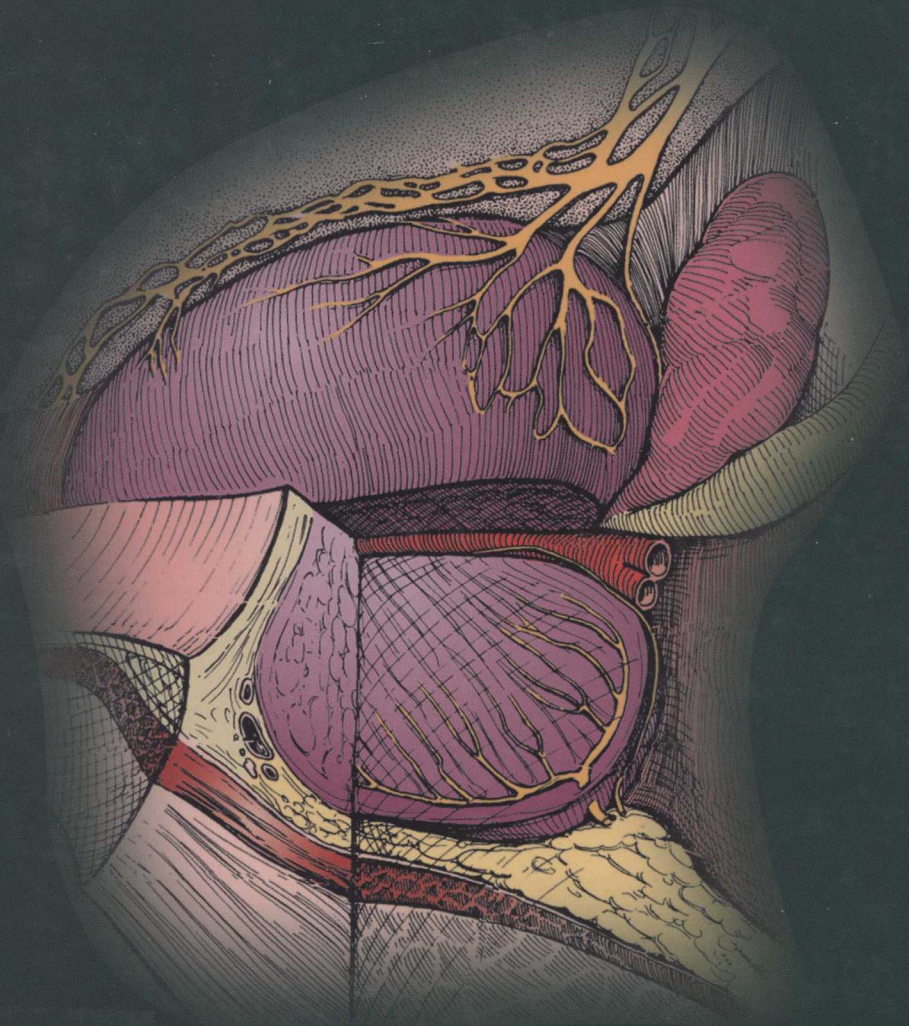
Hinman's Atlas of UROSURGICAL ANATOMY

SECOND EDITION



Gregory T. MacLennan

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Hinman's Atlas of UroSurgical Anatomy

Second Edition

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Dedication

This second edition of Dr. Frank Hinman, Jr.'s Atlas of UroSurgical Anatomy *is dedicated to my best friend, my wife, Carrol Anne MacLennan, and to the memory of Dr. Martin I. Resnick, who, as the Chairman of Urology at University Hospitals Case Medical Center in Cleveland, Ohio, was my mentor, my good friend, and my inspiration in many of my endeavors.*

Foreword

Many characteristics define a good surgeon beyond simple technical skills. Good judgment, decisiveness coupled with appropriate caution, command of the operating field and arena, and compassion for the patient are all hallmarks of a superior surgeon. Undoubtedly, though, an essential underlying necessity is knowledge of surgical anatomy. Even the most highly skilled technician cannot achieve optimal results without an in-depth understanding of anatomic details and relationships between various anatomic structures.

Hinman's Atlas of UroSurgical Anatomy has been an invaluable resource for surgeons who perform procedures on the genitourinary systems. Other anatomy texts provide fundamental descriptions of anatomy, but the unique aspect of *Hinman's* is the organizational approach, which combines embryology with mature anatomy and then places the anatomic findings in a clinical perspective. Rather than a simple, dry presentation of anatomy, the book assumes a much more relevant role for clinicians through beautiful illustrations and tables. Further, imaging studies and pathologic photographs help create a comprehensive approach that relates the anatomy to other pertinent details of patient management.

The three sections of the atlas present unique but complementary approaches to surgical anatomy. Section I is organized by systems and allows focused study of vascular, lymphatic, neural, and other systems. Section II, the body wall, contains information and illustrations of great use for planning surgical incisions and approaches. Section III addresses individual organs and their anatomy and development. Each of these areas is crucial and the manner in which the book is arranged permits detailed focus on relevant anatomic findings and principles while interrelating different systems and organs.

Understanding normal anatomy is, obviously, essential, but a surgeon must also be prepared for anatomic variation. Moreover, understanding the embryology that may lead to abnormalities or aberrancy in anatomy allows not only recognition of the variation but also suitable planning for how best to address it. The book stands out in this regard. Surgically important variations in systems or organs are well described, illustrated, and complemented by imaging when appropriate.

Greg MacLennan, a widely respected and skilled pathologist, has brought his considerable expertise to his role as Editor of this revised edition of *Hinman's Atlas of UroSurgical Anatomy*. Surgeons are always reliant upon their pathology colleagues, and Dr. MacLennan has helped produce a text that serves as a wonderful complement to *Hinman's Atlas of Urologic Surgery*. The latter is the best comprehensive atlas for a step-by-step description of surgical procedures, but the information in it is greatly enhanced by understanding better the basic anatomy and principles underlying the described operations.

As new operations and surgical approaches arise, different or even novel aspects of anatomy become important. This revised edition incorporates and includes updated and relevant information of practical value to clinicians. Dr. Hinman recognized the need for a *UroSurgical Anatomy Atlas,* and Dr. MacLennan has continued the proud tradition of the text with this revised edition. Surgeons and their patients are the beneficiaries.

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Preface

In his preface to the first edition of *Atlas of UroSurgical Anatomy*, Dr. Frank Hinman, Jr. explained in detail his rationale for creating the book, the approach he took to presenting the material, and his expectations of the ways in which urologists and others might use the book to better care for patients. It is clear that he wished to compile anatomic information from many sources, including his own studies, into a single comprehensive and well-organized textbook that could be consulted quickly and efficiently by urologic surgeons to assist them in planning and conducting surgical procedures. Undoubtedly, surgeons in other specialties besides urology have benefited from his work. Upon reading the first edition, one is unavoidably humbled by the vast scope of the work that Dr. Hinman and his colleagues invested in this book. Readers are strongly encouraged to review Dr. Hinman's original preface before embarking on an exploration of its contents.

When the decision was made to create a second edition of the book, a number of principles were brought into play. It was decided early on that the original black and white illustrations could be made more visually appealing and perhaps more easily understood by colorizing as many of them as seemed practical and reasonable. Furthermore, it was believed that the details of surgical procedures should be described in and restricted to companion texts devoted to adult and pediatric urologic surgery, and therefore, being somewhat redundant, images of this nature were to be removed from this textbook. In addition, following the examples of other current textbooks of anatomy, it was believed that anatomy can be presented in ways other than line drawings, and with that in mind, it was decided to supplement Dr. Hinman's original material with a variety of other new and relevant images, including clinical photographs, intraoperative photographs from open surgical, laparoscopic, and endoscopic procedures, and images from the fields of radiology and pathology. While I have easy access to pathology specimens, I found it necessary to procure other types of images from a large and diverse group of colleagues, who were astonishingly helpful and graciously cooperative in this matter. In all cases, contributors are acknowledged by name in the figure legends, and it is hoped that this small acknowledgment is sufficient to convey my very sincere and profound gratitude to them for their generous assistance in enhancing the educational content and the visual appeal of this new edition.

In the early stages of planning this second edition, I was greatly pleased and enthusiastic about the notion of being able to carry out this work with my mentor and good friend, Dr. Martin Resnick, with whom I had previously collaborated on some very worthwhile projects. To my great distress and sorrow, and the sorrow of many others who knew and worked with him, Dr. Resnick fell ill and was unable to see this project through to completion. Nonetheless, this second edition is dedicated to his memory.

I am deeply impressed with the courtesy, efficiency, and professionalism of the staff of the Elsevier publishing company, and I am particularly delighted to have had the opportunity to work with Stefanie Jewell-Thomas, Arlene Chappelle, and Peggy Fagen. We all hope that you will find this second edition of *Atlas of UroSurgical Anatomy* useful in your work.

Gregory T. MacLennan, MD

Contents

Section I

SYSTEMS

Chapter 1

Arterial System

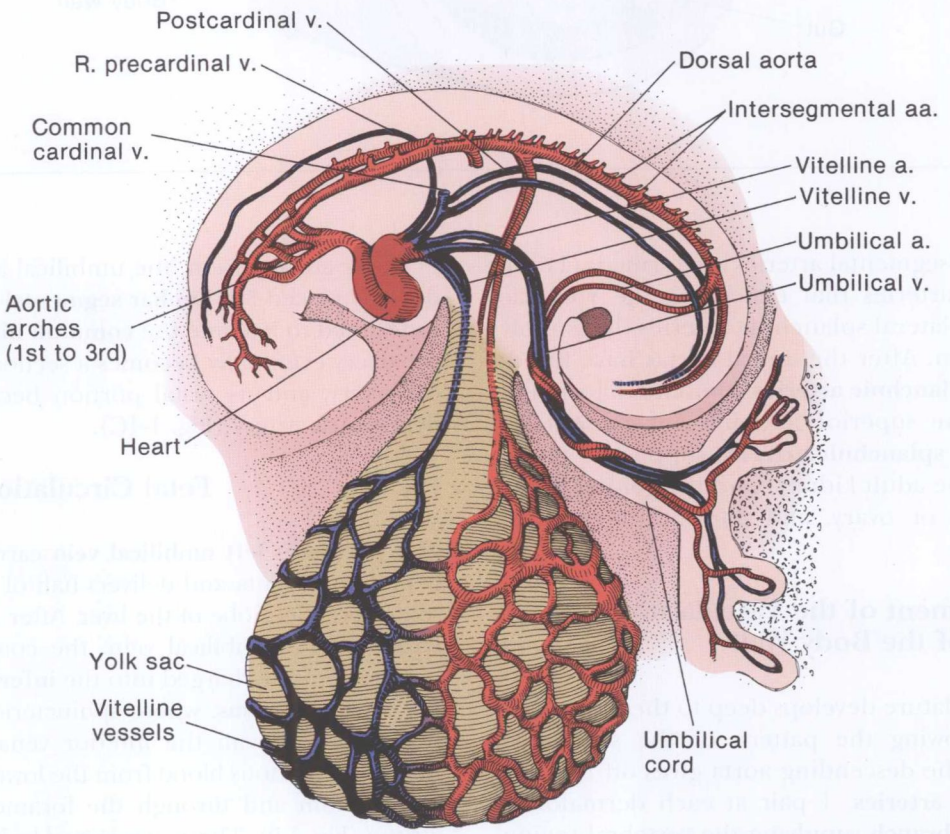

FIGURE 1-1. *(Adapted from Moore KL: The Developing Human, 4th ed. Philadelphia, WB Saunders Company, 1988.)*

A veyne called Arteria . . . to bere and brynge kindely heete from the herte to al the membres.

TREVISA
Barth. De P.R. V.lvi, 1398

DEVELOPMENT OF THE ARTERIAL SYSTEM

Dorsal Aorta

In the third week of gestation, the right and left **aortic arches** turn caudally to form the corresponding **dorsal** (descending) **aortas**. These connect with the **vitelline artery** over the **yolk sac**. The first of the longitudinal veins, the **postcardinal veins,** develop ventrally. The **intersegmental arteries** branch from each aorta (Fig. 1-1). A week later, the two dorsal aortas fuse to form the single dorsal (descending) aorta so that by 8 weeks, a single aortic arch and dorsal aorta are in place.

SEGMENTAL ARTERIES

The **dorsal aorta** at each dermatome gives off a pair of intersegmental arteries, the **dorsal somatic arteries**. Each of these arteries has a **dorsal branch** supplying the vertebral region and **neural tube** and a **ventral branch** having lateral and terminal branches to supply the **body wall** (Fig. 1-2). The posterior intercostal, subcostal, and lumbar arteries are derived from the dorsal somatic arteries. The enlarged 5th lumbar intersegmental artery, as the common iliac artery, will provide the blood supply to the pelvis and lower extremities.

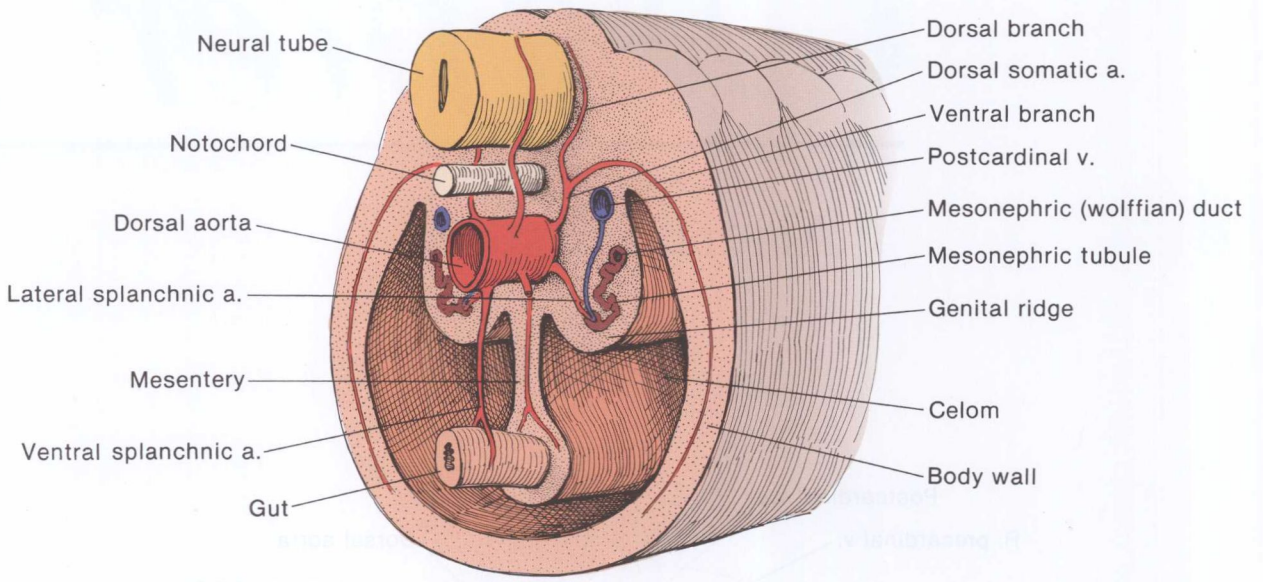

FIGURE 1-2.

Two other sets of segmental arteries are formed: (1) the ventral splanchnic arteries that extend to the yolk sac and gut and (2) the lateral splanchnic arteries that supply the urogenital system. After the dorsal aortas have fused, the paired **ventral splanchnic arteries** combine to form the celiac trunk and the superior and inferior mesenteric arteries. The **lateral splanchnic arteries** supply the **mesonephros** (and also the adult kidney) and the **genital ridge**, including the testis or ovary, and part of the adrenal gland.

Development of the Vasculature of the Body Wall

The segmental vasculature develops deep to the muscles of the body wall, following the pattern of the segmental nerves. At 5 weeks, the descending aorta gives off 30 pairs of **dorsal segmental arteries**, 1 pair at each dermatome. These have a **dorsal branch** supplying the vertebral region and neural tube and a **ventral branch** that, in turn, has lateral and terminal branches. These branches supply the major muscles of the trunk and overlying skin by way of the intercostal, subcostal, and lumbar arteries. The more anterior portion of the body wall is supplied by a "ventral aorta" through **anastomotic arteries,** which will form the internal mammary and superior and inferior epigastric arteries (Fig. 1-3).

From the segmentally arranged vessels such as the **intercostal** or **lumbar arteries**, branches run perpendicularly through the muscle as **perforators** to the skin, where they become **cutaneous vessels**.

Umbilical Artery

The **umbilical arteries** originate as ventral branches of the paired dorsal aortas and enter the **umbilical cord** lateral to the **allantois** (Fig. 1-4 A,B).

After aortic fusion, the umbilical arteries arise from the dorsally placed **5th lumbar segmental artery**, the vessel that is destined to become the **common iliac artery**. The umbilical artery eventually becomes a section of the superior vesical artery, and its distal portion becomes the obliterated hypogastric artery (Fig. 1-4C).

Fetal Circulation

The persistent **left umbilical vein** carries oxygenated blood from the placenta and delivers half of it to the hepatic sinusoids of the left lobe of the liver. After entrance of the **portal vein** into the umbilical vein, the combined placental and portal flow is discharged into the **inferior vena cava** through the **ductus venosus**, where sphincteric action regulates the relative flow. From the inferior vena cava, hepatic blood mixed with venous blood from the lower body passes into the right atrium and through the foramen ovale into the left atrium (Fig. 1-5). There, it is joined by blood from the pulmonary veins. After traversing the atrium, the blood goes through the left ventricle into the ascending aorta. Some blood remains in the right atrium to be directed by the valve of the foramen ovale into the right ventricle and on into the pulmonary trunk. Because pulmonary resistance is high, only a small portion of the blood goes to the lungs; most of it passes through the ductus arteriosus into the **aorta**. Most of the blood, with some addition from the left ventricle, has already circulated through the head and upper limbs. It passes down the aorta to supply the abdomen and lower extremities and into the right and left **umbilical arteries** to the placenta.

Circulatory Alterations at Birth

Five vascular structures become obsolete at birth: the foramen ovale, ductus venosus, ductus arteriosus, and the paired umbilical vessels. As the pressure in the left atrium rises from the relative increase in pulmonary flow over that

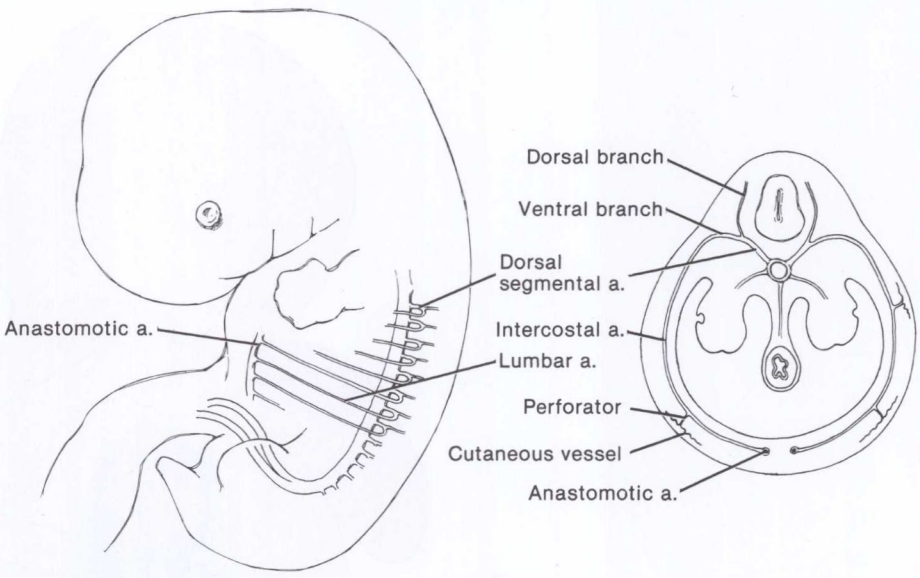

FIGURE 1-3.

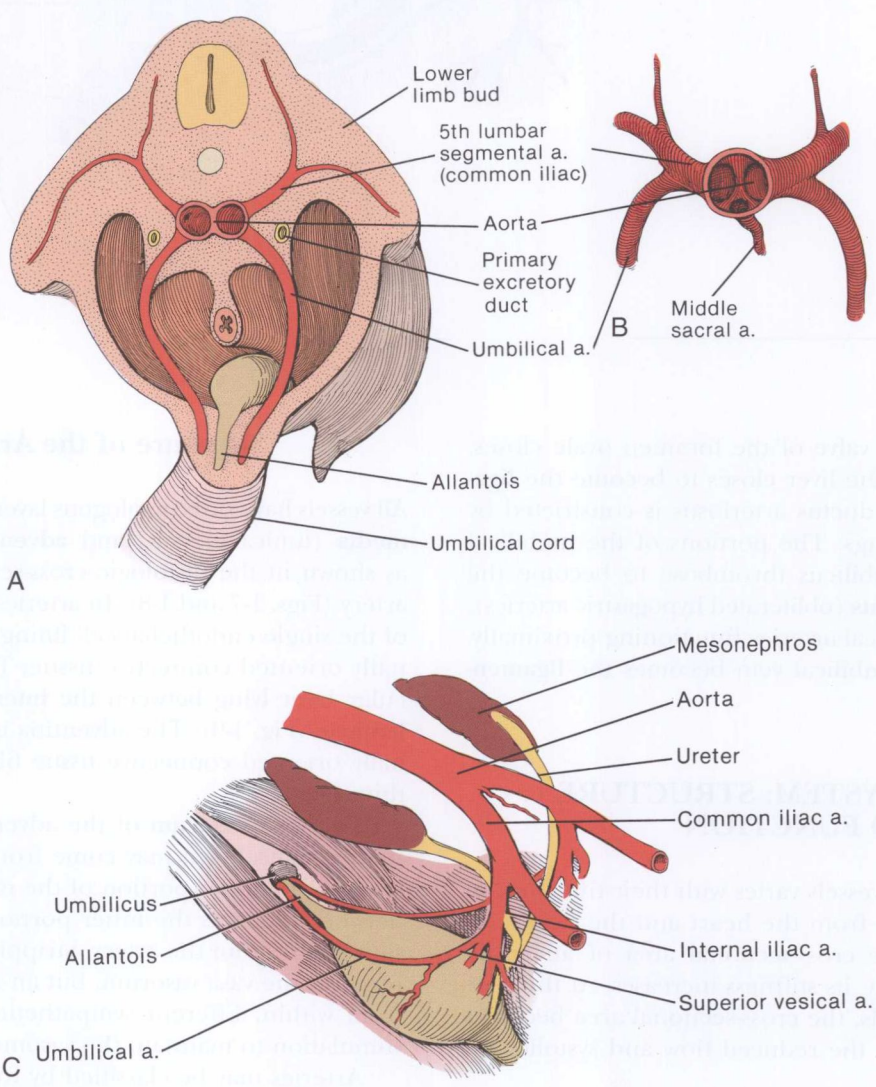

FIGURE 1-4.

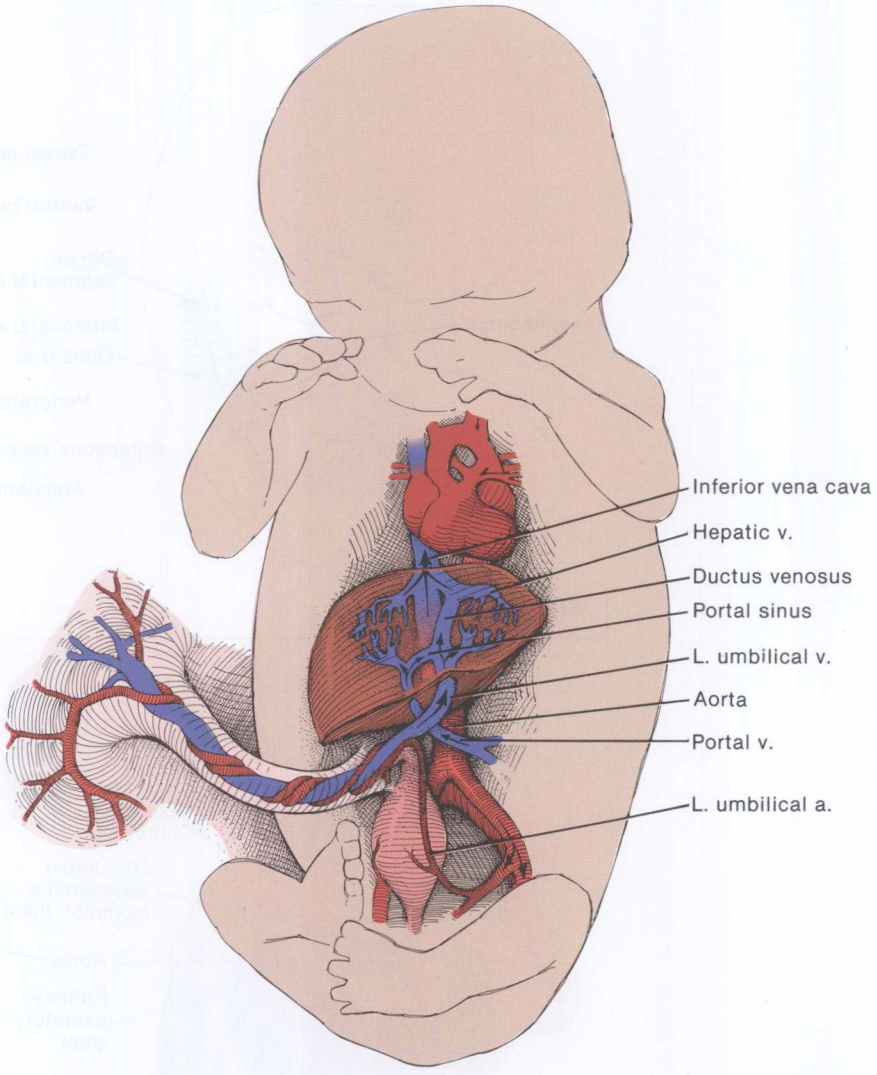

FIGURE 1-5.

of the right atrium, the valve of the foramen ovale closes. The ductus venosus in the liver closes to become the **ligamentum venosum**. The ductus arteriosus is constricted by bradykinin from the lungs. The portions of the umbilical arteries nearest the umbilicus thrombose to become the **median umbilical ligaments** (obliterated hypogastric arteries), leaving the superior vesical arteries functioning proximally. The thrombosed left umbilical vein becomes the **ligamentum teres** (Fig. 1-6).

ARTERIAL SYSTEM: STRUCTURE AND FUNCTION

The structure of blood vessels varies with their function. In general, as the distance from the heart and the degree of branching increase, the cross-sectional area of an artery decreases and conversely, its stiffness increases. At the arteriolar and capillary levels, the cross-sectional area becomes greater in keeping with the reduced flow and systolic and pulse pressures.

The response of a blood vessel to clamping, ligating, or suturing depends on its wall structure.

Structure of the Arterial Wall

All vessels have three analogous layers: **intima** (tunica intima), **media** (tunica media), and **adventitia** (tunica adventitia), as shown in the histologic cross-section of a medium-sized artery (Figs. 1-7 and 1-8). In arteries, the intima is composed of the single endothelial cell lining, supported by longitudinally oriented connective tissue. The media is a fibromuscular layer lying between the **internal** and **external elastic laminae** (Fig. 1-9). The adventitia is composed of longitudinally oriented connective tissue fibers and is covered by a thin **sheath**.

The **vasa vasorum** of the adventitia usually arises from the vessel itself but may come from an adjacent one. They nourish the outer portion of the media through a capillary network, whereas the inner portions are supplied by diffusion from within the artery. Stripping the adventitial sheath removes the vasa vasorum, but an adequate supply remains from within. Efferent sympathetic nerves supply constant stimulation to maintain the vasomotor tone of the vessels.

Arteries may be classified by function. The major arteries are *conducting arteries*, which are rich in elastic qualities and so can absorb the force of the heart and change it to a

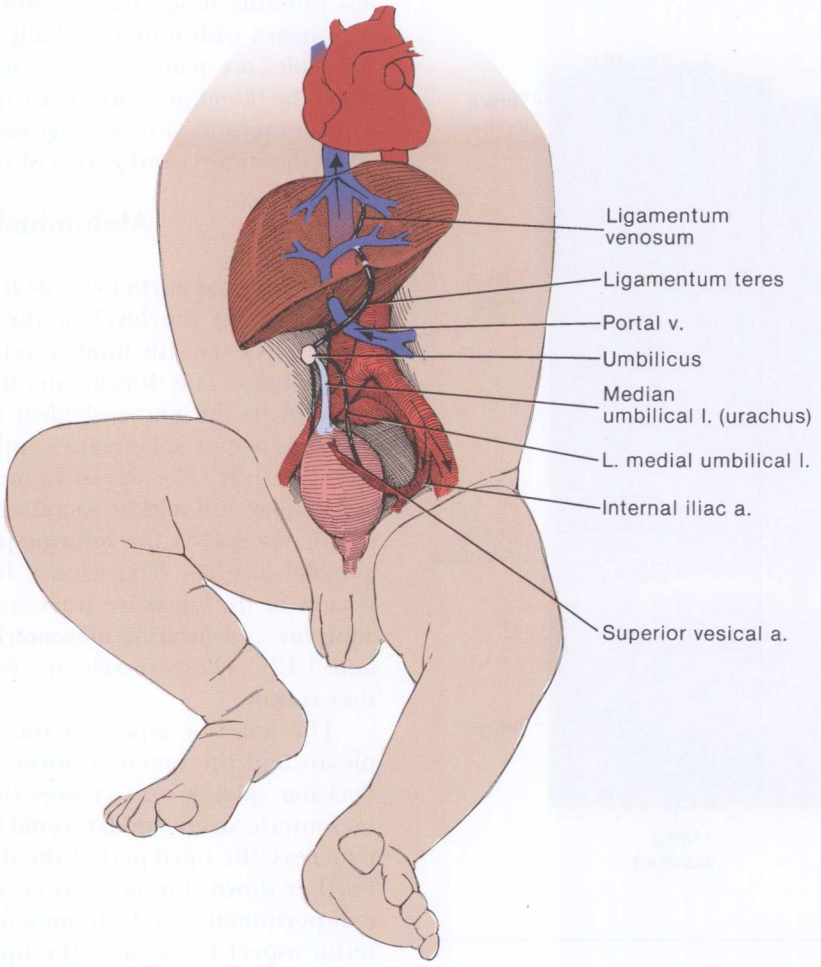

FIGURE 1-6.

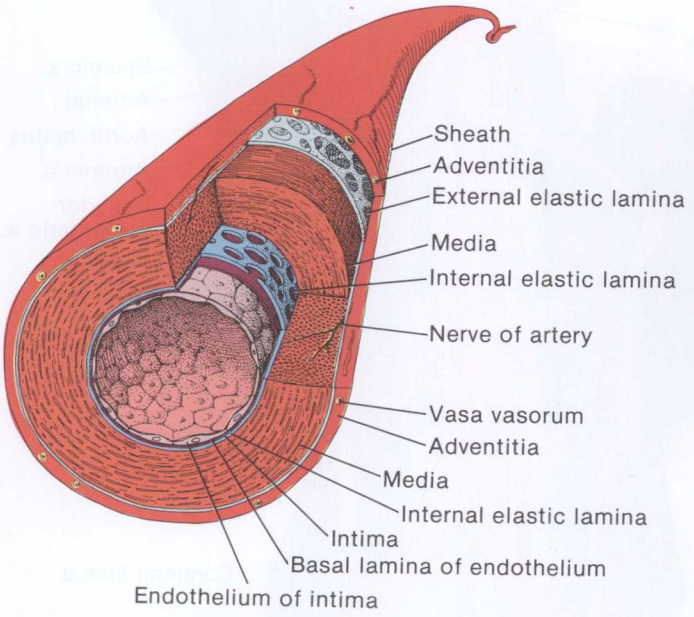

FIGURE 1-7.

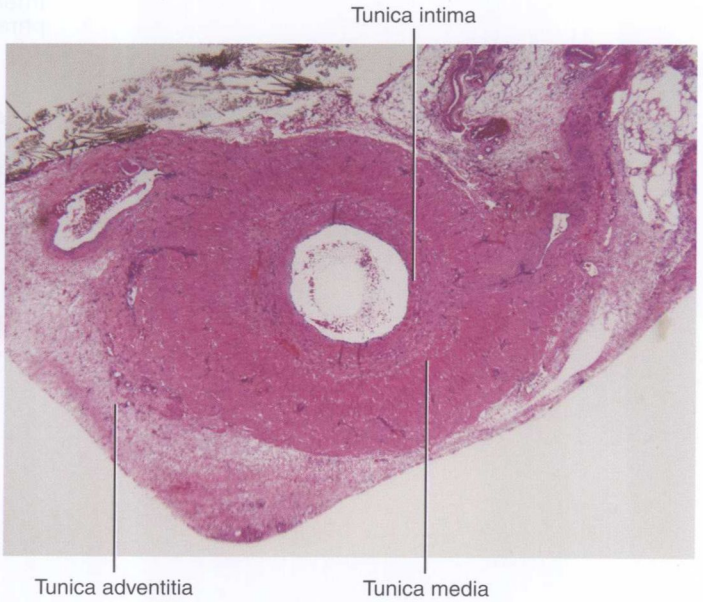

FIGURE 1-8.

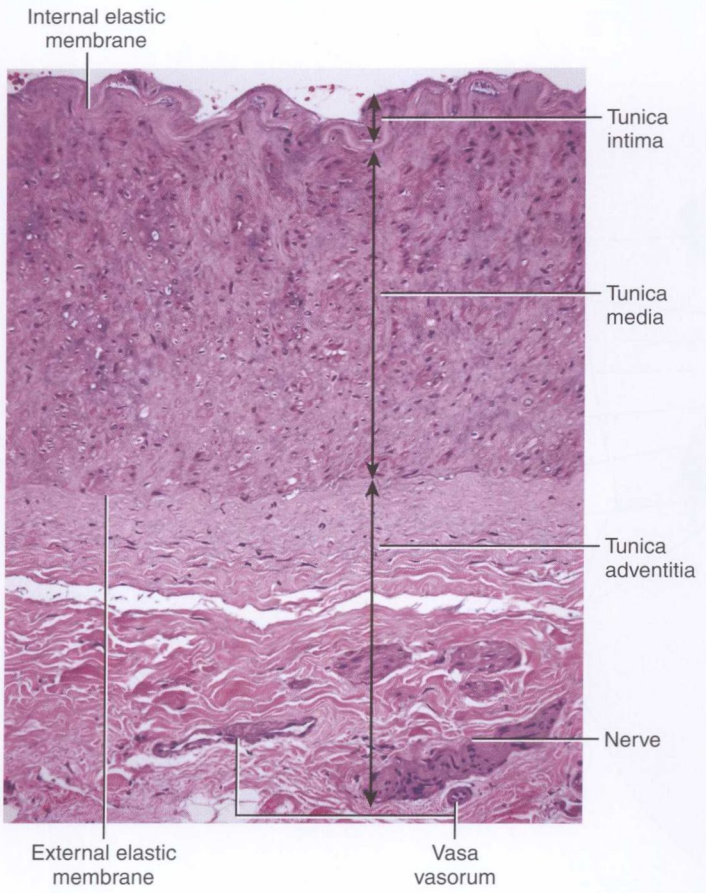

FIGURE 1-9.

less pulsatile flow. Medium and small arteries are *distributing arteries*, with muscular walls that aid in regulating flow. Arterioles are *resistance vessels*, which by restricting the flow affect the blood pressure. The capillaries, sinusoids, and postcapillary venules are *exchange vessels*, their function being to allow the ingress and egress of tissue fluid.

Abdominal Aorta

The **abdominal aorta** extends from the **aortic hiatus** of the diaphragm at the level of the 12th thoracic vertebra to the level of the 4th lumbar vertebra. It gives off four sets of branches: The dorsal, lateral, and ventral branches correspond to the embryological development of the dorsal somatic, lateral splanchnic, and ventral splanchnic vessels (see Fig. 1-3). The dorsal branches enter the body wall as the **lumbar** and **middle sacral arteries**. The lateral branches supply viscera via the **inferior phrenic, adrenal, renal,** and **gonadal** arteries. The ventral branches, which supply the viscera of the digestive tract, are the **celiac trunk** and the **superior** and **inferior mesenteric arteries** (Figs. 1-10, 1-11, and 1-12). These vessels are described under the organs they supply.

The anterior aspect of the aorta lies under the celiac plexus and the omental bursa. The pancreas with the underlying splenic vein crosses the aorta, with the superior mesenteric artery and left renal vein between. Caudal to the pancreas, the third part of the duodenum crosses the aorta. Further down, the aorta is covered by the posterior parietal peritoneum and the mesentery of the bowel. The posterior aspect lies against the upper four lumbar vertebrae,

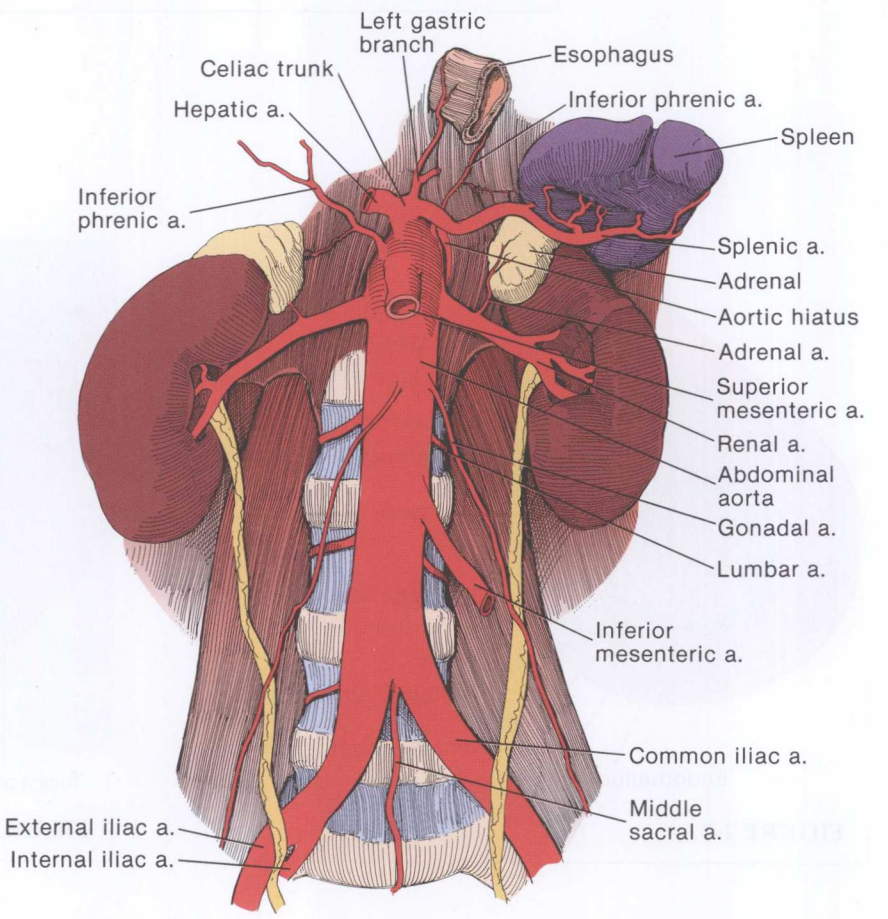

FIGURE 1-10.

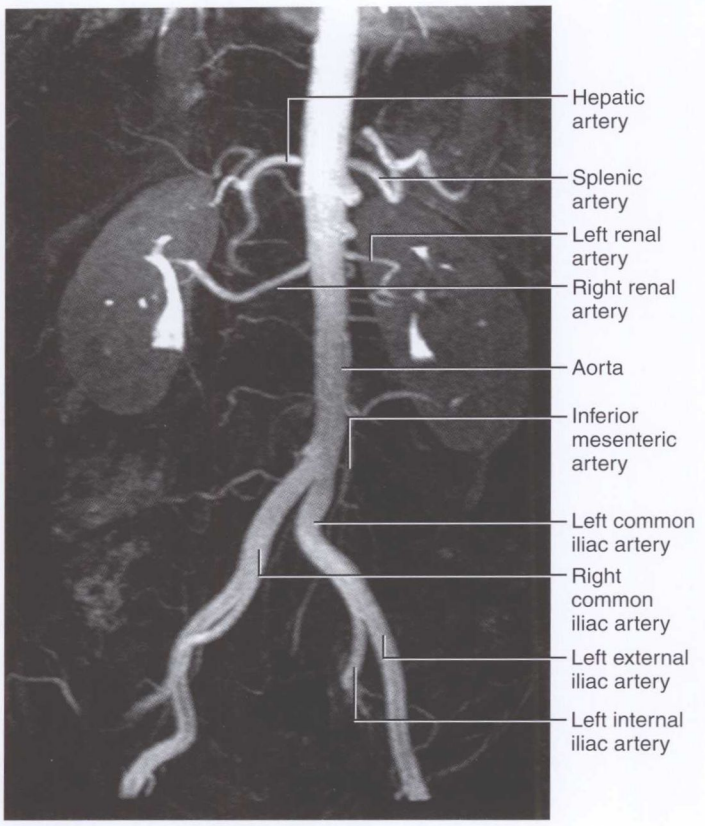

FIGURE 1-11. *(Image courtesy of Raj Paspulati, MD.)*

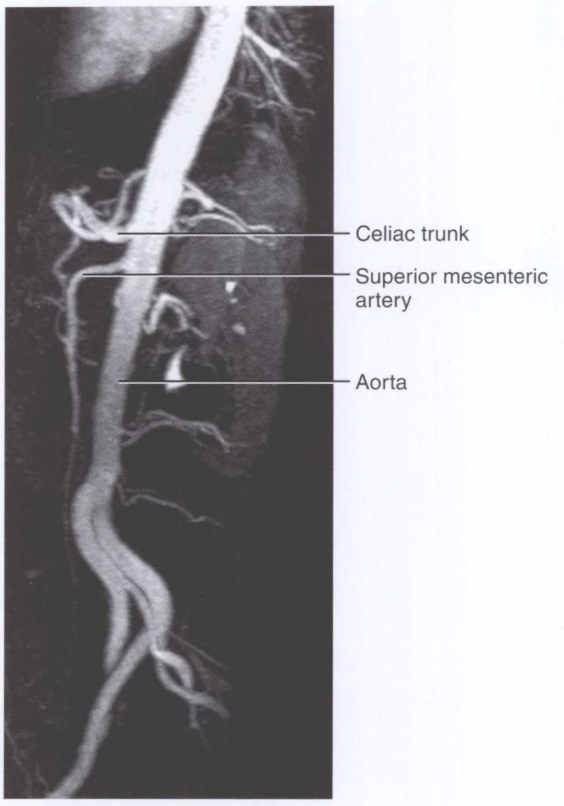

FIGURE 1-12. *(Image courtesy of Raj Paspulati, MD.)*

the corresponding intervertebral discs, and the anterior longitudinal ligament, with the 3rd and 4th lumbar veins intervening. The cisterna chyli, the thoracic duct, the azygos vein, the right diaphragmatic crus, and the right celiac ganglion lie to the right of the aorta. To the left are the left diaphragmatic crus and the left celiac ganglion, as well as the ascending portion of the duodenum and its junction with the jejunum and the sympathetic trunk.

The major arteries supplying specific parts of the genitourinary tract are described in the appropriate chapters.