UG Embryology

Learning Objectives

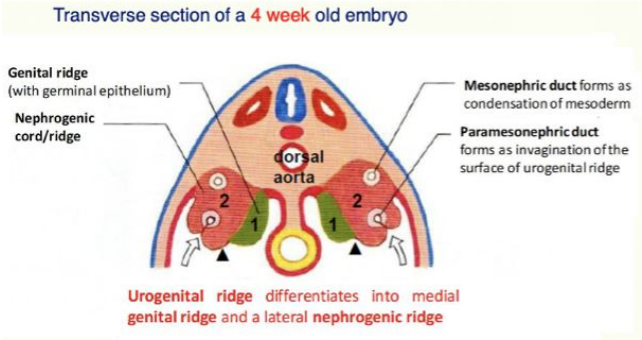
Describe the embryonic development of the renal system, including pronephros,mesonephros and metanephros
Describe morphologic differentiation of the urinary tract
Appreciate the embryonic origin of urine forming system and urine excreting system
Appreciate the process of ascent of the kidneys and descent of the gonads
Understand the derivatives of the cloaca

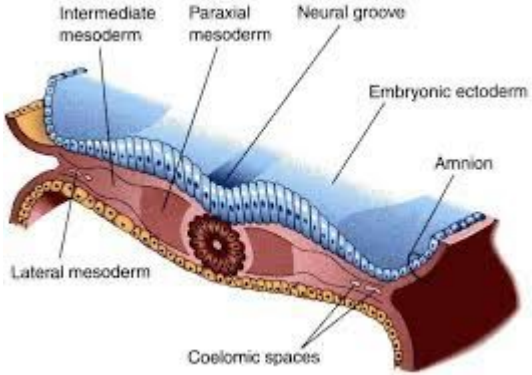
Describe the embryonic development of the male and female genital tract
Understand the process of sexual differentiation including chromosomal sex determination
Understand the origins and differentiation of internal genital organs
Understand the origins and differentiation of external genitalia

Describe the embryonic development of the renal system, inc pronephros, mesonephros and metanephros

The UG system is derived from the **intermediate mesoderm**

- The development of the urinary system begins with formation of the nephrogenic cord in week 4
- The nephrogenic cord develops into the - pronephros mesonephros and metanephros
- The bladder and urethra derive from the endoderm - NOT from the mesoderm like the rest of the UG system





Development of the nephrogenic cord -

Pronephros -

- Develops in the 4th week
- Its non functional - only a transitory state
- It dies in the 5th week of development - as the mesonephros develops

Mesonephros -

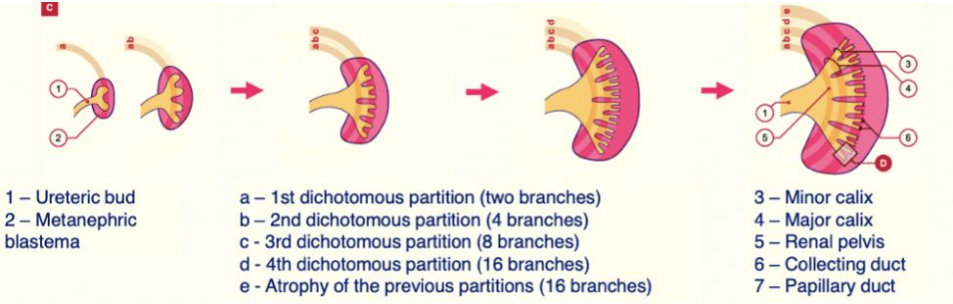
- Differentiates during the 4th week and degenerates after the 8th week of development
- Functional between 6th and 10th week
- Becomes future bladder and genitalia

Metanephros -

- Definite kidney
- Develops during the 5th week
- Develops into ureteric bud and metanephric blastema

Describe the morphological differentiation of the urinary tract

- During the 6th week, the ureteric bud begins the branching cascade – ureter, renal pelvis, major and minor calices and collecting ducts
- There are 4 stages of nephron development -
  - Vesicle (V) stage - 13-19 weeks
  - S shaped body (S) stage - 20-24 weeks
  - Capillary loop © stage - 25-29 weeks
  - Maturation (M) stage - infants 1-6 months



Appreciate the embryonic origin of the urine forming and urine excreting system

So currently we know that the metanephros consists of the ureteric bud and the metanephric blastema

The metanephric blastema gives rise to the **urine forming system**

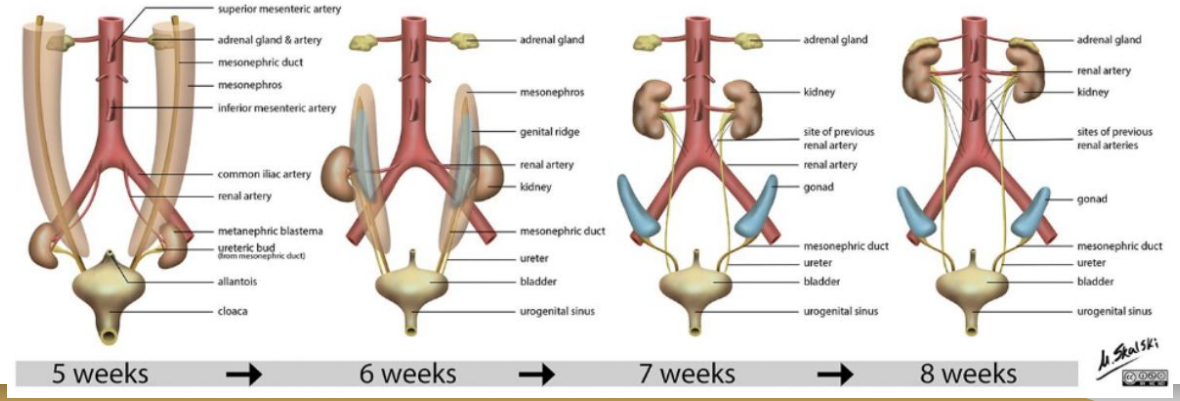
- DCT and PCT
- The renal corpsucle (bowmans capsule with peritubular capillaries)

The ureteric bud gives rise to the **urine excreting system**

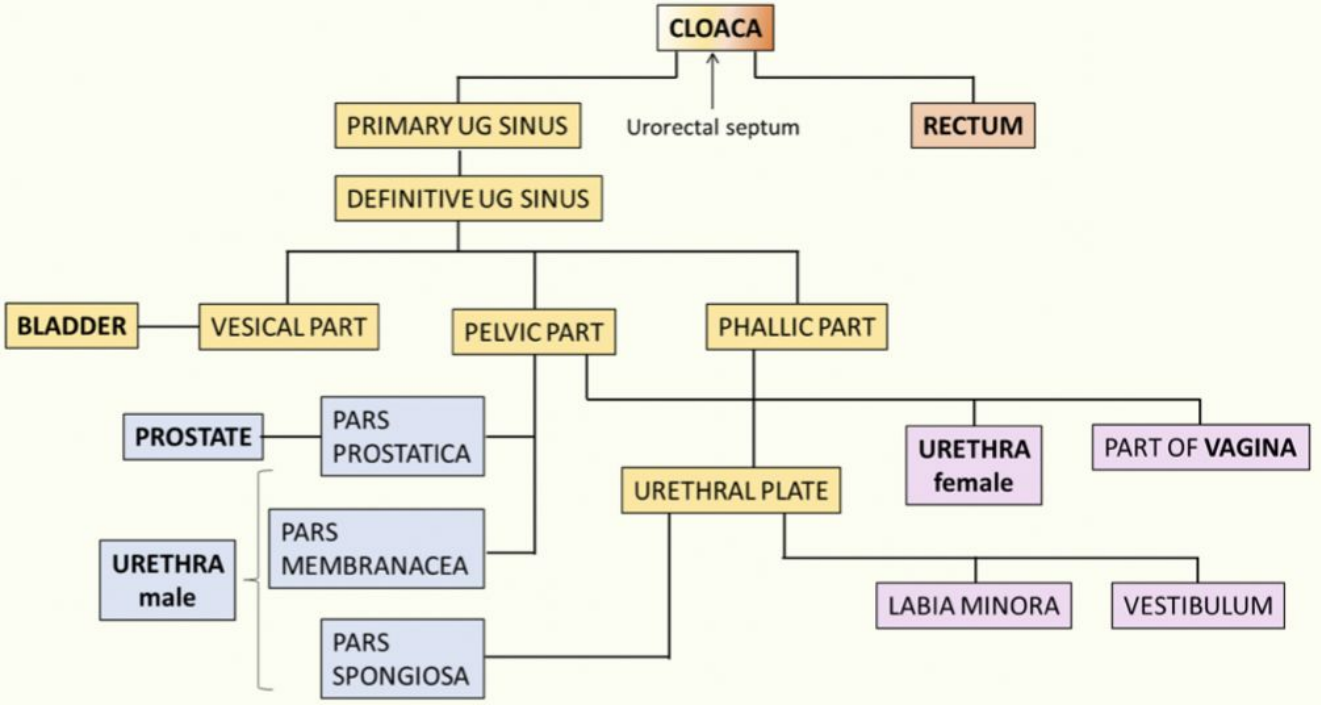
- The ureter
- The renal pelvis
- Major and minor calices
- The collecting ducts

Appreciate the process of ascent of the kidneys and descent of the gonads

- The kidneys are initially located near the tail of the embryo
- Growth of the embryo causes the kidneys to ascend up towards the final position
- Once they have come into contact with the adrenal glands, they stop
- As they ascend, the ureters elongate and open into the bladder and also the blood supply changes from common iliac arteries to the aorta



Understand the derivatives of the cloaca



Summary of the embryonic origins of the urinary system

Intermediate mesoderm → kidneys, ureters, vasculature of kidneys

Splanchnopleuric mesoderm → smooth muscle and connective tissue of the BLADDER

Endoderm → bladder and urethra

Ectoderm (neural crest cells) → autonomous nervous system of the kidney

It’s important to know these both directions because they can test either way in the exam!

Describe the embryonic development of the male and female genitcal tract

There are 3 main stages of the reproductive system embryonic development -

1. Differentiation of gonads (sex determination)
2. Differentiation of internal genital organs
3. Differentiation of external genital organs

The gonads (testes/ovaries) are dervied from - **genital ridges** (generated from intermediate mesoderm) and **primordial germ cells (PGCs)**

Genital ducts arise from the mesonephric/Wollfian (MALE) and paramesonephric/mullerian (FEMALE) ducts

it's crucial to remember both names because they use both versions in exams

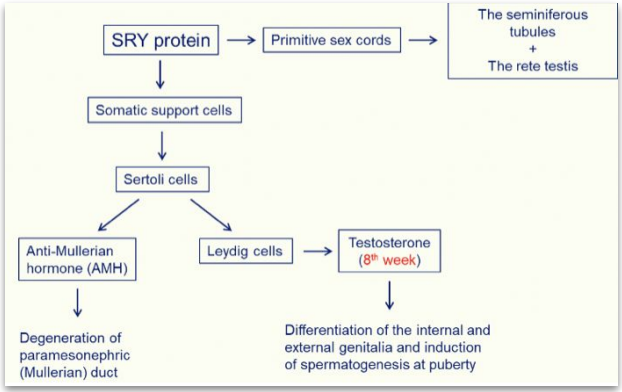
(Wolf = alpha = male)

Understand the process of sexual differentiation including chromosomal sex determination

Between 0-6 weeks, is the indifferent stage.

After the 6th week is when sexual differentiation begins.

Differentiation is largely influenced by the absence/presence of **SRY protein (aka TDF - testis determining factor).** When the SRY protein is expressed, male development is triggered, if it isn't expressed, female development is triggered.



Understand the origins and differentiation of internal genital organs

Differentiation of the male internal genital organs -

- Testes begin differentiation during 7th week (under influence of SRY protein).
- The seminal vesicles AND the prostate gland develop in the 10th week
- Descent of the testes -
    - **Gubernaculum** - attaches the gonads to the labioscrotal swelling
    - The testes originally begin near the inguinal canal and then descend when the gubernaculum **shortens** - drawing the testes downwards into the scrotum
    - Abnormalities -
        - Congenital indirect inguinal hernia - part of intestine descends into the scrotum
        - Cryptorchidism - failure of one or both testes to descend

Differentiation of the female internal genital organs -

- The ovaries differentiate during the 8th week of development
- In the **absence** of SRY protein, the gonadal cords **degenerate.**

IMPORTANT

The genital ducts arise from the paired mesonephric and paramesonephric ducts.

MALES	**mesonephric/wolffian duct**	**UG sinus**
	Epididymis Vas deferens Seminal vesicle Ejaculaltory duct	Urinary bladder (vesical part) Pelvic part (urethra, prostate) Phallic part (spongy urethra and urethral glands)
FEMALES	**paramesonephric/mullerian duct**	**UG sinus**
	Uterus Fallopian tube Vagina (upper ⅓)	Vagina (lower ⅔) Urethra Urethral glands, vestibular glands Vaginal vestibule

All of these are derivatives of the cloaca ‼️ → the derivatives of the UG sinus are ENDODERMAL - not mesodermal

Understand the origins and differentiation of external genitalia

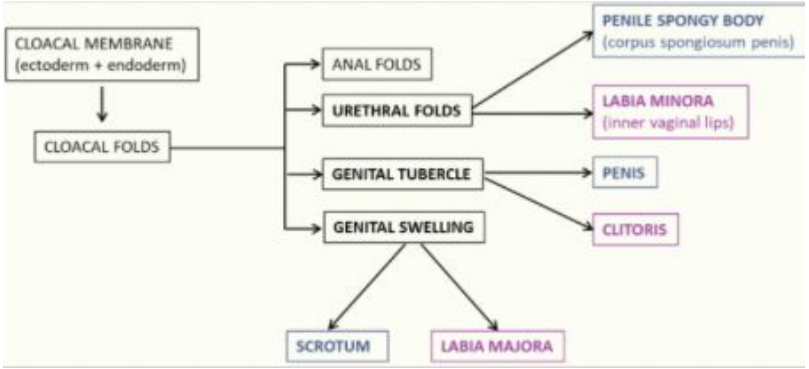
The cloaca gives rise to the anal fold, urethral fold, genital tubercle and genital (labioscrotal) swelling

The **genital tubercle** gives rise to - **penis** in males, and **clitoris** in females

The **genital swelling** gives rise to - **scrotum** in males, and **labia majora** in females

The **urethral fold** gives rise to - **corpus spongiosum** in males, and **labia minora** in females.

Here's a chart to make it easier to understand



A few extra key dates to remember

- Week 4 - formation of the mesonephric duct
- Week 5 - formation of the paramesonephric duct
- Week 6 - end of indifferent stage of the gonads
- Week 15 - prostate becomes active
- Week 28 - testes pass through the inguinal canal
- Week 36 - testes reach the scrotum

Questions

1. What is the penis derived from?

a) Anal fold

b) Urethral fold

c) Genital tubercle

d) Genital swelling

1. What is the penis derived from?

a) Anal fold

b) Urethral fold

c) Genital tubercle ✅

d) Genital swelling

2) Which of these is NOT derived from the mesonephric duct?

a) Epididymis
b) Vas deferens
c) Prostate gland
d) Seminal vesicle
e) Ejaculatory duct

2) Which of these is NOT derived from the mesonephric duct?

a) Epididymis
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3) what does the entire UG system derive from?

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Intermediate mesoderm

4) when does the ureteric bud begin the branching cascade?

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Week 6

5) which of these is derived from the urogenital sinus?

a) Penis
b) Labia majora
c) Upper ⅓ of the vagina
d) Lower ⅔ of the vagina
e) Epididymis

5) which of these is derived from the urogenital sinus?

a) Penis
b) Labia majora
c) Upper ⅓ of the vagina
d) Lower ⅔ of the vagina ✅
e) Epididymis