GYNECOLOGIC AND OBSTETRIC UROLOGY

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SECTION I

ANATOMY, PHYSIOLOGY AND EXAMINATION OF THE FEMALE GENITOURINARY TRACT

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INTRODUCTION

Our two specialties (gynecology and urology) cannot remain watertight compartments when it is the patient we are endeavoring to make watertight.

T. Millin, 1949

The close functional and anatomic relationships of the female urinary and genital tracts have their origins in embryologic development. These relationships take on clinical importance because alterations in one system can affect morphology and function in the other. In practice, the urologist may be the first physician to see a patient with gynecologic disease presenting with urinary tract symptoms; the gynecologist may encounter unexpected but significant alterations of the urinary tract in his practice.

The specialized training of gynecologists no longer regularly includes female urology; similarly, the urologist in his training is only minimally exposed to the pathophysiology of gynecologic conditions that affect the urinary tract. With this volume we hope to provide the physician who treats female pelvic disease with a current textbook of gynecologic and obstetric urology. In addition to the traditional subjects, there are chapters on asymptomatic bacteriuria, pregnancy in renal transplant recipients, suprapubic bladder drainage, and the urinary tract in genital anomalies and infertility, subjects not covered in earlier texts. This book is not intended to compete with textbooks of female urology or gynecologic surgery, but rather to cover specific areas where the urinary tract is affected by physiologic and pathologic alterations in the female genital tract. Developments in medicine have identified new problems of overlapping medical responsibility not covered in previous books.

This collaborative effort had its origins at the University of Iowa, where the urology and gynecology operating rooms were adjacent and shared a common scrub area. As the result of a close clinical collaboration we undertook this effort. The contributing authors represent both disciplines. We have tried at all times to avoid repetition and duplication but have allowed each author to present material from his own perspective. For example, urinary tract changes secondary to cervical carcinoma are dealt with by a urologist in Chapter 4 (The Urologic Examination), and in a more detailed fashion by a gynecologist in Chapter 21 (Urinary Tract Involvement by Invasive Cervical Carcinoma).

In Section III, Urinary Incontinence, the reader will find five chapters devoted to the surgical correction of urinary stress incontinence. The standard vaginal and abdominal procedures are presented, as well as a newly modified combined procedure. In addition, two operations are presented for the correction of persistent urinary stress incontinence following failure of surgical repair. The choice of an operative procedure in any surgical treatment continues to be a very individual decision for the surgeon. It is hoped that the first chapter in this section, dealing with the pathophysiology, diagnosis, and classification of urinary stress incontinence, will help the reader to choose the appropriate operation for the individual patient. There are many other operations not presented in this text, each favored by, and modified by, its advocates. Descriptions of these procedures will be found in gynecologic and urologic surgical texts and in the current literature.

We would like to acknowledge the role and contribution of our teachers: in obstetrics and gynecology, James H. Nelson, Jr. (now the Joe Meigs Professor of Gynecology at Harvard University), Louis M. Hellman, and J. Edward Hall, Department of Obstetrics and Gynecology at State University of New York – Downstate Medical Center; in urology, Hugh J. Jewett and William W. Scott of The Johns Hopkins University, and the late Rubin H. Flocks of The University of Iowa.

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Our efforts in completing this book were made considerably easier by the help we received from our publisher, W. B. Saunders. Marie Low, Editor, was most helpful in the planning and preparation of this volume. We would also like to acknowledge Grant Lashbrook, Lorraine Battista, Herb Powell, and particularly Betsy Galbraith for their technical assistance.

HERBERT J. BUCHSBAUM
JOSEPH D. SCHMIDT

CONTENTS

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DEVELOPMENTAL ANATOMY

MARGARET B. AYDELOTTE, PH.D.

During embryologic development there is a close association between the urinary and genital systems, especially in the early stages. Both systems develop largely from the urogenital ridges, bilateral thickenings of mesoderm, composed of intermediate mesoderm and overlying coelomic epithelium, which lie along the dorsal wall of the abdominal cavity. In the male the close connection between the two systems is retained in the adult, but in the female this early association is lost with the development of separate müllerian (paramesonephric) ducts, which give rise to the uterus and fallopian tubes. Although the urinary and genital systems are closely linked in development, it is easier to describe their formation by separate accounts, after first reviewing some aspects of early embryology.

EARLY DEVELOPMENT

Two weeks after fertilization, the implanted human embryo consists of a flat disk with two layers of cells, a columnar ectoderm forming the floor of the amniotic cavity, and a layer of flattened endodermal cells comprising the roof of the yolk sac (Figure 1–1). Both layers of the embryonic disk are continuous at their edges with tissue that will form the extraembryonic membranes.

The third germ layer, the mesoderm, from which the urogenital system largely develops, segregates by gastrulation, beginning in the early part of the third week of development (Figure 1–2). Ectodermal cells of the primitive streak (i.e., in the midline at the future caudal end of the embryo) sink below the surface and migrate laterally, spreading out between the ectoderm and endoderm to form the embryonic mesoderm. At two sites in the midline of the embryo, the mesoderm fails to separate the ectoderm from the adhering, underlying endoderm. One of these two remaining bilaminar regions is found cephalad to the developing notochord, and is destined to become the oropharyngeal (or buccopharyngeal) membrane; the other region lacking mesoderm lies caudad to the primitive streak, and will form the cloacal membrane (Figure 1–2). Mesodermal cells continue to migrate around the edges of both of these membranes to meet in the midline. That mesoderm which comes to lie lateral to the cloacal membrane contributes to the external genitalia, and that which extends to the midline, initially caudal to the cloacal membrane, helps to form the phallus and the infraumbilical part of the body wall (Patten and Barry, 1952).

The intraembryonic mesoderm differentiates as shown in Figure 1–3. On each side of the developing notochord and neural tube the paraxial mesoderm forms segmentally arranged blocks of tissue, the somites. The columns of intermediate mesoderm adjacent to the somites show segmentation only at the cranial end of the embryo. Distal to the intermediate mesoderm, the coelomic cavity forms as the lat-

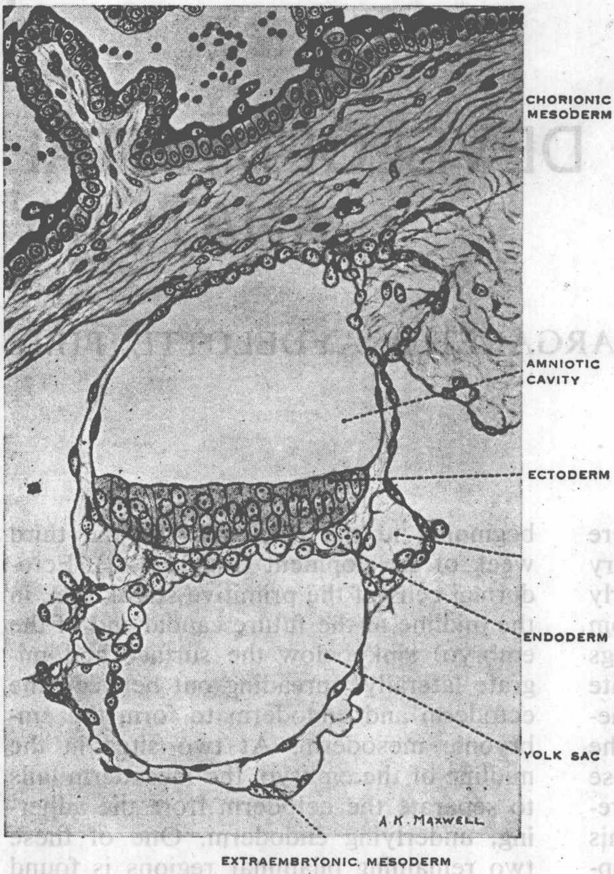

Figure 1–1. Transverse section through the anterior part of the bilaminar embryonic disc and chorionic vesicle of a 15-day-old human embryo. (From Hamilton, W. J., and Mossman, H. W.: Hamilton, Boyd and Mossman's Human Embryology. Ed. 4. The Macmillan Press Ltd, London, 1972.)

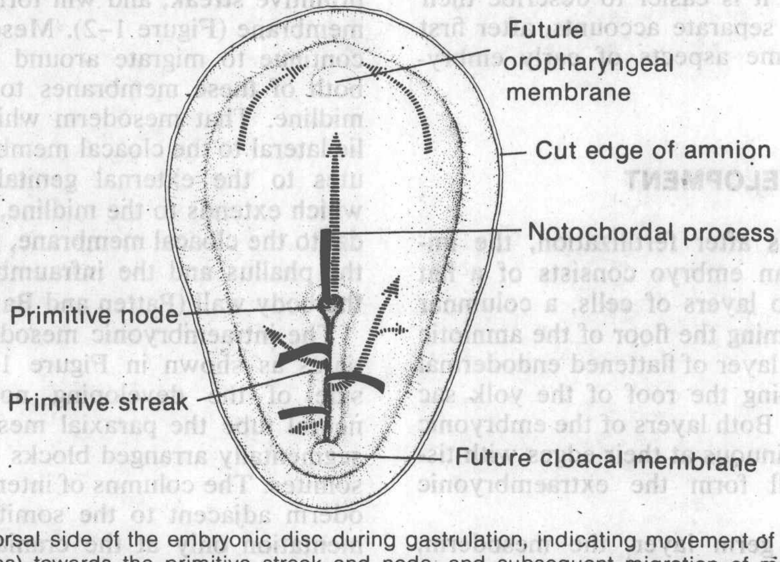

Figure 1–2. Dorsal side of the embryonic disc during gastrulation, indicating movement of superficial cells (solid black lines) towards the primitive streak and node, and subsequent migration of mesodermal cells (broken lines) away from the primitive streak between the ectodermal and endodermal germ layers. (From Langman, J.: Medical Embryology. Ed. 3. © 1975 The Williams & Wilkins Co., Baltimore.)

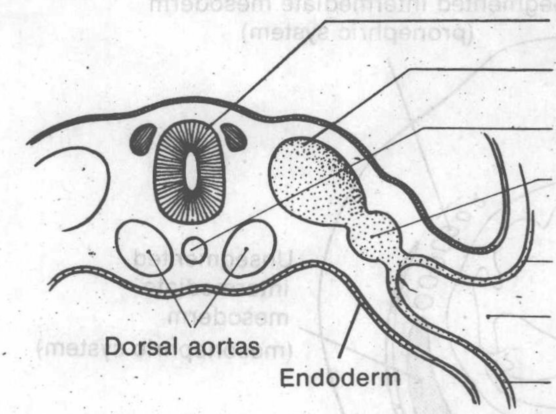

Figure 1–3. Diagrammatic cross-section of a 3-week embryo, showing development of the mesoderm. (From Tuchmann-Duplessis, H., David, G., and Haegel, P.: Illustrated Human Embryology, Vol. 1, 1972. Courtesy Springer-Verlag, New York, and Masson, Editeurs, Paris.)

eral plate mesoderm splits into the outer somatic and inner splanchnic layers. Both the intermediate mesoderm and a portion of the coelomic lining, the superficial layer of lateral plate mesoderm, contribute to the urogenital system.

DEVELOPMENT OF THE URINARY SYSTEM

The Kidney and Ureter

Below the mesothelium along the dorsal wall of the coelomic cavity, the intermediate mesoderm on each side of the embryo forms a longitudinal ridge, the nephrogenic cord. Each nephrogenic cord shows a craniocaudal sequence in its development. The most cranial portions differentiate before the more caudal regions, and according to the classic view, the ridge gives rise successively to three kidneys; the pronephros, the mesonephros, and the metanephros, or definitive kidney (Figure 1–4). The first two are not completely distinct in the human being, the caudal end of the pronephros merging with the cranial end of the mesonephros. There is probably little reason to regard them as separate entities, but for convenience their names are retained (Potter, 1972).

Pronephros

The pronephros is a transitory, nonfunctional structure in the human being. It consists of a few nephrotomes, small clumps of cells or vesicles which begin to form late in the third week of development from the cervical segmented intermediate mesoderm. These vesicles or tubules have no glomeruli, do not connect with the pronephric duct, and regress by the end of the fourth week. The pronephric duct arises independent of the pronephric vesicles (Torrey, 1954), and first appears as a solid cord of cells in the dorsal part of the nephrogenic cord. The duct acquires a lumen progressively from its cranial end, and gradually extends in a caudal and then a ventral direction. It opens into the dorsolateral part of the cloaca early in the fifth week of development (Figure 1–4).

Mesonephros

As the pronephros regresses, the nephrogenic cord in the thoracic and lumbar regions gives rise to tubules of the mesonephros. These tubules become S-shaped and open laterally into the adjacent portion of the pronephric duct, called at this point in development the mesonephric (or wolffian) duct. The medial end of each mesonephric tubule enlarges and invaginates to form a Bowman's capsule in association with a developing knot of capillaries, the glomerulus (Figure 1–5*A*). The S-shaped mesonephric tubule lengthens rapidly and becomes highly coiled, but no loop of Henle develops. Since the most cranial mesonephric tubules degenerate

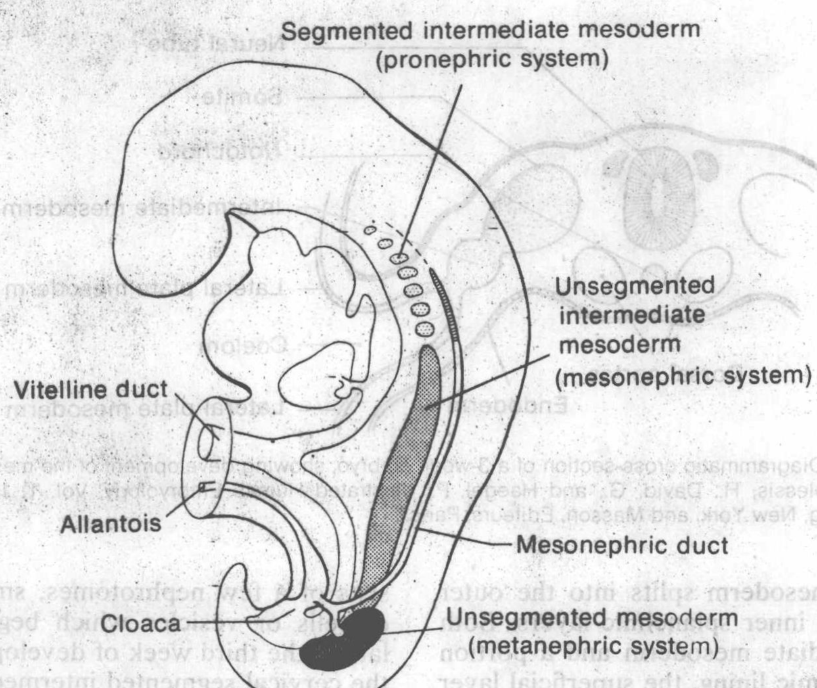

Figure 1–4. Relative positions of the pronephros, mesonephros and metanephros and associated mesonephric duct. (From Langman, J.: Medical Embryology. Ed. 3. © 1975 The Williams & Wilkins Co., Baltimore.)

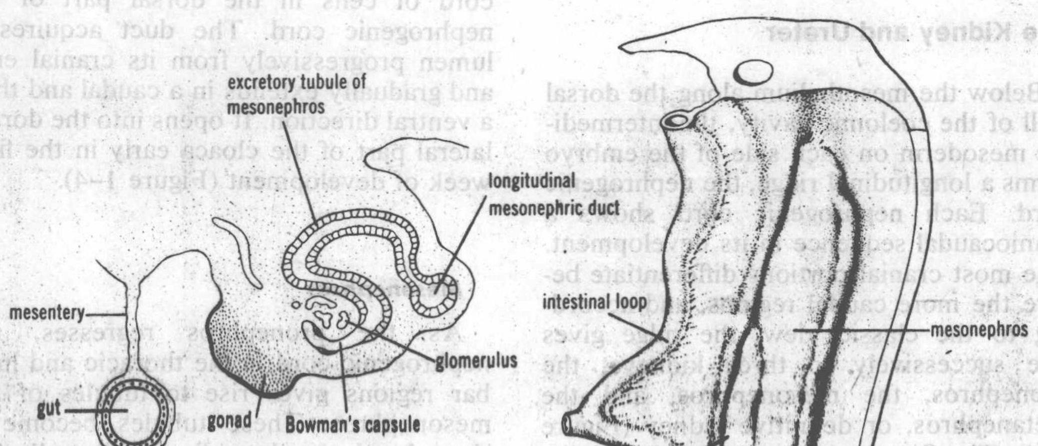

Figure 1–5. *A*, Transverse section through the lower thoracic region of a 5-week embryo, showing a mesonephric excretory tubule. Note the Bowman's capsule and developing glomerulus at the medial end of the tubule and the opening laterally to the mesonephric duct. The gonad is beginning to form on the medial side of the mesonephros.

B. The relationship between the left mesonephros and developing gonad. (From Langman, J.: Medical Embryology. Ed. 3. © 1975 The Williams & Wilkins Co., Baltimore.)

before the more caudal ones differentiate, the full extent of the mesonephros cannot be appreciated by examining only one stage. At its peak of development towards the end of the second month, the mesonephros forms a prominent oval swelling on each side of the dorsal mesentery, suspended from the abdominal wall by a thick mesonephric mesentery (Figure 1–5*B*).

Structural differences have been observed between the functional units of the mesonephros and metanephros: (1) the distal tubules, (2) the absence of the loops of Henle from the mesonephric nephrons, and (3) the arrangement of glomerular arterioles (de Martino and Zamboni, 1966). However, because of clear similarities between the nephrons of the meso- and metanephroi, notably in the structure of the Bowman's capsules and proximal tubules, it is likely that during the third and fourth months of fetal life the mesonephros excretes small quantities of dilute urine (Leeson, 1957; de Martino and Zamboni, 1966). With its gradual recession the mesonephros is nonfunctional by the end of the fourth month, and the definitive kidney has progressively taken over the role of urine production. The mesonephric glomeruli all disappear, but a few tubules which fail to degenerate at this stage in the female remain associated with the ovaries as vestigial structures, the epoophoron and paroophoron (see page 13).

Metanephros

The permanent kidney or metanephros has a dual origin: the metanephric blastema gives rise to the nephrons, or excretory units of the kidney, while the ureteric bud forms the system of collecting ducts, calyces, pelvis of the kidney, and the ureter. During the fifth week of development, the ureteric bud develops as a hollow outgrowth from the caudal end of each mesonephric duct, close to its opening into the cloaca (Figure 1–6). The bud grows dorsocranially, its tip pushing into the most caudal portion of the nephrogenic cord in the lower lumbar and sacral segments. This part of the nephrogenic cord then condenses to form a cap of tissue, the metanephric blastema, around the tip of the ureteric bud.

Mutual inductive influences have been demonstrated between these two components: a specific stimulus from the metanephric blastema induces the ureteric bud to enlarge, form an ampulla, and undergo a series of dichotomous branchings (Grobstein, 1955), while differentiation of normal nephrons from the nephrogenic blastema occurs only in response to an inductive stimulus from the ampullae of the ureteric bud (Potter, 1972). If the ureteric bud fails to develop or to reach the metanephric mesoderm, no normal kidney forms on that side (Davidson and Ross,

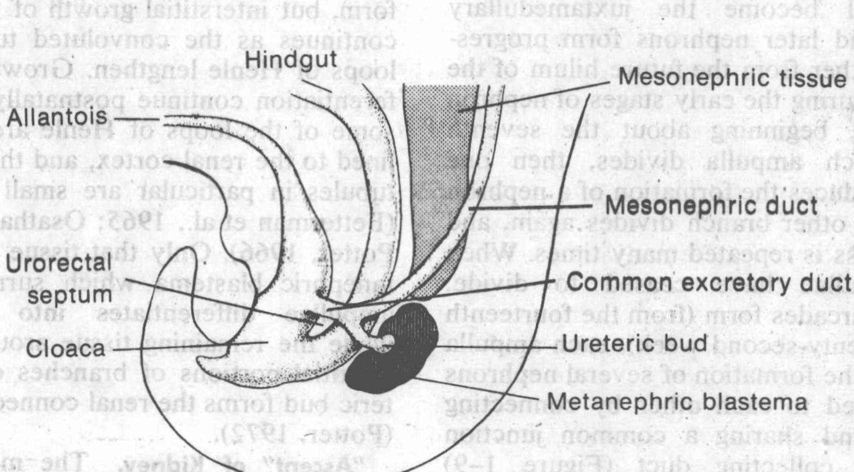

Figure 1–6. Caudal end of a 5-week embryo, showing the relationship between the mesonephric duct, its outgrowth, the ureteric bud, and the cloaca. Note that the urorectal septum is beginning to divide the cloaca. (From Langman, J.: Medical Embryology. Ed. 3. © 1975 The Williams & Wilkins Co., Baltimore.)