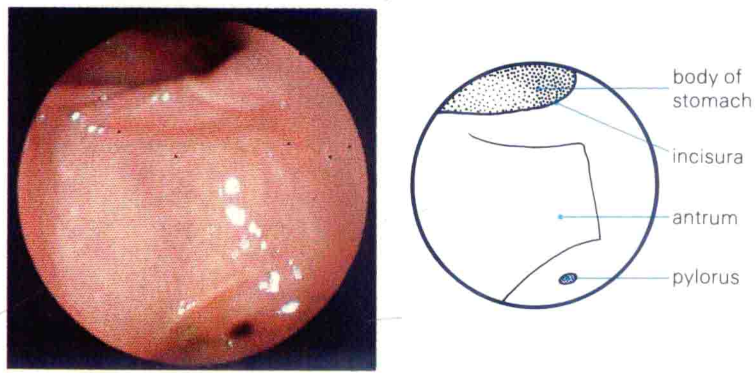


Fig.1.20 Endoscopic view of the incisura with the instrument retroverted.

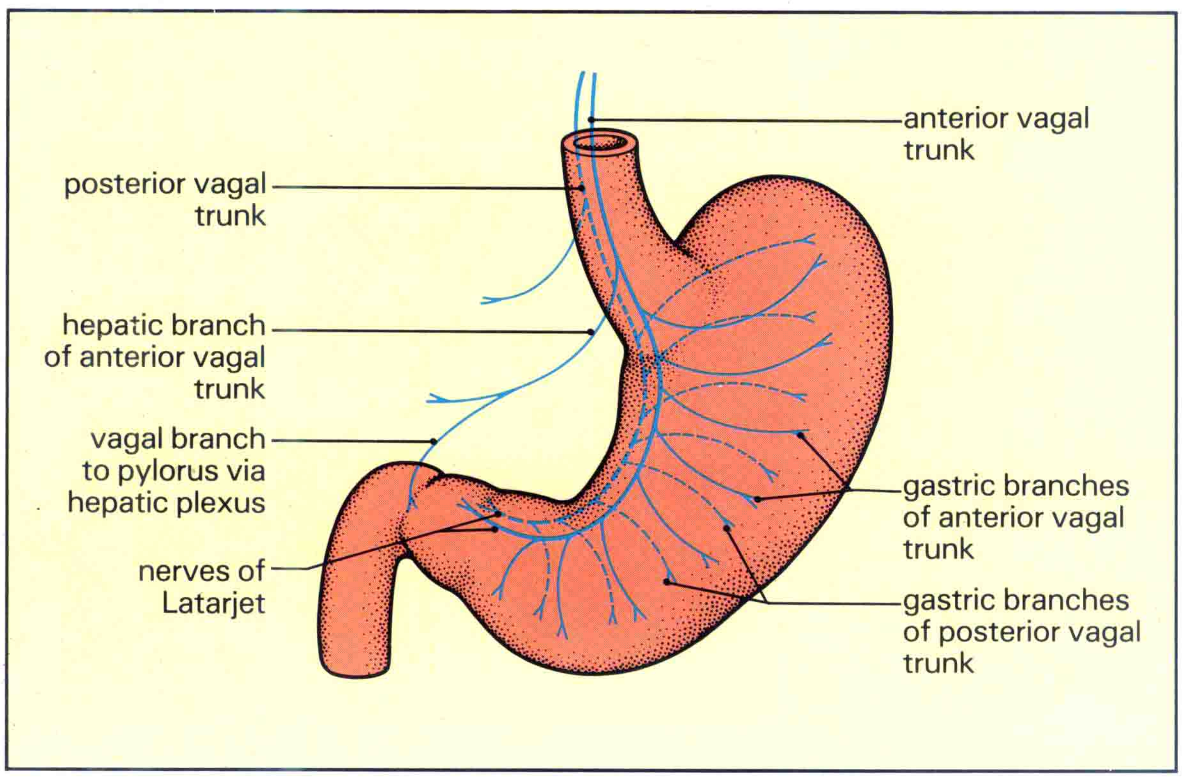


Fig.1.21 Diagram showing the anatomical arrangement of the vagus nerves.

The mucosa of the fundus and body of the stomach is covered by regular columnar epithelium which extends for a short distance into the gastric pits. The gastric glands open into the base of the pits. In the body the glands comprise two types of specialized secretory cells. In the upper half of the glands there are the parietal cells, which produce hydrochloric acid and intrinsic factor which binds vitamin B_{12}. In the lower half are found the pepsin producing chief cells (Figs.1.22-1.25). The antral, or pyloric glands do not contain acid or pepsin-producing

Fig. 1.22 Cross-section through the body of the stomach showing acid-secreting and pepsin-producing glands. H & E stain, x 50. Courtesy of Dr. P. Wheater.

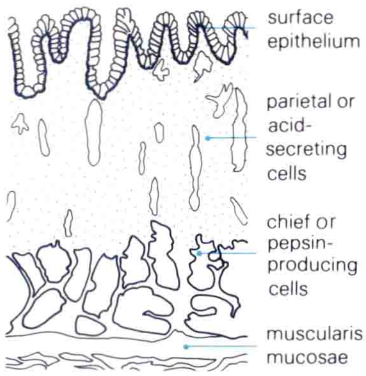
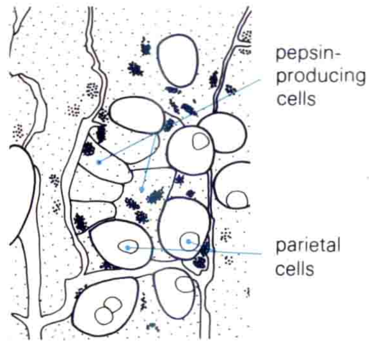


Fig. 1.23 Histology of the body of the stomach showing the deep-staining pepsin-producing cells and the pale-staining parietal or acid secreting cells. H & E stain, x 480.



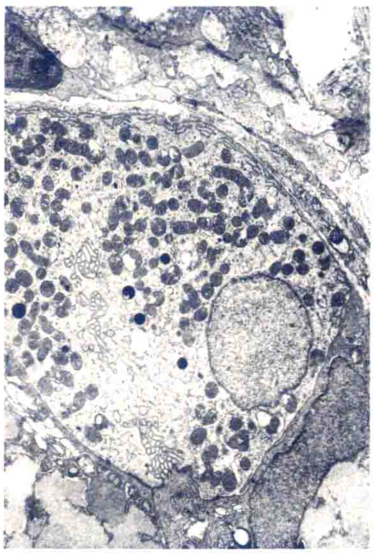
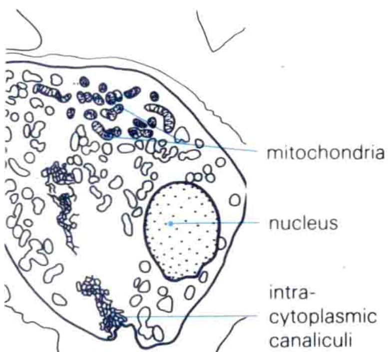


Fig. 1.24 Electron micrograph of an acid-secreting or parietal cell showing abundant mitochondria and the intra-cytoplasmic canalicular system of the cell. x 3000. Courtesy of Dr. D. Day.



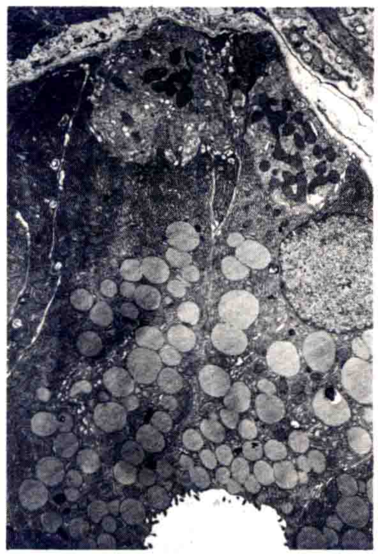


Fig. 1.25 Electron micrograph showing the typical granules of a chief or pepsin-producing cell from the body of the stomach. x 3000. Courtesy of Dr. D. Day.

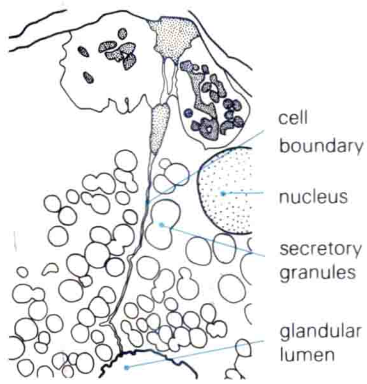
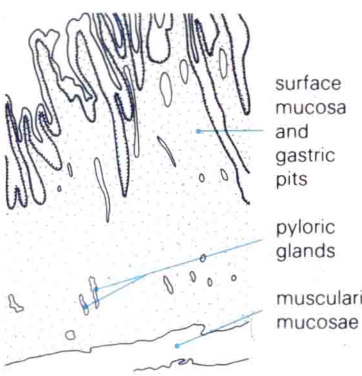


Fig. 1.26 Cross-section through the pyloric region of the stomach showing the deeper gastric pits compared to those in the body which open into the mucus-secreting pyloric glands beneath. H & E stain, x 50.



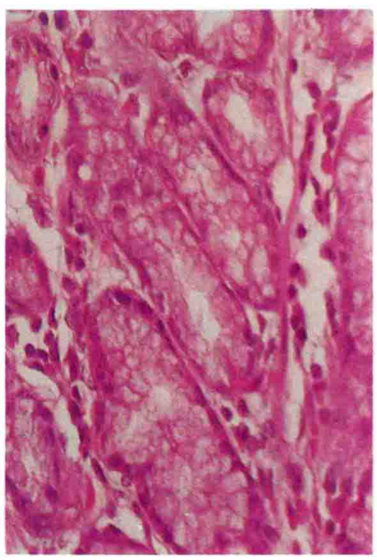
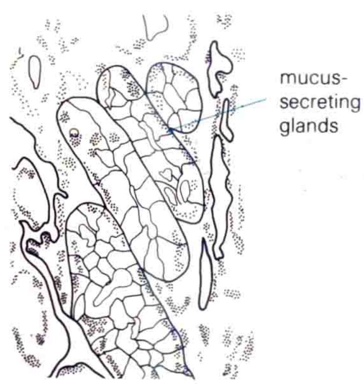


Fig. 1.27 The simple mucus-secreting glands in the pylorus. H & E stain, × 125.



cells, but are mucus secreting (Figs.1.26 & 1.27). The majority of the gastrin producing, or 'G' cells, are found in the antrum interspersed between these mucus cells (Figs.1.28-1.30).

The stomach functions as a reservoir and mixing chamber for ingested food allowing gastric acid and pepsin to start the process of digestion. The volume of the resting stomach is 50ml or less. However, receptive relaxation of the gastric body occurs as food and liquid are ingested so that there is little rise in intra-gastric pressure.

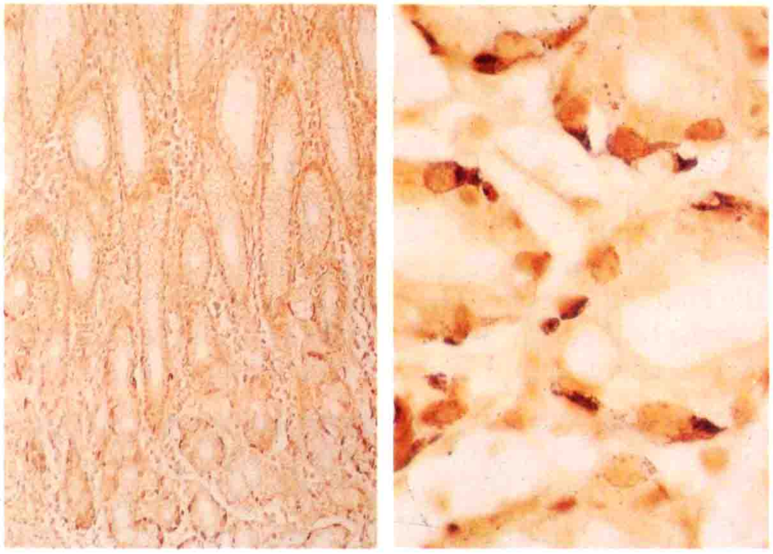
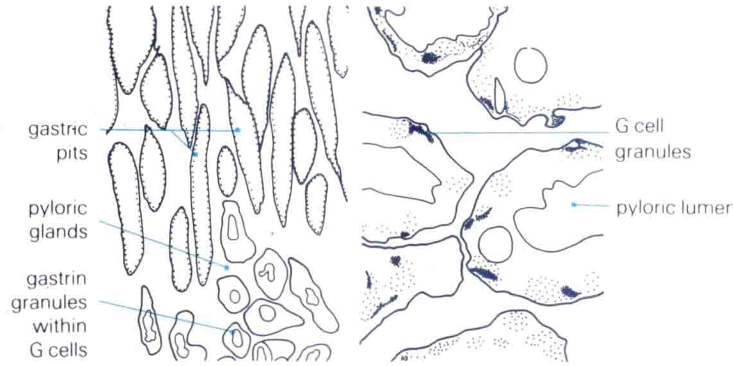


Fig.1.28 Photomicrographs of the gastric antrum showing G cells (part of the APUD system) within the pyloric glands. Grimelius, silver impregnation, x 120 (left), x 800 (right).



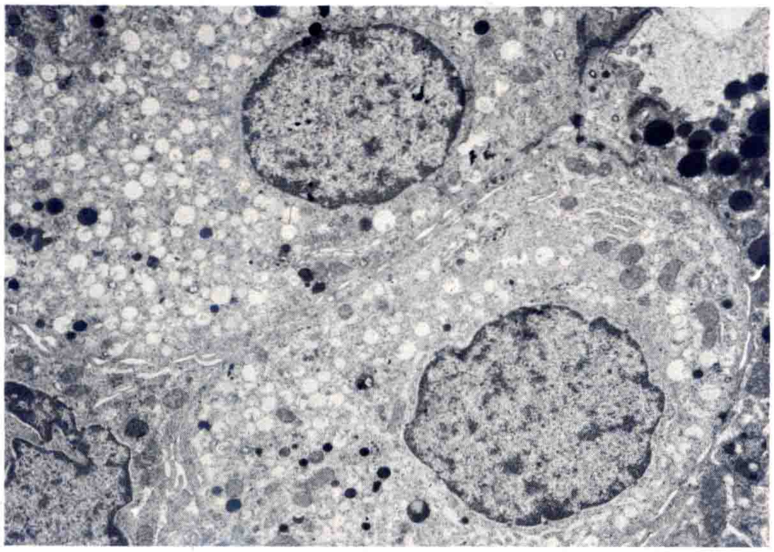
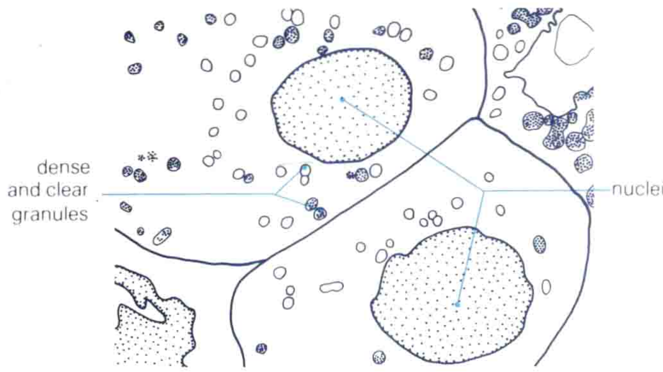


Fig.1.29 Electron micrograph of G cells demonstrating the two patterns (dense and clear) of gastrin neurosecretory granules, x 7500. Courtesy of Dr. J. Polak.



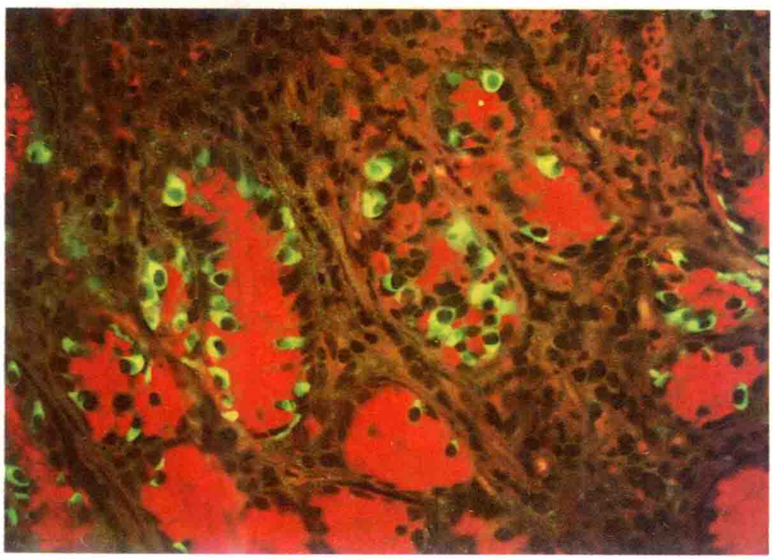
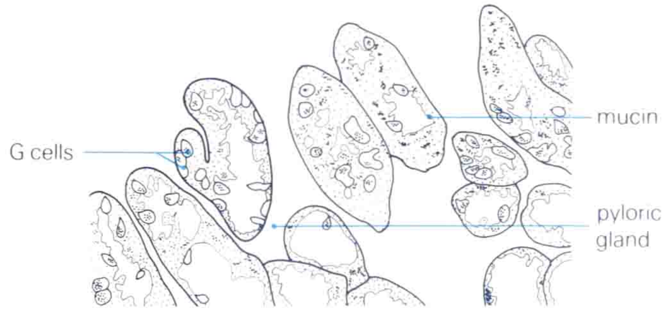


Fig.1.30 Green fluorescing G cells in the pyloric glands demonstrated by using fluorescine – labelled anti-gastrin. The pyloric glands appear brown with the mucin (red) which has taken up the PAS (periodic – Schiff reagent) counterstain. Courtesy of Dr. J. Polak.



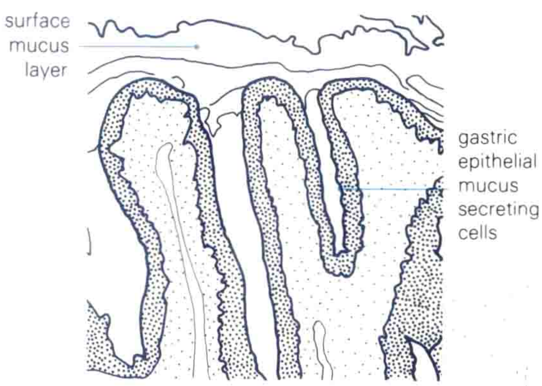
The mucosa of the stomach is protected by a layer of mucus, a gelatinous material composed of proteins, glycoproteins and mucopolysaccharides secreted by the surface epithelium (Figs.1.31 & 1.32). The functions of mucus remain unclear. It appears to protect the gastric mucosa against surface injury by physical irritants and to buffer gastric acid under basal conditions, although its effect in buffering stimulated acid secretion is negligible.

The most important physiological mediators of gastric acid secretion are acetylcholine, gastrin and histamine. The vagus nerve acts on the parietal cells to stimulate acid production and on the antral gastrin cells to stimulate gastrin release, in both cases via the action of acetylcholine. In addition, acetylcholine potentiates the parietal cell response to other secretagogues. Gastrin is also released directly by the chemical action of peptides and amino acids bathing the pyloric glandular mucosa and by antral distension.

The parietal cells also contain histamine receptors, and histamine, which occurs throughout the entire gastro-intestinal tract, also stimulates acid production. It is not clear whether histamine is the final common path for gastric secretion, or whether receptors for histamine, gastrin and acetylcholine on the parietal cells interact with each other and with the secretory apparatus within the cell. Both the injection of histamine and the synthetic analogue of gastrin, pentagastrin, are capable of maximally stimulating acid production by the parietal cells. This is the basis of the augmented histamine and pentagastrin tests for assessment of acid secretory capacity (Fig.1.33).

Peristaltic waves (Figs.1.34 & 1.35) initiated by the gastric pacemaker in the fundus of the stomach occur at a rate of 3 min^{-1} and these gradually propel the viscous gastric contents into the distal antrum. The rate at which the contents pass into the duodenum depends upon their physical and chemical composition: solids, lipids and hypertonic fluids all empty at a slower rate than isotonic fluids.

Fig. 1.31 Histology of the surface gastric mucosa showing the covering layer of mucin. H & E stain, x 320.



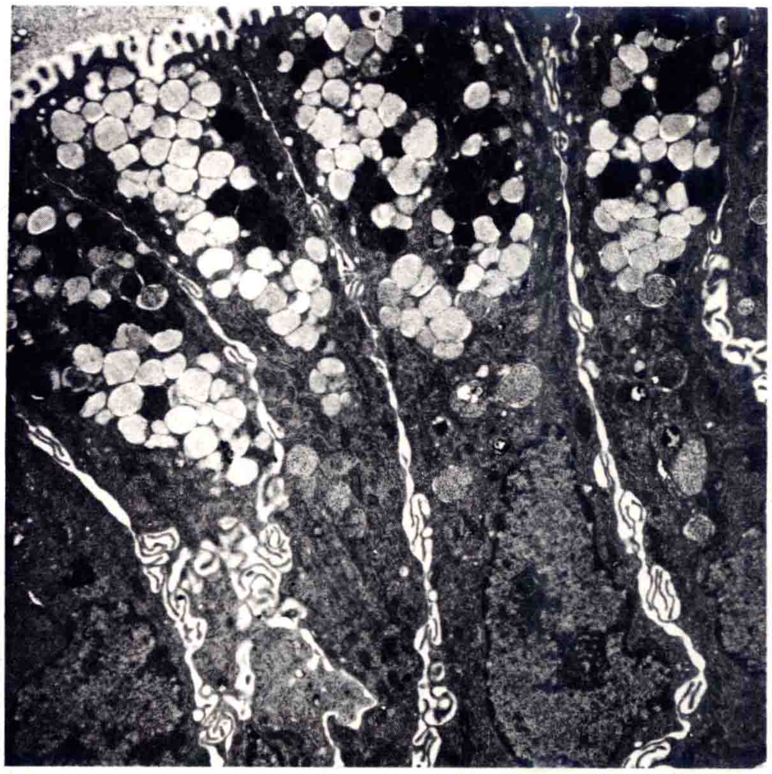
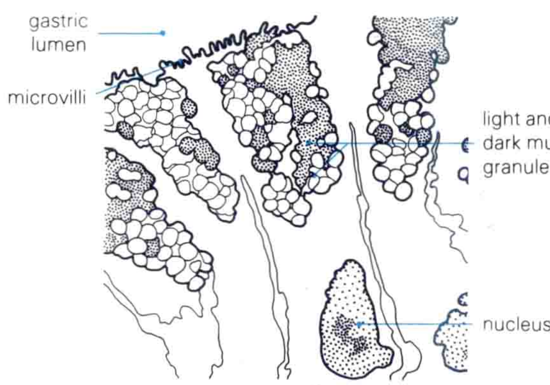


Fig.1.32 Electron micrograph showing the surface, mucus-secreting epithelial cells of the stomach. x 3200.



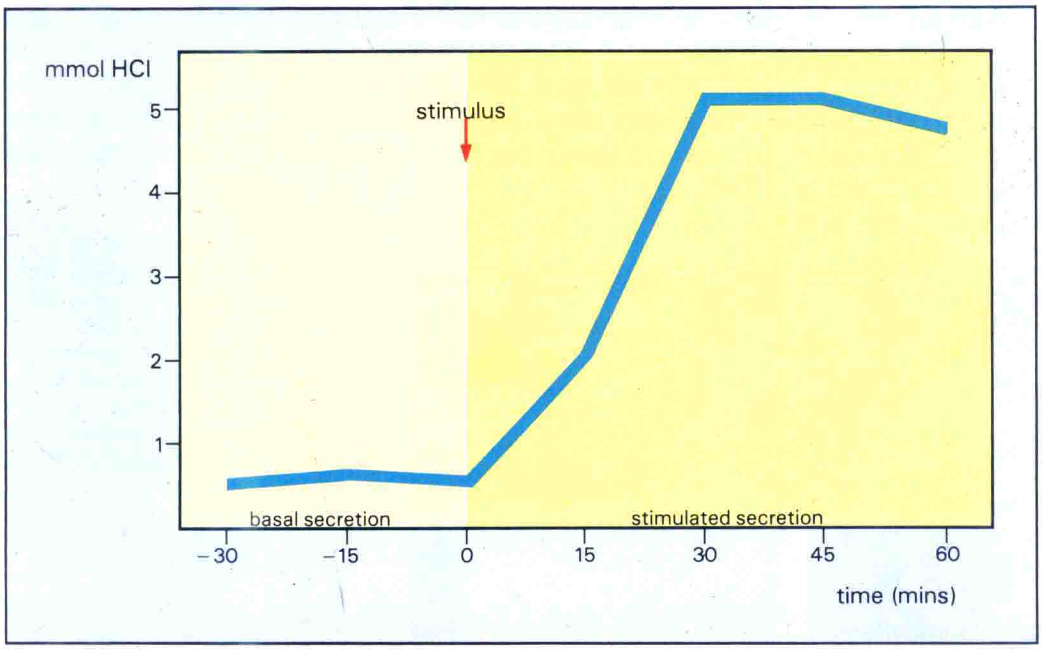


Fig. 1.33 Acid secretion study showing increased gastric acid output following stimulation with pentagastrin, 6uKg^{-1}

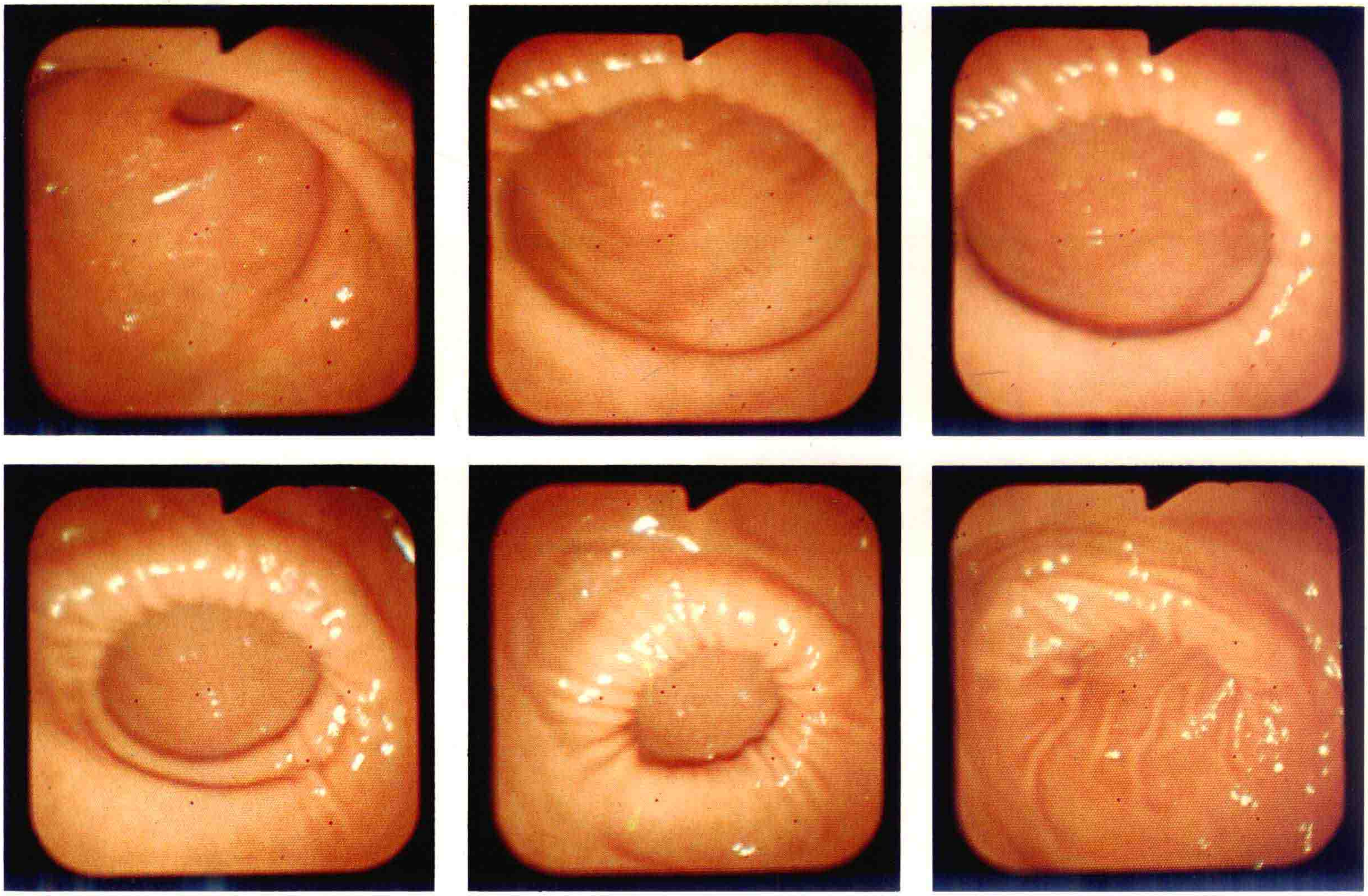


Fig.1.34 Sequential endoscopic views showing a peristaltic contraction wave advancing along the body of the stomach to the antrum and terminating in closing the pylorus.