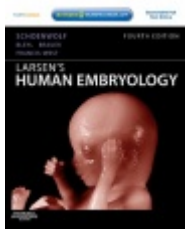
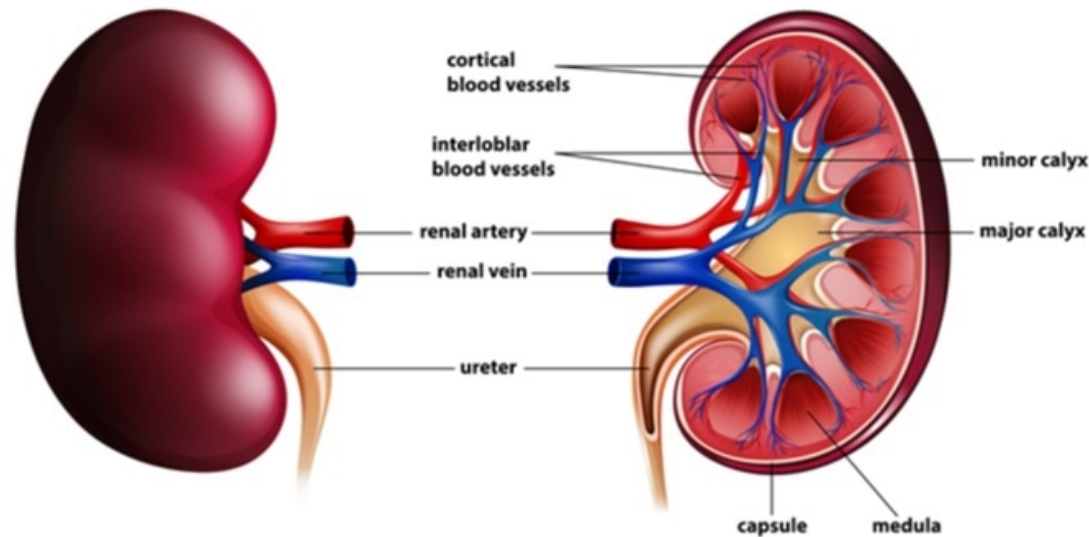
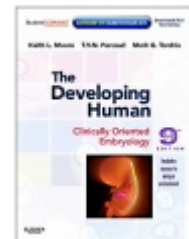


Development of the Urinary System



Resources:
<http://php.med.unsw.edu.au/embryology/>
 Larsen's Human Embryology
 The Developing Human: Clinically Oriented Embryology



Dr Annemiek Beverdam – School of Medical Sciences, UNSW
 Wallace Wurth Building Room 234 – A.Beverdam@unsw.edu.au

Development of the Urinary System

Anatomy of the Urinary System

Embryonic origins of Urinary System

Kidney Development

Nephrogenesis

Development of the Renal Vasculature

Development of the Urinary Bladder and Urethra

Congenital Abnormalities of the Urinary System

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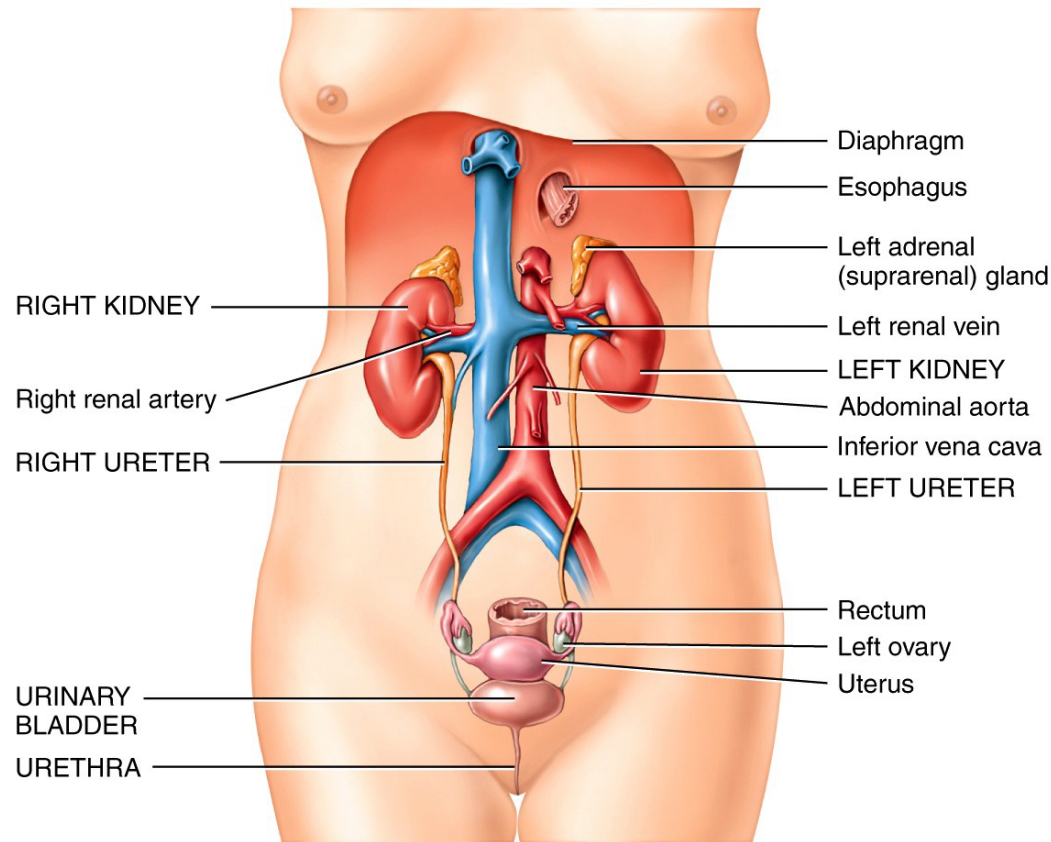
Anatomy of the Urinary System

Consists of kidneys, ureters, urinary bladder and urethra

Blood filtration and control of body fluid homeostasis

Production of urine

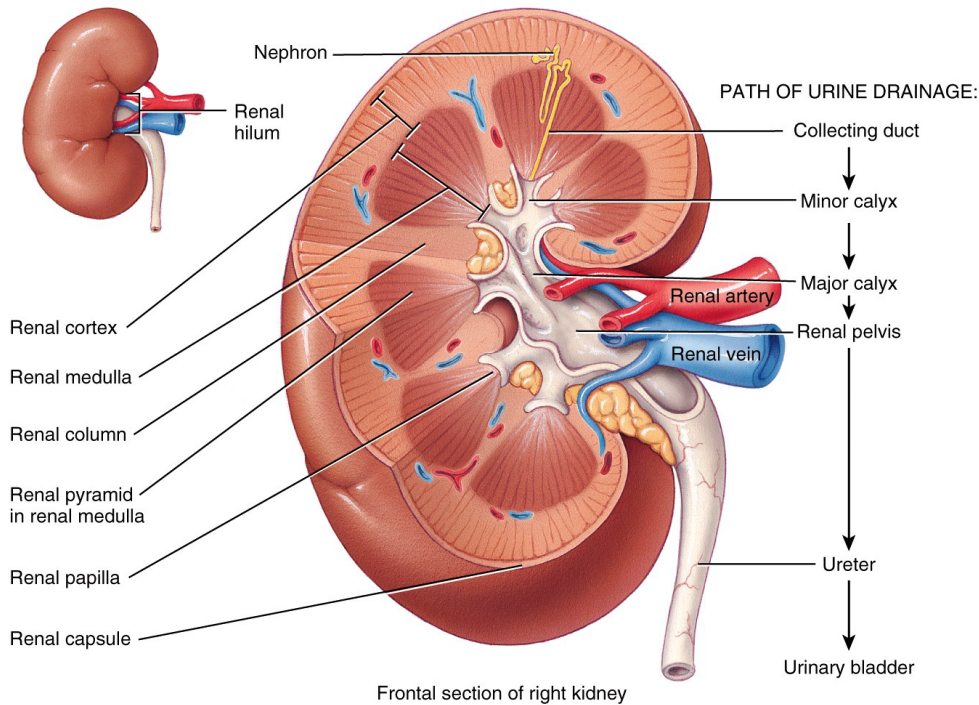
Functional unit: nephron ($\sim 10^6$ /kidney)



Anterior view

Anatomy of the Urinary System

kidneys



Paired organs

Covered by renal capsule

Renal cortex

Renal medulla

Renal hilum (renal artery, vein, pelvis)

Nephrons: in renal pyramids and renal cortex

Renal pelvis

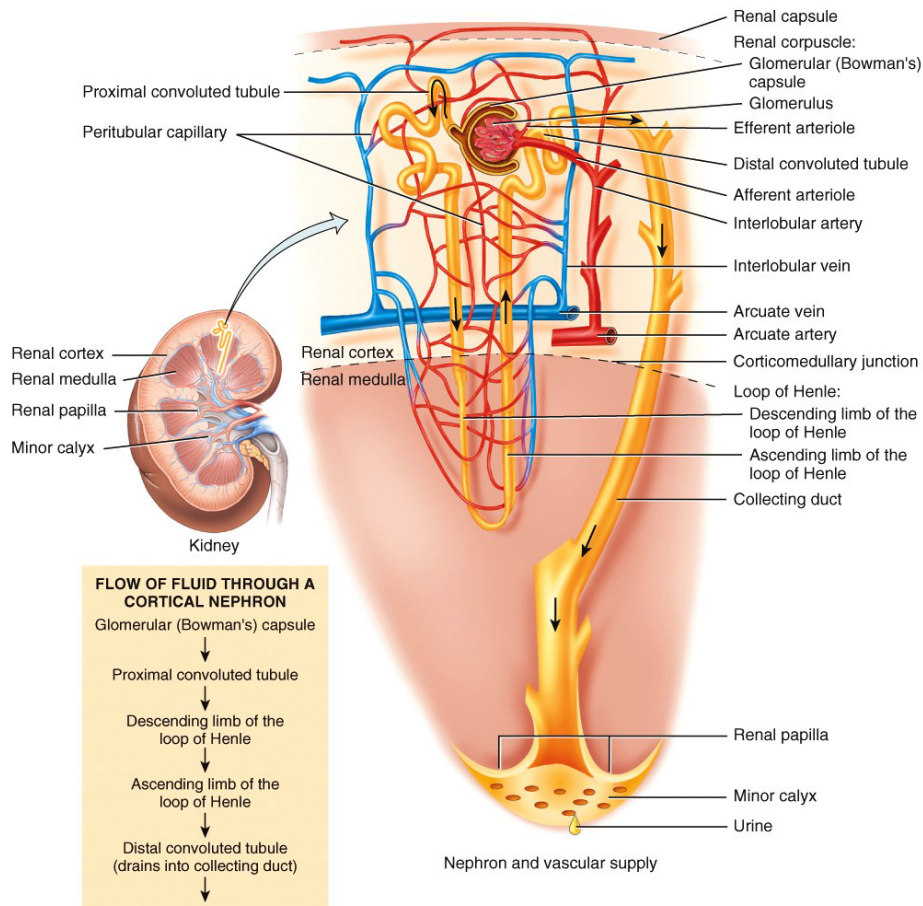
Ureter

Urinary bladder

Urethra

Anatomy of the Urinary System

nephrons



Nephrons: in renal pyramids and renal cortex

Nephrons consist of:

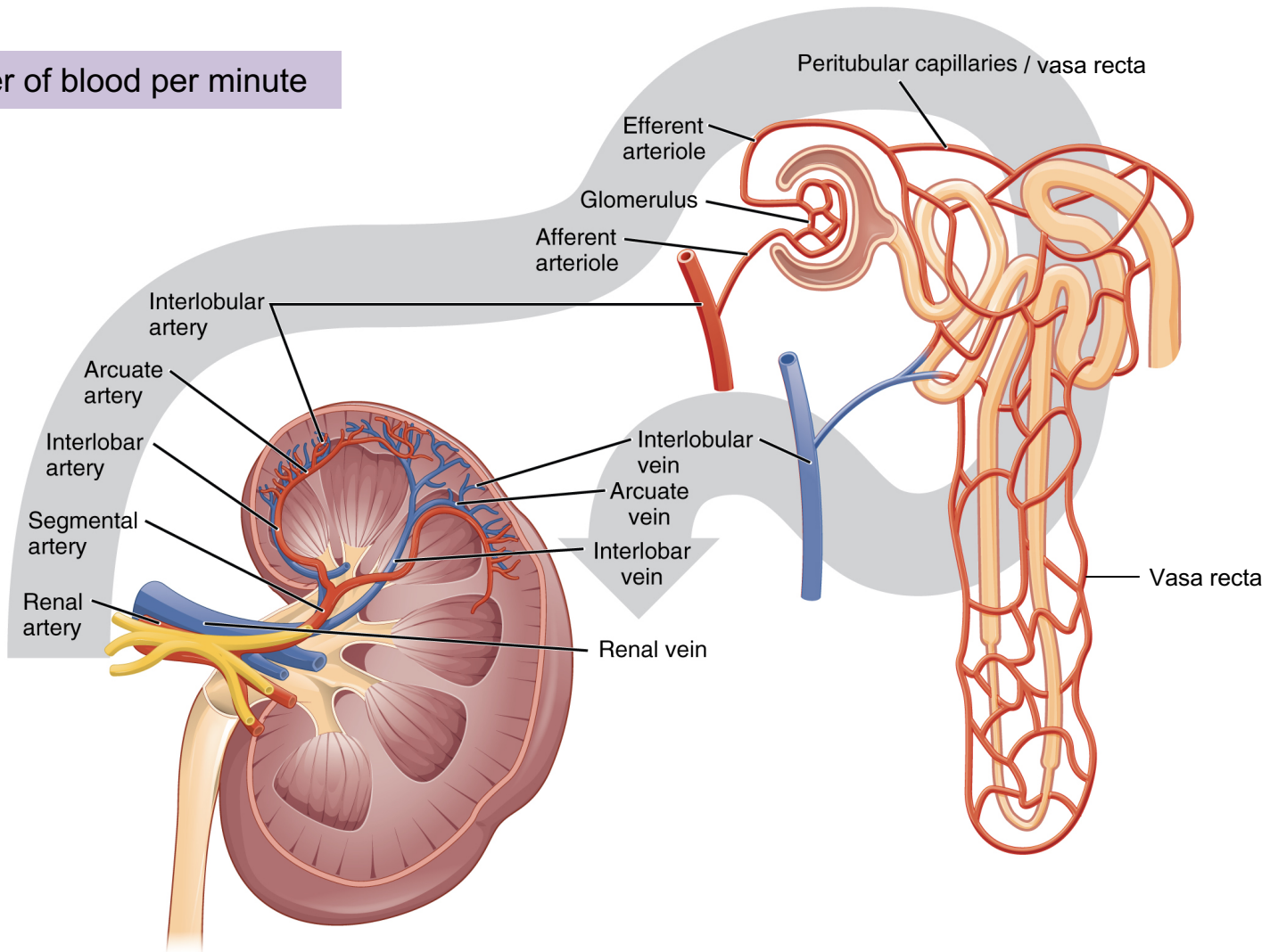
- Renal corpuscle (cortex):
Bowman's capsule
Afferent arteriole
Glomerulus
Efferent arteriole
- Renal tubules (cortex and medulla):
Proximal convoluted tubule
Loop of Henle
Distal convoluted tubule
Collecting duct

Renal pelvis
Ureter
Urinary bladder
Urethra

Anatomy of the Urinary System

Renal blood circulation

1.2 liter of blood per minute



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Congenital Abnormalities of the Urinary System

Trilaminar Embryo

Ectoderm (Neural crest)

brain, spinal cord, eyes, *peripheral nervous system*
epidermis of skin and associated structures,
melanocytes, cranial connective tissues (dermis)

Mesoderm

musculo-skeletal system
limbs
connective tissue of skin and organs
urogenital system, heart, blood cells

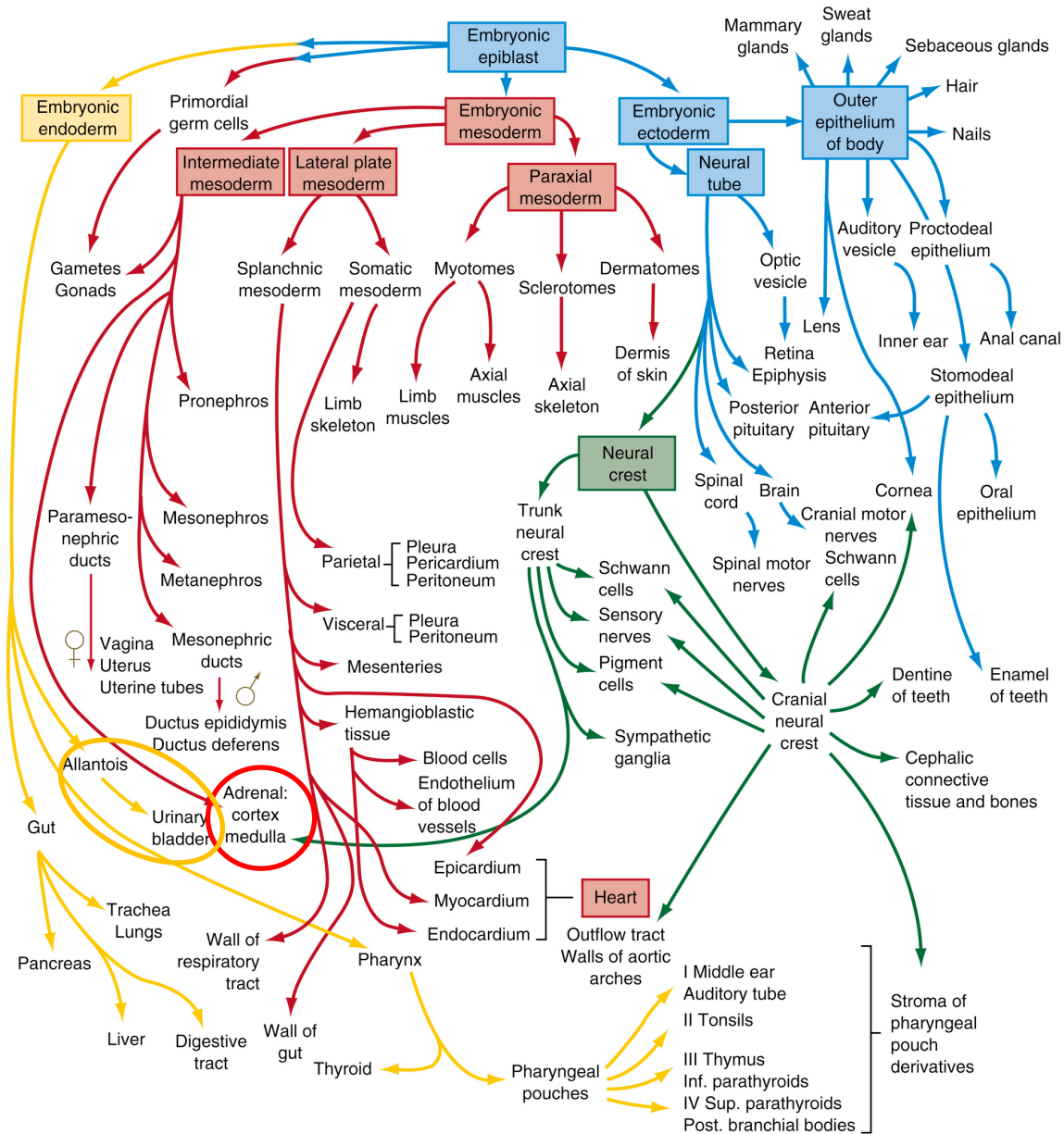
Endoderm

epithelial linings of gastrointestinal and respiratory tracts,
and of the **bladder and urethra**

Embryonic origins of the Urinary System

Intermediate mesoderm: kidneys
Endoderm: urinary bladder, urethra

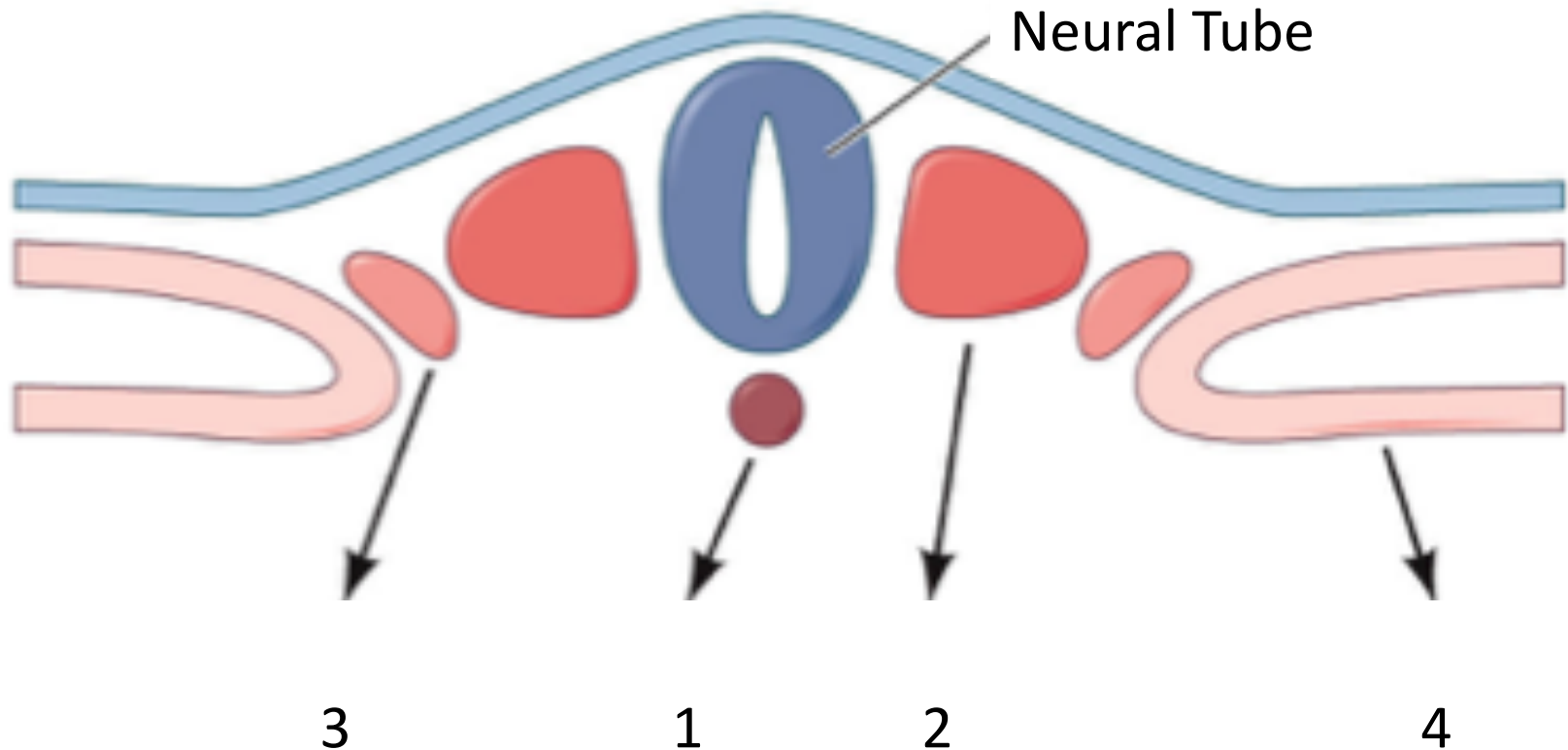
Embryonic origins of the reproductive system



Embryonic origins of the Urinary System

Intermediate mesoderm

Intermediate mesoderm gives rise to the kidneys



3

1

2

4

1: notochord

2: paraxial mesoderm

3: intermediate mesoderm

4: lateral plate mesoderm

Embryonic origins of the Urinary System

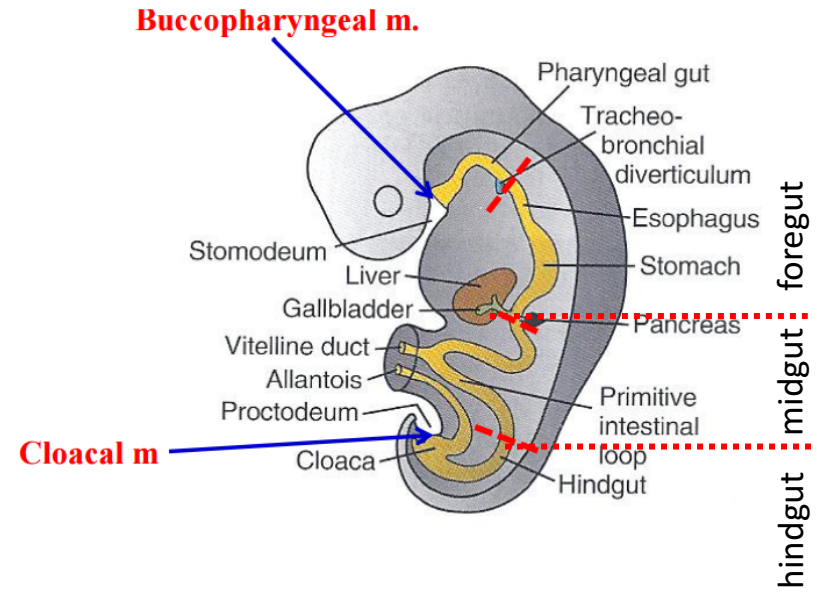
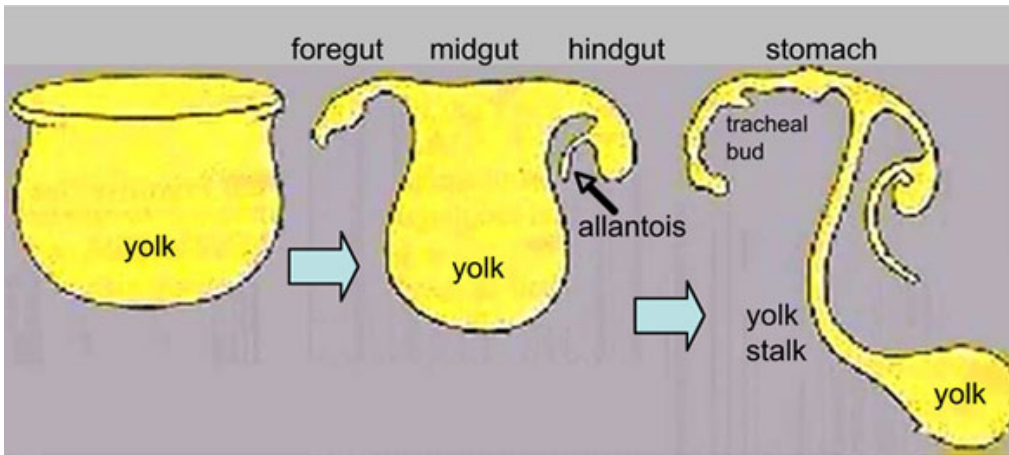
Endoderm

Lining of the GI tract:

Primitive gut: foregut, midgut and hindgut

Oral cavity and cloaca

Cloaca/allantois will give rise to urinary bladder and urethra



Development of the Urinary System

Anatomy of the Urinary System

Embryonic origins of Urinary System

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Development of the Renal Vasculature

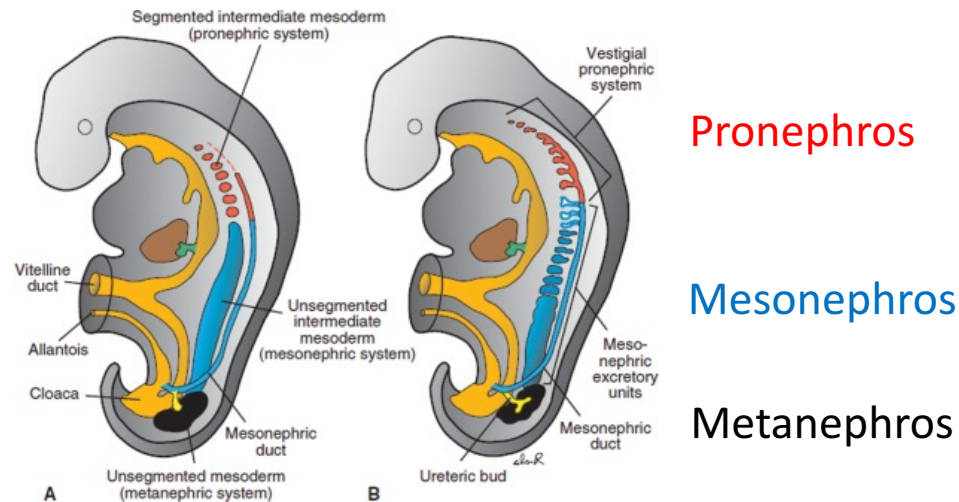
Development of the Urinary Bladder and Urethra

Congenital Abnormalities of the Urinary System

Kidney development

Intermediate mesoderm generates 3 nephric systems:

- Pronephros:
 - from segmented intermediate mesoderm
 - regresses
- Mesonephros:
 - embryonic kidney
 - reproductive system
 - Ureteric bud: collecting duct and tubules of the kidney
- Metanephros:
 - Adult kidney (capsule, glomeruli and nephron tubules)



Kidney development

Metanephros development

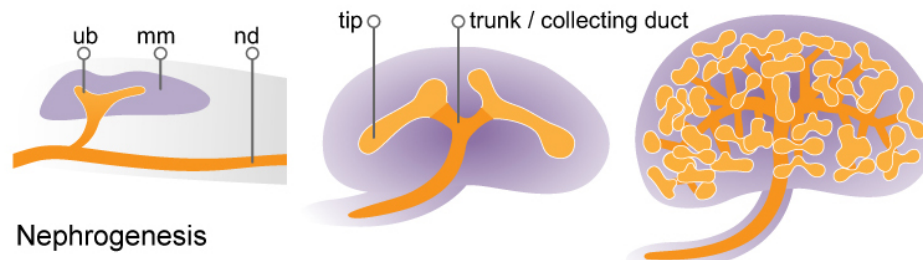
Proximal end of ureteric bud ends into mesonephric duct (-> cloaca)

Ureteric bud grows out distally and branches out

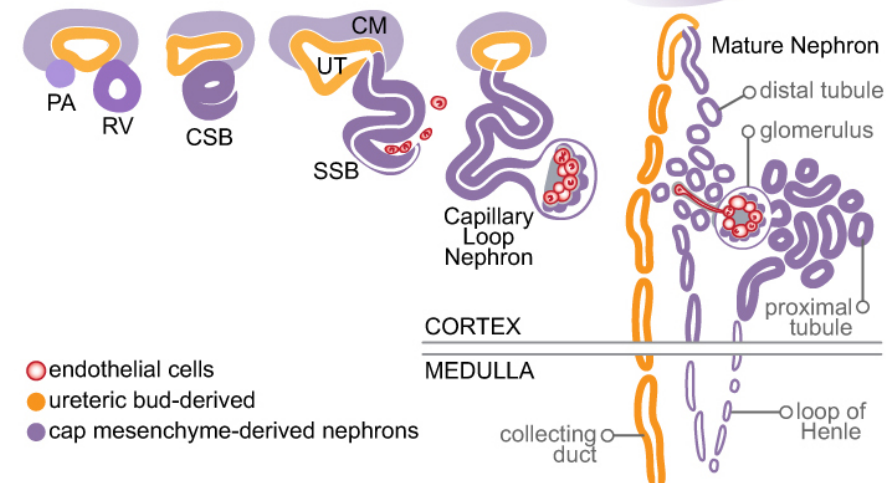
Ureteric bud gives rise to ureter, renal pelvis, collecting ducts

Metanephric mesenchyme gives rise to renal capsule and cortex, glomeruli and nephron tubules

Ureteric Bud Formation & Branching



Nephrogenesis



Kidney development

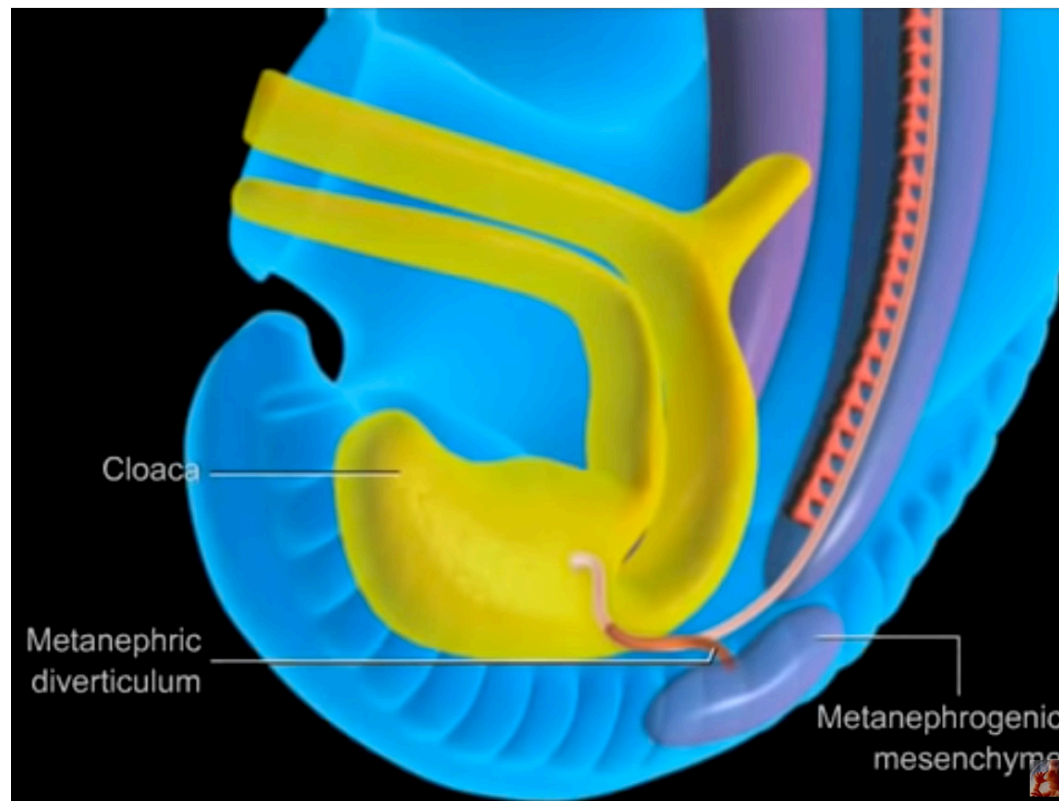
Metanephros development

Proximal end of ureteric bud ends into mesonephric duct (cloaca)

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Ureteric bud gives rise to ureter, renal pelvis, collecting ducts

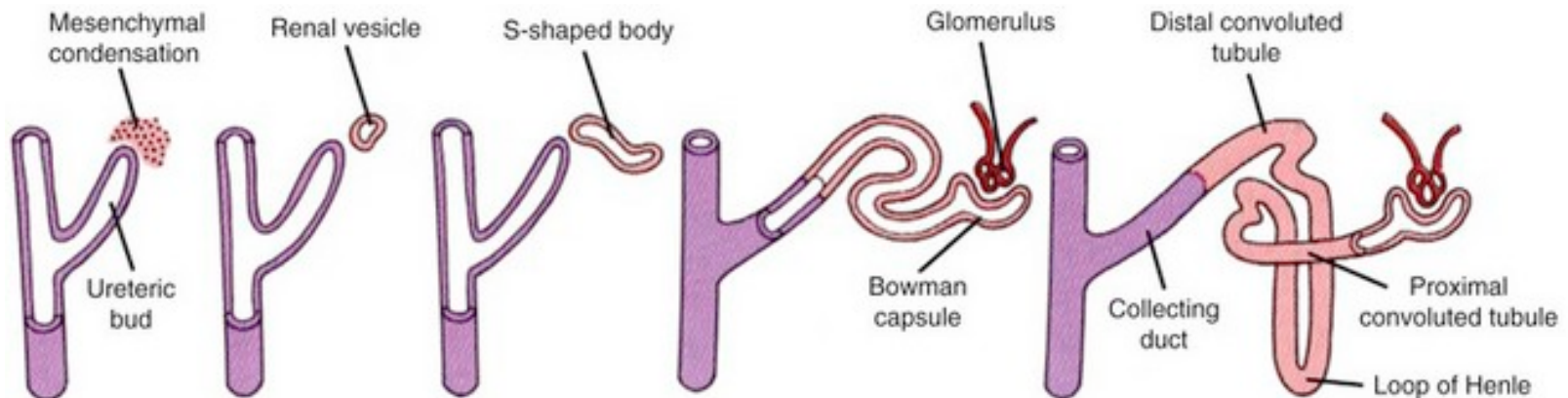
Metanephric mesenchyme gives rise to renal capsule and cortex, glomeruli and nephron tubules



Nephrogenesis

Four developmental stages:

1. Vesicle (V) stage: 13-19 weeks: epithelialization and cyst formation
2. S-shaped body (S) stage: 2—24 weeks: invaginations of vesicle
3. Capillary loop (C) stage: 25-29 weeks: invasion of vasculature
4. Maturation (M) stage: infants up to 6 months



Mesenchyme
Condensation,
Epithelialization

V-stage

S-stage

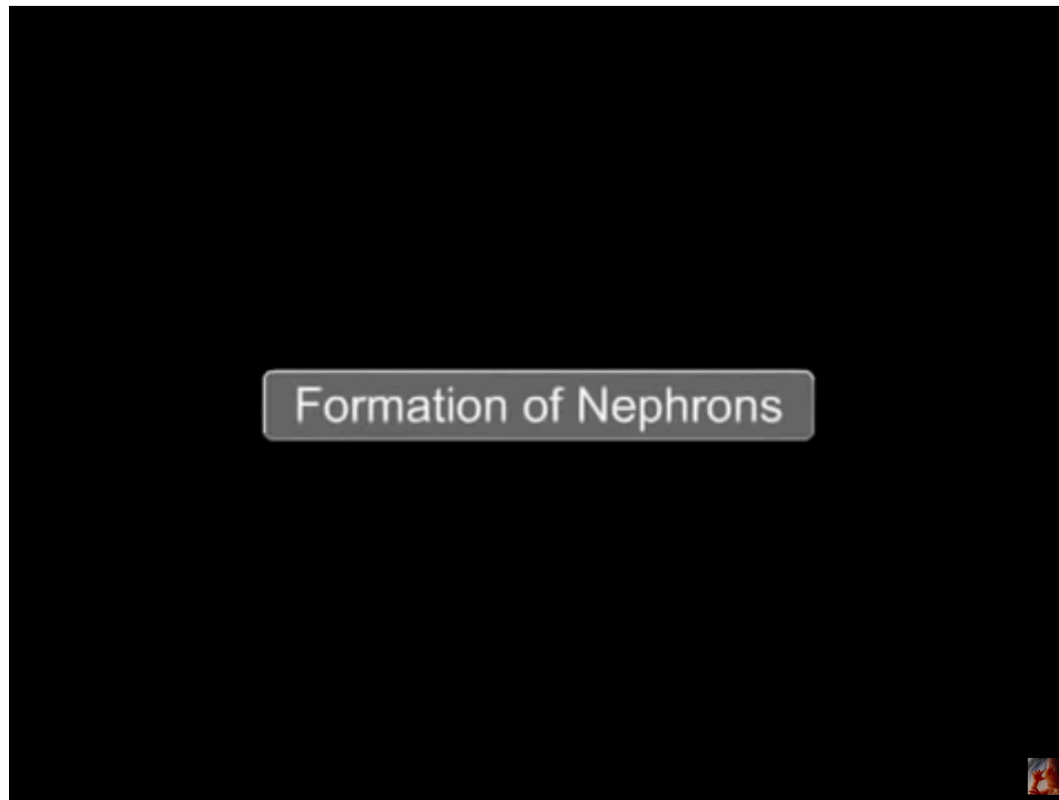
C-stage

Maturation

Nephrogenesis

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Kidney Development

Nephrogenesis

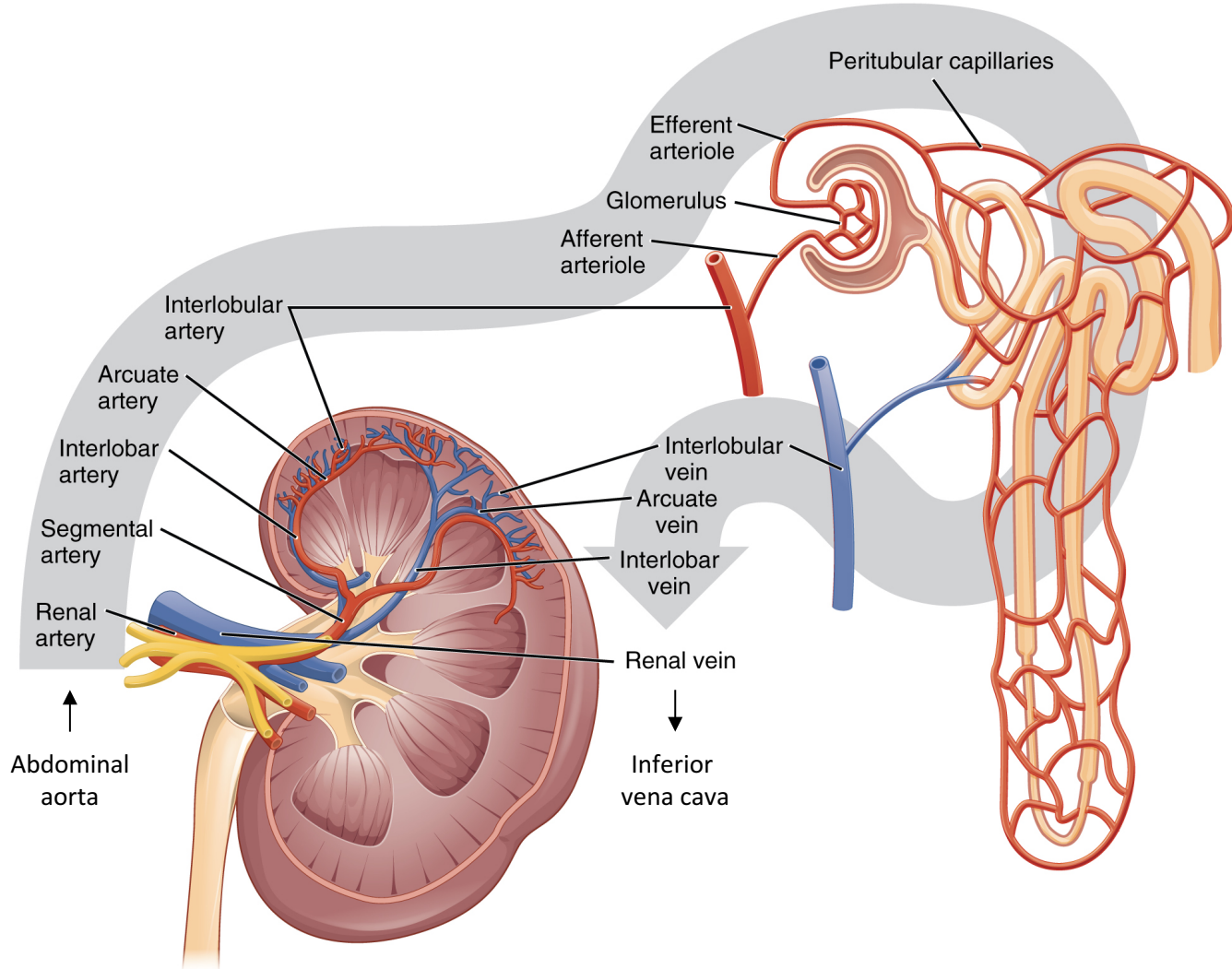
Development of the Renal Vasculature

Development of the Urinary Bladder and Urethra

Congenital Abnormalities of the Urinary System

Renal vasculature

Anatomy



Renal vasculature

Development

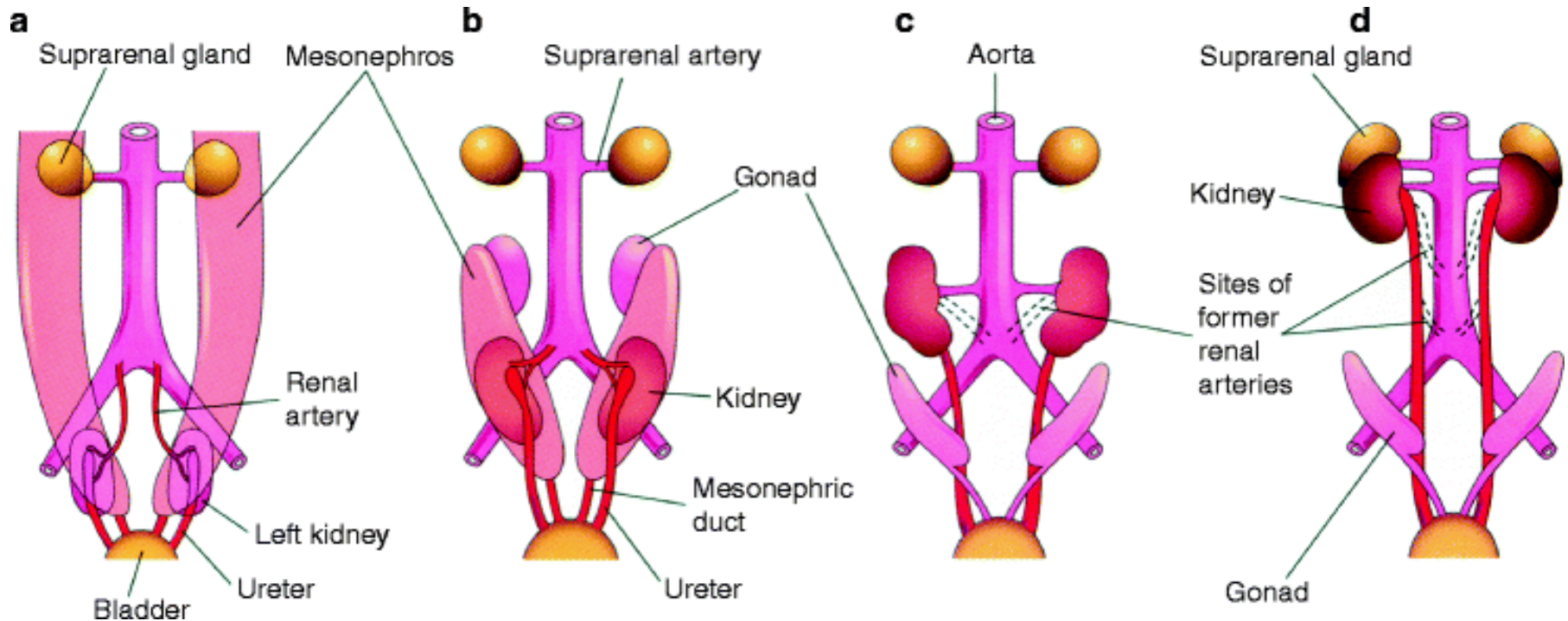
Renal artery sprouts into metanephros from dorsal aorta

From week 6: kidney ascent from pelvis to abdomen

Kidneys are supplied by arteries at successively higher levels during ascent

(25% of people have 2+ renal arteries per kidney)

Week 9: kidneys reach adrenal glands



Renal vasculature

Development

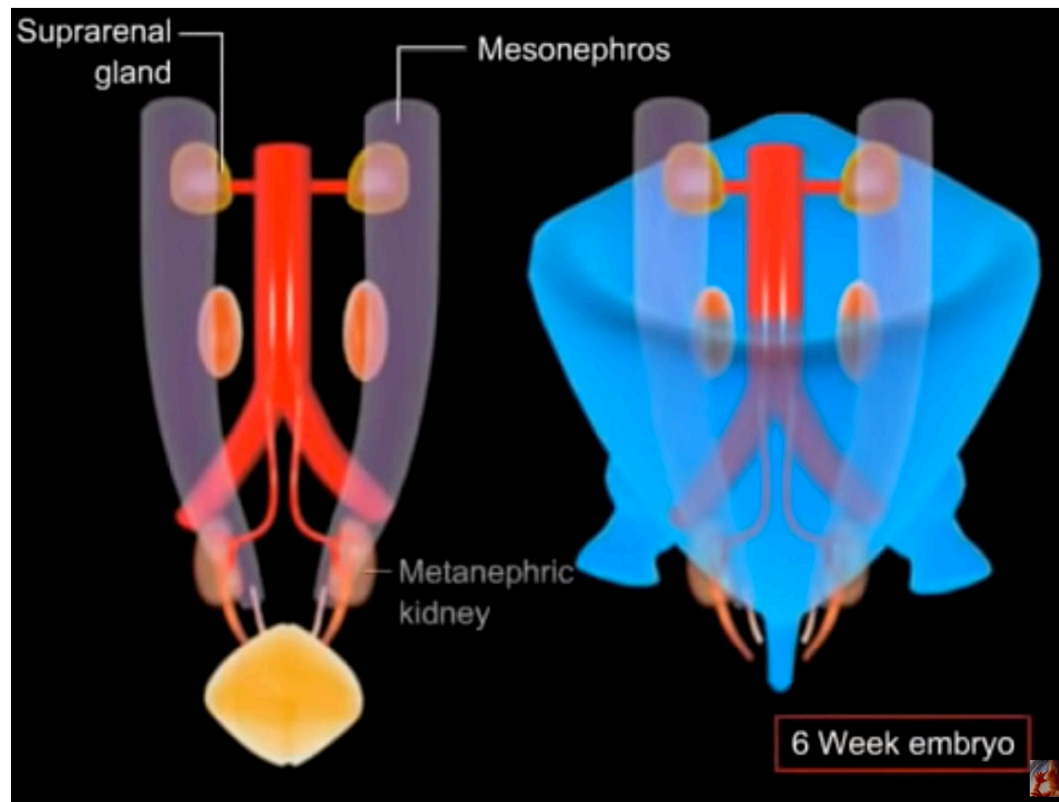
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Congenital Abnormalities of the Urinary System

Development of the Urinary Bladder and Urethra

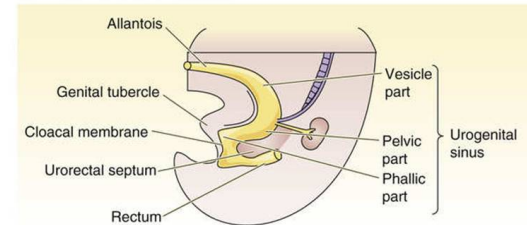
Cloaca is lined by endoderm-derived epithelium

Urorectal septum separates hindgut from urogenital sinus

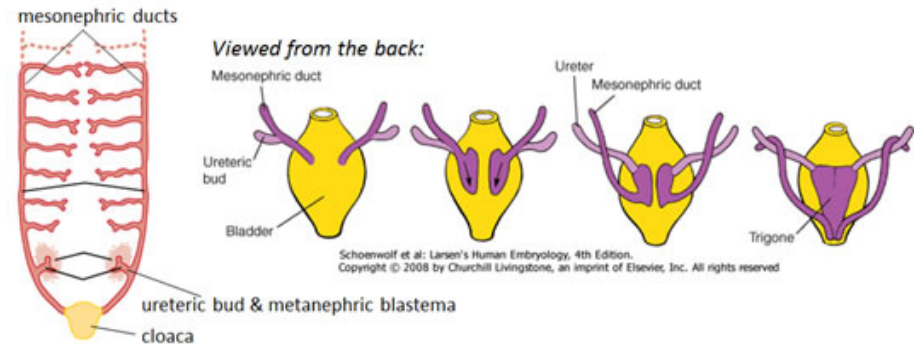
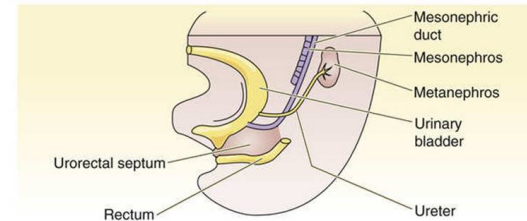
Ureters develop from ureteric buds
Ureters separate from mesonephric ducts,
and end cranially in trigone of urogenital sinus

Urogenital sinus gives rise to
bladder and urethra

A PARTITIONING OF CLOACA



B INDIFFERENT UROGENITAL SINUS



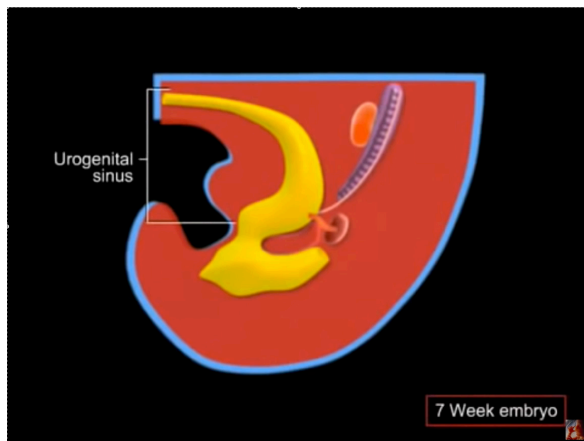
Development of the Urinary Bladder and Urethra

Cloaca is lined by endoderm-derived epithelium

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Trilaminar Embryo

Embryonic origins of Urinary System

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Nephrogenesis

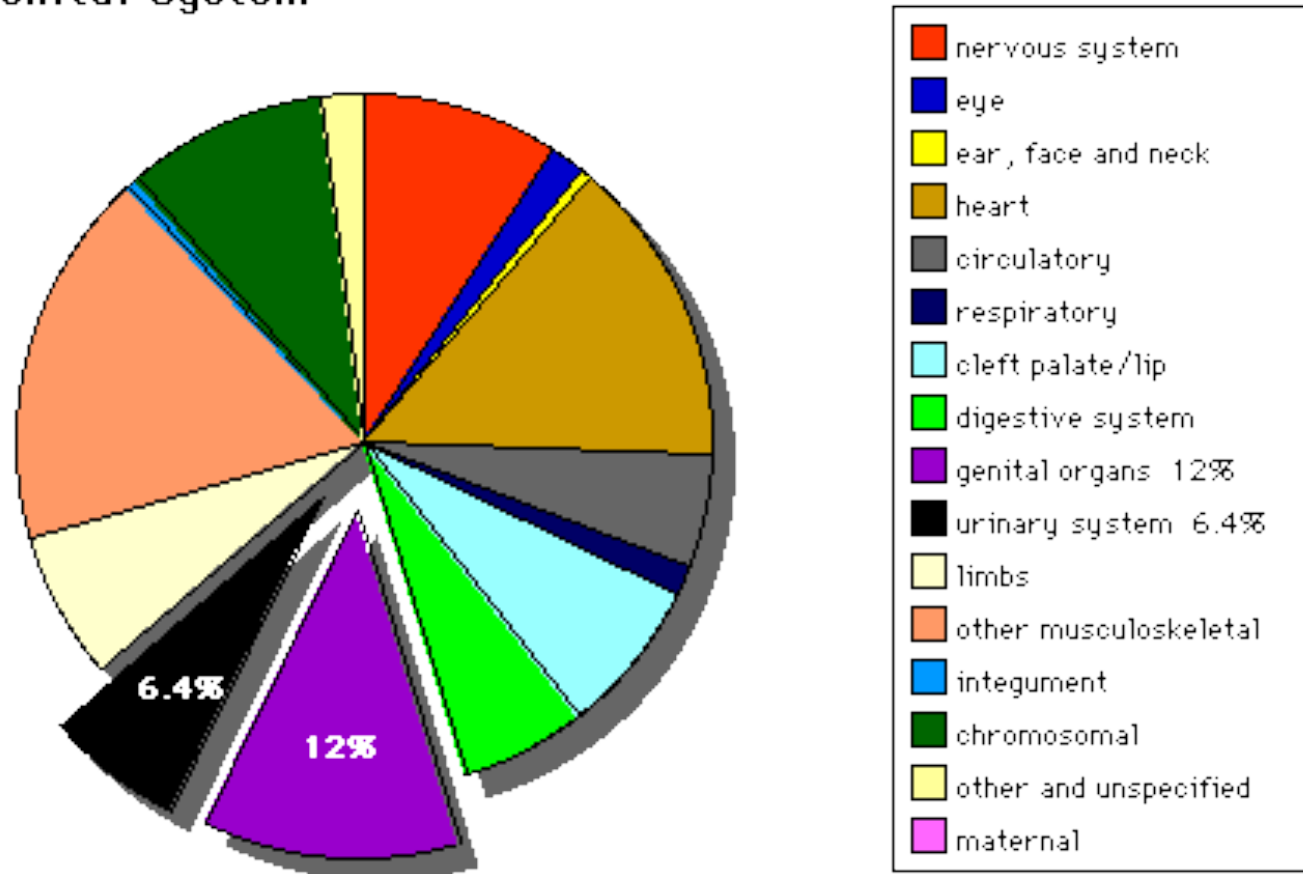
Development of the Renal Vasculature

Development of the Urinary Bladder and Urethra

Congenital Abnormalities of the Urinary System

Congenital Abnormalities of the Urinary System

Congenital Malformations by System 81-92 Urogenital System



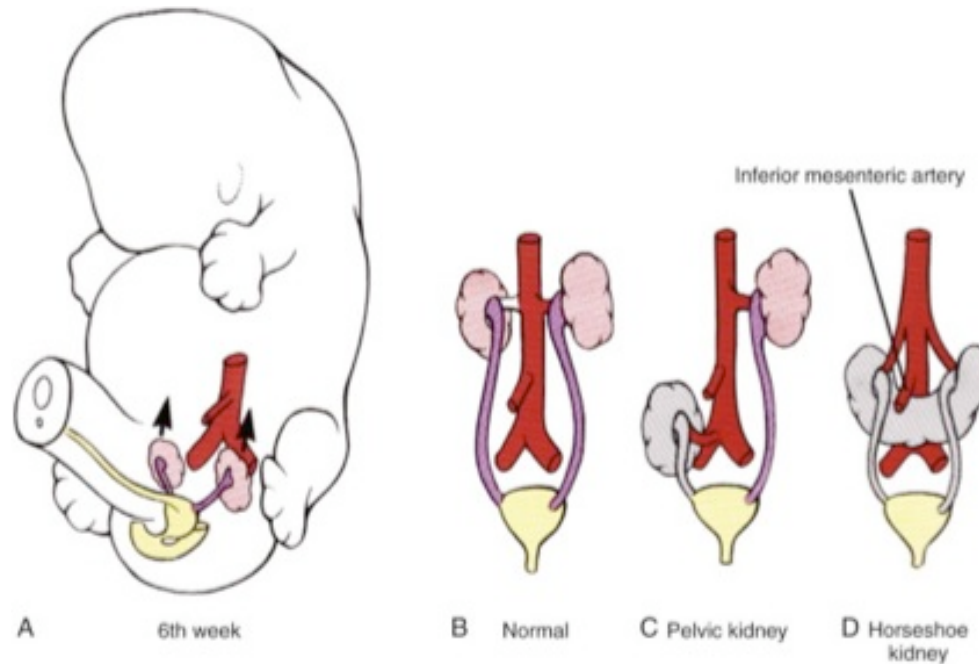
Data source: Congenital Malformations Australia 1981-92

Congenital Abnormalities of the Urinary System

Horseshoe Kidney, Pelvic Kidney

Horseshoe kidney: during kidney ascent the two metanephric blastemas can come into contact, mainly at the lower pole, resulting in fusion.

Renal ectopia or pelvic kidney: kidney ascent failure



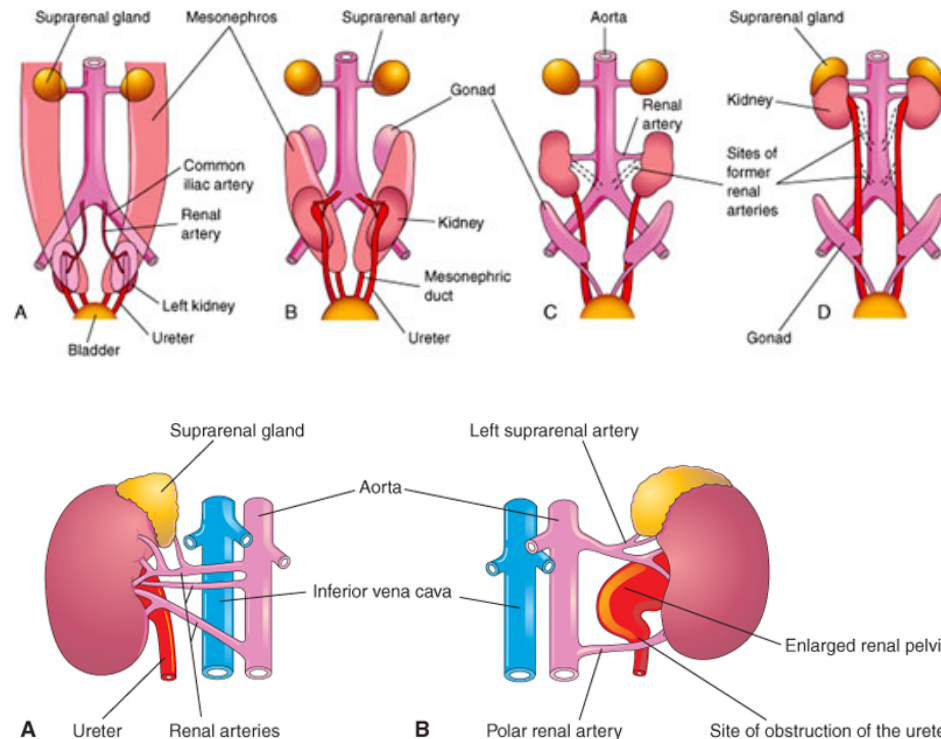
Congenital Abnormalities of the Urinary System

Supernumerary Renal Arteries

During kidney ascent, renal arteries form and degenerate at progressively anterior levels

Supernumerary/accessory renal arteries: failure of degeneration

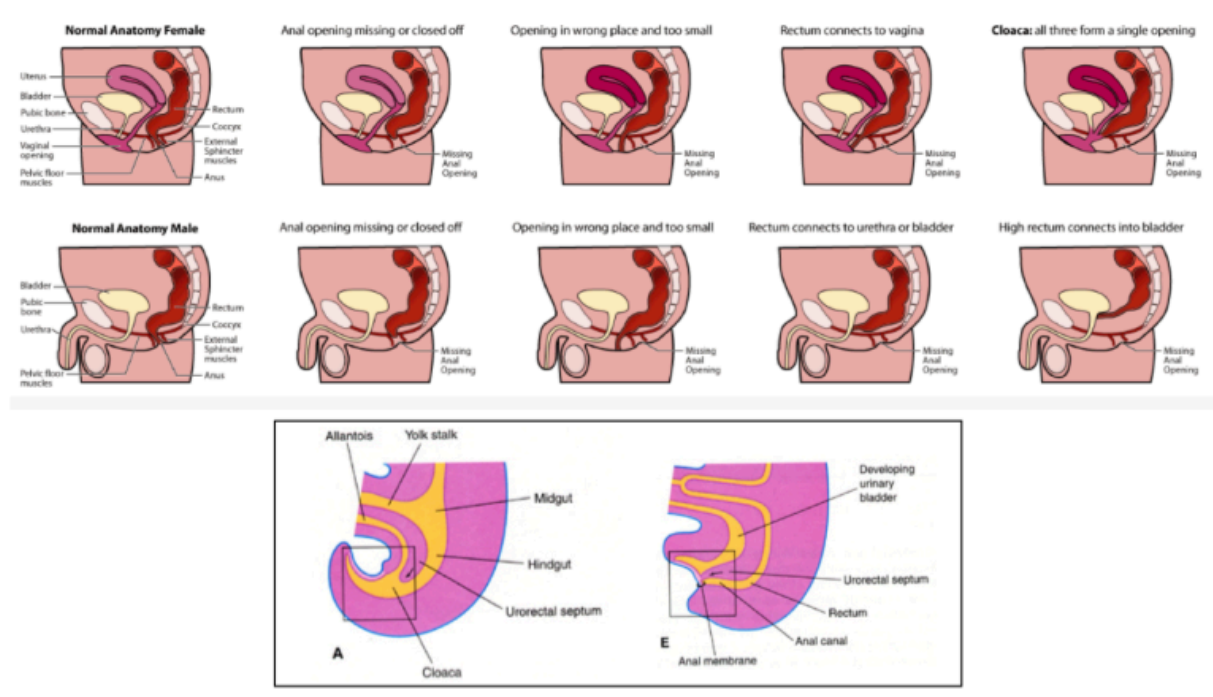
Occurs in 25% of population



Congenital Abnormalities of the Urinary System

Urorectal Septum Malformation

Problems with growth or position of urorectal septum results in anorectal anomalies:



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