Applied Genitourinary Embryology

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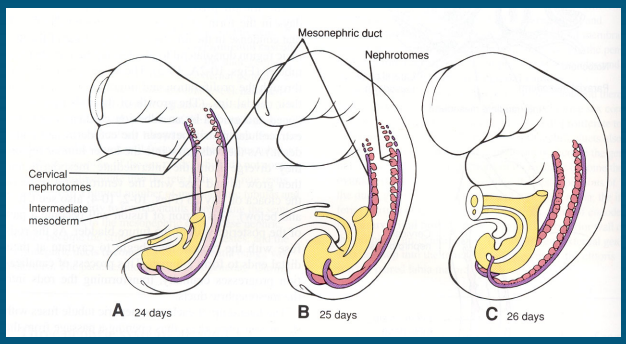
- Kidney
- Ureter/Trigone
- Bladder/Urethra
- Gonads
- Genital Ducts
- External Genitalia

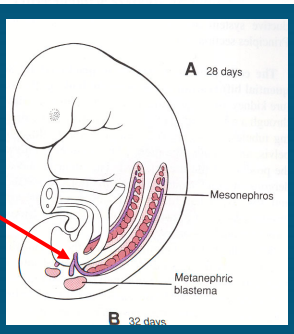
Kidney – intermediate mesoderm

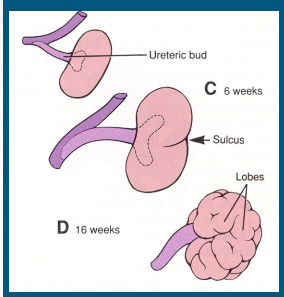
- Pronephros –
  - hollow balls of tissue appear and disappear during 4th week – non functional
- Mesonephros –
  - multiple nephric tubules
  - as caudad ones form cervical are disappearing
  - drain into mesonephric ducts, tubules regress, duct later forms part of male genital duct
- Metanephros –
  - final nephric system
  - induced by ureteral bud from mesonephric duct which penetrates metanephric blastema and leads to mutual induction

mesonephros



Origin of metanephric kidney

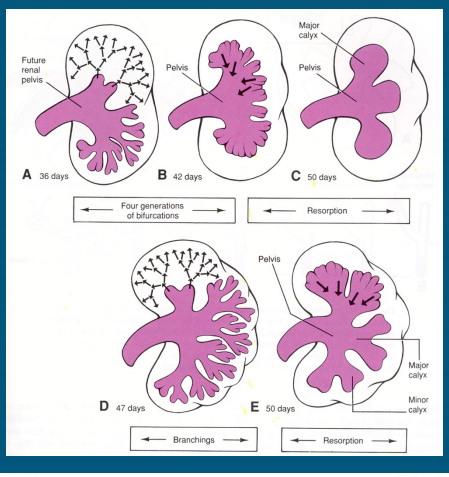




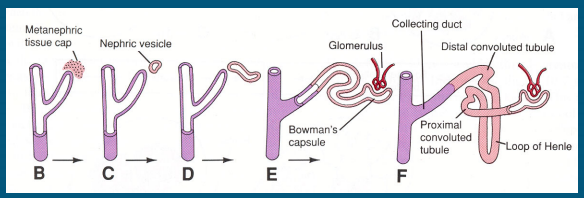
Kidney

- Collecting system-
  - sequential branching of ureteric bud
  - frequent branching and resorption
  - ultimately 3 million collecting ducts
- Morphogenesis tightly regulated
  - each collecting duct = one nephron
- Capillary glomerulus invaginates tubule
- PCT through DCT – intermediate mesoderm
- Collecting duct to trigone – ureteral bud

Development of renal pelvis and calyces



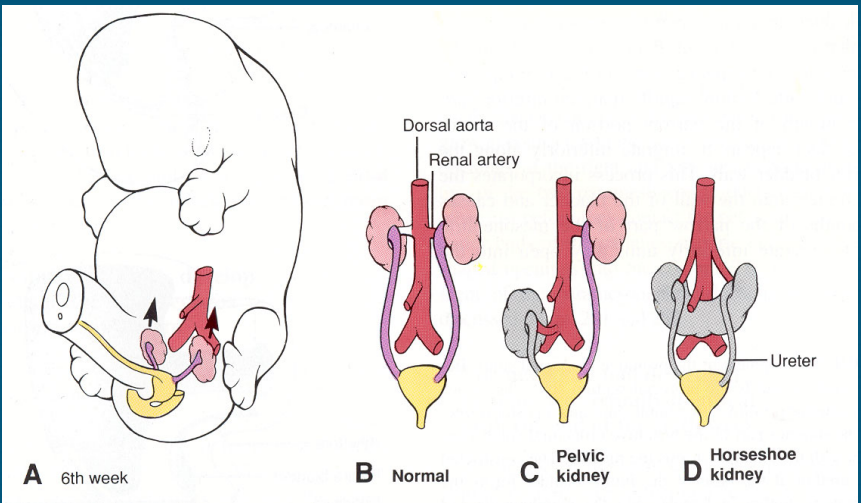
Development of collecting system and nephron



Kidney Ascent

- Kidneys ascend because of differential somatic growth
- Transient arteries supply kidney as it moves
  - Persistent arteries lead to accessory vessels
- Failure to ascend = Pelvic kidney
- Fusion of inferior poles = Horseshoe kidney
  - Becomes caught under IMA

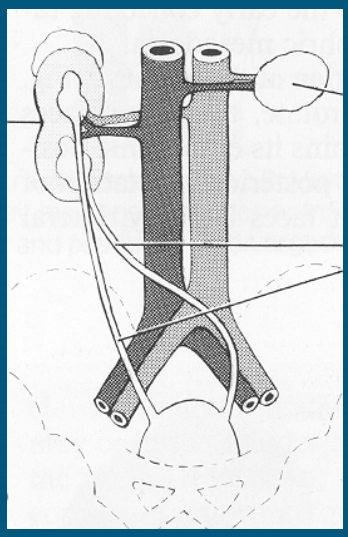
Normal and abnormal ascent of the kidneys



Renal anomalies

- Bilateral renal agenesis – 1/5000 – Potter's
- Unilateral renal agenesis – 1/1200
  - Either absent ureteral bud or noncontact with metanephric blastema
    - With absent ipsilateral vas deferens 50% have absent ipsilateral kidney
- Renal dysplasia - ? Early obstruction
- Multicystic kidney- ? Early obstruction
- Ectopia – 1/900
  - Simple
  - Crossed
    - Fusion – six forms (sometimes mistaken for tumors and removed; diverse blood supply – difficult to remove)

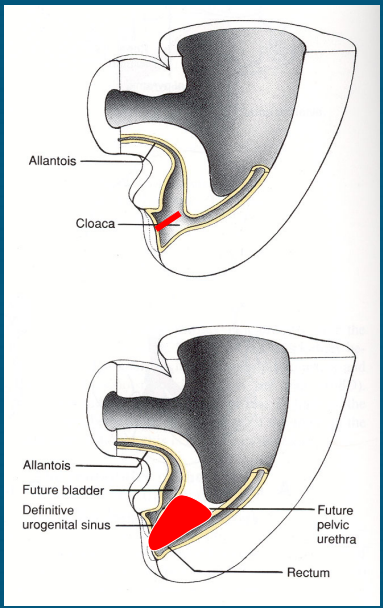
Crossed fused ectopia



Urogenital Sinus

- Cloaca partitioned by urorectal septum
  - Urogenital sinus (UGS)
  - Rectum
- Mesonephric ducts into back of UGS

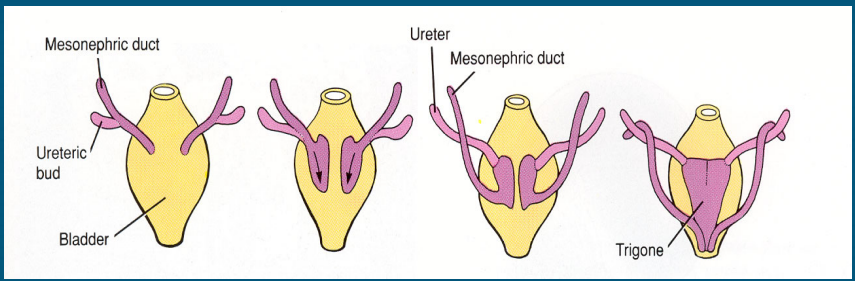
Development of Urogenital sinus



Ureter/Trigone

- Ureter
  - ureteric bud from mesonephric duct
  - optimal distance from urogenital sinus
- Duct and ureter enter UGS and separate
- Ureter moves craniolaterally
- Mesonephric duct moves caudomedially to form ejaculatory duct

Entry of mesonephric duct into bladder wall



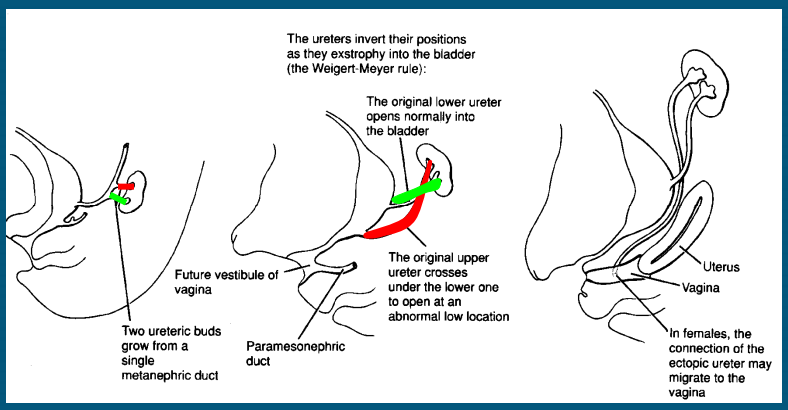
Ureter/Trigone Anomalies

- Bud too close to UGS
  - migrates too far
  - reflux
- Bud too far from UGS
  - delayed separation from mesonephric duct
  - may end in urethra
  - if very far may end in vas/seminal vesicle or in vagina
- Two buds or early separation
  - Ureteral duplication
- Persistence of Chwalla's membrane
  - Between ureter and UGS
  - ureterocoele

Ureteral Duplication

- Weigart-Meyer Rule
  - lower bud (closest to UGS) contacts lower portion of blastema (lower pole)
  - bud closest to UGS is incorporated into bladder first and migrates further craniolaterally
- Thus – Lower pole ureteral orifice more lateral and cranial than upper pole u.o. – ureters cross
- Upper pole may be dysplastic because ureter just contacted margin of metanephric tissue

Ureteral duplication with ectopic ureter



Urogenital Sinus

- Cloaca partitioned by urorectal septum
  - Urogenital sinus (UGS)
  - Rectum
- Mesonephric ducts open into back of UGS

Urogenital Sinus

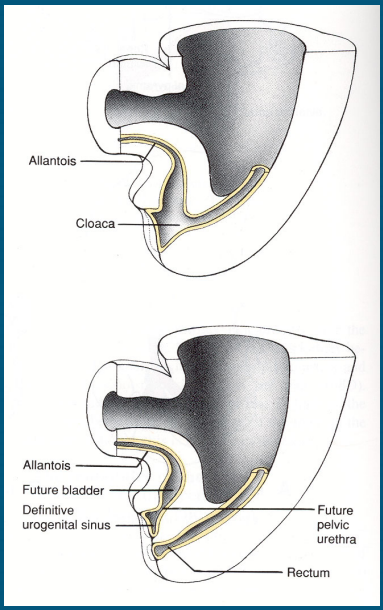
Divides into 3 portions

- Upper - Bladder – (trigone is from mesonephric ducts)
- Middle - Pelvic UGS
  - Males
    - membranous and prostatic urethra
  - Females
    - membranous urethra
- Lower - Definitive UGS
  - Males
    - penile urethra
  - Females
    - vestibule of the vagina

Bladder Anomalies

- Urachal anomalies
  - Failure of allantois to disappear
    - Fistula, cyst or sinus
- Exstrophy
  - Cloacal membrane normally disappears as mesoderm migrates medially to form abdominal wall
  - If membrane disappears prematurely or migration of mesoderm is impeded exstrophy occurs
    - Bladder exstrophy – if occurs after division by urorectal septum
    - Cloacal exstrophy – if occurs before division

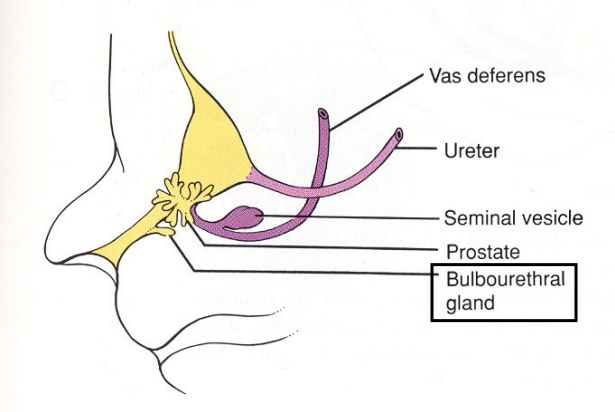
Development of
Urogenital sinus



Prostate

- Endodermal evaginations from pelvic urethra
  - Grow into surrounding mesenchyme – muscular component
- Under influence of DHT
- Bulbourethral glands bud from urethra just distal to prostate
- In females similar buds form Skene's glands

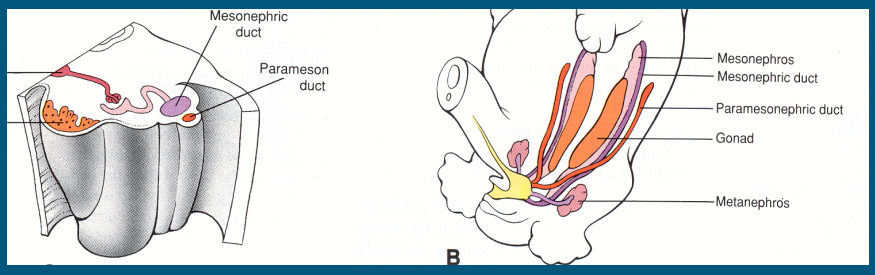
Prostate development



Gonads

- Induced to develop by primordial germ cells that migrate to the mesenchyme of the posterior body wall – primitive sex cords
- Gonads induce formation of genital ridges just medial to mesonephric duct
- At same time paramesonephric ducts form lateral to mesonephric ducts

Formation of genital ridges



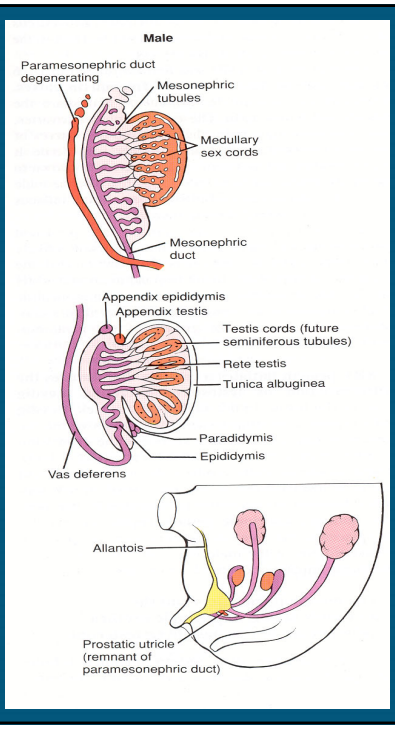
Gonads

- Mesonephric Ducts = Wolffian Ducts
  - Form male genital ducts
  - Disappear in females
- Paramesonephric Ducts = Mullerian Ducts
  - Form female genital ducts
  - Disappear in males

Gonads - Males

- Testis determining factor (TDF) encoded on the sex-determining region of the Y chromosome (SRY)
- TDF induces Sertoli cell formation
- Organize to form testis cords
- At puberty become canalized – seminiferous tubules
- Distal ends forms rete testis
- Rete testis connects to mesonephric duct remnant
  - Nonunion can cause azoospermia
- Mesonephric remnant becomes vas deferens
- Paramesonephric duct degenerates
  - Remnants = appendix testis and prostatic utricle

Male Gonadal Development

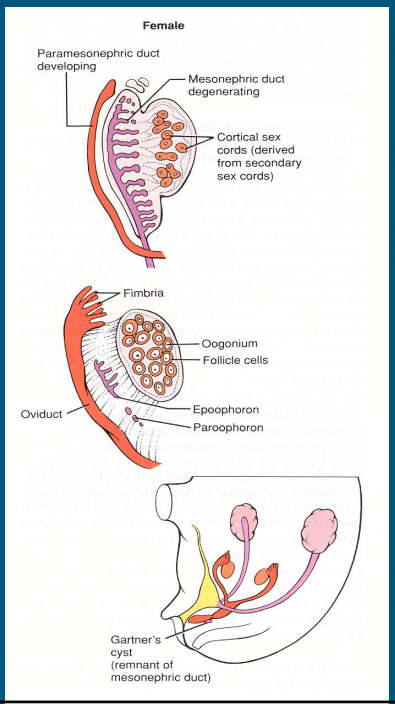


Gonads - Females

- Absent Y chromosome – no TDF
- Primitive sex cords break into clusters (no tubules to contact the mesonephric duct)
- Germ cells shed from surface of ovary

- Mesonephric duct degenerates
  - Remnants = epoophoron, paroophoron and Gartner's cyst

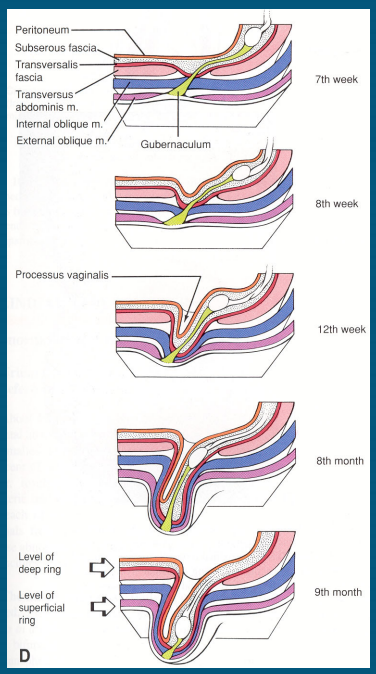
Female Gonadal Development



Gonadal Descent

- Dependent on Gubernaculum
- Connects gonad to inguinal canal area
- Evagination of the peritoneum (processus vaginalis) pushes through layers of abdominal wall – forming inguinal canal
- Somatic growth without gubernacular growth pulls gonad into scrotum
- Also dependent on hormones

Gonadal Descent



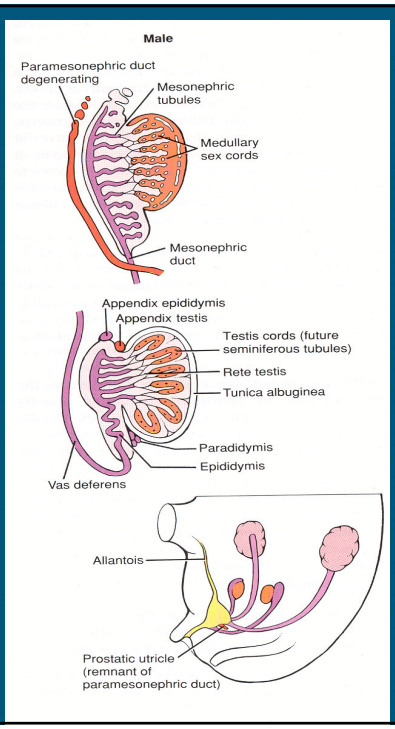
Genital Ducts

- Mesonephric Ducts = Wolffian Ducts
  - Form male genital ducts
  - Disappear in females
- Paramesonephric Ducts = Mullerian Ducts
  - Form female genital ducts
  - Disappear in males

Genital Ducts - Male

- AMH (anti-mullerian hormone) causes paramesonephric ducts to regress
- Mesonephric duct gives rise to vas deferens and epididymis
- Portion of duct degenerates leaving appendix epididymis
- Seminal vesicle buds from distal mesonephric duct

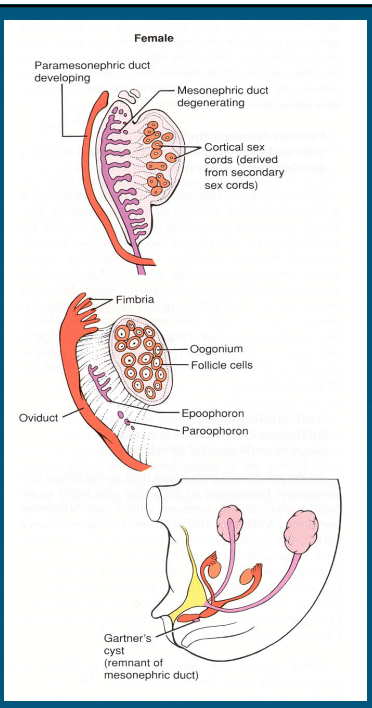
Genital Ducts - Male

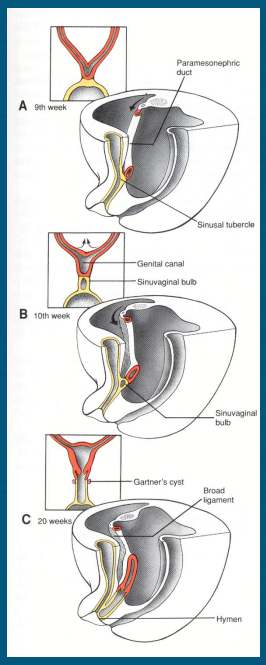


Genital Ducts - Female

- In the absence of AMH paramesonephric ducts develop and mesonephric ducts degenerate
- Gives rise to fallopian tubes, uterus and superior vagina
- Where paired paramesonephric ducts meet they fuse to form uterovaginal canal-joined to UGS
  - Upper 4/5 of vagina from paramesonephric ducts
  - Lower 1/5 from UGS
- Fusion anomalies lead to bicornuate or septated uterus

Genital Ducts - Female





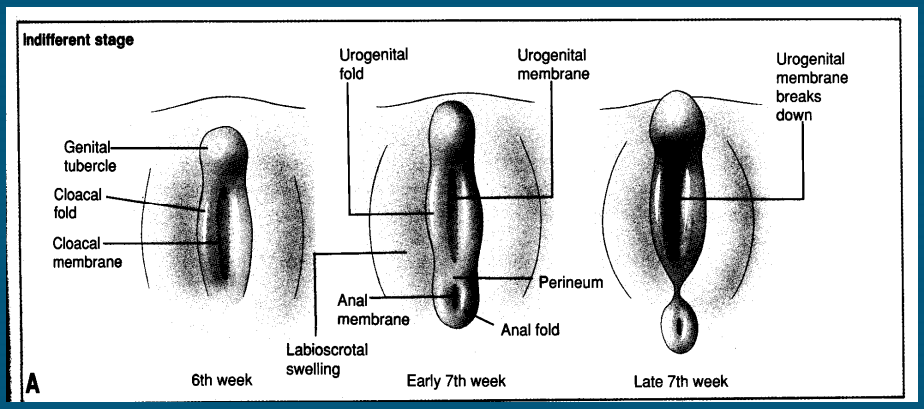
Sexual Ambiguity

- All disorders of sexual ambiguity can be explained on the basis of androgen abnormalities
- In the male – too little
- In the female – too much

External Genitalia

- Cloacal folds develop on either side of cloacal membrane
- Meet anteriorly to form genital tubercle
- After urorectal septum separates UGS from rectum the anterior folds become urethral folds
- Labioscrotal swellings appear on either side of the urethral folds

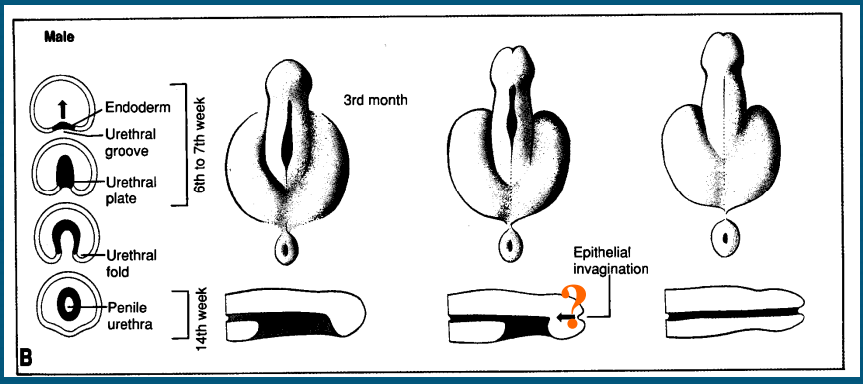
External Genitalia – Indifferent Stage



External Genitalia - Male

- Genital tubercle elongates and pulls urethral groove
- Urethral folds close to form urethra
  - (In the past it was taught that the glanular urethra forms from invagination of ectoderm from the tip proximally
    - Contradicted by recent studies)
- Labioscrotal folds fuse to form scrotum

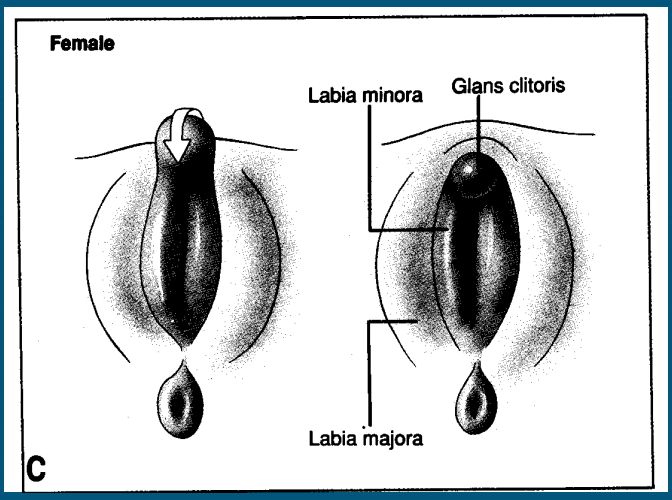
External Genitalia - Male



External Genitalia - Female

- Labioscrotal and urethral folds do not fuse
  - Form labia majora and labia minora respectively
- Genital tubercle bends inferiorly to form clitoris

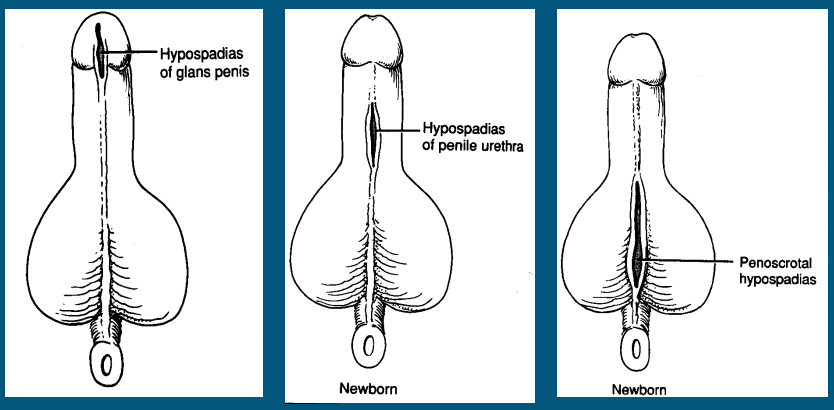
External Genitalia - Female



External Genitalia - anomalies

- Hypospadias – incomplete fusion of urethral folds or glanular urethra fails to meet penile urethra
- Epispadias – genital tubercle forms in abnormal position – not cranial enough

Hypospadias



- Kidney
- Ureter/Trigone
- Bladder/Urethra
- Gonads
- Genital Ducts
- External Genitalia

Embryology- Q1

The final nephric system is formed from the:

a) Pronephros
b) Mesonephros
c) Metanephros
d) Both b and c
e) None of the above

Embryology- Q2

In males endodermal evaginations from the pelvic urethra ultimately form part of the prostate. In females they form which of the following:

a) Cowpers Glands
b) Bartholins Glands
c) Skenes Glands
d) Glands of Littre

Embryology- Q3

The appendix testis if a remnant of :

a) The Wolffian Duct
b) The Mullerian Duct
c) The Metanephric Blastema
d) The Intermediate Mesoderm

Embryology- Q4

The vas deferens form from the:

a) Paramesonephric Ducts
b) Primitive Sex Cords
c) Mesonephric Ducts
d) Mullerian Ducts