Development of the Urogenital System

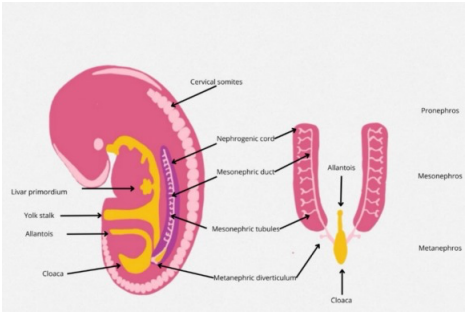
🔷 1. KIDNEY DEVELOPMENT

🧠 **Origin**: Intermediate Mesoderm

🪜 **3 Stages**:

1. **Pronephros** – transient & nonfunctional
2. **Mesonephros** – temporary kidney (early function)
3. **Metanephros** – permanent kidney

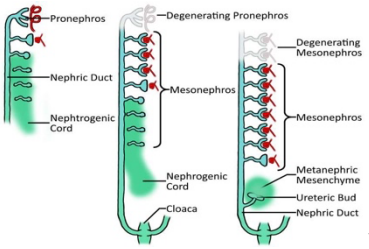
📌 Stage 1: Pronephros (Week 4)



- From cervical intermediate mesoderm
- Forms **7 nephrotomes** → canalize → **pronephric tubules**
- Tubule ends:
  - Medial → internal glomerulus
  - Lateral → **pronephric duct** → opens into cloaca
- 🧬 Fate:
  - Tubules degenerate
  - Duct becomes **mesonephric duct**

📌 Stage 2: Mesonephros

- From thoracic/upper lumbar intermediate mesoderm
- Forms ~70 **S-shaped mesonephric tubules**
- Medial → primitive glomerulus + Bowman's capsule → **renal corpuscle**
- Lateral → joins **mesonephric duct (Wolffian)**



🧬 Fate:

- Degenerates mostly, but parts persist:
  - ♂: Efferent ductules, epididymis (head), paradidymis
  - ♀: Epoophoron, paroophoron

📌 Stage 3: Metanephros (Permanent Kidney) – Week 5 onward

🧩 Components:

1. **Ureteric bud** (→ collecting system)
2. **Metanephric cap/blastema** (→ nephrons)

🌀 Ureteric bud forms:

- Ureter
- Renal pelvis → major/minor calyces
- Collecting ducts/tubules

🌱 Metanephric cap (induced by ureteric bud):

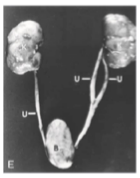
- Forms **renal vesicles** → develop into **nephrons**:
  - Bowman's capsule + glomerulus = **renal corpuscle**
  - PCT, Loop of Henle, DCT → joins collecting tubules

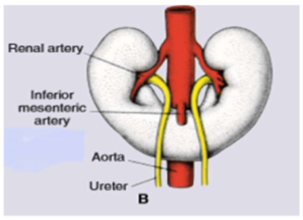
👶 Postnatal Kidney Changes

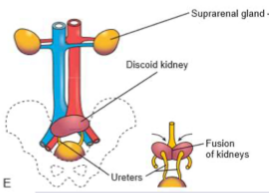
1. Lobulated → smooth by infancy
2. Ascends from pelvis → lumbar region
   - Blood supply shifts: median sacral → common iliac → aorta
3. Rotates medially 90°, hilum turns medially

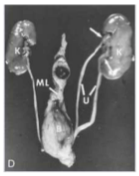
⚠️ Congenital Anomalies

Anomaly	Cause
Renal agenesis	No ureteric bud induction
Polycystic kidney	Dilated collecting ducts
Ectopic kidney	Failed ascent
Horseshoe kidney	Fusion + blocked ascent by IMA
Accessory renal artery	Extra branch
Bifid ureter	Early ureteric bud bifurcation
Double ureter	Duplication before reaching metanephric cap

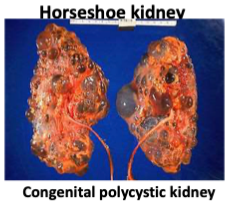

Bifid ureter

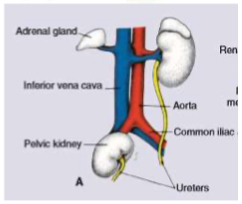




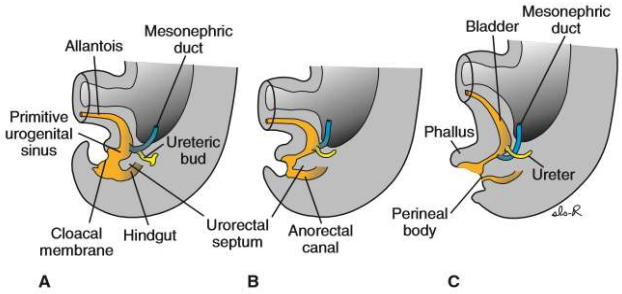

duplication of the urinary tract

Horseshoe kidney


Congenital polycystic kidney



🔷 2. URINARY BLADDER DEVELOPMENT



🌱 **Origin**:

- Endoderm (main part)
- Mesoderm (trigone)

🔄 Cloaca divides:

- **Ventral (urogenital sinus)** → bladder + urethra
- **Dorsal (anorectal canal)** → rectum

🪄 Urogenital sinus parts:

1. **Vesico-urethral canal** → bladder
2. **Pelvic part** → urethra (♂: membranous/infracollicular, ♀: full urethra)
3. **Phallic part** → ♂ penile urethra, ♀ vestibule

🧬 Trigone = absorbed mesonephric ducts

🧵 **Allantois** → urachus → median umbilical ligament

⚠️ Congenital Bladder Anomalies

Anomaly	Description
Ectopia vesicae	Open posterior bladder wall
Urachal fistula	Urine drains from umbilicus
Urachal cyst	Fluid-filled urachus
Urachal sinus	Blind end from umbilicus

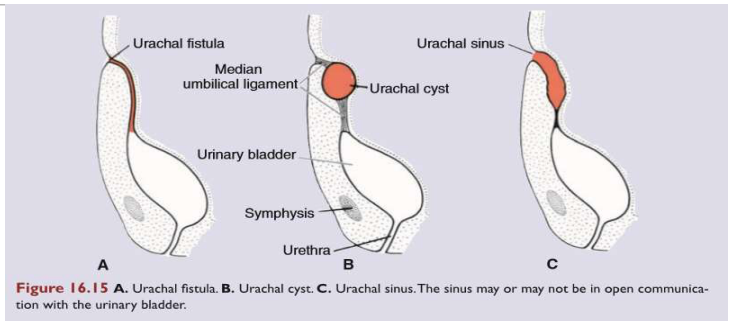


Figure 16.15 A. Urachal fistula. B. Urachal cyst. C. Urachal sinus. The sinus may or may not be in open communication with the urinary bladder.

🔷 3. URETHRA DEVELOPMENT

🧬 **Male**:

- Supracollicular (endoderm) + dorsal wall (mesoderm)
- Infracollicular & membranous = pelvic part
- Penile = phallic part (endoderm), tip = ectoderm

🧬 **Female**:

- All endodermal except dorsal wall (mesodermal)

🔷 4. GONADAL DEVELOPMENT

🌱 **Origin**:

- Coelomic epithelium
- Underlying mesenchyme
- Migrating **primordial germ cells** (endoderm from yolk sac)

🎭 Indifferent stage:

- Genital ridge → primary sex cords

♂ Testis

👨 Driven by **TDF (Y chromosome)**

🪄 Develops:

- Testis cords → seminiferous tubules
- Sertoli cells → MIF → regress Müllerian ducts
- Leydig cells → testosterone
- Germ cells → spermatogonia

⬇️ Descent:

- Internal (to iliac fossa) 4–6 months
- External (into scrotum) 7–9 months via gubernaculum

⚠️ Anomalies:

- Cryptorchidism, ectopic testis, hydrocele, inguinal hernia

♀ Ovary

🚫 No TDF → ovary forms

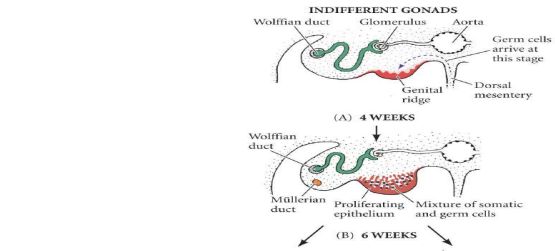
- Primary → medullary cords (degenerate)
- Secondary cords → cortical → follicles
- Germ cells → oocytes (arrested in prophase I)

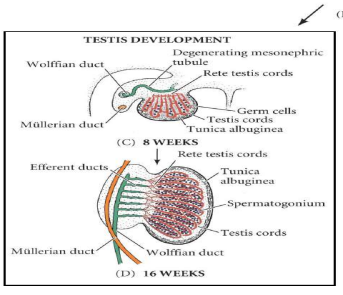
⬇️ Descent: to lesser pelvis via **gubernaculum**

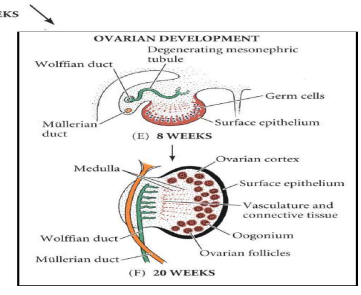
→ forms:

- **Ovarian ligament**
- **Round ligament of uterus**

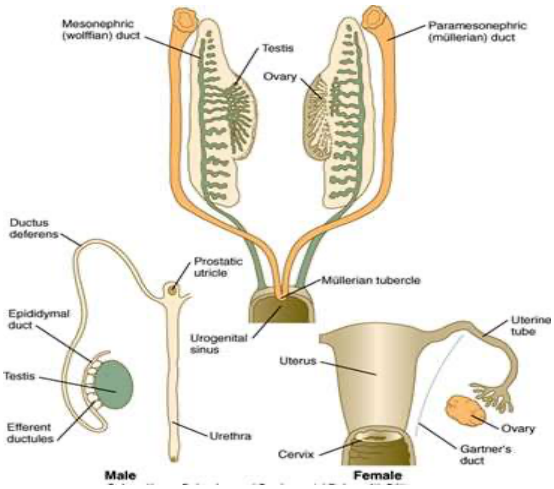
⚠️ Anomalies: ovarian agenesis, canal of Nuck hernia







🔷 5. GENITAL DUCTS



🌱 Mesodermal

🧪 Male:

- Mesonephric duct → epididymis, vas deferens, ejaculatory duct
- Paramesonephric duct regresses (MIF)

🧪 Female:

- Paramesonephric → fallopian tube, uterus, upper vagina
- Mesonephric remnants → epoophoron, Gartner's duct

🧬 Vagina:

- Upper 3/5: mesodermal
- Lower 2/5: endodermal from vaginal plate
- Vestibule: urogenital sinus

⚠️ Anomalies: bicornuate uterus, vaginal septum, atresia, imperforate hymen

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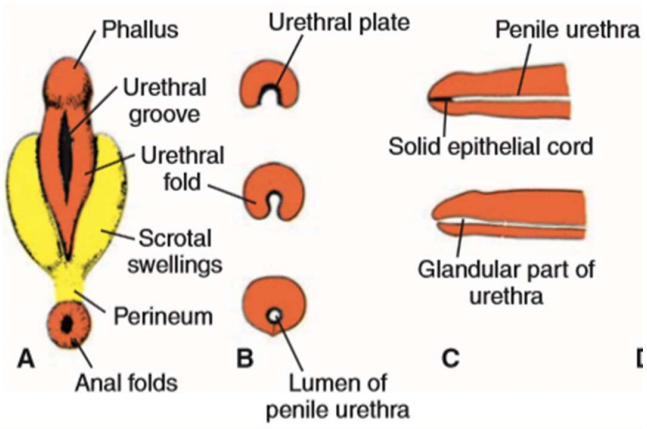
🔷 6. EXTERNAL GENITALIA



🧠 Indifferent until week 7

Driven by:

- ♂ Testosterone
- ♀ Estrogen

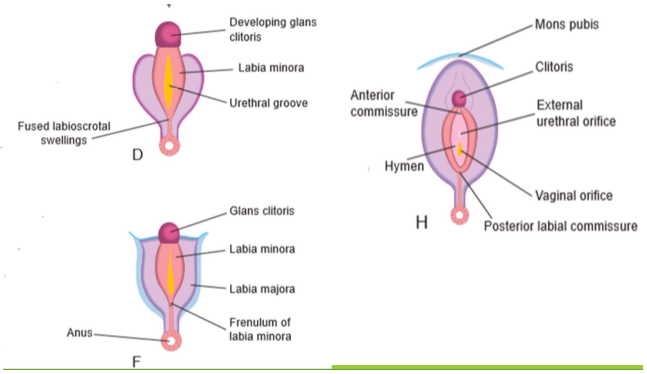
👦 **Male**:

- Genital tubercle → penis
- Urethral folds → fuse → penile urethra
- Genital swellings → fuse → scrotum

👧 **Female**:

- Tubercle → clitoris
- Urethral folds → labia minora
- Genital swellings → labia majora
- Vestibule from urogenital sinus

⚠️ Anomalies: hypospadias, epispadias



🩹 MEMORY TOOLS

🎶 **Mnemonic: "PMM" for kidney stages**

Pronephros → Mesonephros → Metanephros

📜 **Endoderm vs. Mesoderm vs. Ectoderm**

Structure	Layer
Urethra (most)	Endoderm
Trigone	Mesoderm
Glans urethra tip	Ectoderm
