COLON
Structure and Function

Edited by
Luis Bustos-Fernández, M.D.

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Preface

The functional and organic alterations of the colon constitute one of the leading reasons why patients consult gastroenterologists. The irritable colon is one of the most common causes of discomfort in human beings. The organic pathology of the large bowel (malignancy and chronic inflammatory disease) contributes, particularly among Occidental peoples, to discouragingly high levels of morbidity and mortality.

One realizes the importance of having a thorough physiologic knowledge of the colon in order to scientifically plan the functional treatment of organic colonic diseases.

If we consider the large amount of material published on the physiology of the esophagus, stomach, small bowel, pancreas, and liver, we realize that the colon has been relatively neglected. The chapters in this book have been written by people who have done their utmost to alter this imbalance.

I want to thank all the contributors for their generous collaboration that allows me to present in one volume virtually all the information known about the structure and function of the colon, and to record my deep graditude to Dr. Howard Spiro for his willingness to include this volume in his series. I would also like to express my sincere appreciation to Plenum Publishing Corporation for making this book possible. A special thanks goes to Dr. Isable Ledesma de Paolo for her cooperation in selecting the material to be published, to my daughter María Angélica Bustos-Fernández de Aragone for her diversified help in the preparation of the work, and also to my secretary Marcela Claudia Alvarez for her correspondence with the authors, as well as her diligent processing and retyping of some of the revised chapters.

My wife Susana was once more an important supporter of my work.

Luis Bustos-Fernández

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Colon Structure

Gregory L. Eastwood

I. DEVELOPMENT OF THE COLON

During the 5th week of human gestation, the midgut begins to elongate rapidly and extrudes into the umbilical cord. The subsequent enlargement and return of the midgut loop to the abdomen, and the rotation of the bowel during this process, determines the adult configuration of the colon.

The rotation and final placement of the midgut occurs in three stages. The first stage marks the extrusion of the midgut into the umbilical cord, where it remains between the 5th and 10th weeks. This process produces a 90-degree-counterclockwise rotation of the midgut loop, when the embryo is viewed from the ventral side.

The second stage coincides with the return of the midgut to the abdomen. The small intestine enters first, to the right of the superior mesenteric artery, but as more gut returns, the first folds are pushed behind the artery into the left abdomen. These loops of small bowel, in turn, displace the dorsal mesentery of the hindgut to the left so that the descending colon occupies the left flank. The cecum and ascending colon are the last to be reduced into the abdomen and lie at first in the right upper quadrant in front of the small bowel. The colon subsequently elongates, pushing the cecum downward by the 11th week, and completing a 270-degree rotation of the midgut loop.

During the third stage, which continues until shortly before birth, the cecum descends further into the iliac fossa. The mesenteries of the cecum, ascending colon, hepatic flexure, splenic flexure, and descending colon become fused to the posterior abdominal wall, leaving only the transverse colon and sigmoid colon on free mesenteries. The final placement of the colon within the abdomen is thus achieved.

In the rat, between the 16th and 20th days of a 22-day gestation, the mucosa of the colon changes from a simple tube with a tiny lumen lined by stratified epithelium (Fig. 1) to a much more complex structure with a large lumen and well-developed crypts

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lined by a single layer of columnar epithelium (Fig. 2).[1] Further, proliferating cells are present throughout the early stratified epithelium. However, when the crypts develop, the proliferating cells are confined to the lower half of the crypts.[1] An increase in glycoprotein synthesis and the development of the adult pattern of intracellular migration of newly synthesized glycoproteins parallel the changes in cellular differentiation.[2]

Nearly 70 years ago, Johnson described the development of the mucosa of the large intestine in human embryos.[3] He found that the large intestine initially is a simple tube of epithelium, similar to the findings in the rat, and is the last portion of the digestive tract to show distinctive changes in the mucosa. The first change to occur is the formation of longitudinal ridges, which appear first in the rectum and then extend proximally. The ridges also arise in the region of the cecum and subsequently extend distally. Thus, the transverse colon is the last portion of the colon to develop these structures. Villi then form from the longitudinal ridges by segmentation of the ridges and budding of new growths. The mucosal crypts develop from knoblike protuberances of epithelium which extend into the underlying mesenchyme. As the crypts enlarge, the villi diminish in size, until the mature pattern of a flat mucosa which contains only closely spaced crypts, without villi, is achieved.

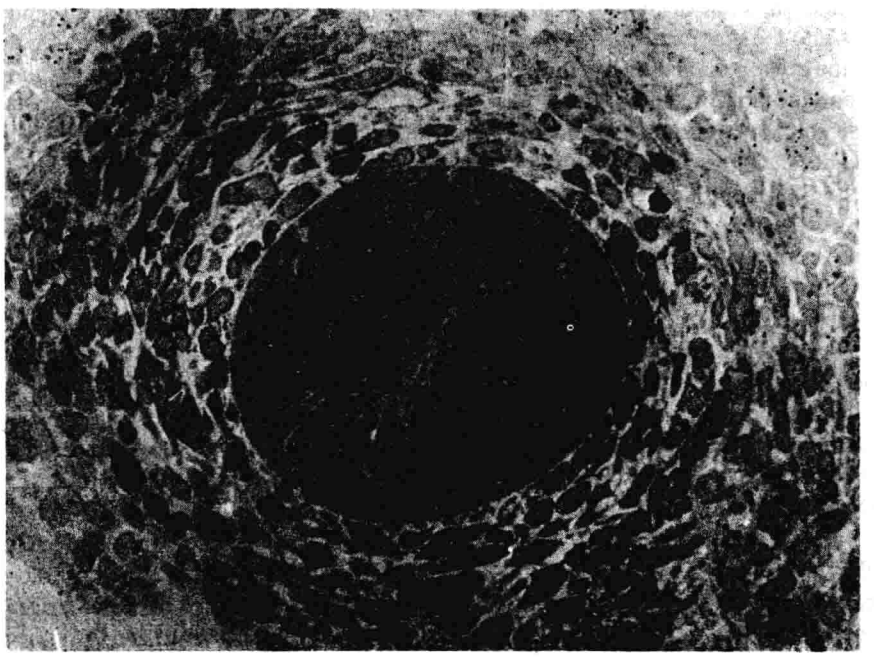

Figure 1. Light microautoradiograph of a cross-section of the colon from a 16-day-gestation fetal rat. The tubular gut consists of a tiny lumen surrounded by 2- to 3-cell-thick layer of stratified epithelium, which in turn is surrounded by a concentrically arranged mesenchyme. Labeled nuclei, identified by accumulations of black granules, are randomly scattered throughout the epithelium and the mesenchyme. (Toluidine blue, × 600)

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