Embryo.UGS

Embryo1

Development of the Kidney

The upper urinary system (kidneys) develops from the intraembryonic intermediate mesoderm, which is positioned behind the intraembryonic coelom on each side of the descending aorta after embryonic folding.

Stages of Kidney Development

1. **Pronephros**

- Originates from the cervical intermediate mesoderm at the 4th week.
- Composed of 7 nephrotomes (cell clusters) that form pronephric tubules.

Each tubule has:

- Medial end: receives capillary plexus->تكوّن (internal glomerulus).
- Lateral end: unites with other tubules to form the pronephric duct, opening into the **cloaca**.

✓ Fate: Pronephric tubules degenerate; the duct becomes the mesonephric duct for the next stage.

2. **Mesonephros**

- Develops from thoracic and upper lumbar intermediate mesoderm.
- About **70** clusters form S-shaped mesonephric tubules.

Each tubule:

- Medial end: forms a primitive glomerulus and Bowman's capsule (renal corpuscle).
- Lateral end: joins the mesonephric (Wolffian) duct.

✓ Fate: Mostly degenerates, replaced by metanephros. Some parts persist as urogenital structures, differing between sexes:

•***Male***: Efferent ductules, head of epididymis, paradidymis, body/tail of epididymis, vas deferens, seminal vesicle, ejaculatory duct, trigone of bladder, part of prostatic urethra, ureteric bud derivatives.

•***Female***: Epoophoron, paroophoron, duct of epoophoron, Gartner's duct, trigone of bladder, dorsal wall of female urethra, ureteric bud derivatives. 👇❗مهم

1. The mesonephric tubules form :

Male	Female
Efferent ductules of the testis Head of epididymis Paradidymis	Epoophorn paroophoron

Genital structures	Urinary structures
- Body and tail of epididymis and its appendix - Vas deferens - Seminal vesicle. - Ejaculatory duct	- Ureteric bud and its derivatives (ureter, renal pelvis, calyces and collecting tubules) - Trigone of the urinary bladder - Posterior wall of the supra collicular part of the prostatic urethra

2. Mesonephric ducts In the FEMALE form

Genital structures	Urinary structures
- Duct of epoophorn. - Gartner's duct.	- Ureteric bud and its derivatives (ureter, renal pelvis, calyces and collecting tubules). - Trigone of the urinary bladder. - The whole dorsal wall of the female urethra.

3. **Metanephros** (Definitive Kidney)

- Appears in the sacral region at the 5th month.

Develops from:

•**Ureteric bud:** Outgrowth from the mesonephric duct near the cloaca, The bud gives rise to the collecting system of urine:Ureter from its stem, Renal pelvis from its cranial end which divides to form 2 calyces which in turn divide to form 7-11 minor calyces,Collecting tubules.

•**Metanephric cap:** Caudal intermediate mesoderm, induced by the ureteric bud to form nephrons (Bowman's capsule, glomerulus, proximal/distal convoluted tubules, loop of Henle).

✓ Each nephron connects to a collecting tubule to form a functional unit.

Postnatal Changes in Metanephros التغييرات بعد الولادة

- Shape: Fetal kidney is lobulated; lobulation disappears in infancy.
- Position: Initially pelvic, supplied by median sacral artery; ascends to abdomen, supplied by abdominal aorta.
- Orientation: Hilum rotates medially by 90° during ascent, originally, the hilum of the kidney is directed anteriorly

Congenital Anomalies of Kidney

•**Renal agenesis:** Absence of one/both kidneys (السبب failure of ureteric bud to induce metanephric cap).

•**Congenital polycystic kidney:** Multiple urine-filled cysts from collecting ducts.

•**Ectopic (Pelvic) kidney:** Fails to ascend.

•**Horseshoe kidney:** Fusion at lower poles, ascent blocked by inferior mesenteric artery.

•**Accessory renal artery:** Extra artery to kidney pole(upper or lower).

•**Bifid ureter:** Bifurcation of ureteric bud(upper end)-> double renal pelvis.

•**Double ureter:** Occurs when the ureteric bud prematurely divides before penetrating the metanephric cup Results in either a double kidney or duplicated ureter and renal pelvis

Development of the Urinary Bladder

•**Cloaca**: Endoderm-lined dilatation at hindgut's end, continuous with allantois الكيس السري (ventrally), receives mesonephric ducts (sides), closed by cloacal membrane (caudally).

- A mesodermal urorectal septum descends between the allantois and hindgut to reach the cloacal membrane.
- The remnant of urorectal septum is perineal body and recto vesical fascia (Denonvilliers' fascia)

The cloaca is divided into two parts:

• Ventral part called the primitive urogenital sinus, which is continuous with the allantois and still receives the right and left mesonephric ducts.

• Dorsal part called anorectal canal, which is continuous with the hindgut and gives rise to the rectum and the upper part of the anal canal.

the cloacal membrane is also divided into two parts

• Ventral part called the urogenital membrane closes the caudal end of the primitive urogenital sinus.

• Dorsal part called the anal membrane closes the caudal end of the anorectal canal.

Parts of the Urogenital Sinus

•**Cranial** (vesico-urethral canal): Forms most of bladder, continuous with allantois.

•**Caudal** (definitive urogenital sinus): Subdivided into **pelvic**-> Forms part of the urethra, & **phallic** parts->Forms terminal urethra.

•**Allantois**: Becomes urachus (fibrous cord), later the median umbilical ligament.

•**Mesonephric ducts**(caudal)**:** Absorbed into bladder wall, form trigone.

Bladder Development

•Major part: From vesico-urethral canal (endodermal).

•**Trigone**: From absorbed mesonephric ducts (mesodermal).❗

•Bladder coats: From splanchnic mesoderm.

Bladder Congenital Anomalies❗❗

- **Ectopia vesicae: Post**erior bladder wall exposed due to anterior abdominal wall defect(infraumbilical), often with **epispadias** فتحة الاحليل بمكان غير الطبيعي.

- **Urachal anomalies: Patent urachus** (fistula)-> Communication between the bladder and umbilicus through a urachusخروج البول من السرّة, **urachal cyst**->A middle segment of the urachus remains open, forming a fluid-filled cyst, **urachal sinus**-> Lower end remains open, forming a tract connected to the bladder(blind focal dilatation of the umbilical end of the urachus)

Development of the Urethra

Male Urethra:

- **Prostatic urethra:** Supracollicular part from vesico-urethral canal (endodermal, except dorsal wall—mesodermal); infracollicular part from **pelvic** urogenital sinus.
- **Membranous urethra:** From **pelvic** urogenital sinus.
- **Penile (spongy) urethra:** From **phallic** urogenital sinus (endodermal), except terminal part in glans (ectodermal ingrowth).

✓ Notes: Most of male urethra is endodermal; dorsal wall of supracollicular part is mesodermal; terminal part in glans is ectodermal.❗

Female Urethra:

Entirely from vesico-urethral canal (endodermal), except dorsal wall (mesodermal, from mesonephric ducts). ❗مهم

Derivatives of the three parts of the urogenital sinus

	Male	Female
1.vesico-urethral	- The urinary bladder ***except*** its trigone, which is mesodermal in origin. - The supracollicular part of the prostatic urethra ***except*** its dorsal wall which is mesodermal in origin	- The urinary bladder ***except*** its trigone, which is mesodermal in origin. - The whole urethra ***except*** its dorsal wall, which is mesodermal in origin
2.Pelvic part	- The infracollicular part of the prostatic urethra. - Membranous urethra	- The pelvic and the phallic parts form: a) Lower 2/5 of the vagina.
3.Phallic part	- The penile urethra except its terminal part in the glans penis, which is ***ectodermal*** in origin.	b) Vestibule of the vagina

Embryo2Development of the Gonads

Gonads originate from three sources:

- **Proliferating coelomic epithelium** (mesodermal) On the medial side of the mesonephros.
- **Adjacent mesenchyme** (mesodermal) dorsal to the proliferating coelomic epithelium.
- **Primordial germ cells** (endodermal), which develop in the wall of the **yolk sac** and migrate along the dorsal mesentery to reach the developing gonad.The coelomic epithelium (on either side of the aorta) proliferates and becomes multi layered and forms a longitudinal projection into the coelomic cavity called the genital ridge.

✓ The genital ridge forms a number of epithelial cords called the primary sex cords that invade the underlying mesenchyme, which separate the cords from each other.

✓ In the indifferent stage (up to 6th-7th week), gonads cannot be distinguished as testis or ovary.لا يمكن تمييز جنس الجنين بعد

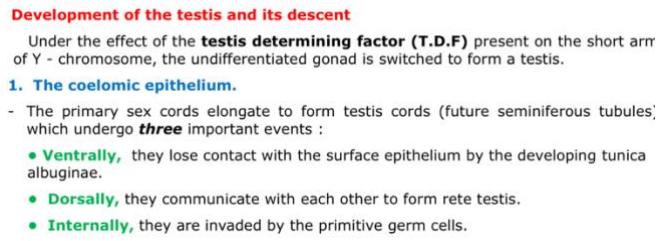
Development of the Testis and Its Descent

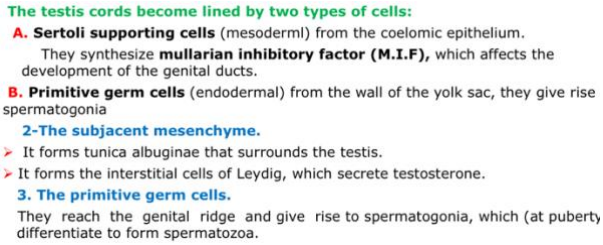
•Under the influence of **Testis Determining Factor** (**TDF**) on the **Y** chromosome, the undifferentiated gonad becomes a testis.

Primary sex cords form testis cords (future seminiferous tubules), **which:**

•Lose contact with surface epithelium (tunica albuginea forms)
•Communicate dorsally (rete testis)
•Are invaded by primitive germ cells
•Testis cords are lined by Sertoli cells (produce Mullerian Inhibitory Factor لمنع تكون الأعضاء الانثوية) and primitive germ cells (become spermatogonia).

•The mesenchyme forms tunica albuginea and Leydig cells (secrete testosterone).





✓ ***Descent of the testis occurs in two phases:***

•**Internal** descent (4th-6th month): to iliac fossa, close to the deep inguinal ring.

•**External** descent (7th-9th month): through inguinal canal into scrotum::

• At 7th month, it traverses the deep inguinal ring.
• At 8th month, it traverses the inguinal canal.
• At 9th month, it begins to traverse the superficial inguinal ring.
•The processus vaginalis ينزل معهاforms the tunica vaginalis, *After descent of the testis the tunica vaginalis is divided into three parts:*
• Proximal part forms the vestige of processus vaginalis at the deep inguinal ring.
• Intermediate part is obliterated .
• Distal part (in the scrotum) persists and forms the tunicavaainalis

✓ Factors aiding descent: gubernaculum shortening, hormones, intra-abdominal pressure.

Congenital anomalies مهم:

- **Cryptorchidism** (undescended testis) in which the testis may remain in the iliac fossa or in any part of the inguinal canal.
- **Ectopic testis** تنزل لمكان غير الطبيعي(maldescended testis) in which the testis descends in the inguinal canal but is located outside the scrotum at root of penis or in the upper part in the front of the thigh .

- **Congenital inguinal hernia->**Happens if the processus vaginalis remains open, allowing intestines to protrude through the inguinal canal.

- **Hydrocele->**Accumulation of fluid around the testis due to a patent processus vaginalis, Peritoneal fluid passes into the patent processus vaginalis and forms a scrotal hydrocele. If only the middle part of the processus vaginalis remains open, fluid may accumulate and give rise to a hydrocele of the spermatic cord

Development of the Ovary

1. Coelomic epithelium:

- The primary sex cords invade into the subjacent mesenchyme to form ***medullary* sex cords.**
- It replaced by fibromuscular stroma, forming the medulla of the ovary.
- The coelomic epithelium proliferates to form a second generation of sex cords called the secondary ***(cortical)* sex cords**, which remain near the coelomic epithelium, forming the cortex of the ovary.
- The cortical sex cords break down to form cell clusters which form perimordial ovarian follicles

2. Subjacent mesenchyme: it forms:

- The stroma of the ovary.
- Very thin tunica albuginae, which intervenes between the ovary and the surface epithelium.

3. Primitive germ cells:

- They invade the primordial follicles and proliferate by ***mitosis*** to form Primary oocytes.
- At 12th week of the intrauterine life, the primary oocytes enter the first meiotic division and are arrested (at 20th week) in its prophase till puberty.

Descent of the ovary :

- The ovary developed (like the testis) in the posterior abdominal wall opposite at 2nd lumbar vertebra, where it is suspended by a genital mesentery.
- It reaches the greater pelvis at 3rd month of gestation
- Then reach the lesser pelvis shortly after birth

- In absence of TDF, gonad becomes ovary.
- Primary sex cords form medullary cords (later replaced by stroma->medulla).
- Secondary (cortical) sex cords form cortex and primordial follicles.
- Germ cells become primary oocytes, arrested in **meiosis I** until puberty.
- Ovary descends from posterior abdominal wall to greater pelvis (by **3rd** month) and then to lesser pelvis (after birth).
  - The **gubernaculum** forms the **ovarian** ligament and **round** ligament of uterus.
  - Canal of Nuck can persist if processus vaginalis remains open.

The genital mesentery of the ovary is divided into three parts:

- **Cranial** part forms the suspensory ligament of the ovary
- **Middle** part forms the mesovarium.
- **Caudal** part is transformed into the gubernaculum of the ovary, which extends between the lower end of the ovary and the developing labium majora.

- The middle of: the gubernaculum is attached to the lateral angle of the developing uterus and thus gives rise to two ligaments.

- Ligament of the ovary, between the ovary and uterus.
- Round ligament of the uterus, between the uterus and labium majora.

Persistence of small processus vaginalis, gives rise to canal of Nuck.

Congenital anomalies:

- **Ovarian agenesis**
- **Congenital inguinal hernia** (ovary may descend via inguinal canal)

Development of the Genital Ducts

Both sexes initially have **mesonephric (Wolffian)** and **paramesonephric (Müllerian)** ducts.

1-Indifferent stage of genital ducts

- Up to the 6th week of development, male or female embryos have two pairs of genital ducts.
  - Two (right and left) mesonephric ducts.
  - Two (right and left) paramesonephric ducts.
- **The paramesonephric duct** develops in the coelomic epithelium ***lateral*** to the cranial end of the mesonephric duct and continues to grow caudally lateral to that duct
- Then crosses ventral to it and then descends ***medial*** to it.
- The upper end of each paramesonephric duct opens by an abdominal ostium into the coelomic cavity (future peritoneal cavity).
- Their lower parts fuse to form a Y - shaped **uterovaginal canal** project into dorsal wall of the urogenital sinus to induce formation of ***Mullerian tubercle***.

In males: مهم

•Sertoli cells produce Anti-Müllerian Factor (AMF), causing regression of paramesonephric ducts.

•Mesonephric ducts develop into male genital ducts; remnants of paramesonephric ducts(mullerian) form appendix testis(cranial end), utricle(caudal), seminal colliculus(mullerian tubercle').

In females:

•Without AMF, paramesonephric ducts (Müllerian) develop into 1uterine tubes(cranial & middle), 2uterus(caudal), and 3 upper vagina(caudal).

•Mesonephric ducts regress; remnants persist as vestigial structures.

Vagina formation: مهم

- Upper 3/5 from uterovaginal canal (mesodermal)
- Lower 2/5 from vaginal plate (endodermal, Müllerian tubercle)
- Vestibule from urogenital sinus
- **Broad** ligaments form as paramesonephric ducts fuse and pull peritoneal folds.

Congenital anomalies:

- **Uterus bicornis(unicollis/bicollis), unicornis->** A uterus with two horns; may be with one cervix (unicollis) or two (bicollis), due to incomplete fusion of the Müllerian ducts.(collis = Cervix)

->Uterus **uni**cornis A uterus with only one horn due to failure of one Müllerian duct to develop.

- **Septate ->** septum in which only the vagina is divided into two, **atretic vagina->** due to failure of canalization of the vaginal plate.

- **Imperforate hymen->** The hymen lacks an opening.

- **Rectovaginal fistula->** septum due to incomplete development of urorectal

Development of External Genitalia

Indifferent Stage (4th-7th week):

Genital tubercle, urethral folds, and genital swellings form but are not yet sexually differentiated.

Male Development (testosterone effect):

- Genital tubercle forms phallus (penis), whose mesenchyme forms two corpora cavernosa.
- *Rupture of the urogenital membrane*

longitudinal urethral groove appears on the ventral aspect of the developing penis. The sides of that groove are bordered by the urethral folds.

- The floor and sides of the urethral groove become lined with an endodermal urethral plate.

- The edges of that plate are continuous with those of the urethral folds.
- The edges of the endodermal urethral plate are fused with each other to form the Penile urethra except its terminal part within the glands penis.

- Urethral folds fuse to form penile urethra and corpus spongiosum
- Genital swellings fuse in midline to form scrotum

Development of the penis:

› Its dorsal and lateral aspects are formed by the mesenchyme of the phallus, whose mesenchyme forms the two corpora cavernosa.

› Its ventral aspect is formed by the mesenchyme of the urethral folds, whose mesenchyme forms the single corpus spongiosum.

Congenital anomalies: **Hypospadias** (ventral urethral opening الجانب السفلي)/ Incomplete fusion of the urethral folds, **Epispadias** (dorsal opening الجانب العلوي, often with ectopia vesicae)

Female Development (estrogen effect(*maternal & placental)****):***

- Genital tubercle forms clitoris (**no** corpus spongiosum) whose mesenchymef Forms its two corpora cavernosa
- Urethral folds become labia minora
- Genital swellings become labia majora
- The vaginal vestibule: is formed when primitive urogenital sinus are shortened to form the vestibule between the two labia minora.

تمّ بحمد الله تعالى

By: ayah freihat