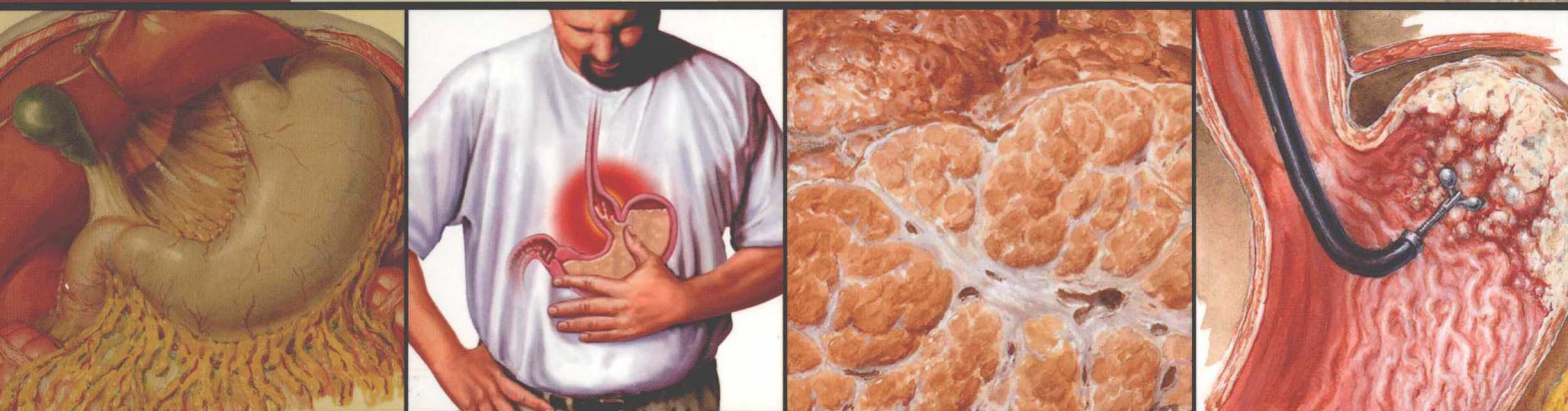


Netter's Gastroenterology

2nd edition



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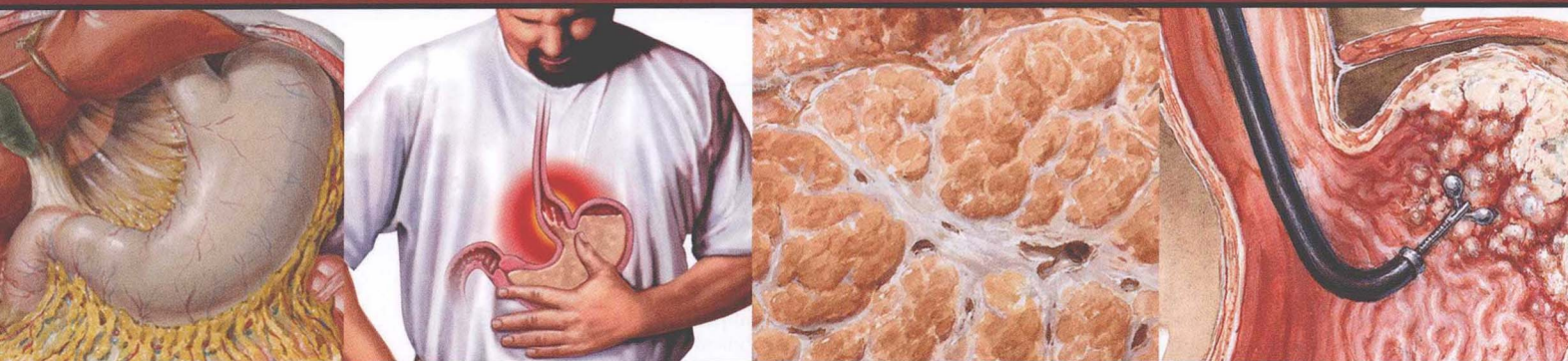
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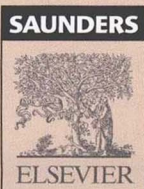
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In today's hectic world, writing scientific text takes place during what most people would consider leisure time. We have forsaken time with our families to compile this book. Hence, we would like to dedicate it completely to our wives and children.

*To our wives—Gladys Floch, Prema Pitchumoni, Bonnie Kowdley,
Robin Floch, Sima Rosenthal, and Elizabeth Scolapio.*

*To our children—Jeffrey Aaron Floch (in memoriam), Craig Lawrence Floch,
Lisa Susanne Adelman, Neil Robert Floch, Sydney Floch, Jake Floch, Sheila Pitchumoni,
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Preface

Anyone who has studied medicine in the past 25 years knows the tremendous value of the illustrations of the late Dr. Frank H. Netter. Students and teachers alike recognize his illustrations as the criteria by which all others are judged and consider them timeless classics because they “teach rather than intimidate.” Perhaps some thus far unimagined technical innovation will one day permit the development of teaching tools that surpass the clarity and educational value of Dr. Netter’s illustrations, but even with the present electronic revolution that day has yet to come, and new generations of students worldwide continue to discover for themselves his remarkable talent.

I have published two previous books in my career—one is among the first texts on the small intestine, and the other is among the first on nutrition in gastrointestinal disease. Although I pledged I would never again undertake such arduous work, the need for a concise yet comprehensive volume covering the basic concepts and the latest developments in the field, along with the opportunity to use the famous Netter collection to illustrate it, overcame my resistance. The result is *Netter’s Gastroenterology*. It was a success, and now we have finished the second edition.

My charge from the publisher was to write a text aimed at the generalist, understandable by the student, and of interest to the gastroenterologist. The approach of this book is different from that of traditional textbooks, which rely primarily on the written word. I sought to cover the field of gastroenterology and nutrition and to provide an efficient and meaningful learning experience to my audience by balancing the visual and the verbal, staying true to the philosophy of Dr. Netter by using the power of illustration to teach while providing essential information in the text. I selected approximately 300 of Dr. Netter’s best illustrations and, with my coauthors, wrote text to illuminate and expand on the concepts the illustrations present. In a traditional textbook, the text is written first, and illustrations are then created to accompany it. In this case, my coauthors and I wrote with the illustrations before us, and our goal was to forge text and pictures into a seamless whole. In this second edition, we have tried to update the narrative and modify the illustrations where necessary. Because medicine is a constantly advancing science, we called on the talents of medical artists Kip Carter, David Mascaro, Steven Moon, Mike de la Flor, and Kristen Wienandt Marzejon to create new illustrations in the Netter style and to update others where appropriate.

The book is organized into 10 sections that correspond to the organs of the gastrointestinal system and to special topics

within that system. These sections have been further divided into 272 concise, condition-oriented chapters, including introductory chapters on anatomy and physiology. The text provides core information about the “clinical picture,” diagnosis, treatment and management, course and prognosis, and, when applicable, prevention and control of each condition. With the increased observation of eosinophilic esophagitis, Neil Floch has added a chapter on that subject. With the advances in the treatment of obesity, this edition adds chapters on bariatric surgery and complications of that surgery by Drs. Neil Floch and Raul Rosenthal. I believe the result is a thorough look at almost all clinical topics in the field.

Although I felt comfortable writing the text for the sections on the stomach, small intestine, colon, and infectious diseases, I invited colleagues to undertake the other areas according to their interests and expertise. Dr. C. S. Pitchumoni, an outstanding scholar in the field of pancreatic diseases working at St. Peter’s University Hospital in New Jersey, agreed to write and update the text for the sections on the pancreas and the gallbladder. Dr. Kris Kowdley of the University of Washington, who has now assumed the leadership in liver disease at the Virginia Mason Medical Center and is recognized as a world authority in liver diseases, agreed to write and update the section on the liver. Dr. Neil Floch, who spent endless hours as a surgeon mastering the techniques of minimally invasive surgery and the Nissan fundoplication procedure and who continues as Head of Minimally Invasive Surgery at Norwalk Hospital in Connecticut, agreed to write and update the section on the esophagus. Dr. Raul Rosenthal, who is so active as a mentor and surgical practitioner at the Cleveland Clinic, in collaboration with his fellows in training, accepted the task of writing the sections on the abdomen. To complete the book, Dr. James Scolapio of the Mayo Clinic in Jacksonville again wrote the section on nutrition for this edition. I am grateful to all these colleagues for their hard work and dedication. The staff of Elsevier, Linda Belfus, Elyse O’Grady, Marybeth Thiel, and Sarah Wunderly, has been of immeasurable help in arranging for the book, editing the text and combining the text and illustrations into the finished form. We are forever thankful to them. Without them, this book and now its second edition would not have been published.

I hope our readers will enjoy this second edition as they did the first and find it helpful as part of their education and an ongoing reference.

Martin H. Floch, MD

About the Artists

Frank H. Netter, MD

Frank H. Netter was born in 1906 in New York City. He studied art at the Art Student's League and the National Academy of Design before entering medical school at New York University, where he received his MD degree in 1931. During his student years, Dr. Netter's notebook sketches attracted the attention of the medical faculty and other physicians, allowing him to augment his income by illustrating articles and textbooks. He continued illustrating as a sideline after establishing a surgical practice in 1933, but he ultimately opted to give up his practice in favor of a full-time commitment to art. After service in the United States Army during World War II, Dr. Netter began his long collaboration with the CIBA Pharmaceutical Company (now Novartis Pharmaceuticals). This 45-year partnership resulted in the production of the extraordinary collection of medical art so familiar to physicians and other medical professionals worldwide.

In 2005, Elsevier, Inc. purchased the Netter Collection and all publications from Icon Learning Systems. There are now over 50 publications featuring the art of Dr. Netter available through Elsevier, Inc. (in the US: www.us.elsevierhealth.com/Netter, and outside the US: www.elsevierhealth.com)

Dr. Netter's works are among the finest examples of the use of illustration in the teaching of medical concepts. The 13-book *Netter Collection of Medical Illustrations*, which includes the greater part of the more than 20,000 paintings created by Dr. Netter, became and remains one of the most famous medical works ever published. *The Netter Atlas of Human Anatomy*, first published in 1989, presents the anatomical paintings from the Netter Collection. Now translated into 16 languages, it is the

anatomy atlas of choice among medical and health professions students the world over.

The Netter illustrations are appreciated not only for their aesthetic qualities, but, more important, for their intellectual content. As Dr. Netter wrote in 1949, ". . . clarification of a subject is the aim and goal of illustration. No matter how beautifully painted, how delicately and subtly rendered a subject may be, it is of little value as a *medical illustration* if it does not serve to make clear some medical point." Dr. Netter's planning, conception, point of view, and approach are what inform his paintings and what makes them so intellectually valuable.

Frank H. Netter, MD, physician and artist, died in 1991.

Learn more about the physician-artist whose work has inspired the Netter Reference collection: <http://www.netterimages.com/artist/netter.htm>

Carlos A. G. Machado, MD

Carlos Machado was chosen by Novartis to be Dr. Netter's successor. He continues to be the main artist who contributes to the Netter collection of medical illustrations.

Self-taught in medical illustration, cardiologist Carlos Machado has contributed meticulous updates to some of Dr. Netter's original plates and has created many paintings of his own in the style of Netter as an extension of the Netter collection. Dr. Machado's photorealistic expertise and his keen insight into the physician-patient relationship informs his vivid and unforgettable visual style. His dedication to researching each topic and subject he paints places him among the premier medical illustrators at work today.

Learn more about his background and see more of his art at: <http://www.netterimages.com/artist/machado.htm>

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Topographic Relations of the Esophagus

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There is a smooth transition from the end of the pharynx, at the level of the cricoid cartilage and the sixth cervical vertebra (C6), to the esophagus (Figs. 1-1 and 1-2). On average, the esophagus is 40 cm (16 inches) long from the upper incisor teeth to the cardia of the stomach, but it may be as long as 43 cm in tall persons or in those with long trunks. The esophagus is divided, with the first part extending 16 cm from the incisors to the lower border of the cricopharyngeus muscle and the rest extending 24 cm.

The aortic arch crosses the esophagus from the left side and is located 23 cm from the incisors and 7 cm below the cricopharyngeus muscle; 2 cm below this level, the left main bronchus crosses in front of the esophagus. The lower esophageal sphincter (LES) begins 37 to 38 cm from the incisors. The esophageal hiatus is located 1 cm below this point, and the cardia of the stomach is yet lower. In children the dimensions are proportionately smaller. At birth the distance from the incisor teeth to the cardia is approximately 18 cm; at 3 years, 22 cm; and at 10 years, 27 cm.

Like a “good soldier,” the esophagus follows a left-right-left path as it marches down the anteroposterior curvature of the vertebral column. It descends anterior to the vertebral column, through the lower portion of the neck and the superior and posterior mediastinum. The esophagus forms two lateral curves that, when viewed anteriorly, appear as a reverse S: the upper esophagus has a convex curve toward the left, and the lower esophagus has a convex curve toward the right. At its origin, the esophagus bends $\frac{1}{4}$ inch (0.6 cm) to the left of the tracheal margin. It crosses the midline behind the aortic arch at the level of the fourth thoracic vertebra (T4). The esophagus then turns to the right at the seventh thoracic vertebra (T7), after which it turns sharply to the left as it enters the abdomen through the esophageal hiatus of the diaphragm, to join the cardia of the stomach at the gastroesophageal (GE) junction.

The esophagus is composed of three segments: cervical, thoracic, and abdominal. Anterior to the cervical esophagus is the membranous wall of the trachea. Loose areolar tissue and muscular strands connect the esophagus and the trachea, and recurrent laryngeal nerves ascend in the grooves between them. Posterior to the esophagus are the longus colli muscles, the prevertebral fascia, and the vertebral bodies. Although the *cervical esophagus* is positioned between the carotid sheaths, it is closer to the left carotid sheath. The thyroid gland partially overlaps the esophagus on both sides.

The *thoracic esophagus* lies posterior to the trachea. It extends down to the level of the fifth thoracic vertebra (T5), where the trachea bifurcates. The trachea curves to the right as it divides, and thus the left main bronchus crosses in front of the esophagus. Below this, the pericardium separates the esophagus from the left atrium of the heart, which lies anterior and inferior to

the esophagus. The lowest portion of the thoracic esophagus passes through the diaphragm into the abdomen.

On the left side of the esophageal wall, in the upper thoracic region, is the ascending portion of the left subclavian artery and the parietal pleura. At approximately the level of T4, the arch of the aorta passes backward and alongside the esophagus. Below this, the descending aorta lies to the left, but when that vessel passes behind the esophagus, the left mediastinal pleura again comes to adjoin the esophageal wall. On the right side, the parietal pleura is intimately applied to the esophagus, except when, at the level of T4, the azygos vein intervenes as it turns forward.

In the upper thorax, the esophagus lies on the longus colli muscle, the prevertebral fascia, and the vertebral bodies. At the eighth thoracic vertebra (T8), the aorta lies behind the esophagus. The azygos vein ascends behind and to the right of the esophagus as far as the level of T4, where it turns forward. The hemiazygos vein and the five upper-right intercostal arteries cross from left to right behind the esophagus. The thoracic duct ascends to the right of the esophagus before turning behind it and to the left at the level of T5. The duct then continues to ascend on the left side of the esophagus.

A small segment of *abdominal esophagus* lies on the crus of the diaphragm and creates an impression in the underside of the liver. Below the tracheal bifurcation, the esophageal nerve plexus and the anterior and posterior vagal trunks adhere to the esophagus.

As the esophagus travels from the neck to the abdomen, it encounters several indentations and constrictions. The first narrowing occurs at the cricopharyngeus muscle and the cricoid cartilage. The aortic arch creates an indentation on the left side of the esophagus, and the pulsations of the aorta may be seen during esophagoscopy. Below this point, the left main bronchus creates an impression on the left anterior aspect of the esophagus. The second narrowing occurs at the LES.

Although the esophagus is described as a “tube,” it is oval and has a flat axis anterior to posterior with a wider transverse axis. When the esophagus is at rest, its walls are approximated and its width is 2 cm, but it distends and contracts depending on its state of tonus.

ADDITIONAL RESOURCES

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Gray H, Bannister LH, Berry MM, Williams PL, editors: *Gray's anatomy: the anatomical basis of medicine and surgery*, New York, 1995, Churchill Livingstone.

Peters JH, DeMeester TR: Esophagus and diaphragmatic hernia. In Schwartz SI, Shires TG, Spencer FC, editors: *Principles of surgery*, ed 7, New York, 1999, McGraw-Hill, pp 1081-1179.

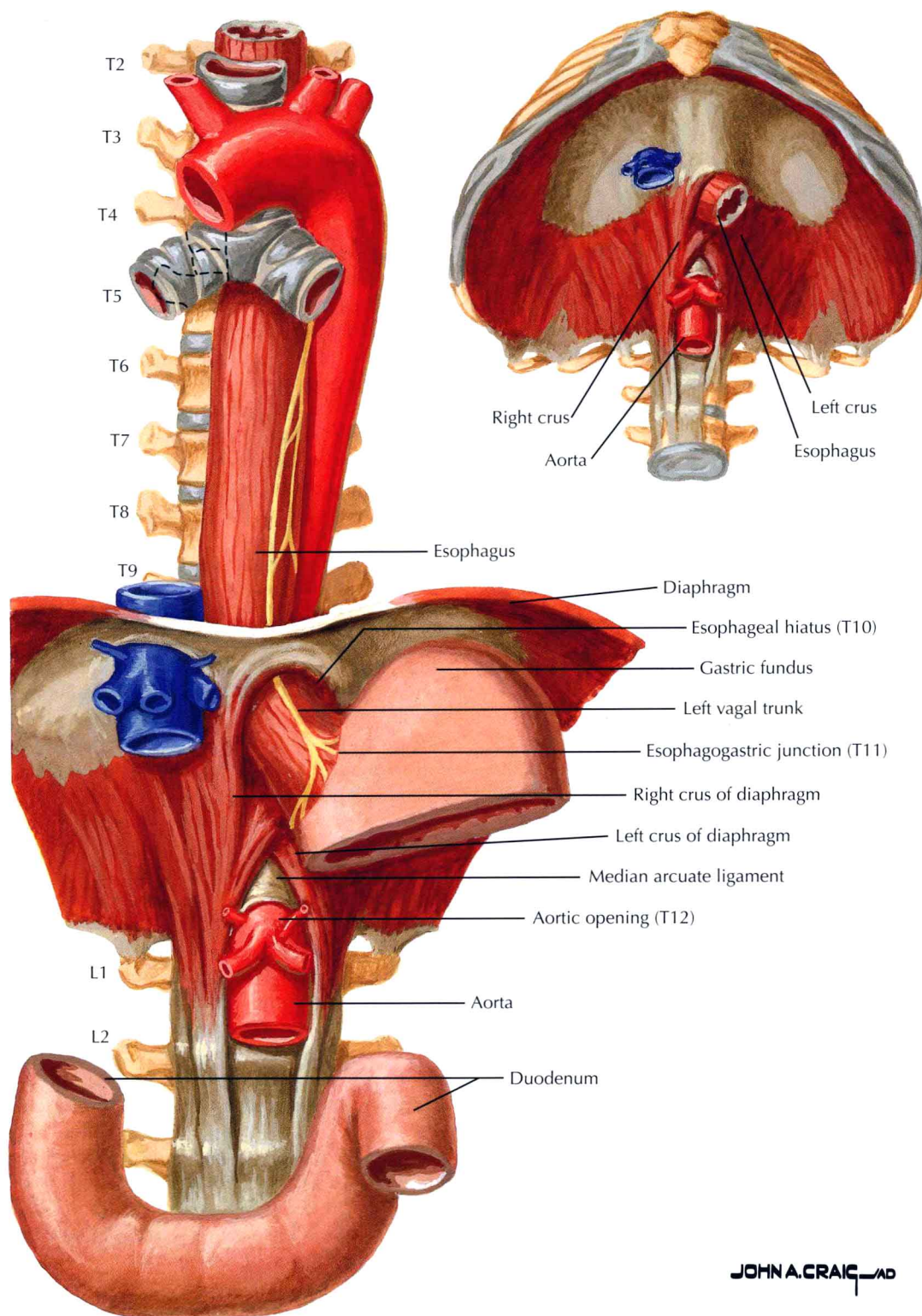


Figure 1-1 Regional Anatomy of Diaphragm, Stomach, and Esophagus.

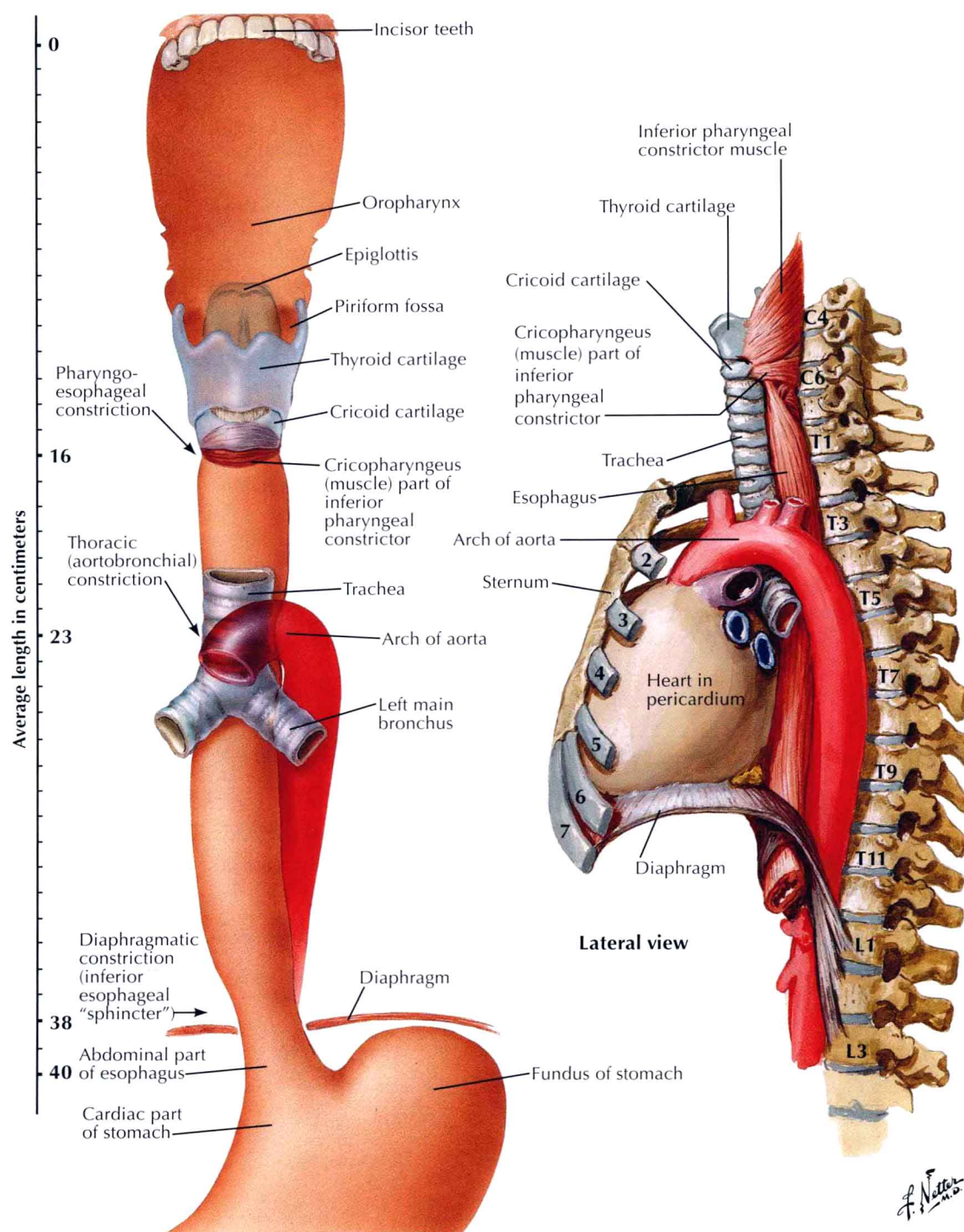


Figure 1-2 Topography and Constrictions of Esophagus.

Musculature of the Esophagus

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The esophagus is composed of outer longitudinal and inner circular muscle layers (Figs. 2-1 and 2-2). On the vertical ridge of the dorsal aspect of the cricoid cartilage, two tendons originate as they diverge and descend downward around the sides of the esophagus to the dorsal aspect. These tendons weave in the midline of the ventral area, creating a V-shaped gap between the two muscles known as the V-shaped area of Laimer. This gap, or bare area, exposes the underlying circular muscle. Located above this area is the cricopharyngeus muscle. Sparse longitudinal muscles cover the area, as do accessory fibers from the lower aspect of the cricopharyngeus muscle.

In the upper esophagus, longitudinal muscles form bundles of fibers that do not evenly distribute over the surface. The thinnest layers of muscle are anterior and adjacent to the posterior wall of the trachea. The longitudinal muscle of the esophagus receives fibers from an accessory muscle on each side that originates from the posterolateral aspect of the cricoid cartilage and the contralateral side of the deep portion of the cricopharyngeus muscle. As the longitudinal muscle descends, its fibers become equally distributed and completely cover the surface of the esophagus.

The inner, circular, muscle layer is thinner than the outer longitudinal layer. This relationship is reversed in all other parts of the gastrointestinal (GI) tract. In the upper esophagus, the circular muscle closely approximates the encircling lower fibers of the cricopharyngeus muscle. The upper esophageal fibers are not circular but elliptical, with the anterior part of the ellipse at a lower level of the posterior part. The ellipses become more circular as the esophagus descends, until the start of its middle third, where the fibers run in a horizontal plane. In one 1-cm segment, the fibers are truly circular. Below this point, the fibers become elliptical once again, but they now have a reverse inclination; that is, the posterior part of the ellipse is located at a lower level than the anterior part. In the lower third of the esophagus, the fibers follow a spiral course down the esophagus. The elliptical, circular, and spiral fibers of this layer are not truly uniform and parallel but may overlap and cross, or they may even have clefts between them. Some fibers in the lower two thirds of the esophagus pass diagonally or perpendicularly, up or down, joining fibers at other levels. These branched fibers are 2 to 3 mm wide and 1 to 5 cm long and are not continuous.

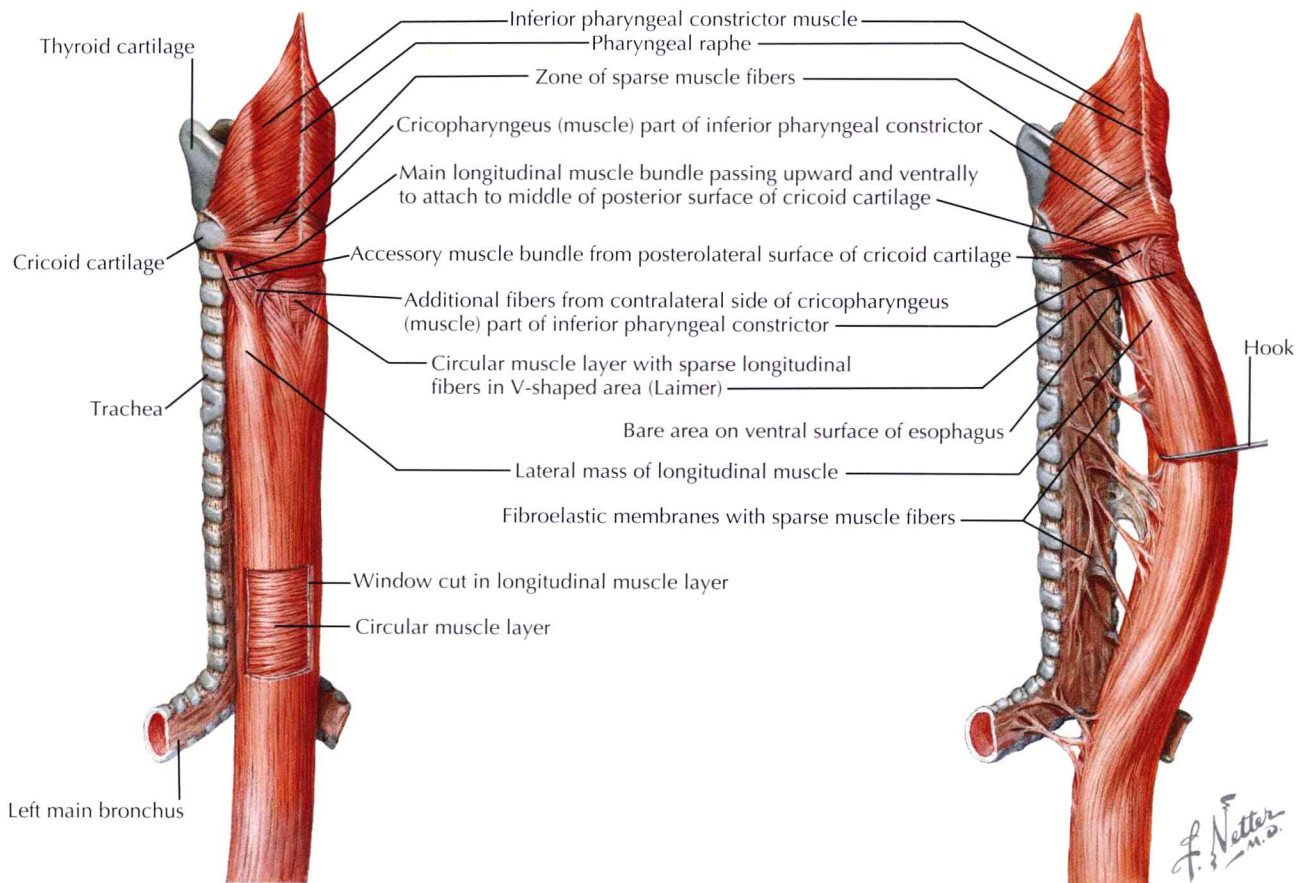


Figure 2-1 Musculature of the Esophagus.