

DEVELOPMENT OF URINARY AND REPRODUCTIVE SYSTEM

Urinary system development

Intermediate mesoderm

Nephrogenic mesoderm

Urogenital ridge, nephrogenic cord

Pronephros

Mesonephros

Metanephros

Cloaca, urinary bladder, ureters

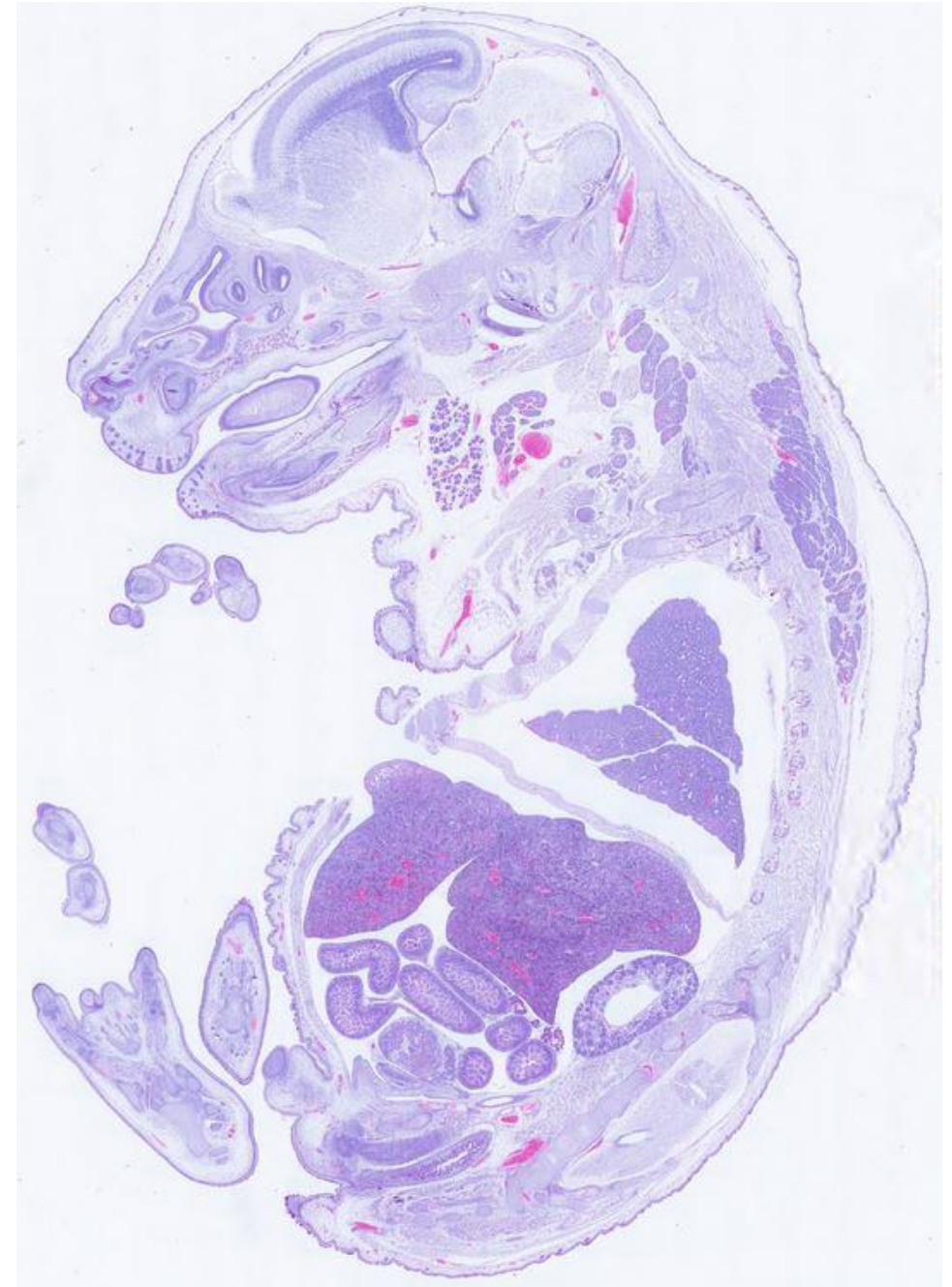
Reproductive system development

Indifferent gonad

Testis, Epididymis

Ovarium, uterus, vagina

External genitalia



DEVELOPMENT OF THE URINARY SYSTEM

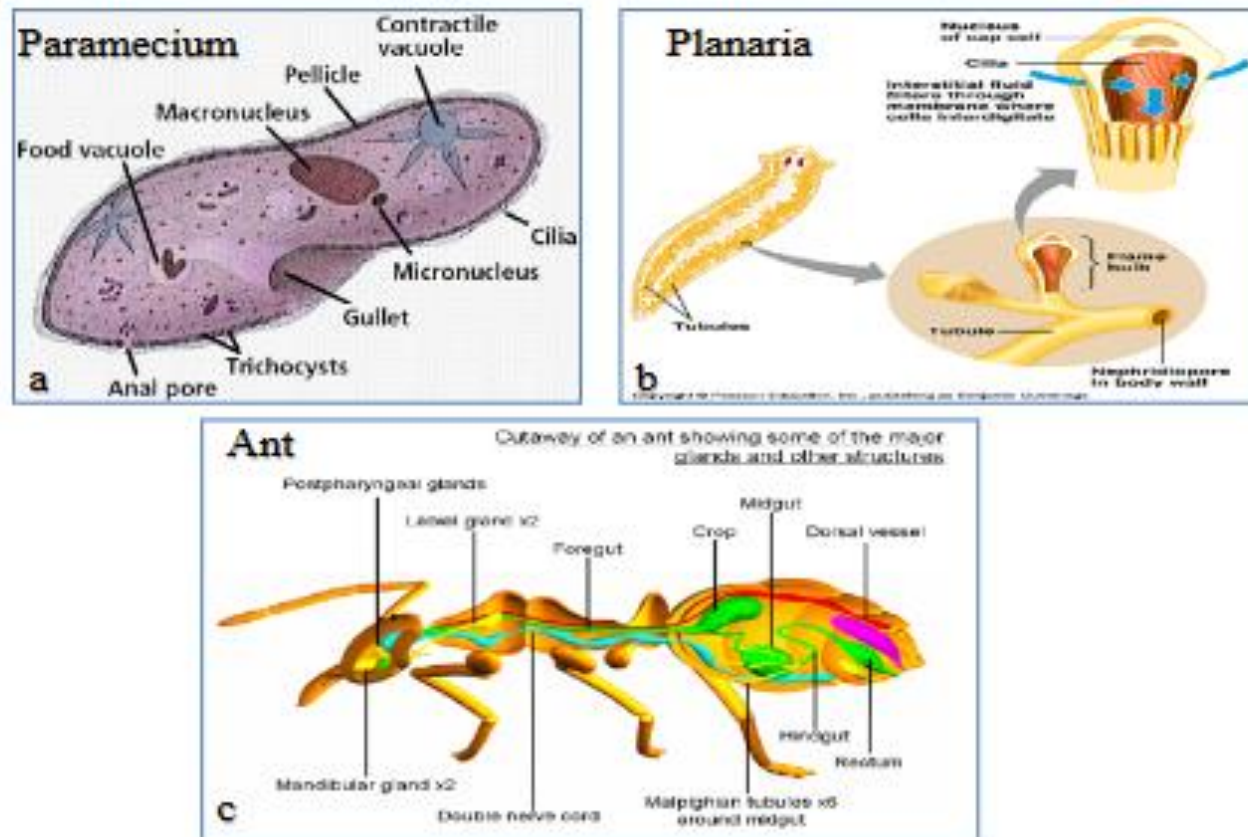


Figure 1: The three types of invertebrate excretory structures.

Evolution of the vertebrates is a fascinating story viewed in terms of the external osmotic environment in which various classes evolved. Fresh water, marine and terrestrial habitats possessed different problems for the maintenance of internal water balance and the excretion of nitrogenous wastes. The evolution of the kidney in vertebrates illustrates how pronephric, mesonephric and metanephric kidney, represent successful evolutionary responses to these environmental pressures. So many variations in the evolution of the kidney are correlated with these environmental factors. Variations in the structure of the vertebrate kidney from fish to man are primarily in the nature of alterations in number, complexity, arrangement and location of the kidney tubules.

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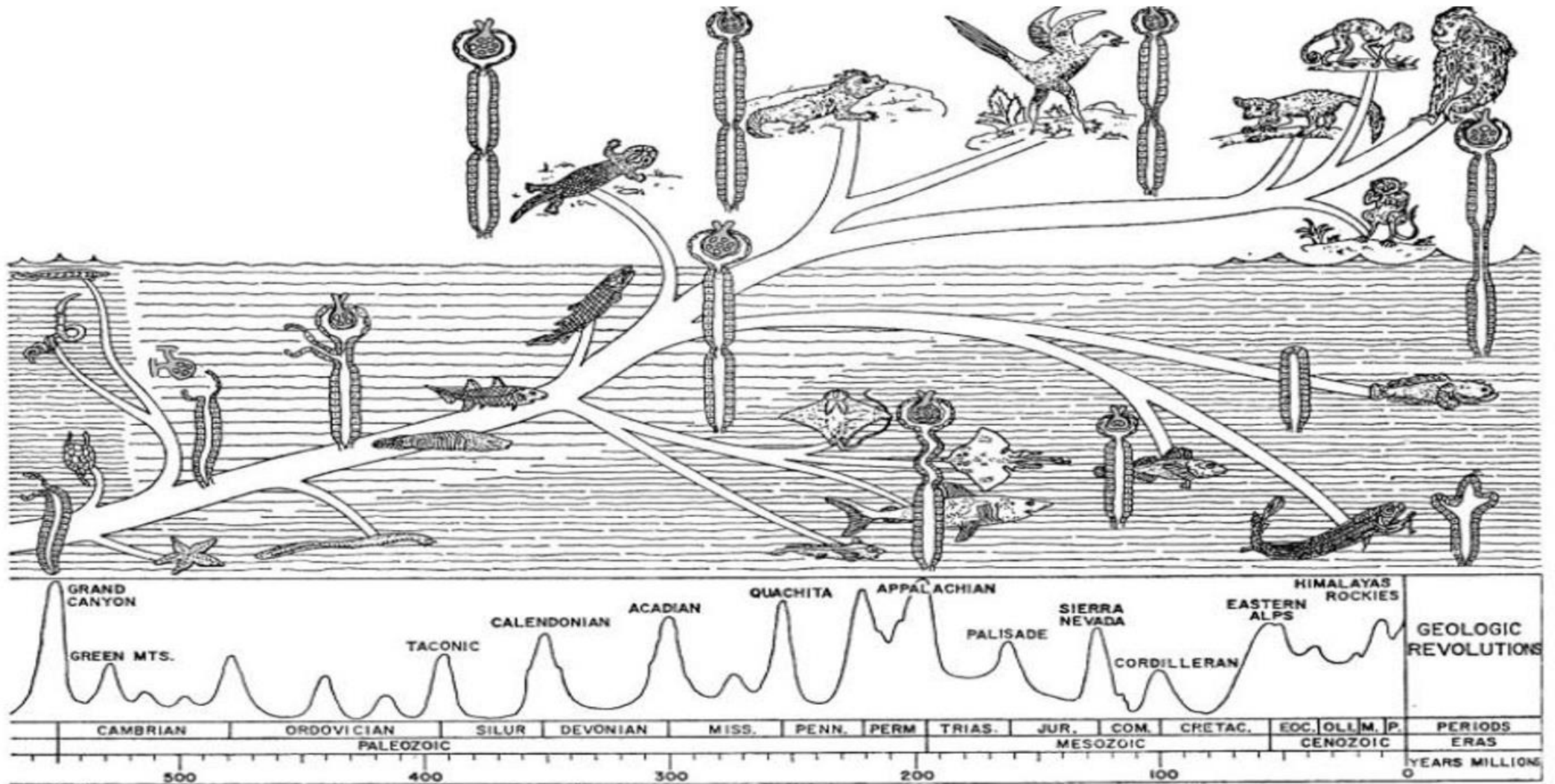


Figure 5: Synopsis of the evolution of the vertebrates in relation to saltwater (darkly shaded) and freshwater (lightly shaded) habitat. The irregular curve illustrates mountain-building episodes (geologic revolutions) which have influenced this evolutionary history. The time scale is such that the Pleistocene era and recent time are compressed.

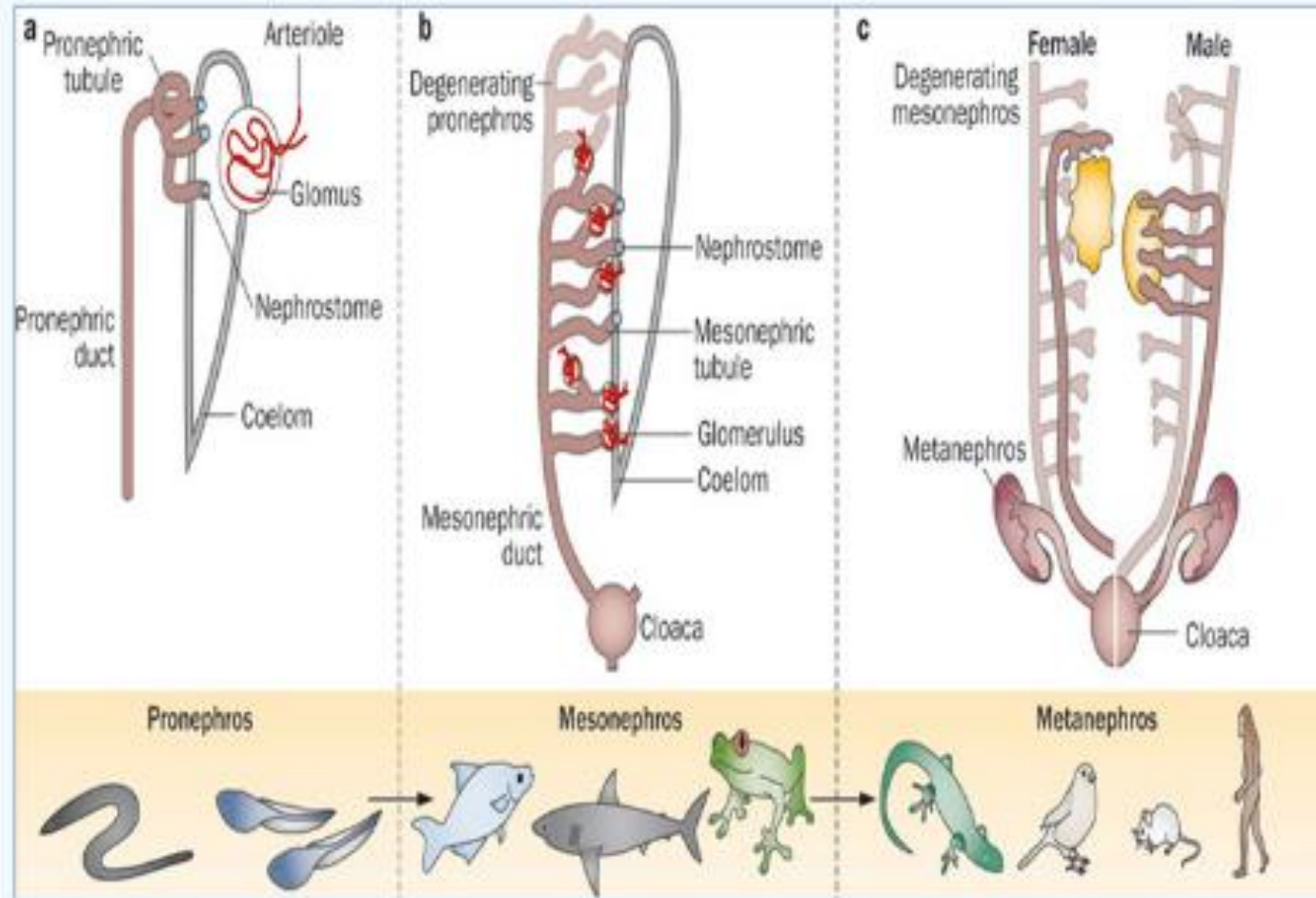
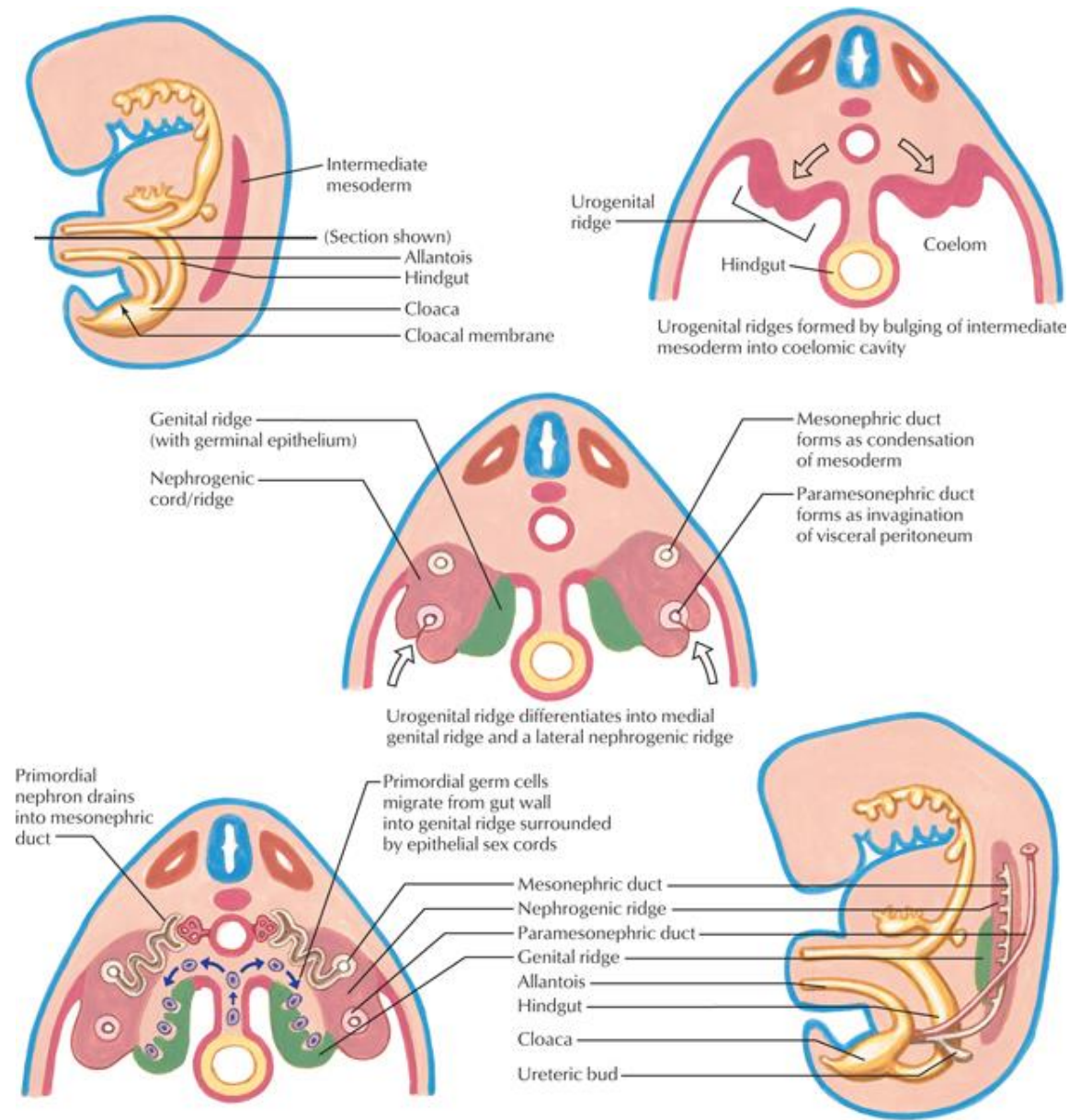
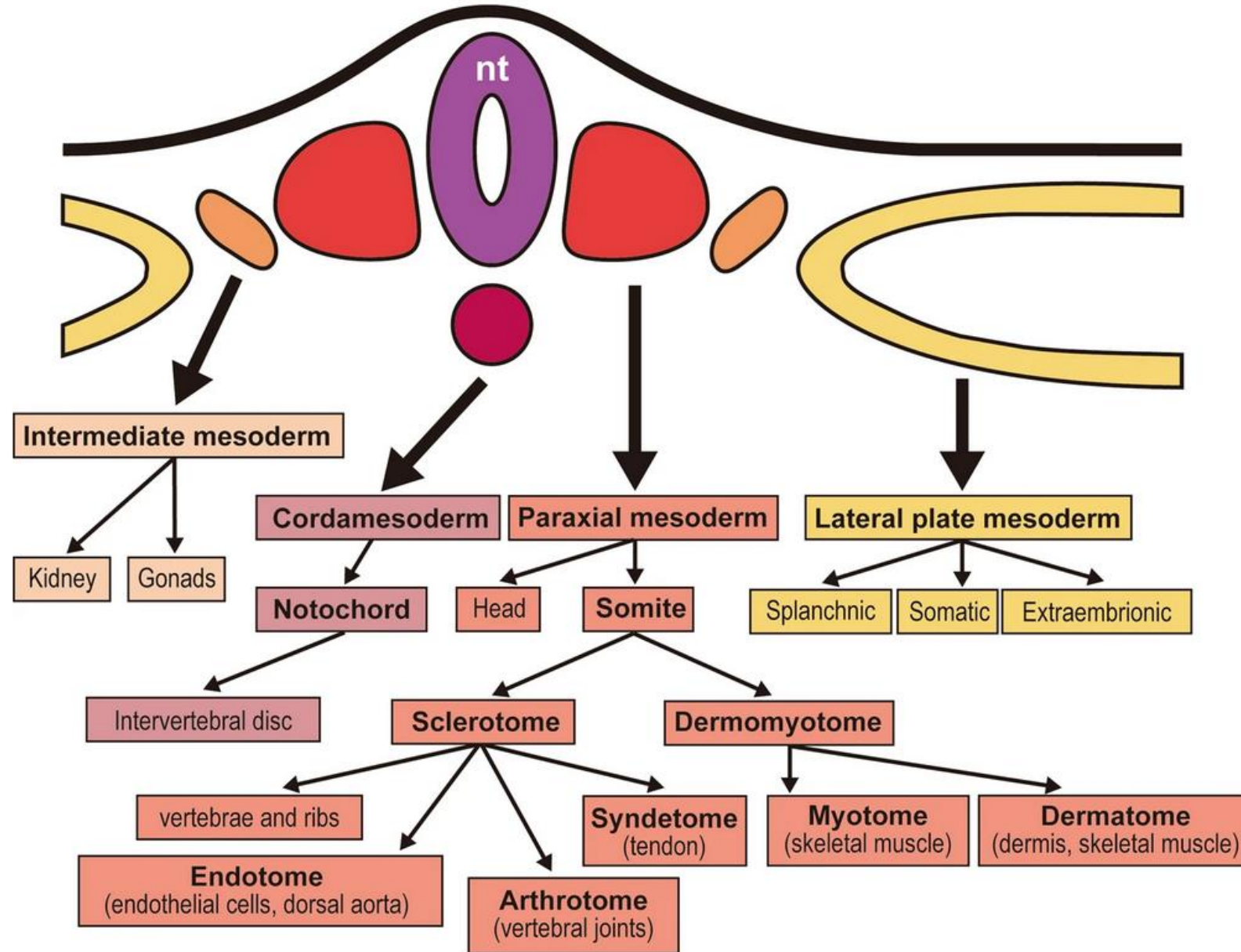


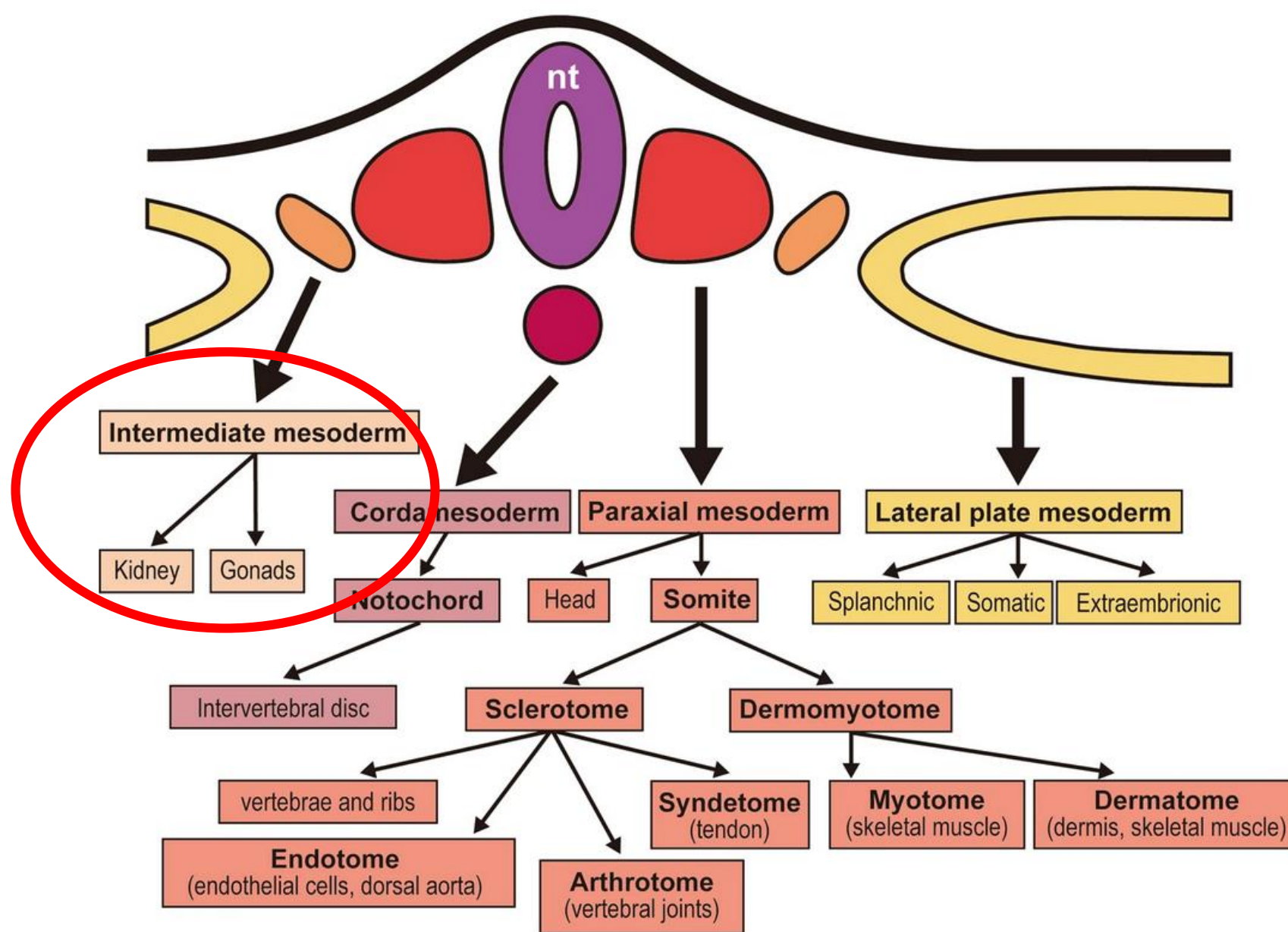
Figure 2: Types of developing vertebrate kidney.

- Intermediate mesoderm
- cloaca
- Early structures of one system become later parts of other system
- temporary presence of structures typical for lower Vertebrates
- Epithelium – mesenchyme interaction
- Indifferent organs differentiate afterwards, it depends on the sex determination



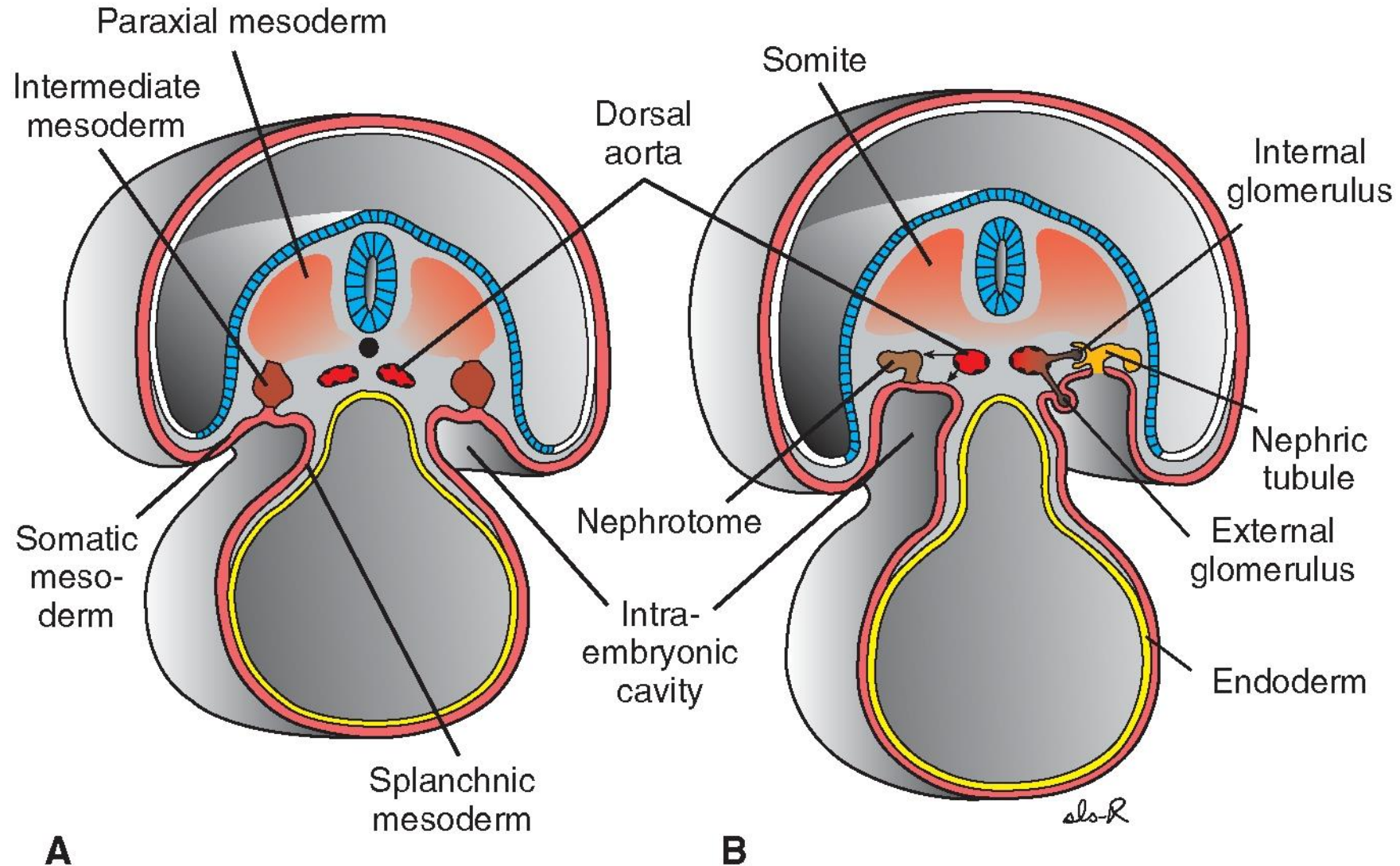


Tani, S., Chung, Ui., Ohba, S. *et al.* Understanding paraxial mesoderm development and sclerotome specification for skeletal repair. *Exp Mol Med* **52**, 1166–1177 (2020). <https://doi.org/10.1038/s12276-020-0482-1>



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Intermediate mesoderm, nefrogenic ridge

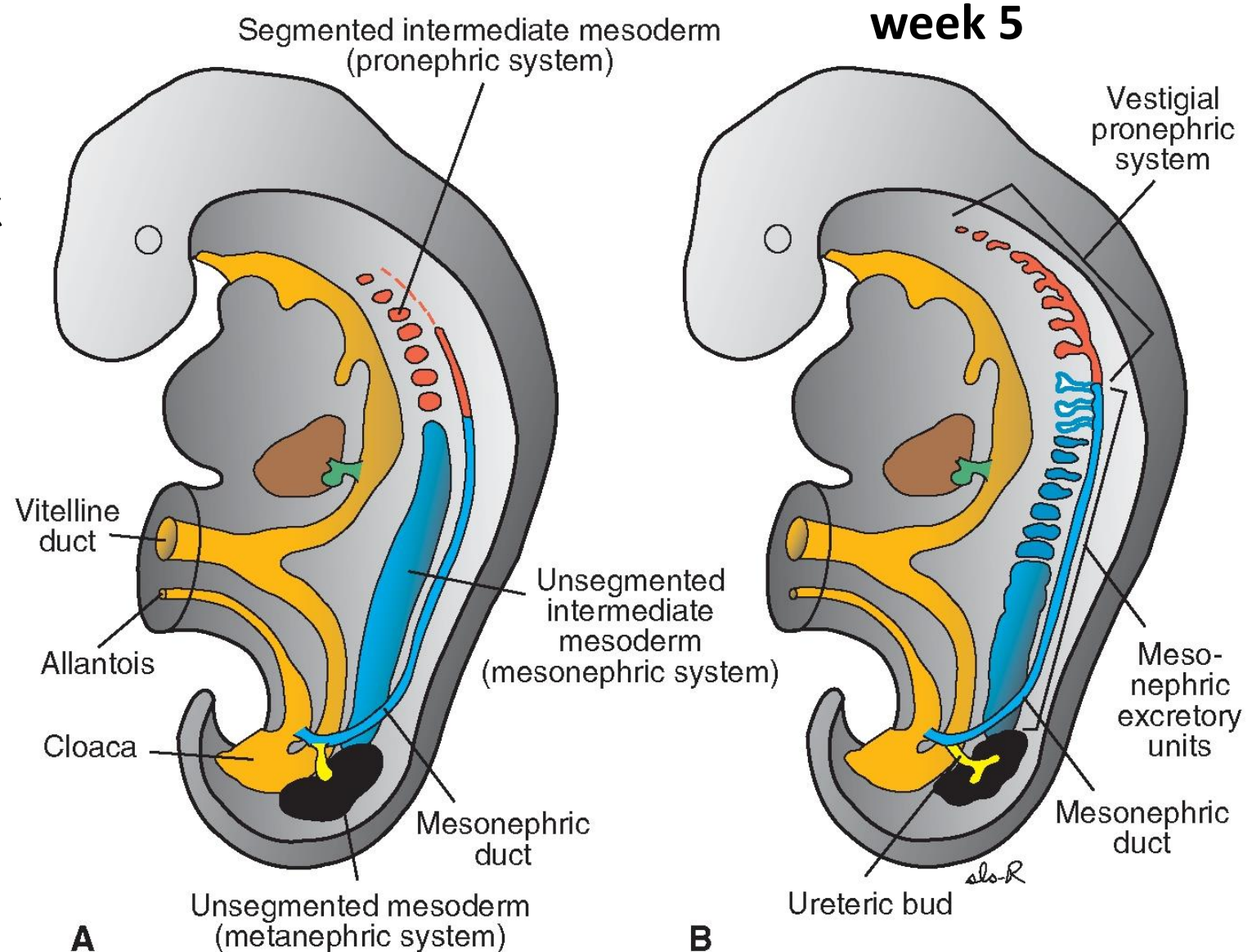


Intermediate mesoderm, nefrogenic ridge



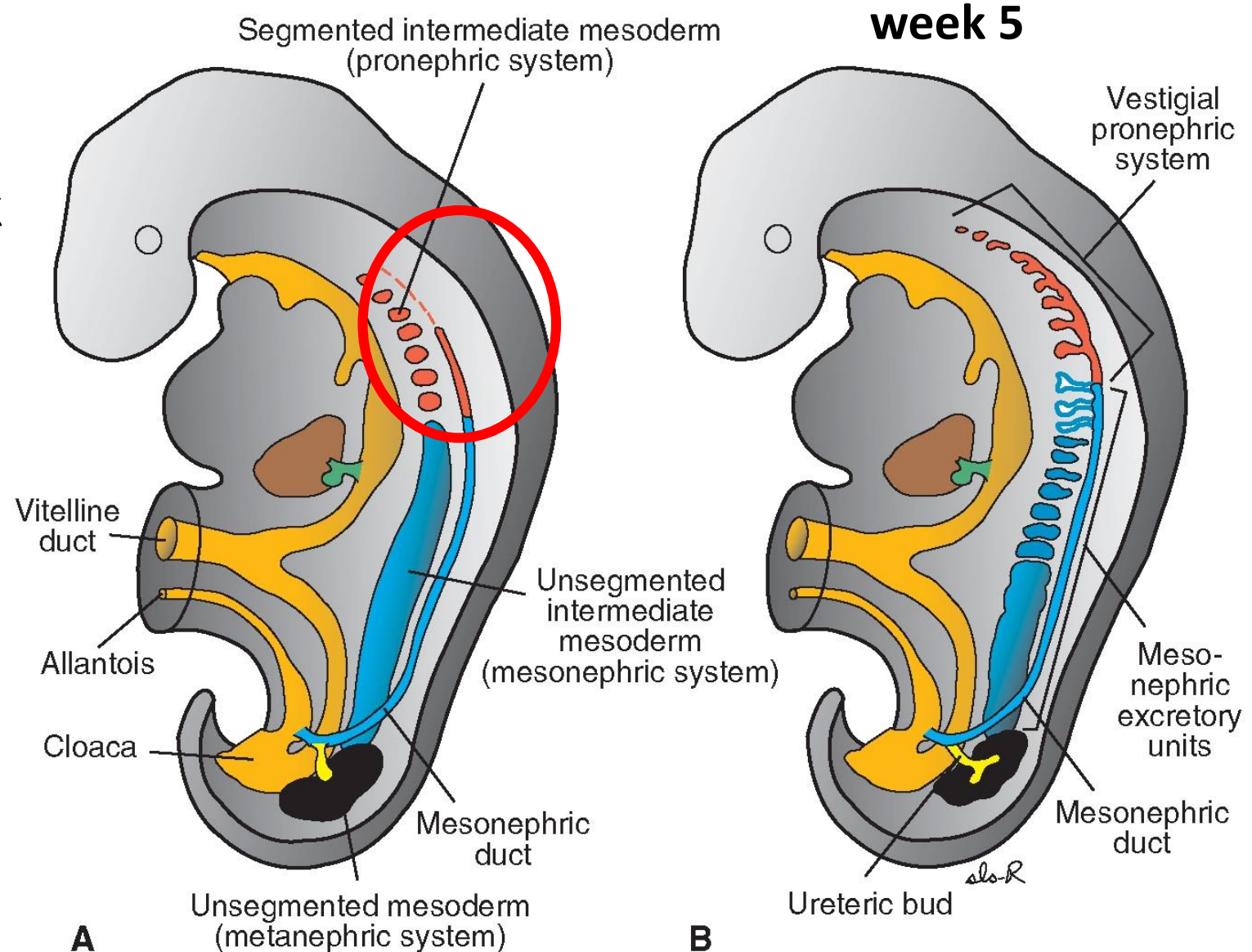
Three consequent organs

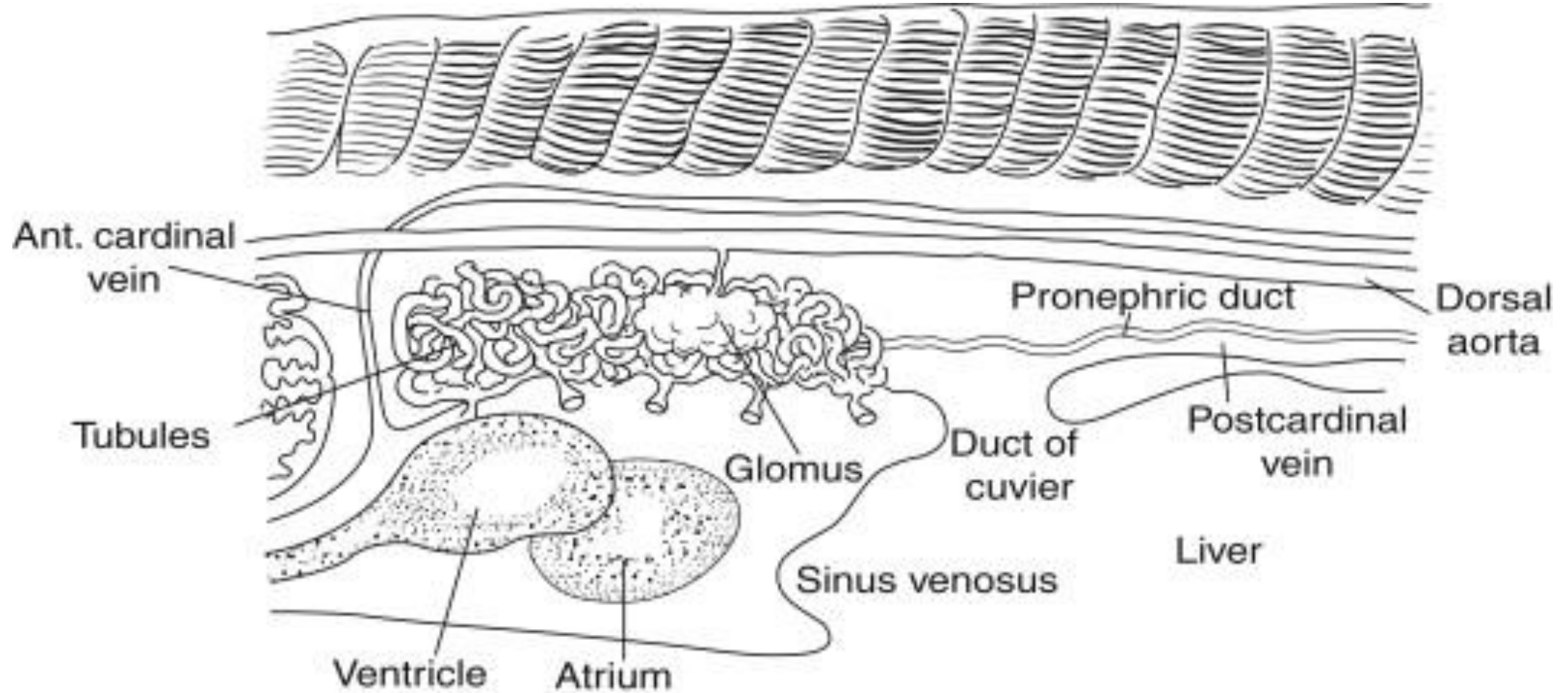
- **PRONEPHROS: 3. – 4. week**
(C2,3 – Th1)
- **MESONEPHROS: 4. – 6. week**
 - (Th2 – L3)
- **METANEPHROS: from 5. week**
 - (L4,5)

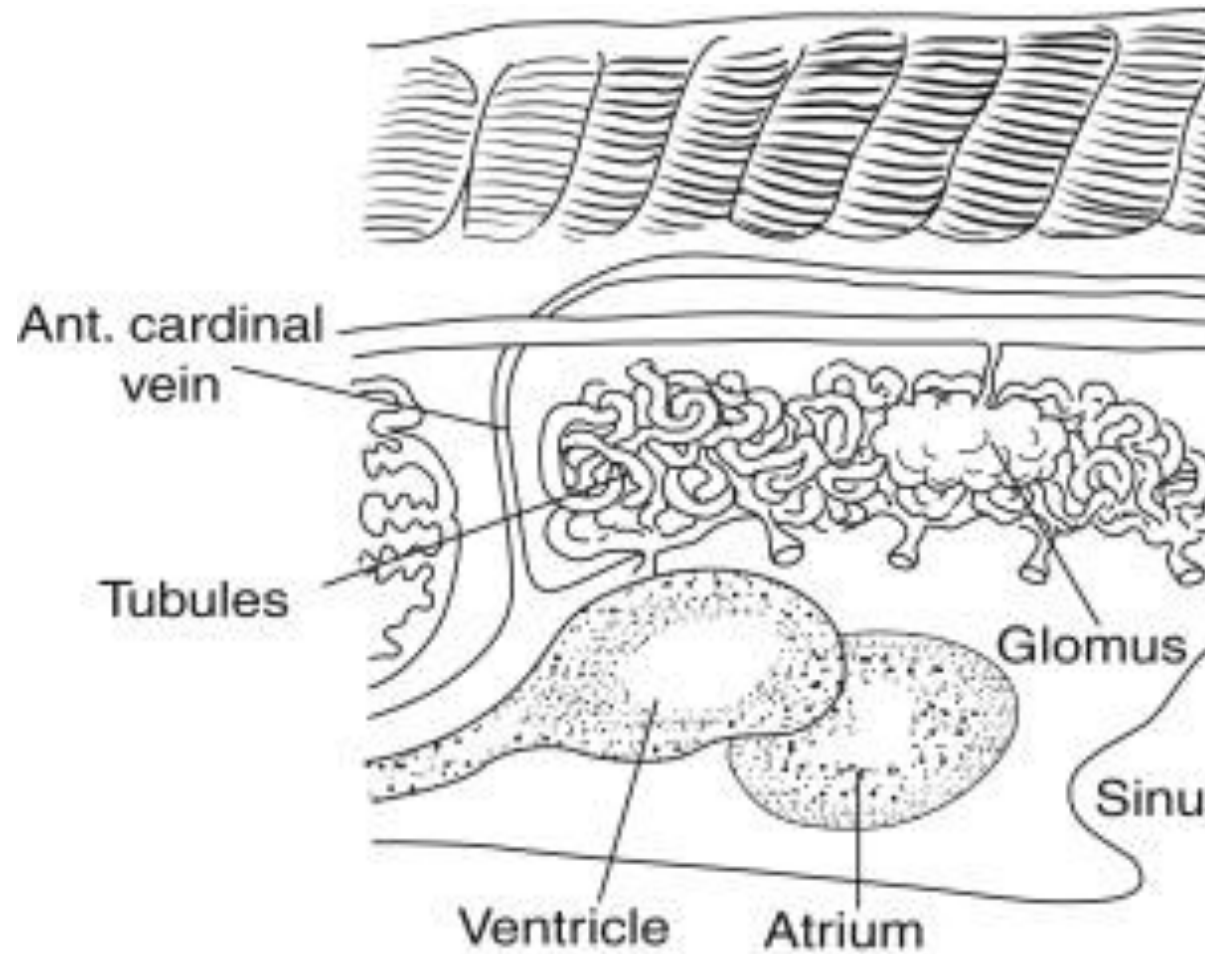


Three consequent organs

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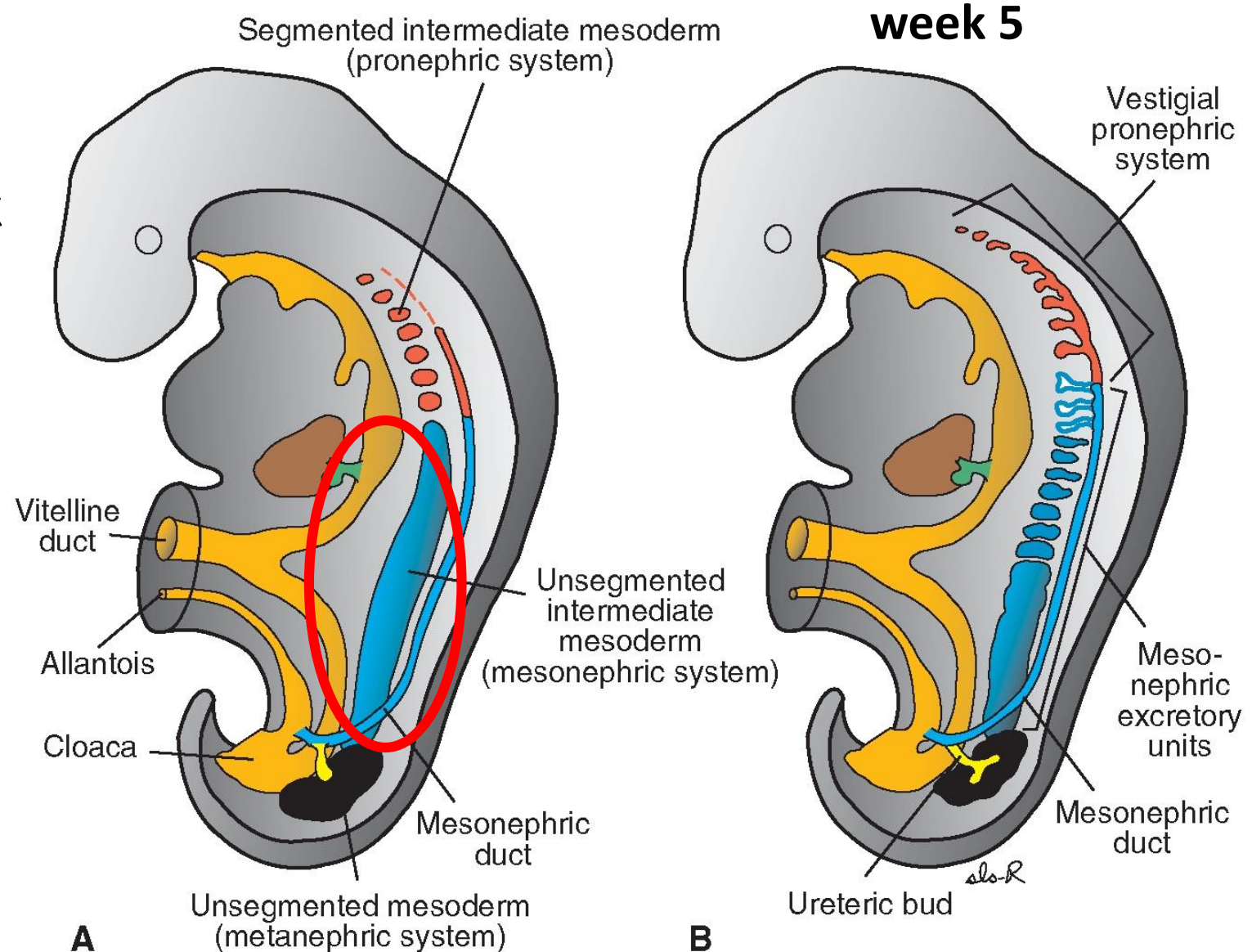


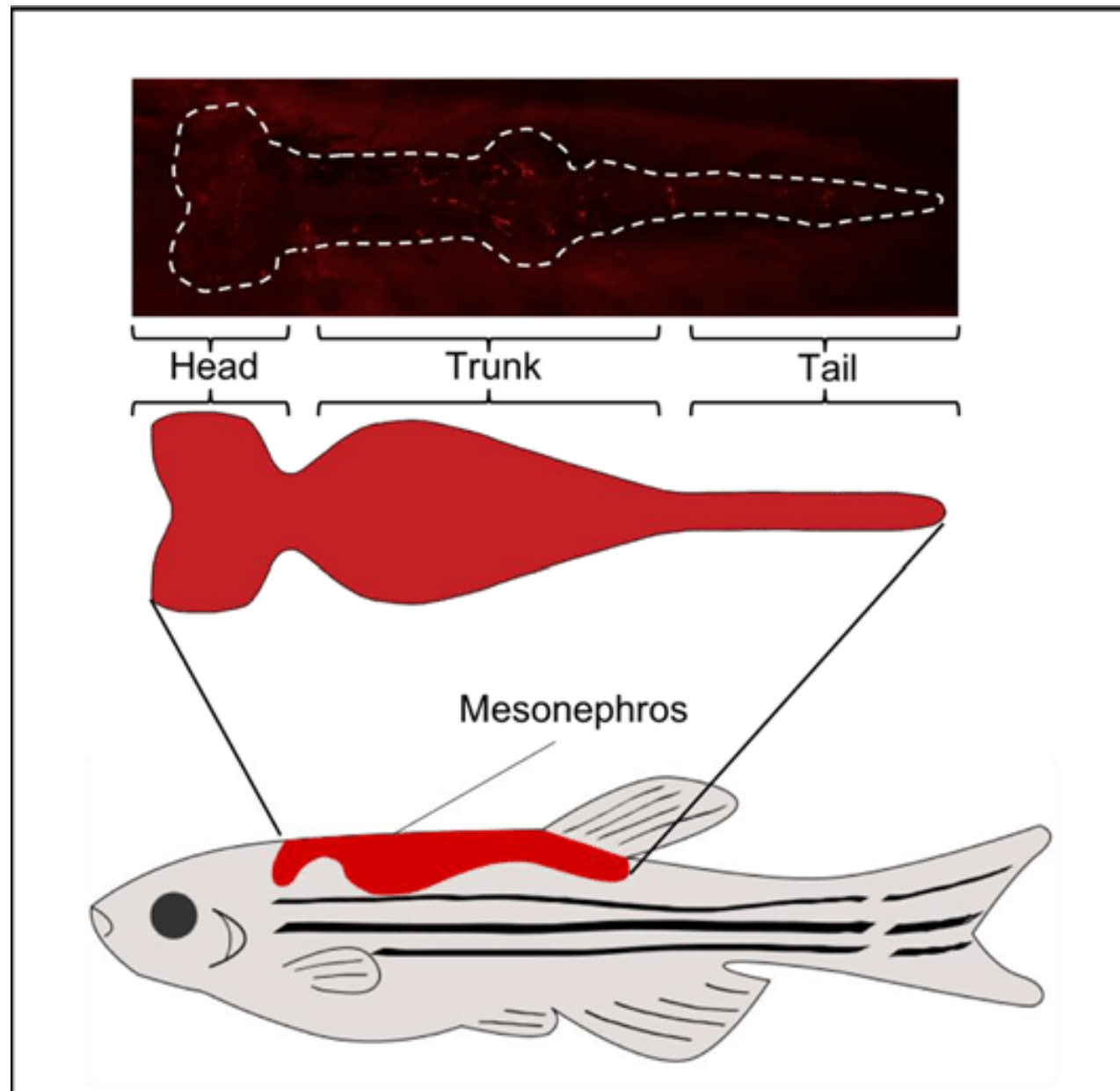




Three consequent organs

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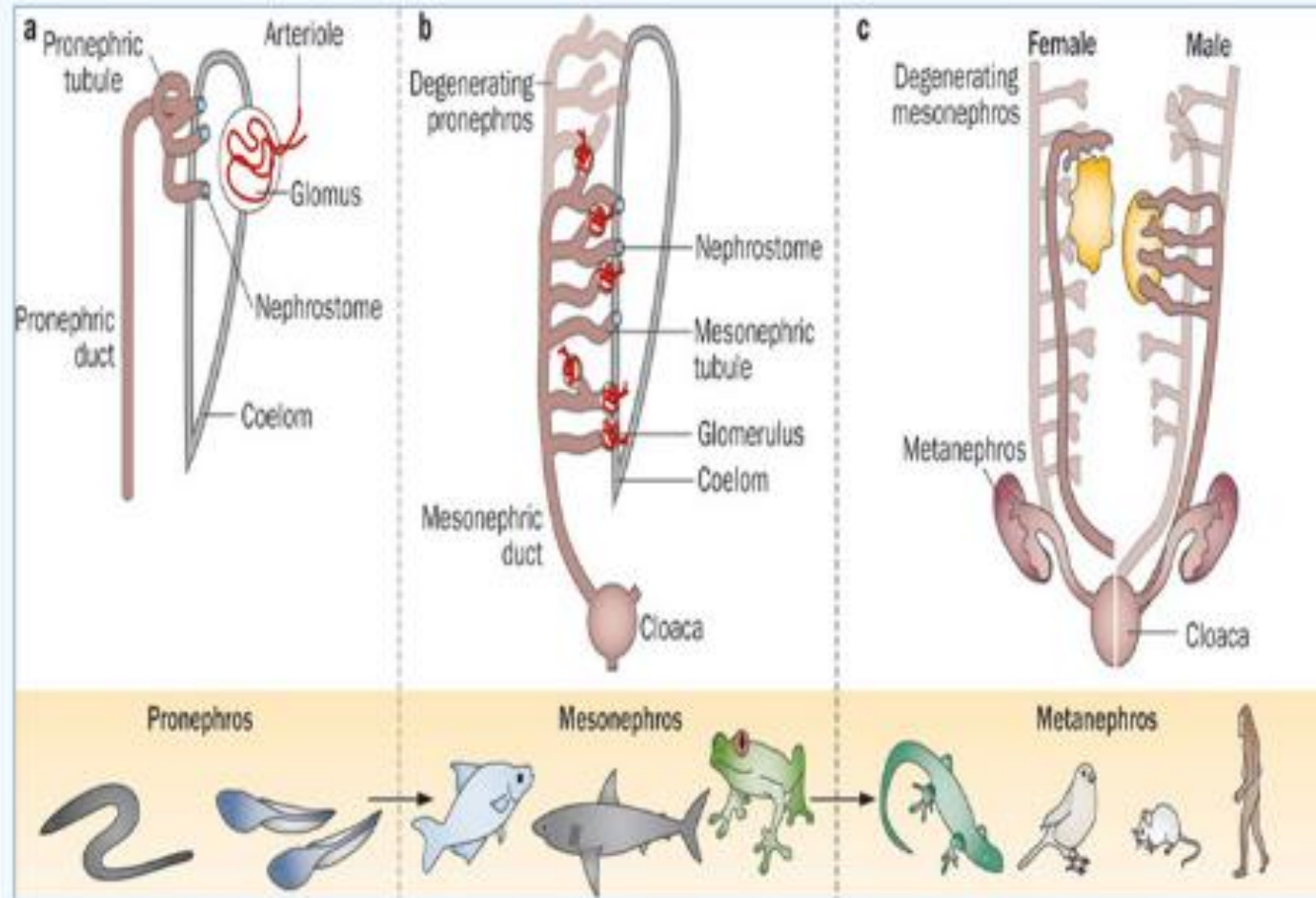
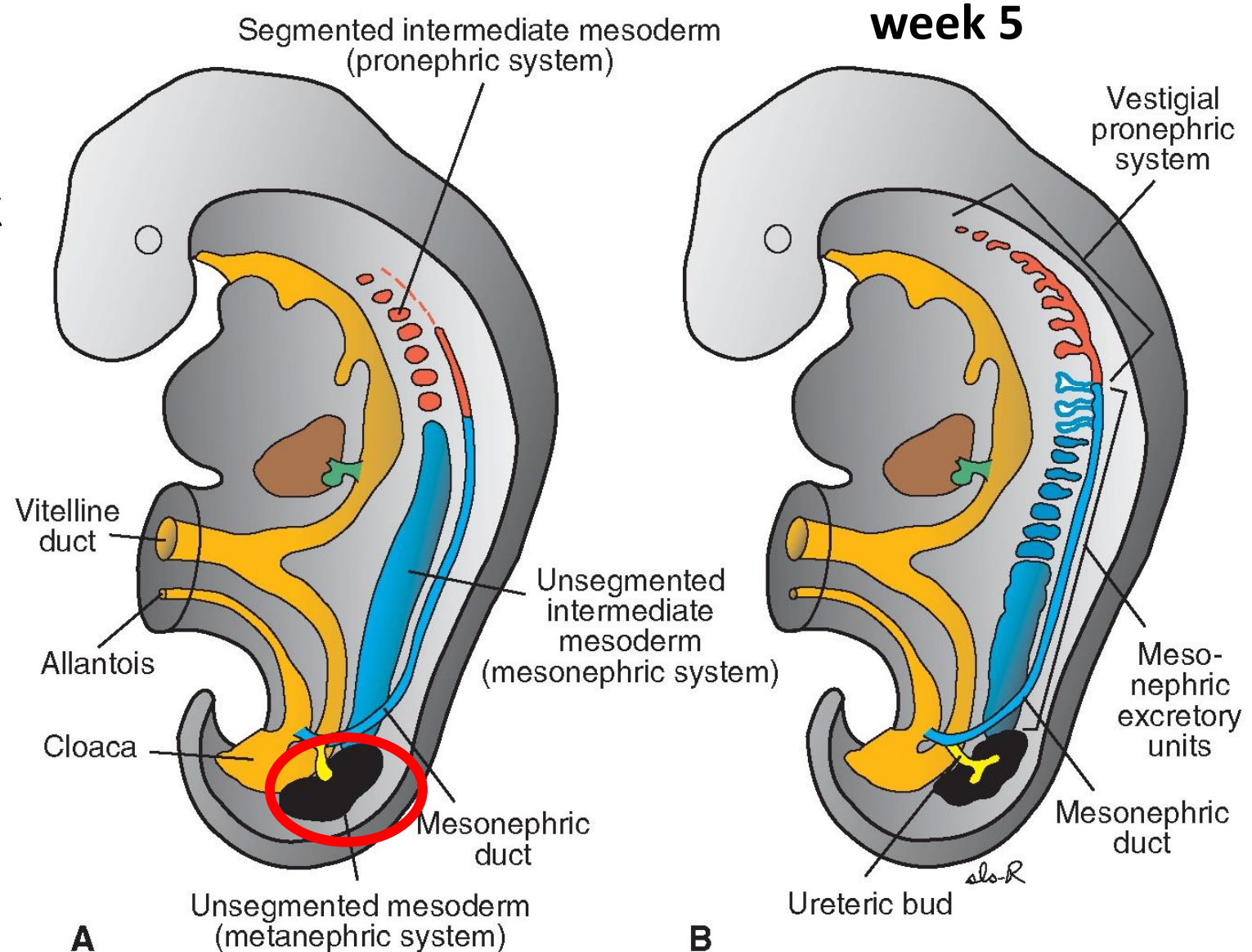
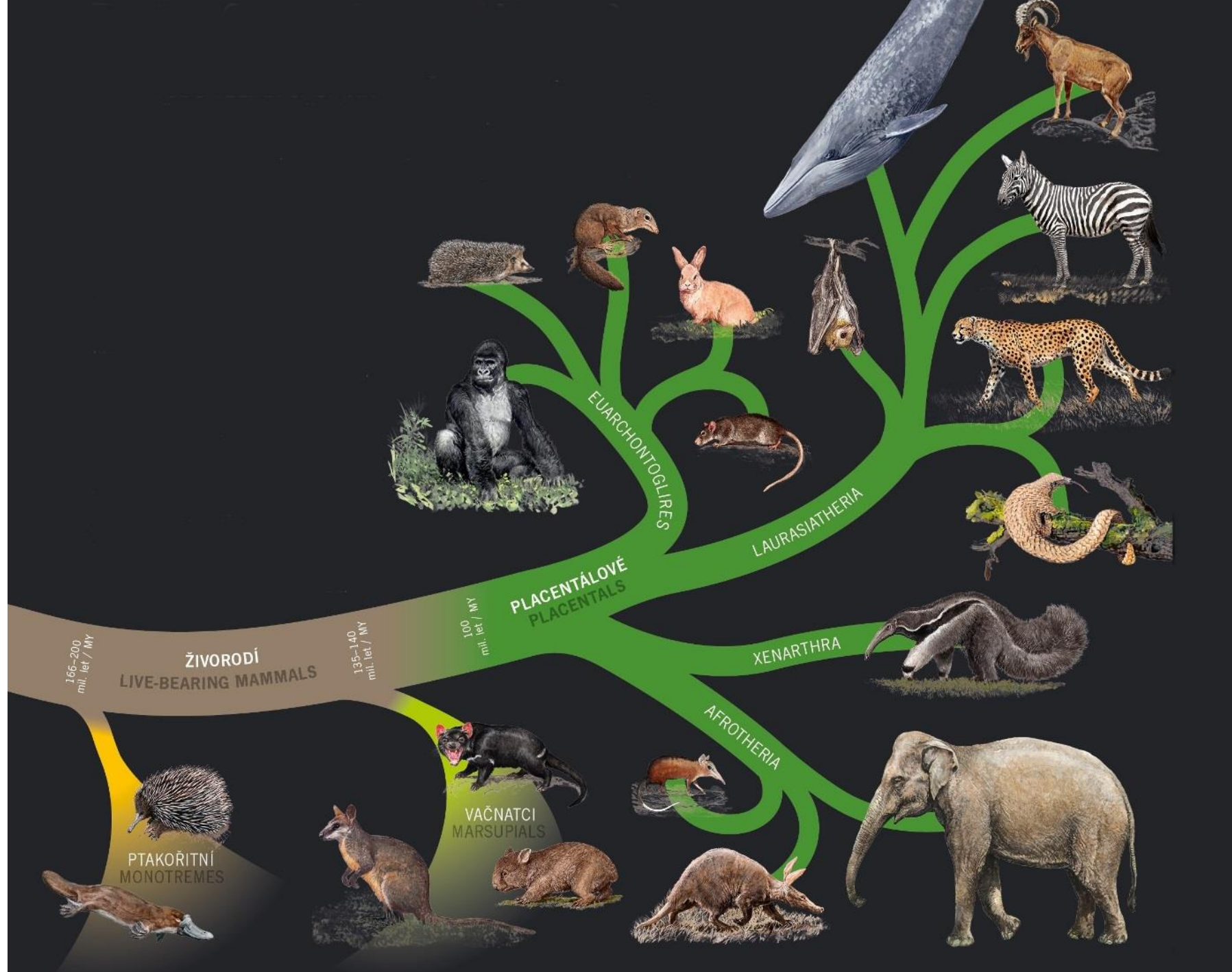


Figure 2: Types of developing vertebrate kidney.

Three consequent organs

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(C2,3 – Th1)
- **MESONEPHROS: 4. – 6. week**
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- **METANEPHROS: from 5. week**
 - (L4,5)

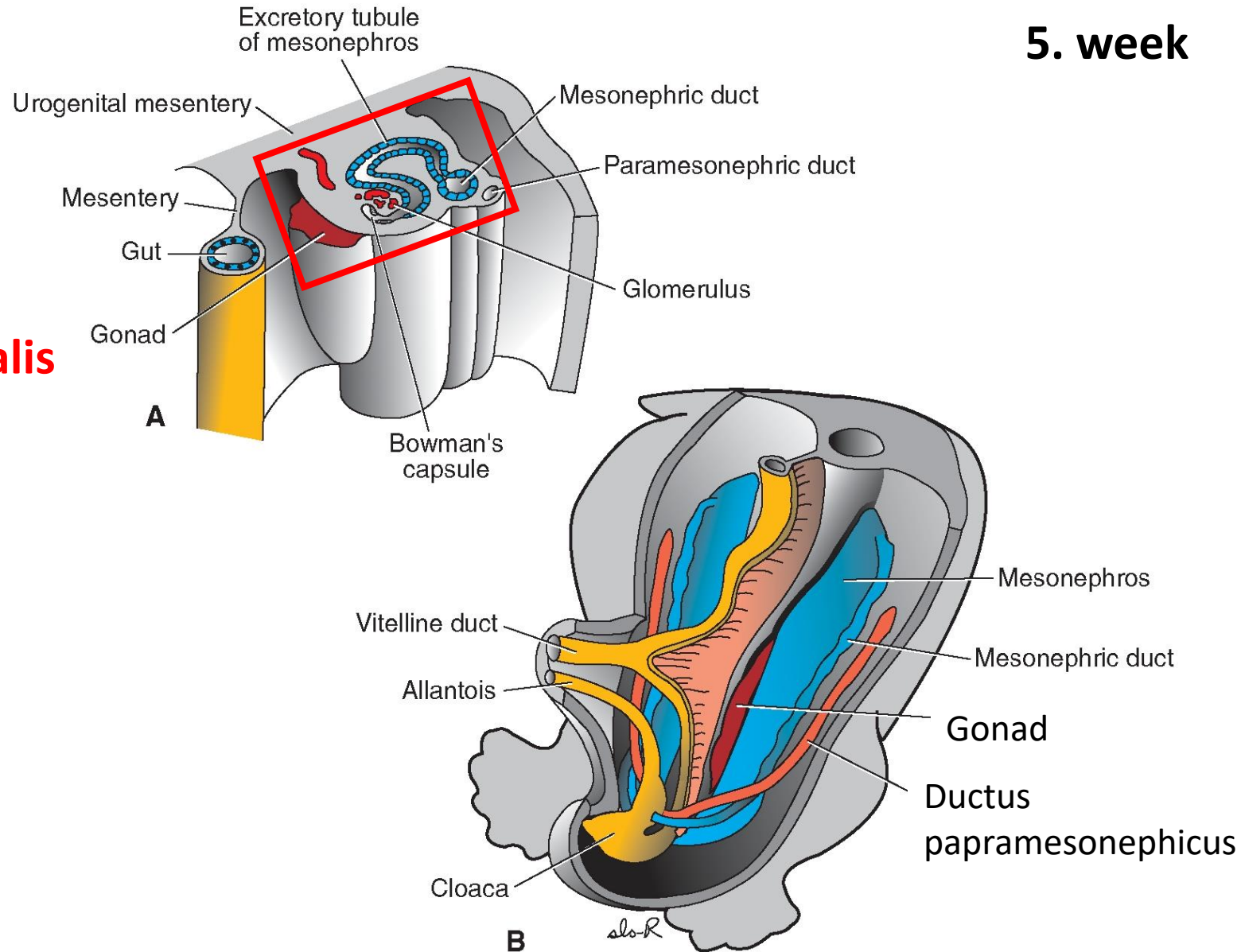




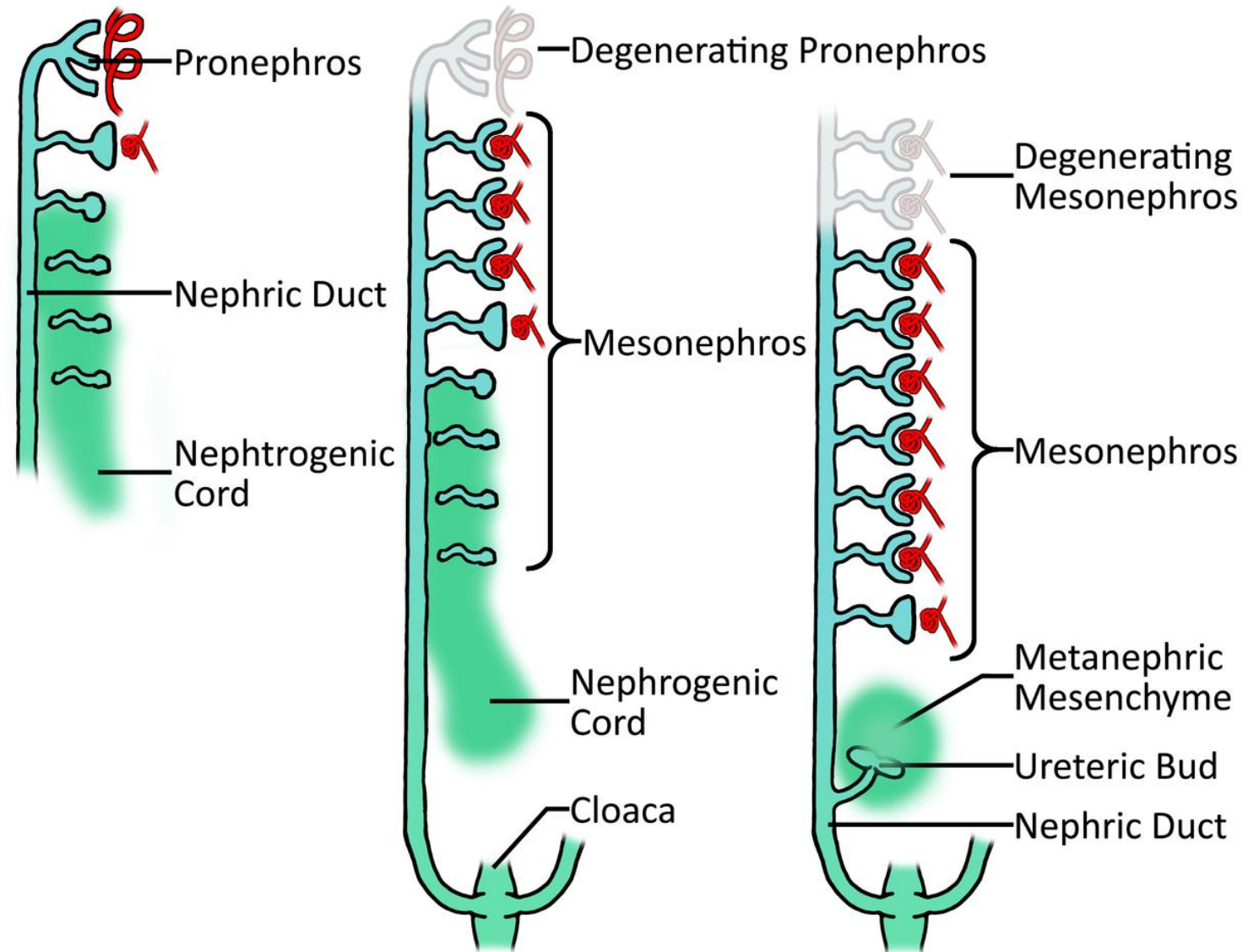
Intermediate mesoderm, urogenital ridge

5. week

Plica urogenitalis

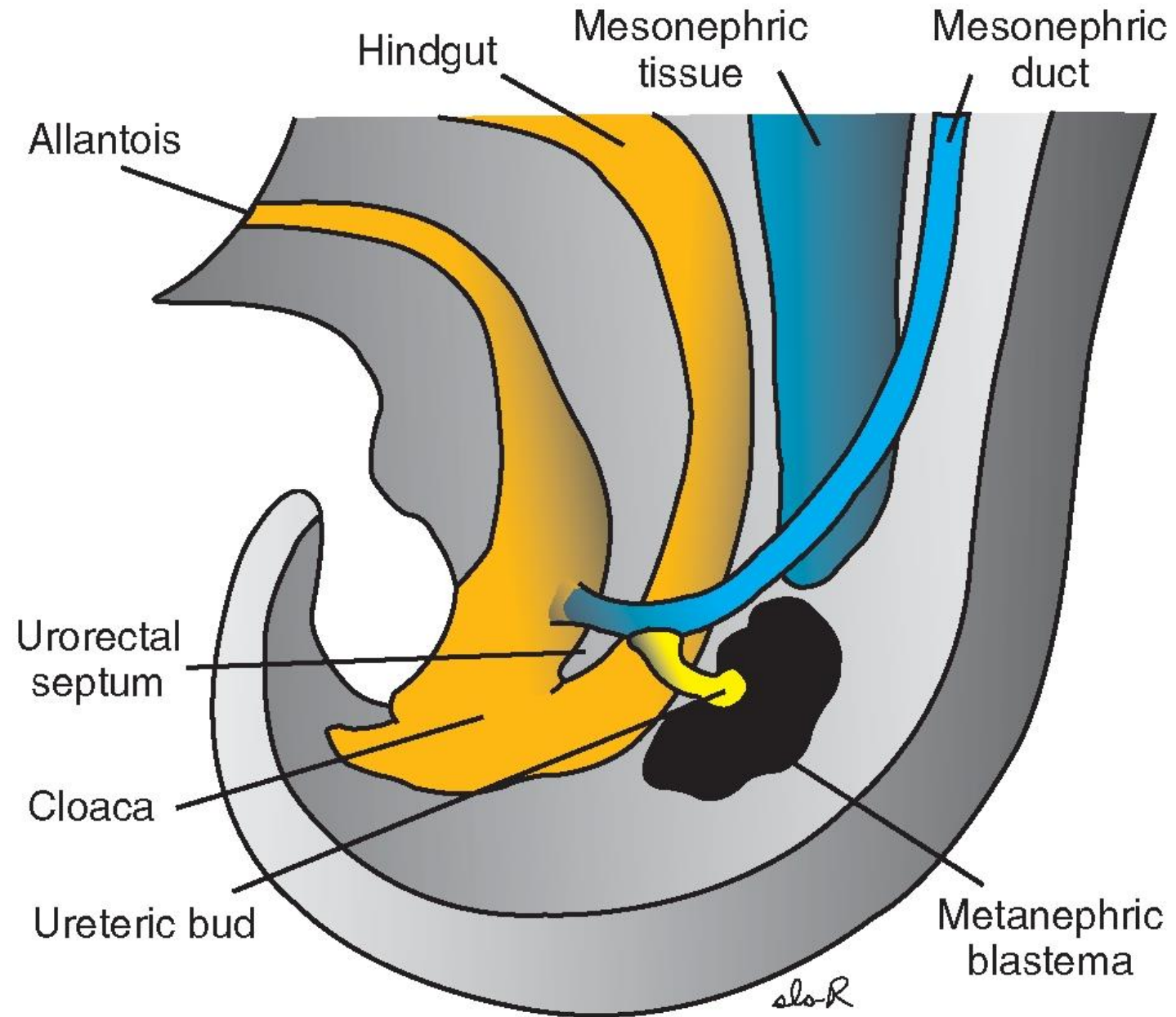


Pronephros, mesonephros

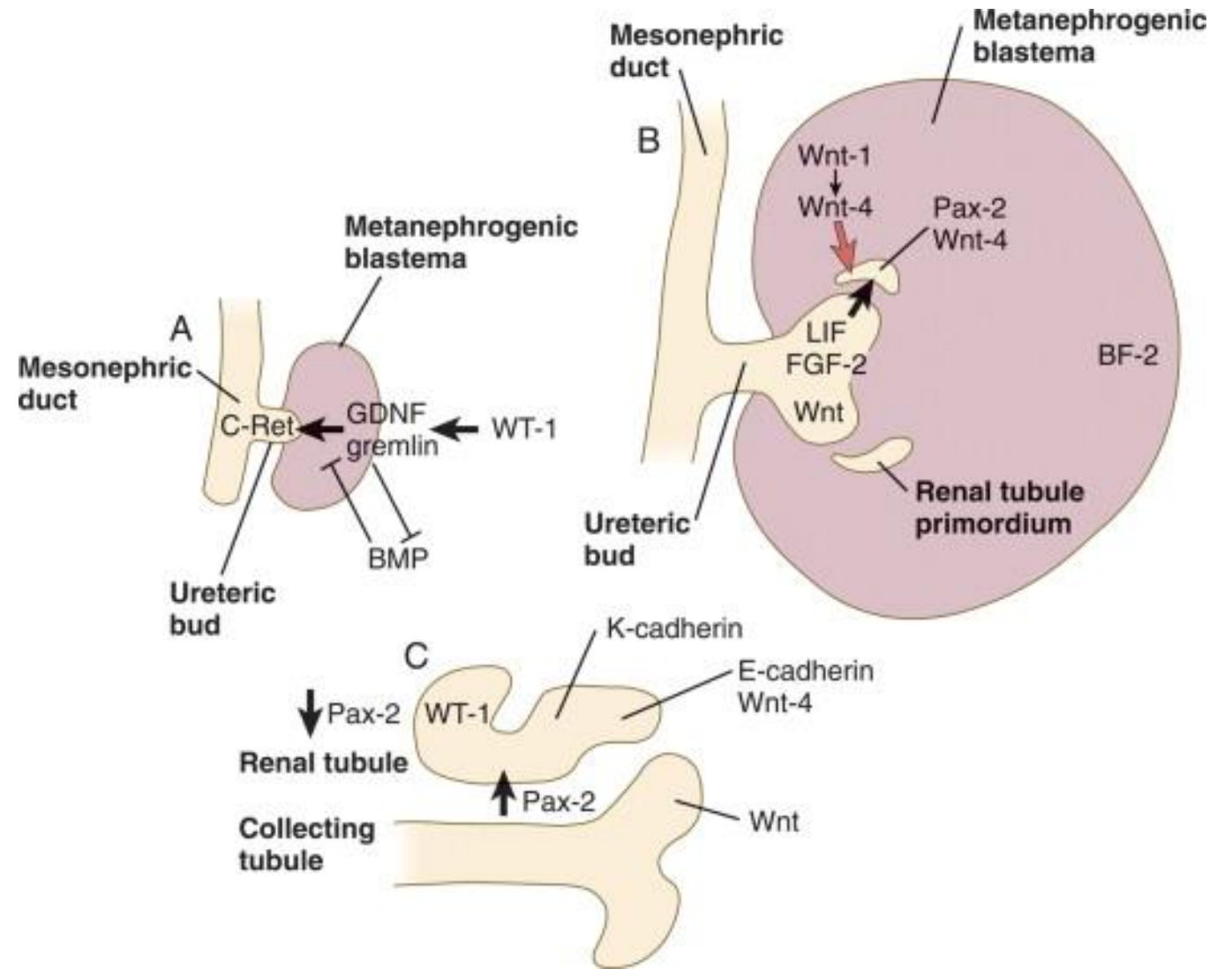


Metanephros

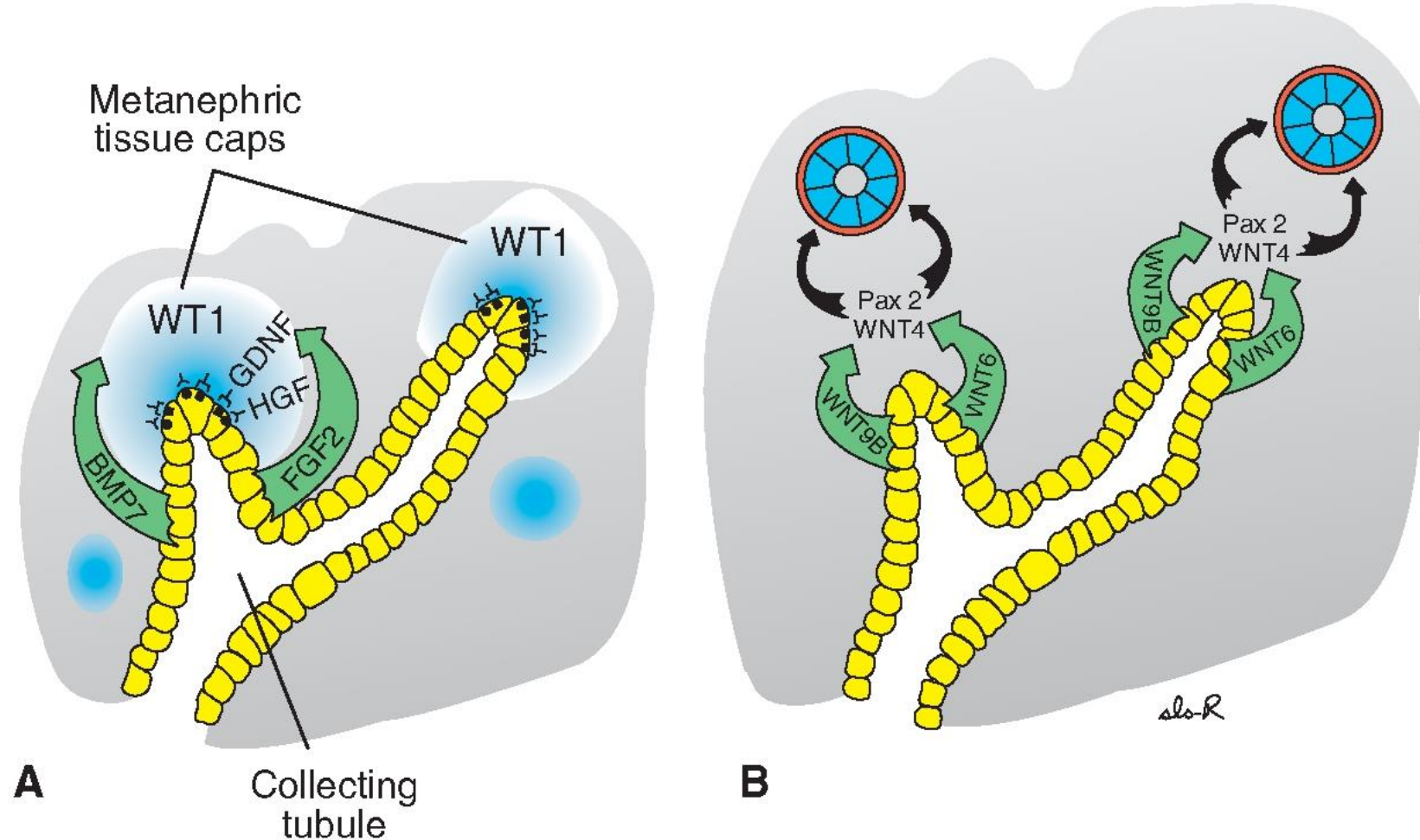
Reciprocal inductive signals between the metanephric mesenchyme and the ureteric bud



Reciprocal inductive signals between the metanephric mesenchyme and the ureteric bud



Metanephros – molecular regulations



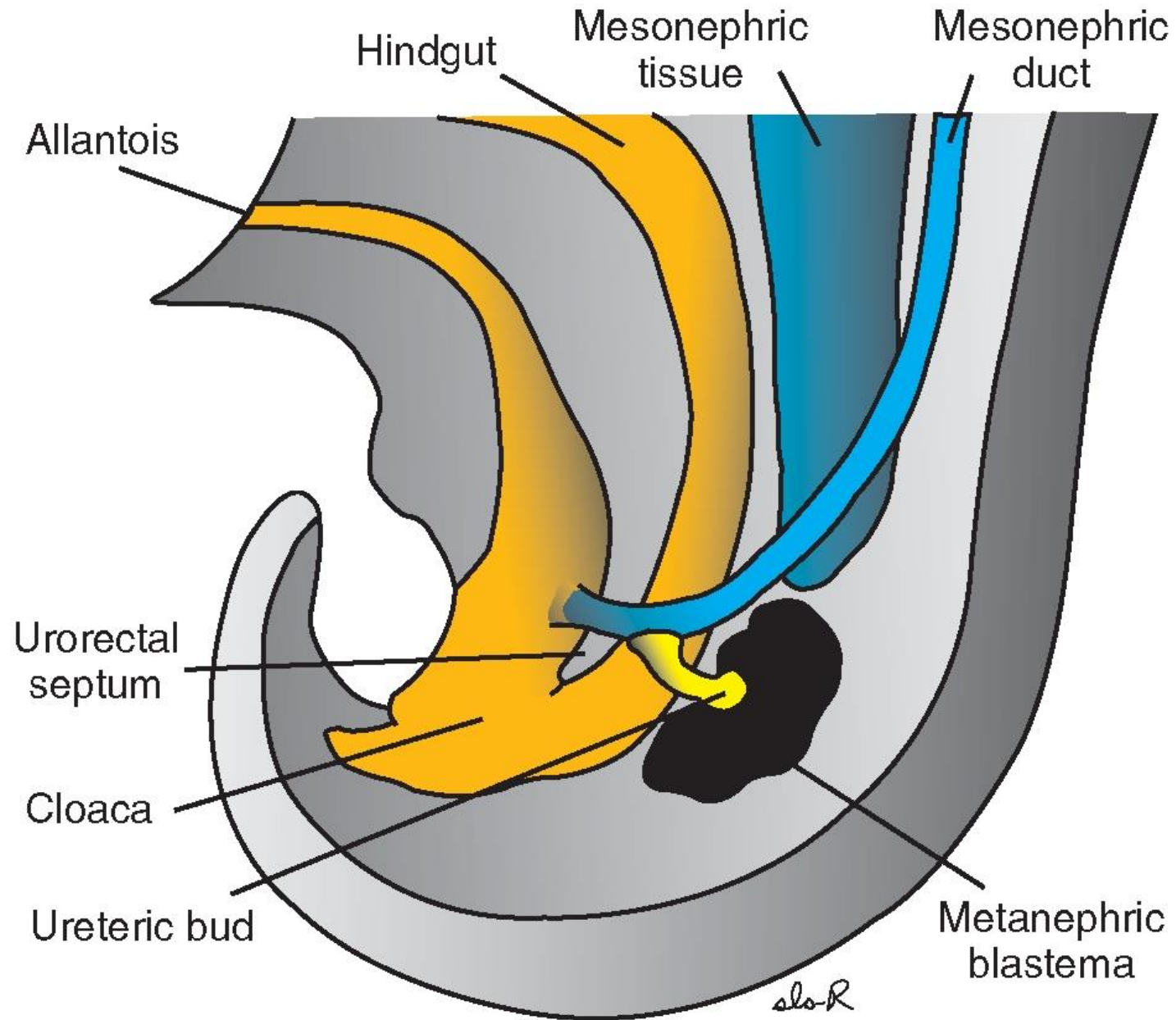
Metanephros

- **URETERIC BUD**

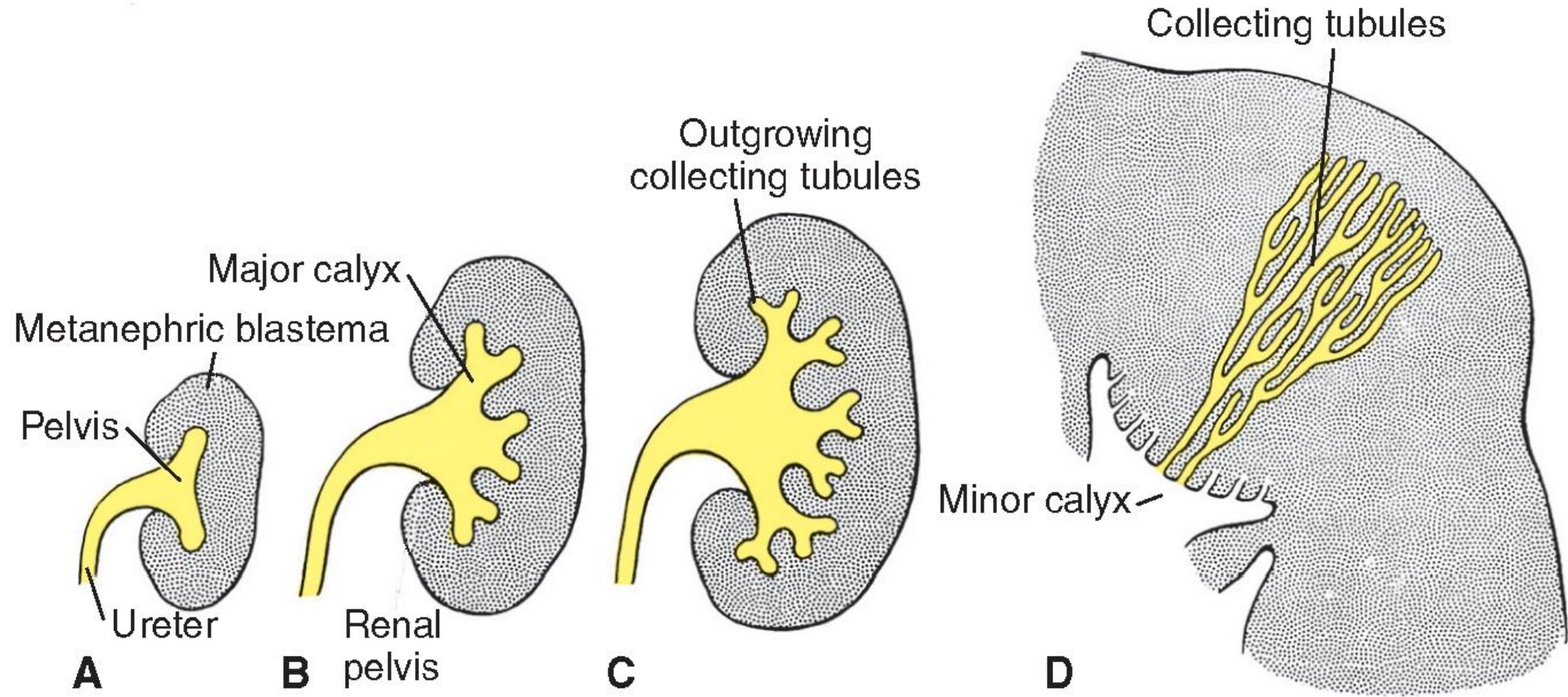
- Collecting ducts
- Parts of urinary tract
 - renal calices
 - renal pelvis
 - ureter

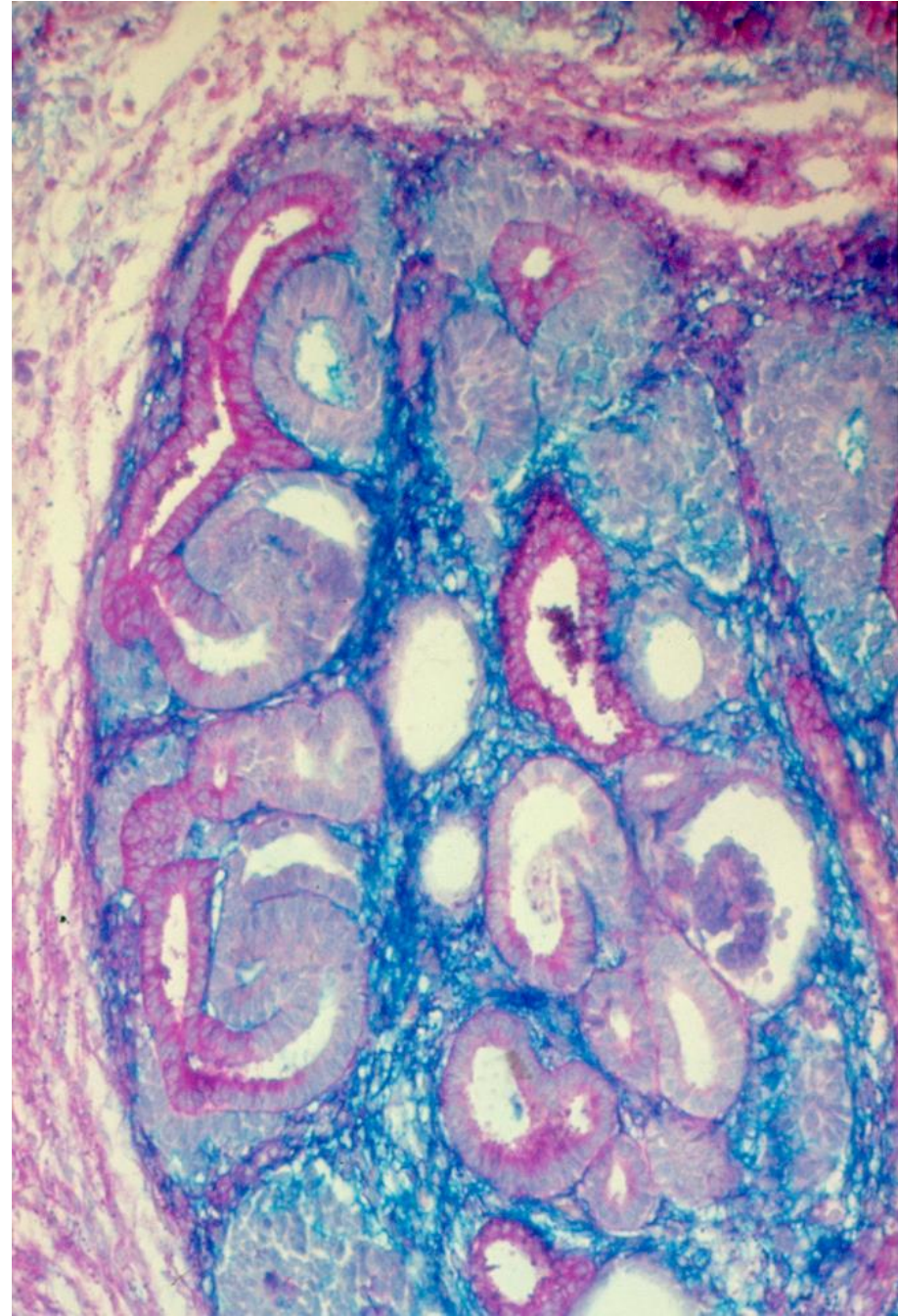
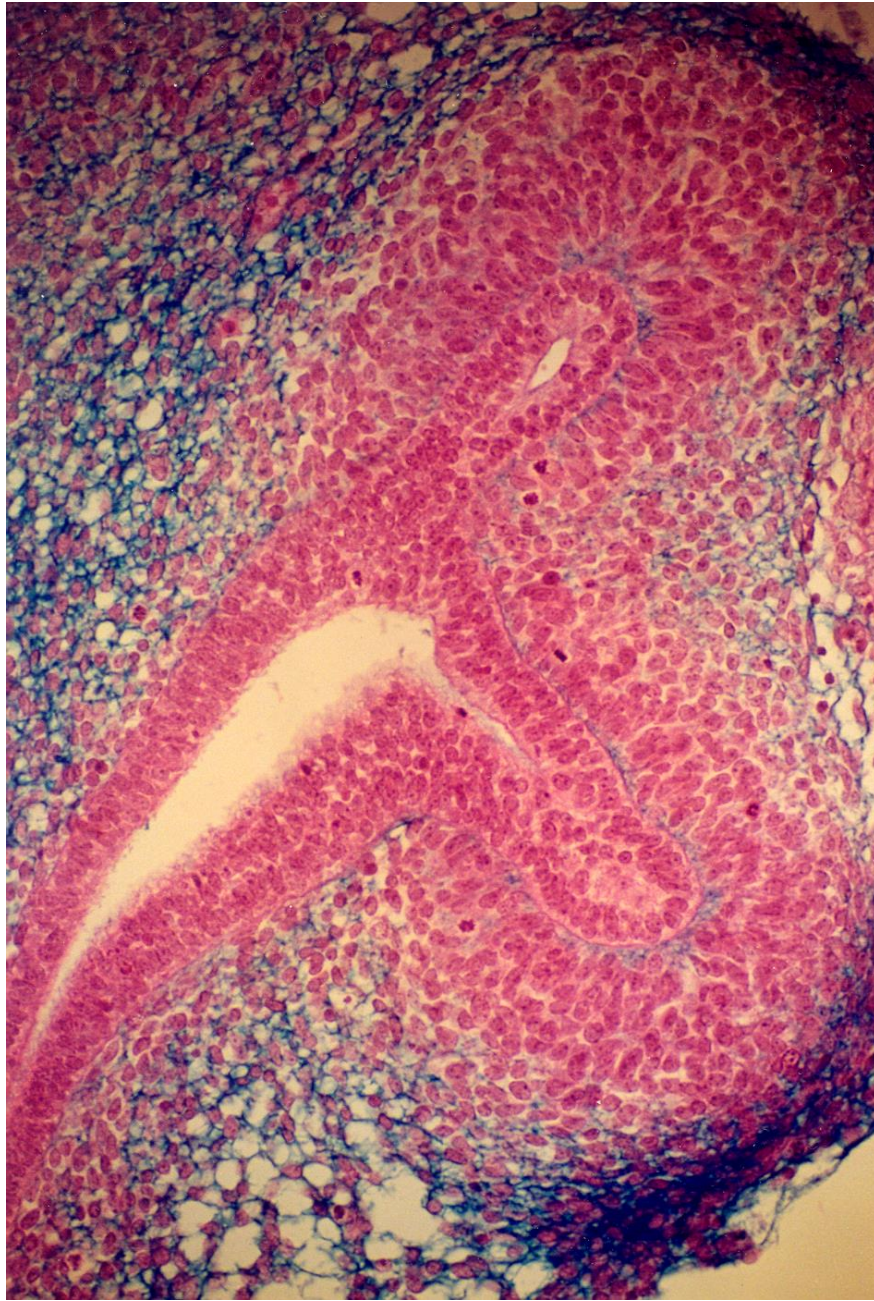
- **METANEPHROGENIC BLASTEMA**

- Nephron:
 - Bowman's capsule
 - Proximal tubule
 - Loop of Henle
 - Distal tubule

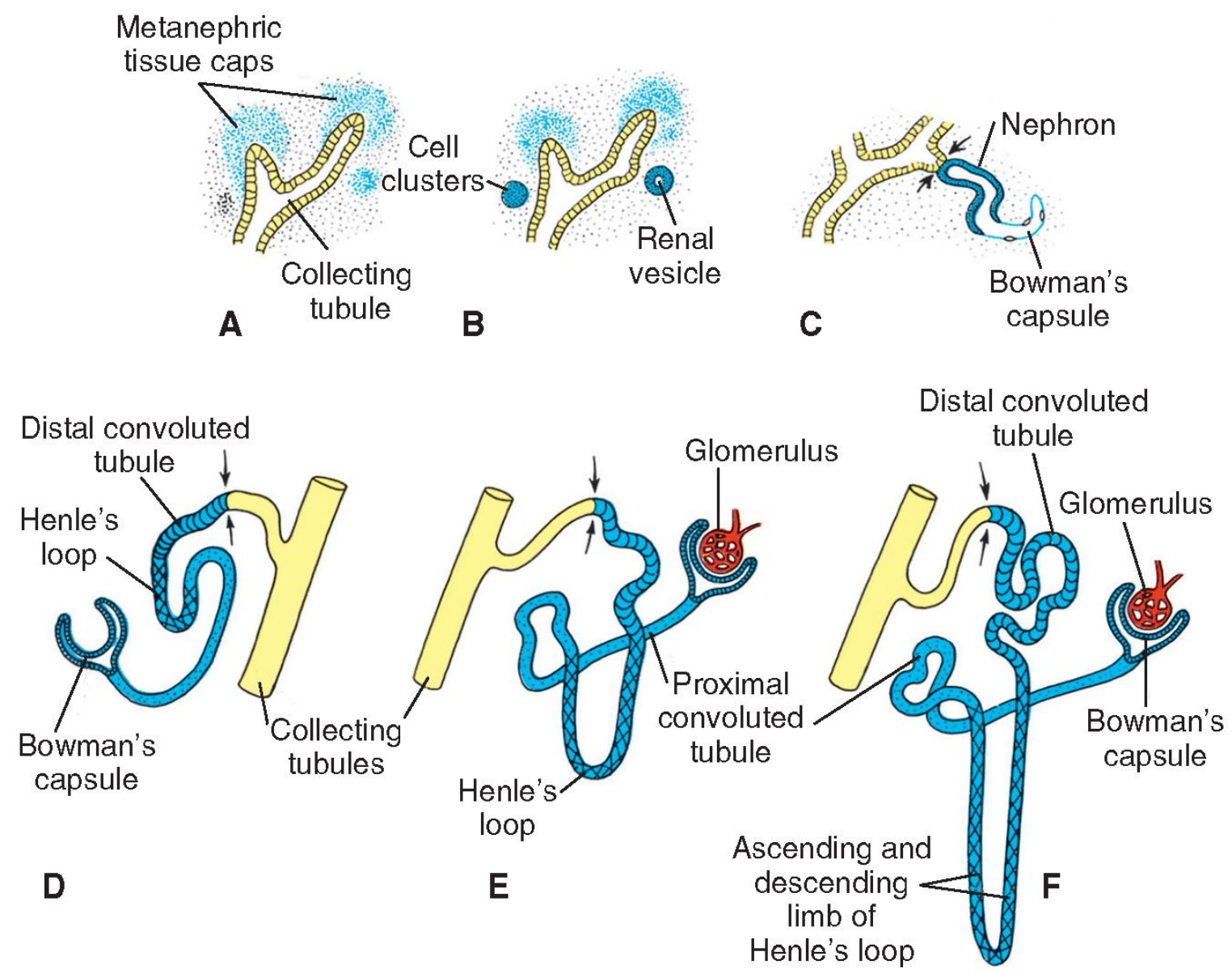


Metanephros – ureteric bud





Metanephros



abdominal wall

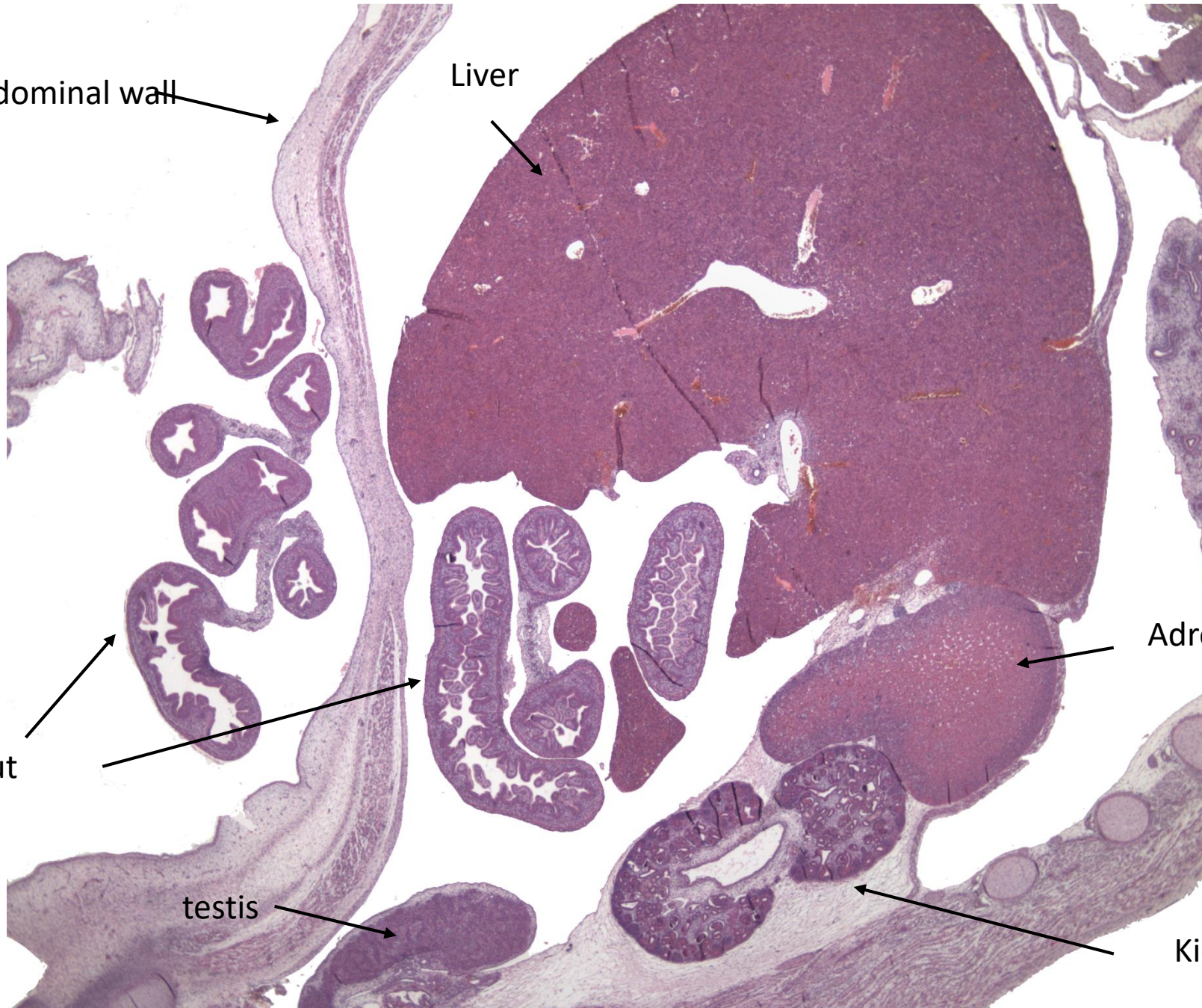
Liver

Gut

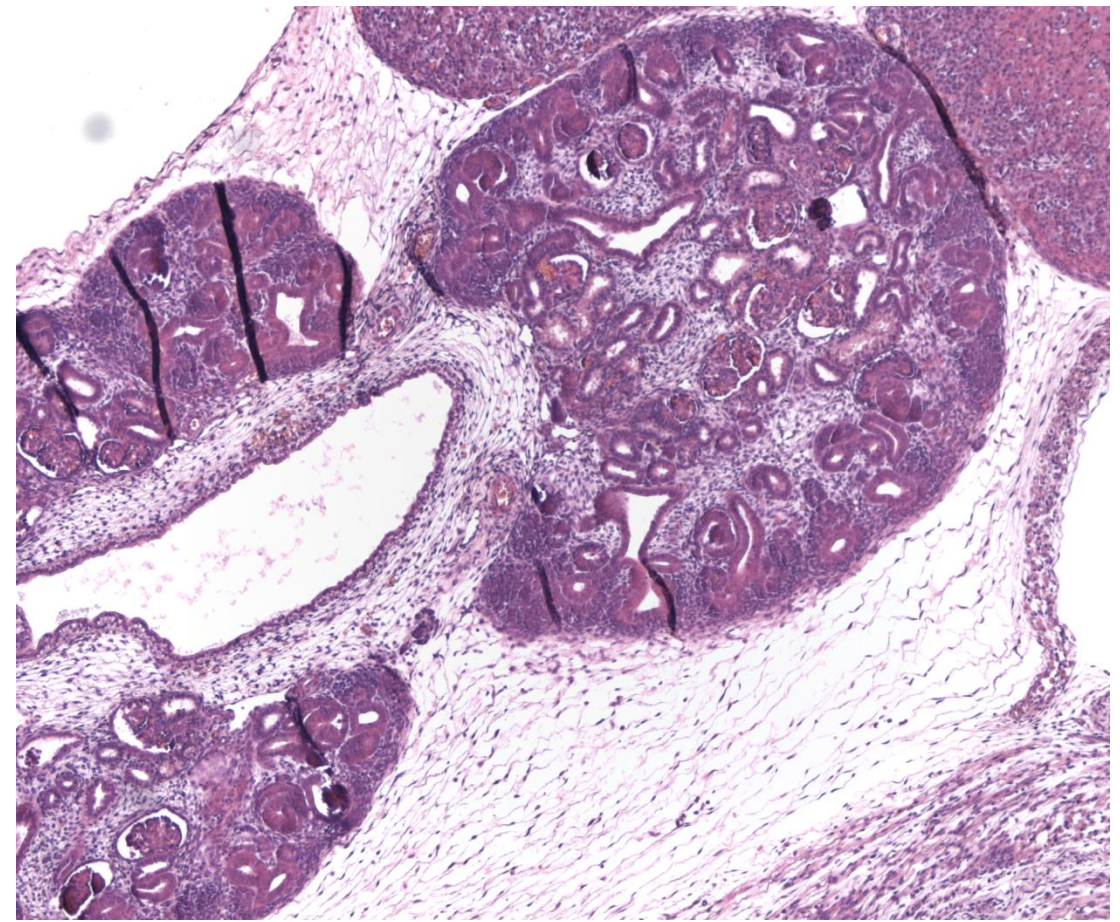
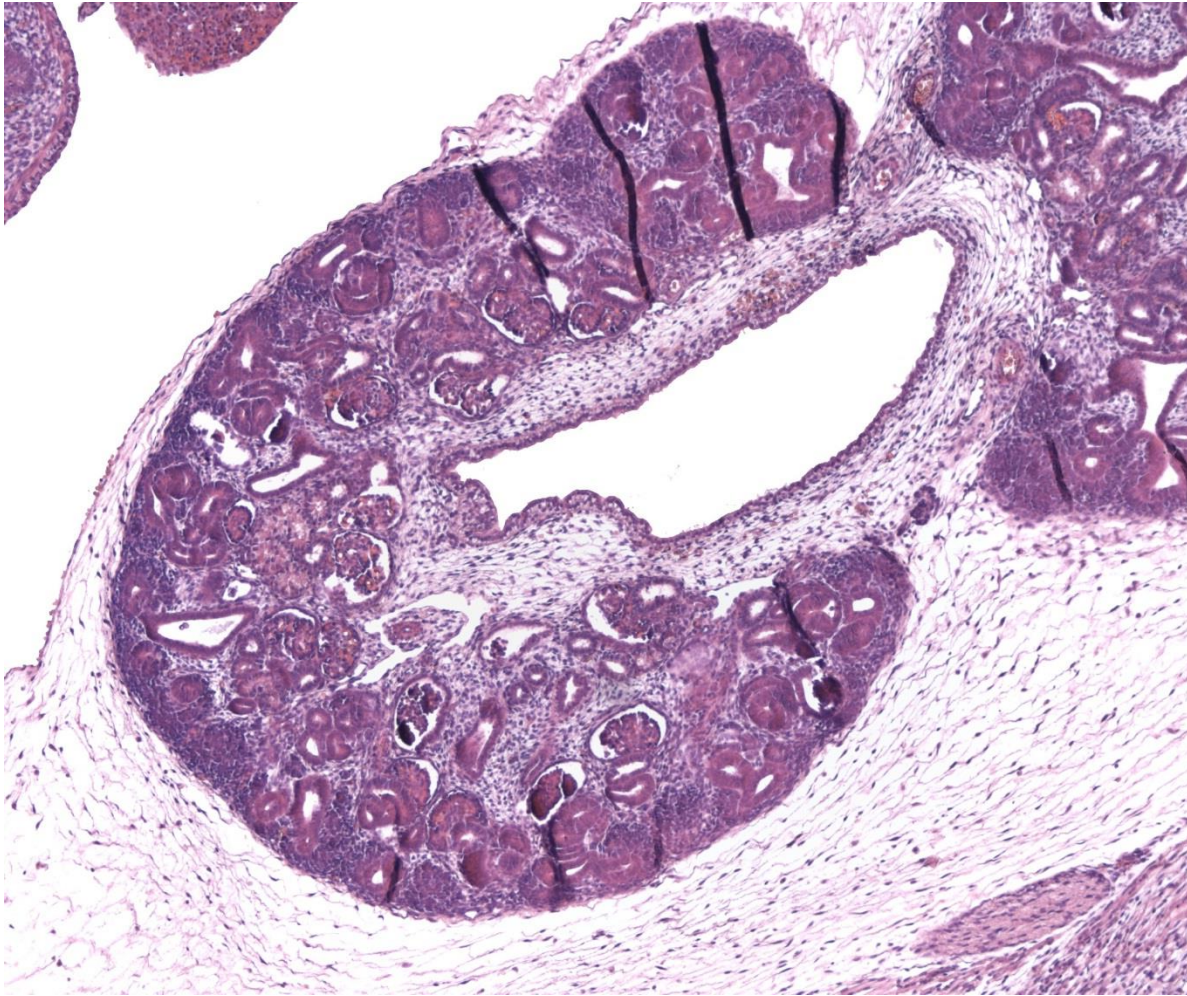
testis

Adrenal gland

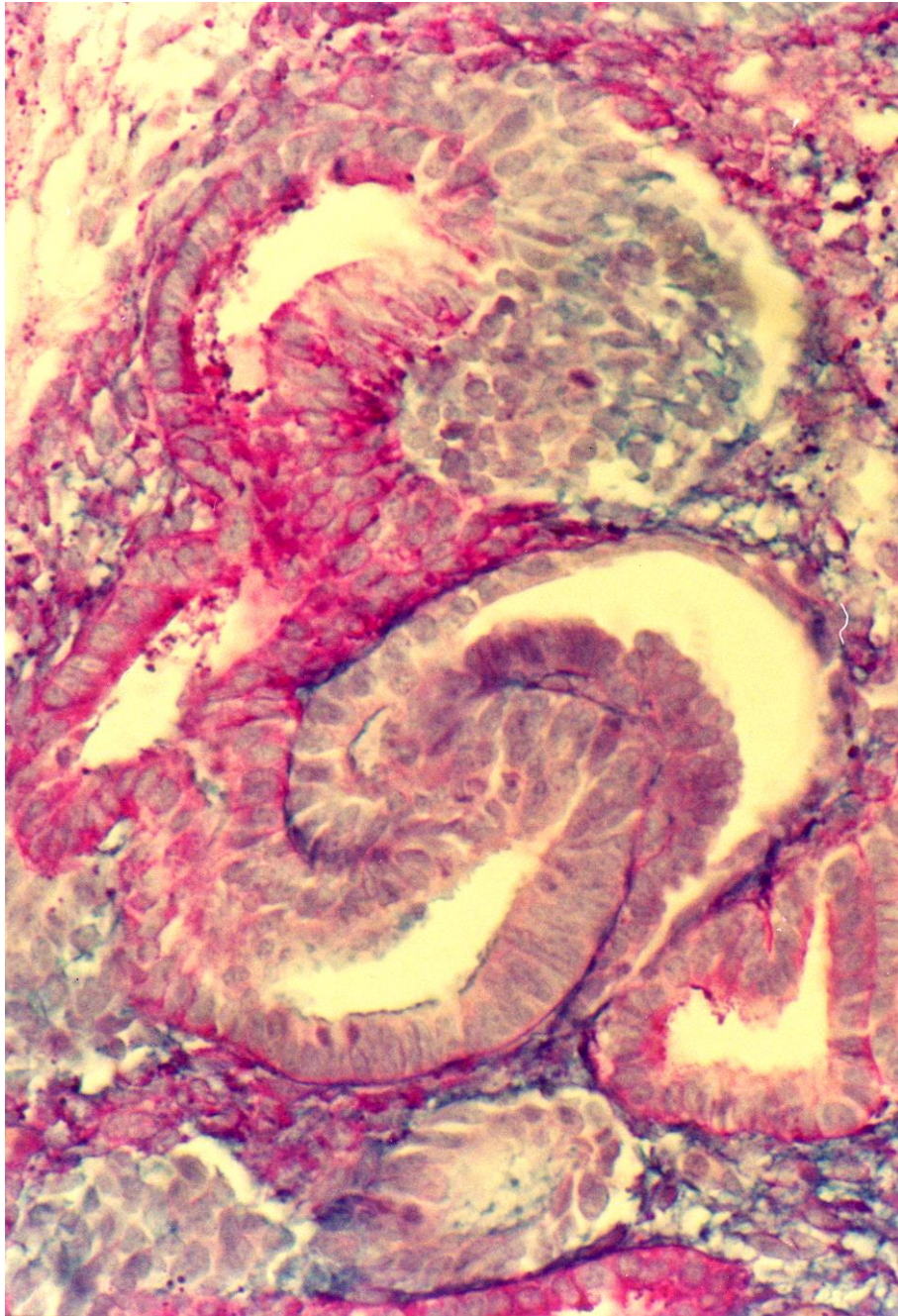
Kidney







Kidney
(lobulated)



Polycystic kidneys

- **AUTOSOMAL RECESSIVE**
- **AUTOSOMAL DOMINANT**
 - 10 % of patients with chronic renal failure

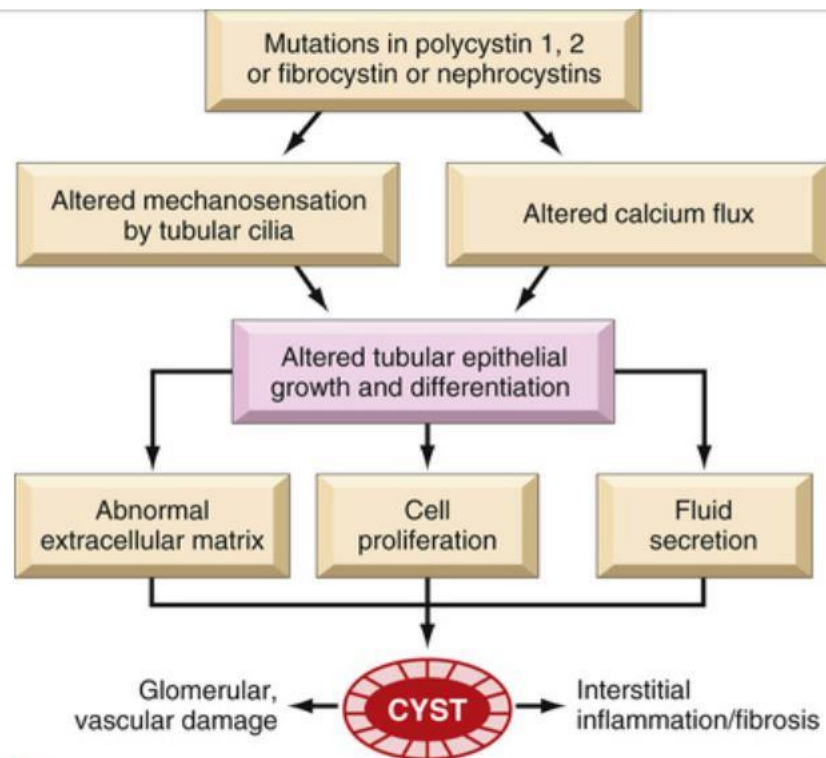
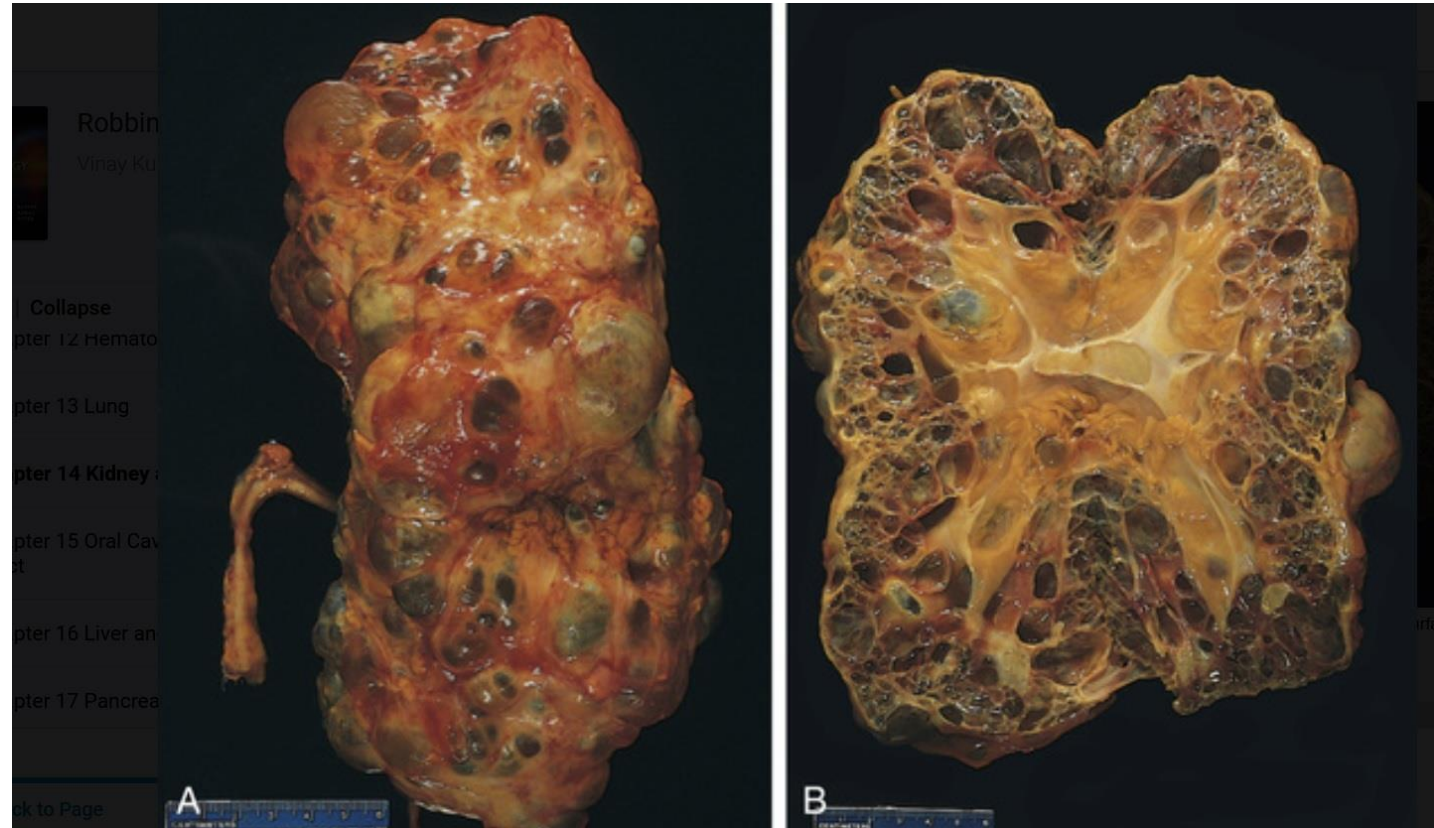
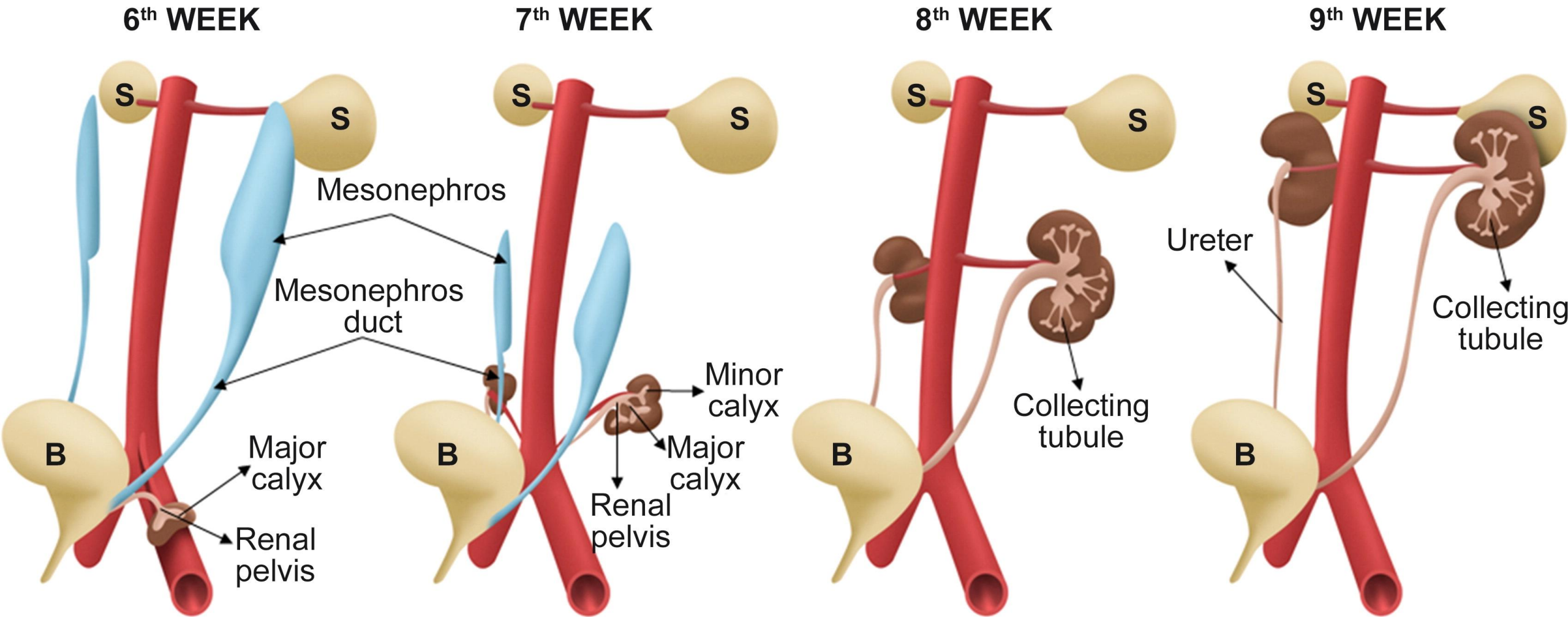


FIG. 14.21 Possible mechanisms of cyst formation in cystic kidney diseases (see text).



Kumar, Vinay, et al. *Robbins Basic Pathology*. Available from: Elsevier eBooks+, (10th Edition). Elsevier - OHCE, 2017.

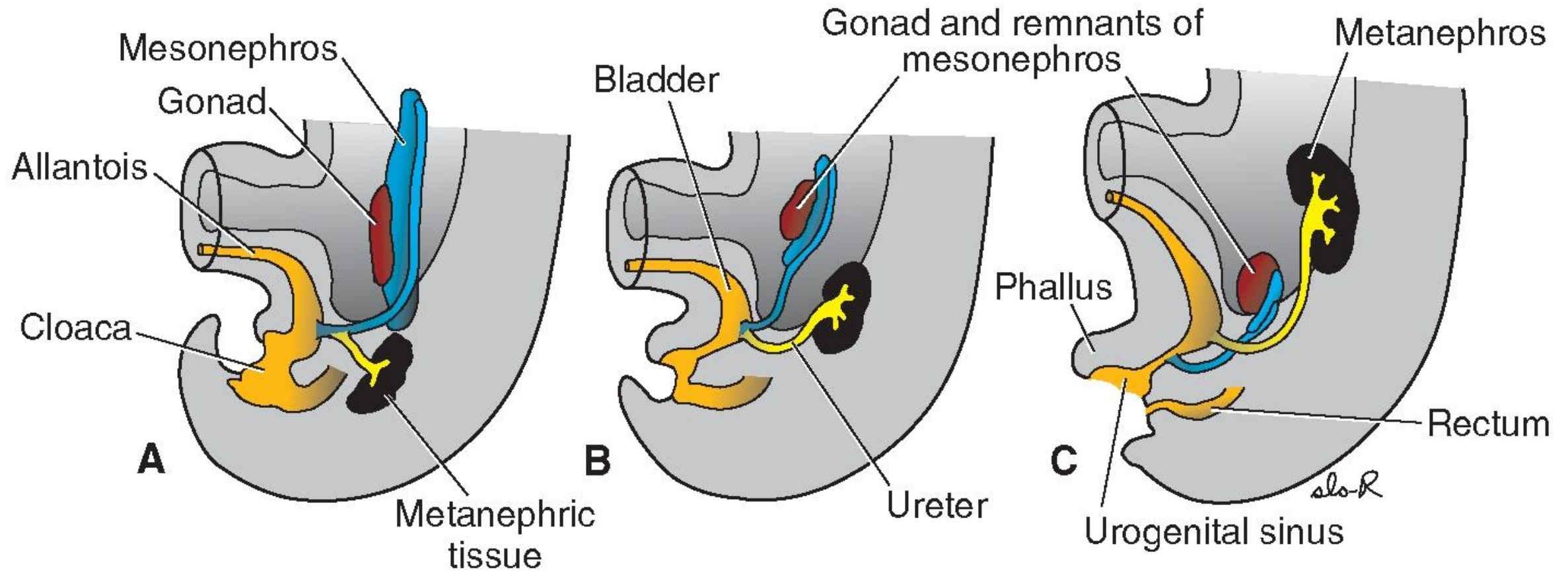
Kidney ascent and rotation



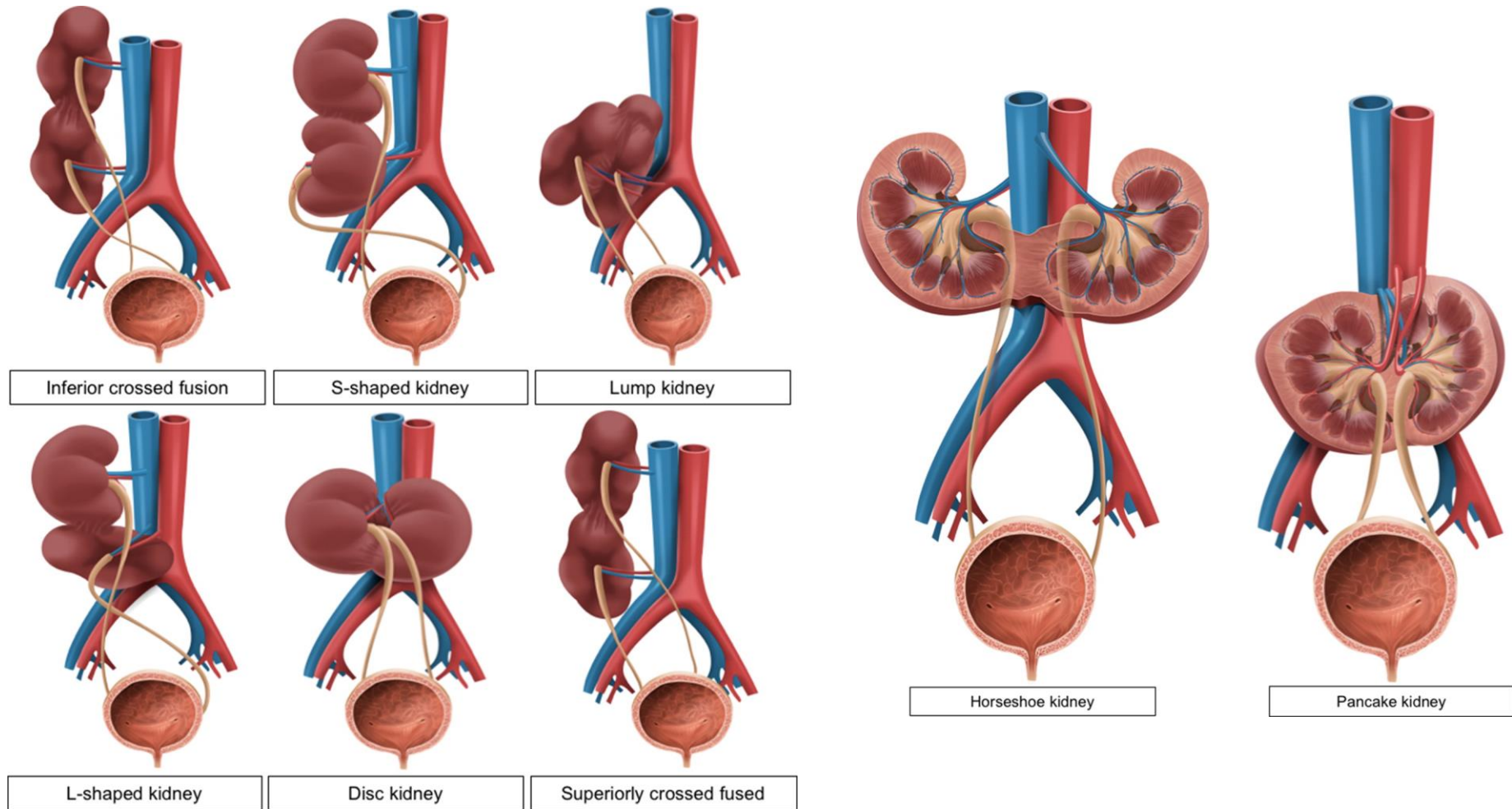
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Abdallah P. Houat, Cassia T. S. Guimarães, Marcelo S. Takahashi, Gustavo P. Rodi, Taísa P. D. Gasparetto, Roberto Blasbalg, and Fernanda G. Velloni. RadioGraphics 2021 41:2, 462-486

Kidney ascent and rotation



Developmental defects

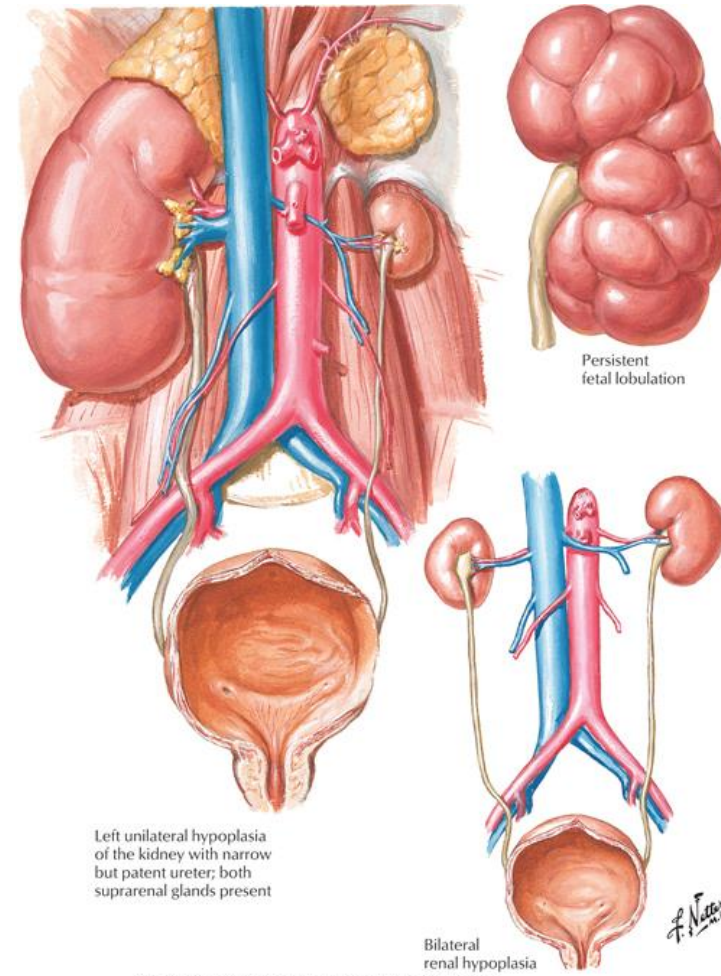


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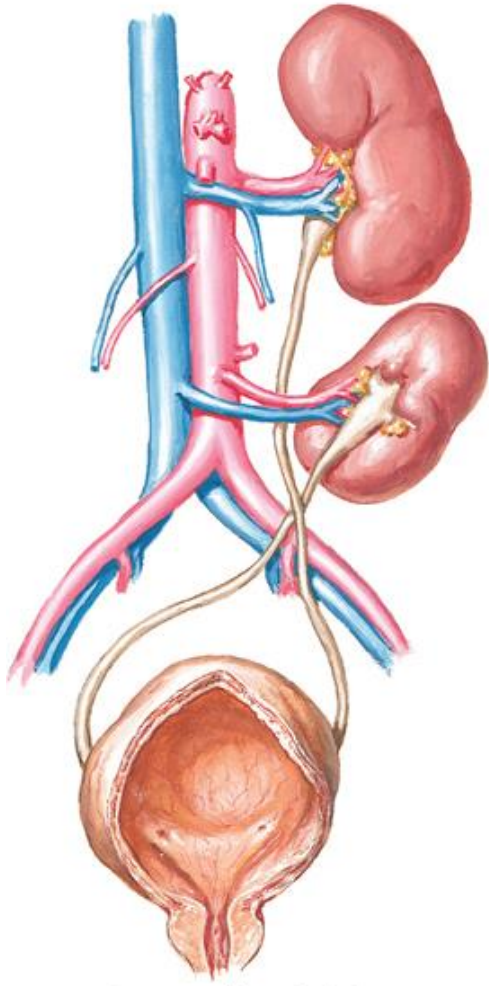
Developmental defects

Persistent lobulisation

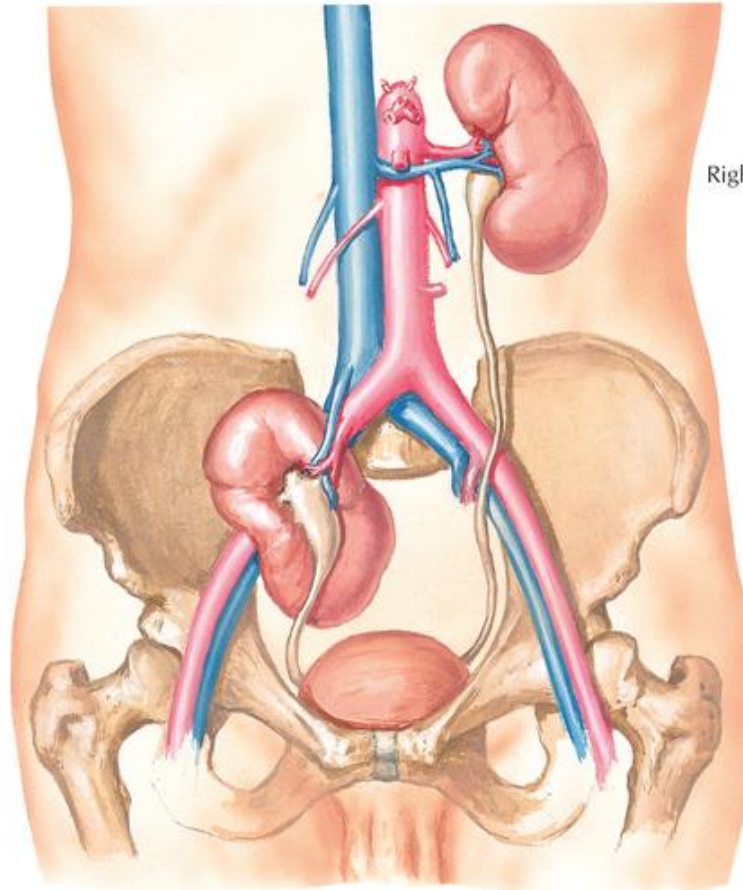


Kidney ectopia

Ectopia of the kidney



Crossed ectopia of the right kidney



Right pelvic kidney

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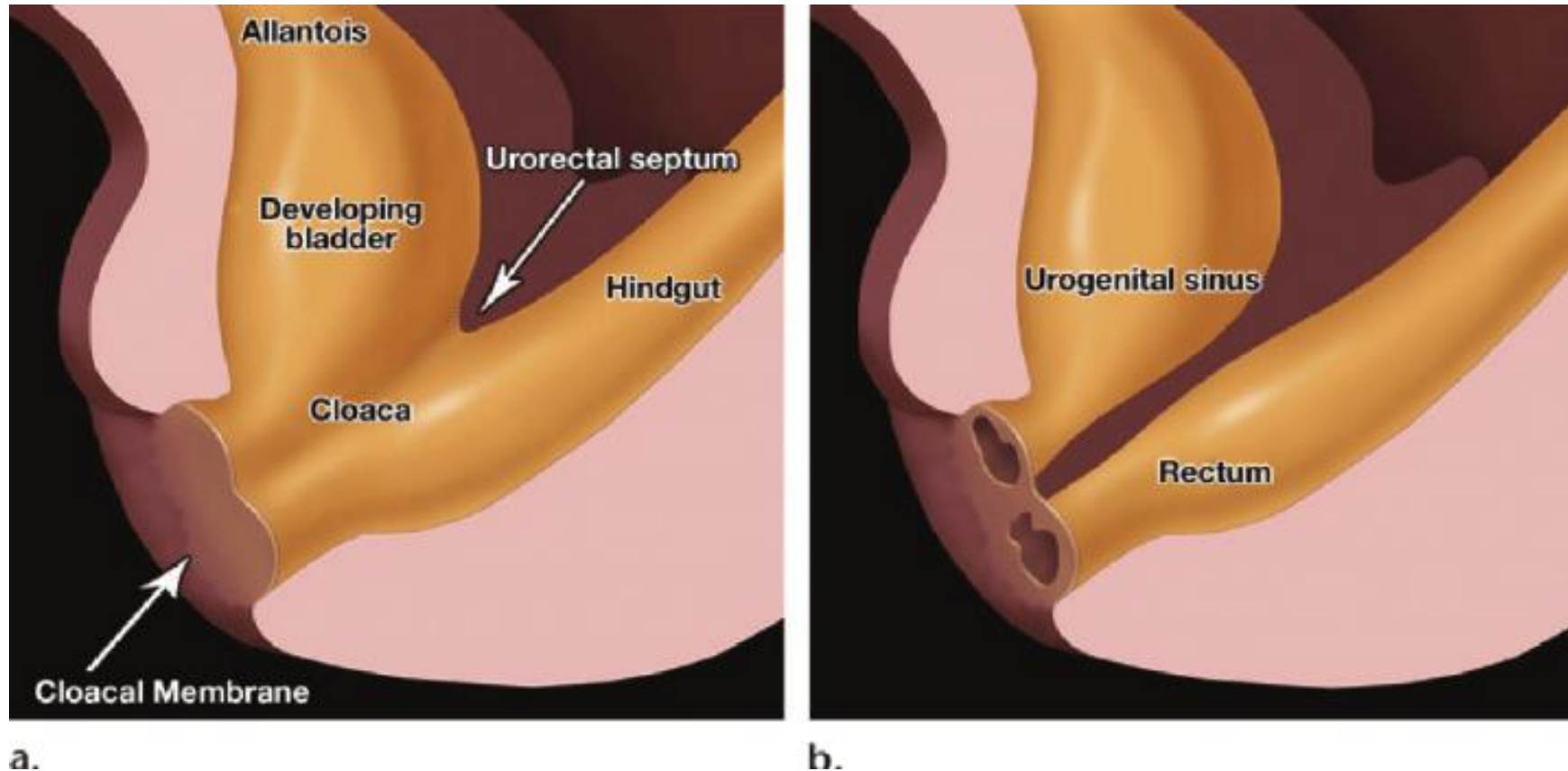
F. Netter M.D.

Ren migrans



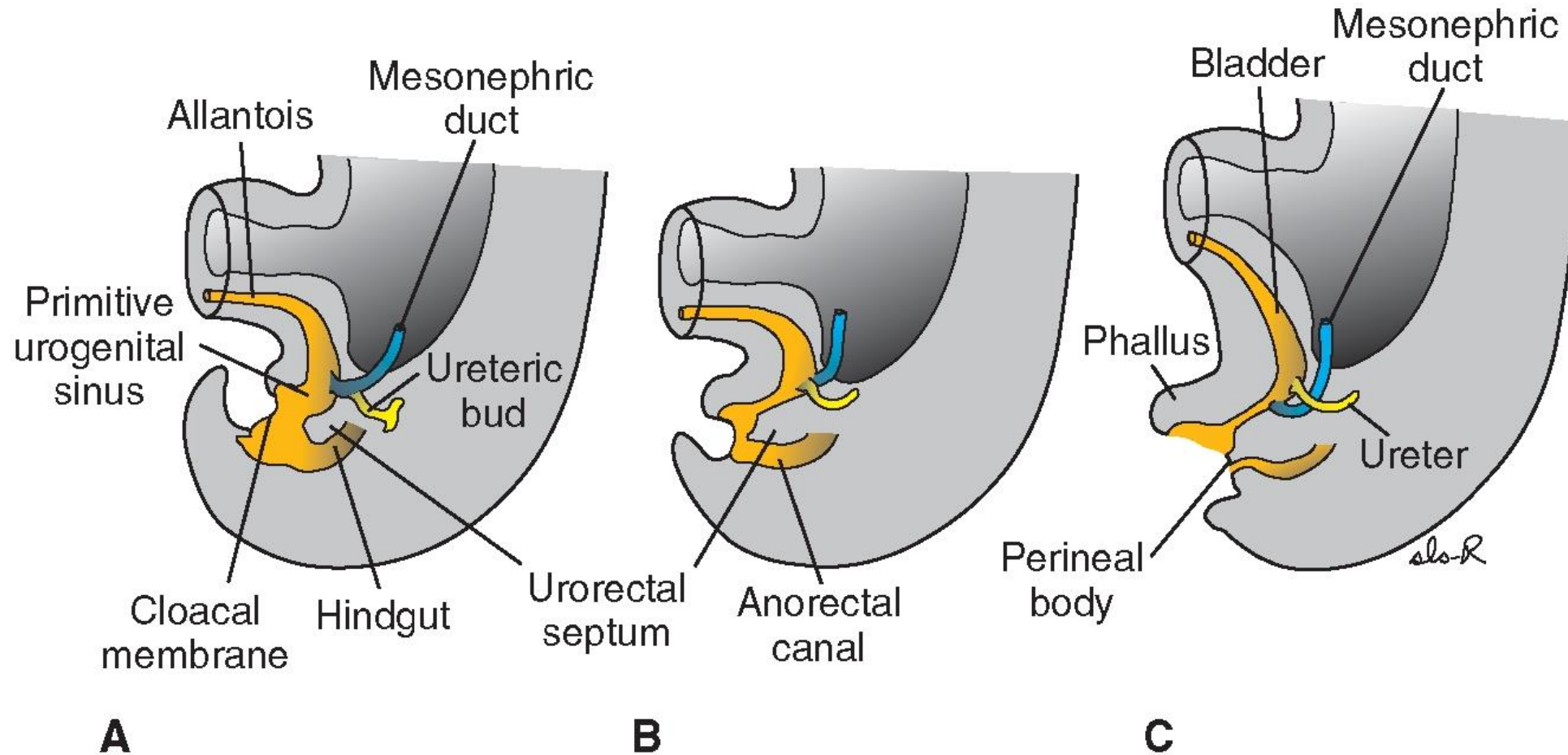
Case courtesy of Sami Elhinnawi, Radiopaedia.org, rID: 56632

Cloacal development – septum urorectale



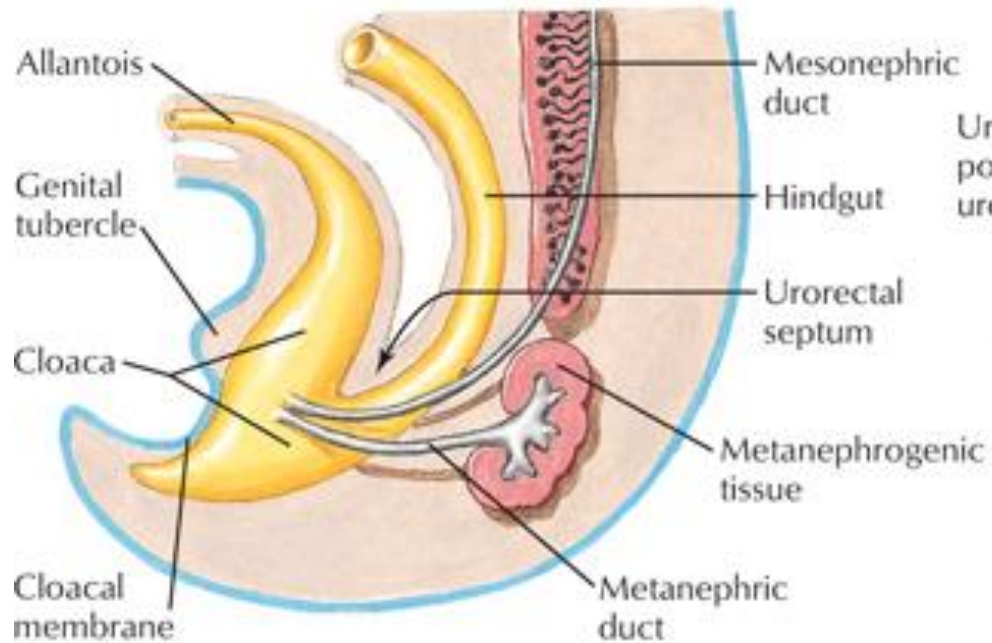
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Cloacal development – septum urorectale

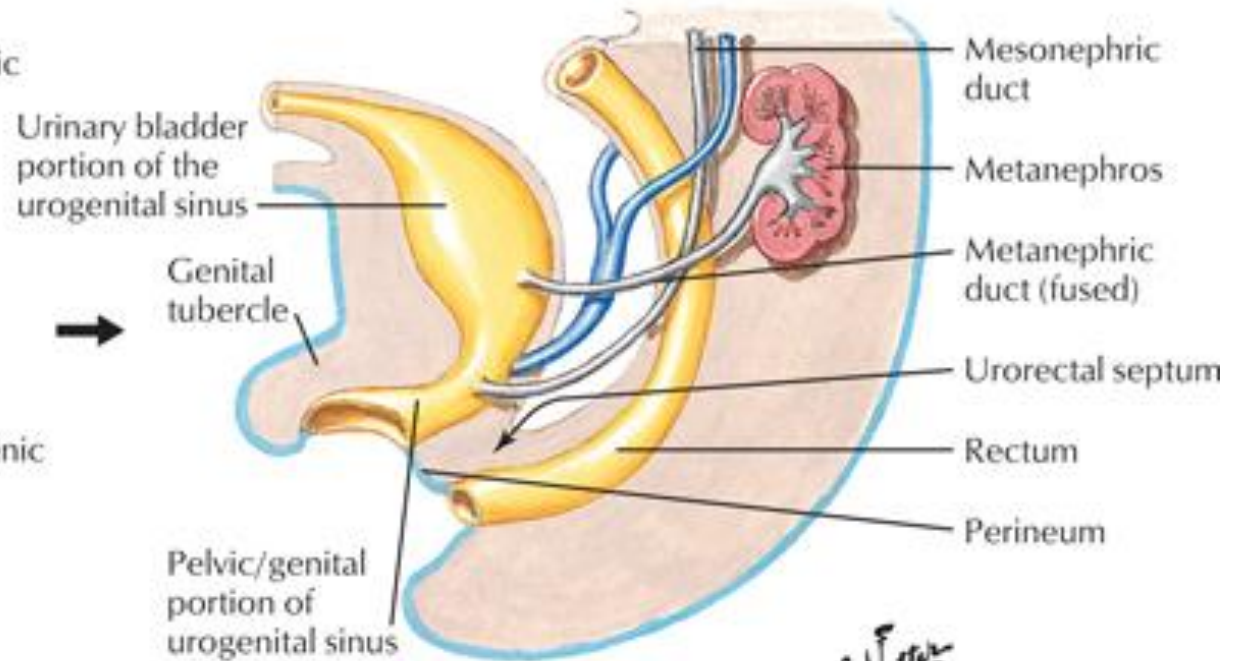


Cloacal development – septum urorectale

Division of the cloaca by the urorectal septum



Urogenital sinus and rectum

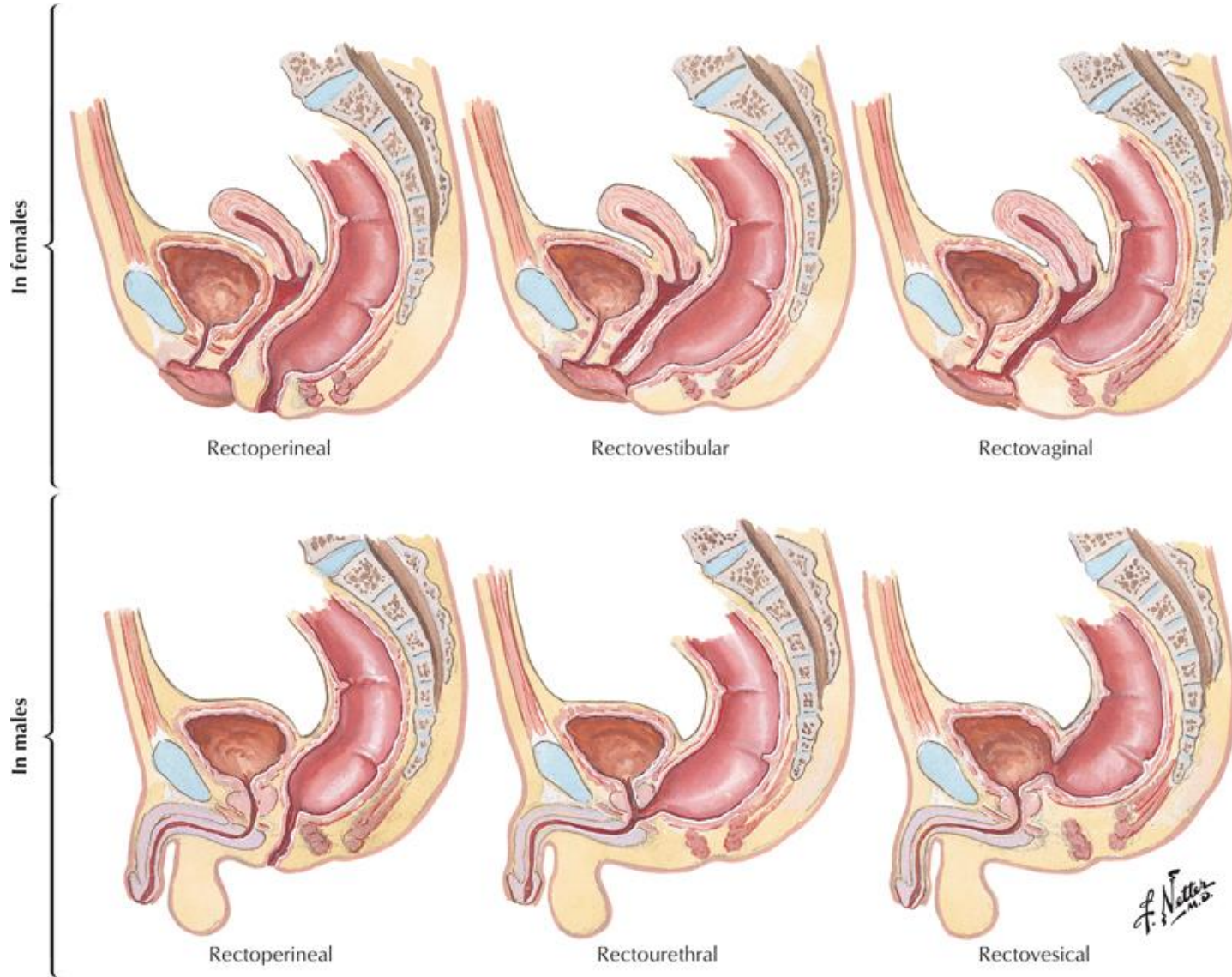


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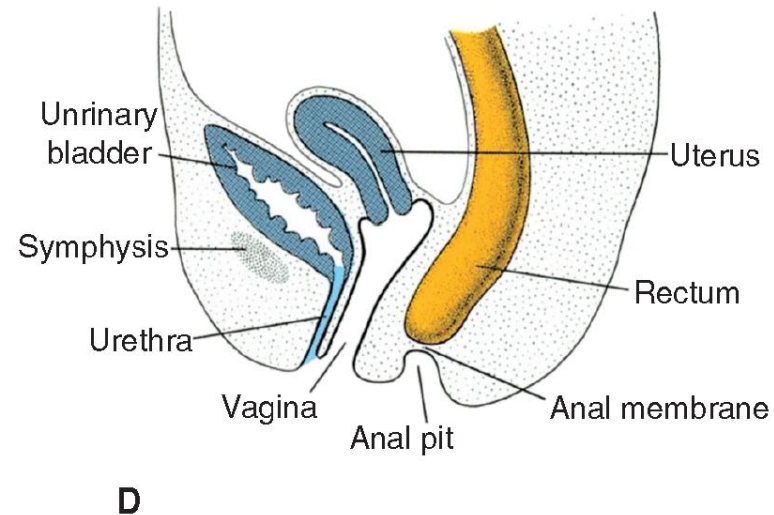
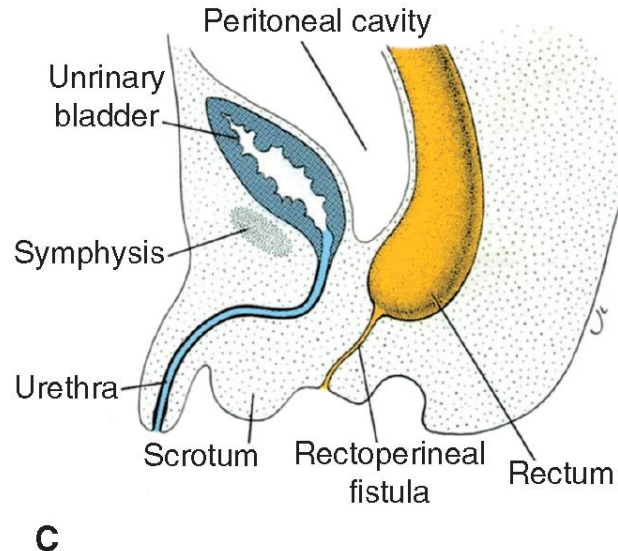
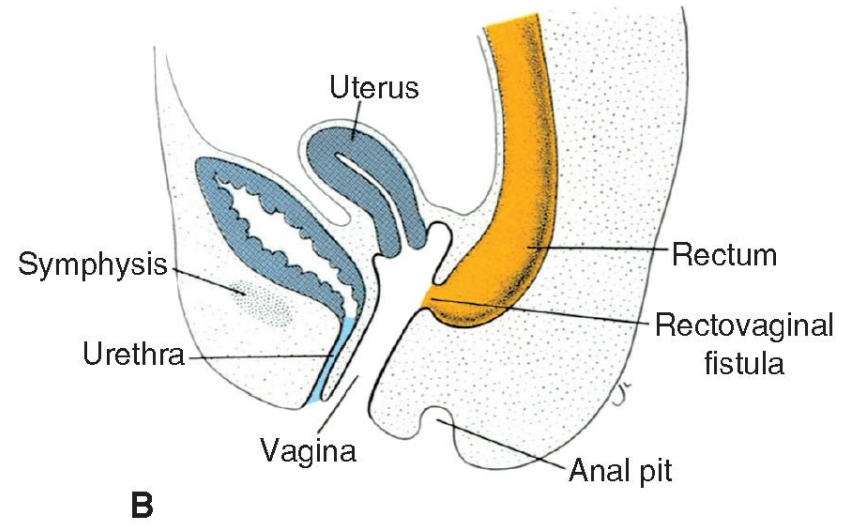
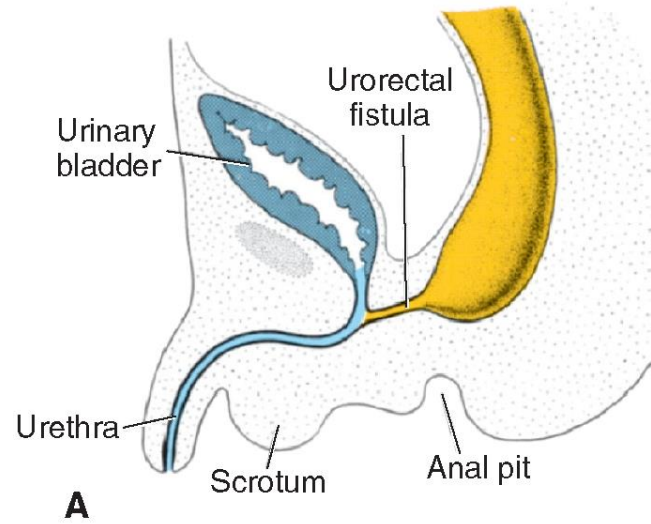
F. Netter M.D.

Cloacal development – developmental defects

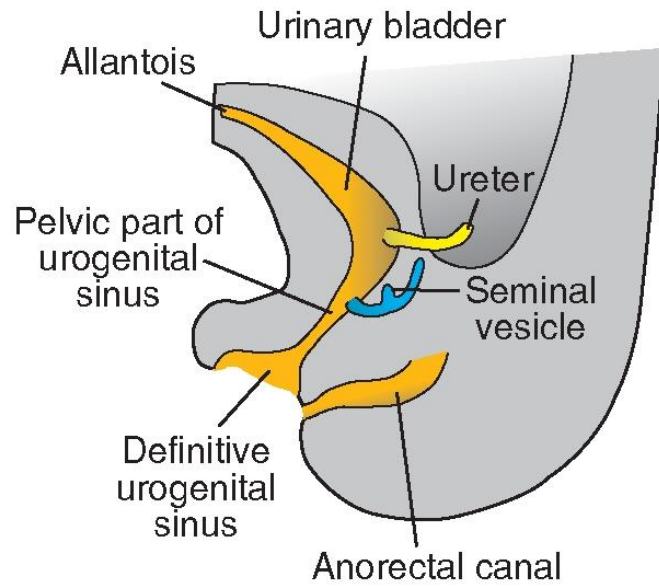
Fistulas resulting from the incomplete division of the cloaca



Cloacal development – developmental defects

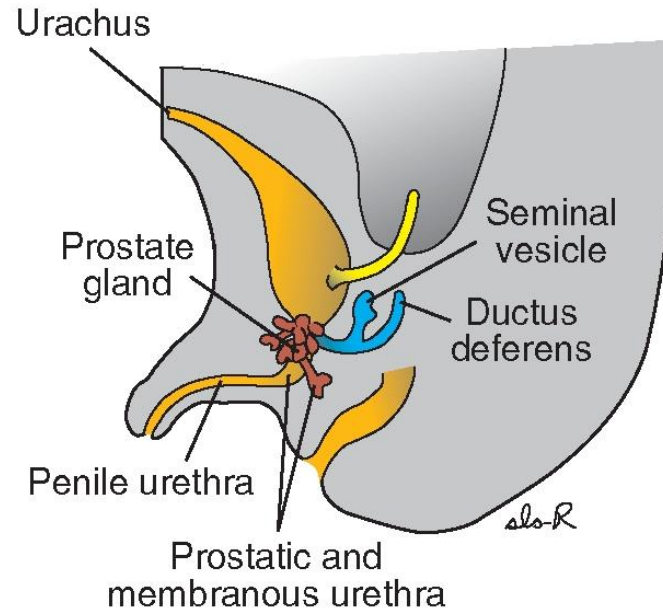


Ureter, urinary bladder



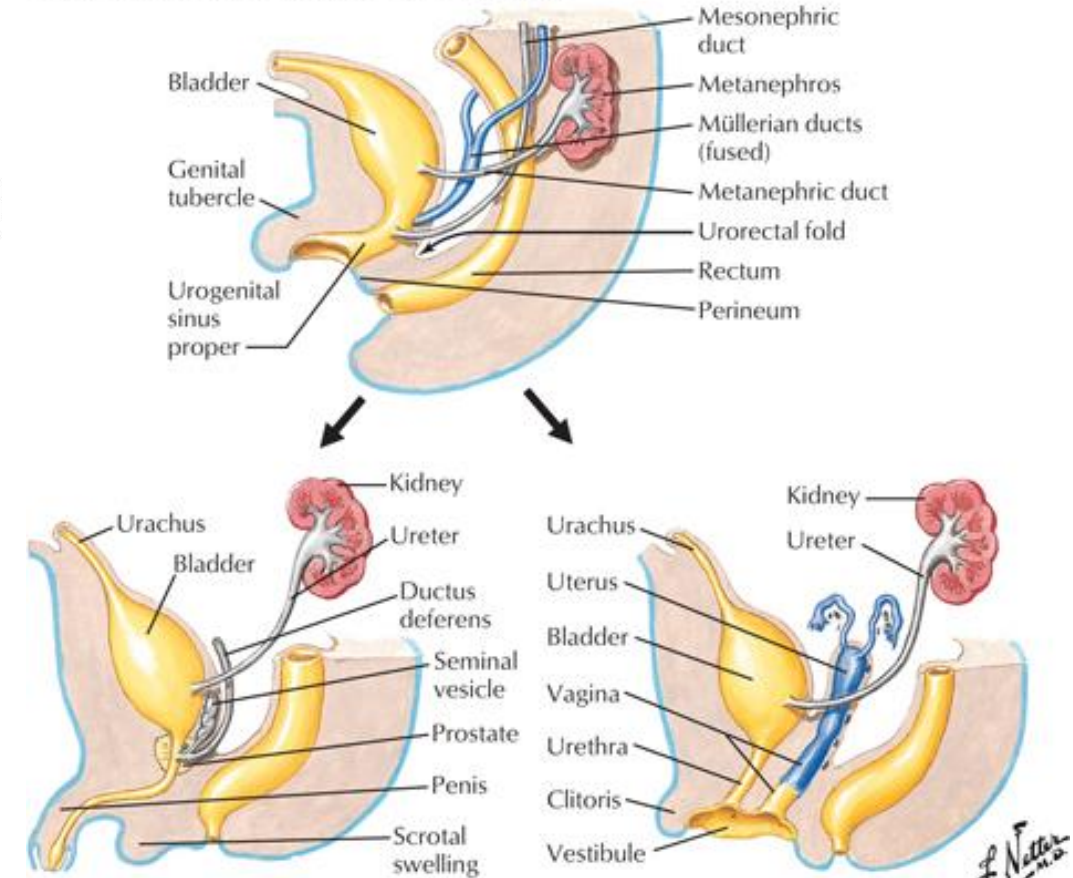
A

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B

Lateral view (both sexes have identical primordia)



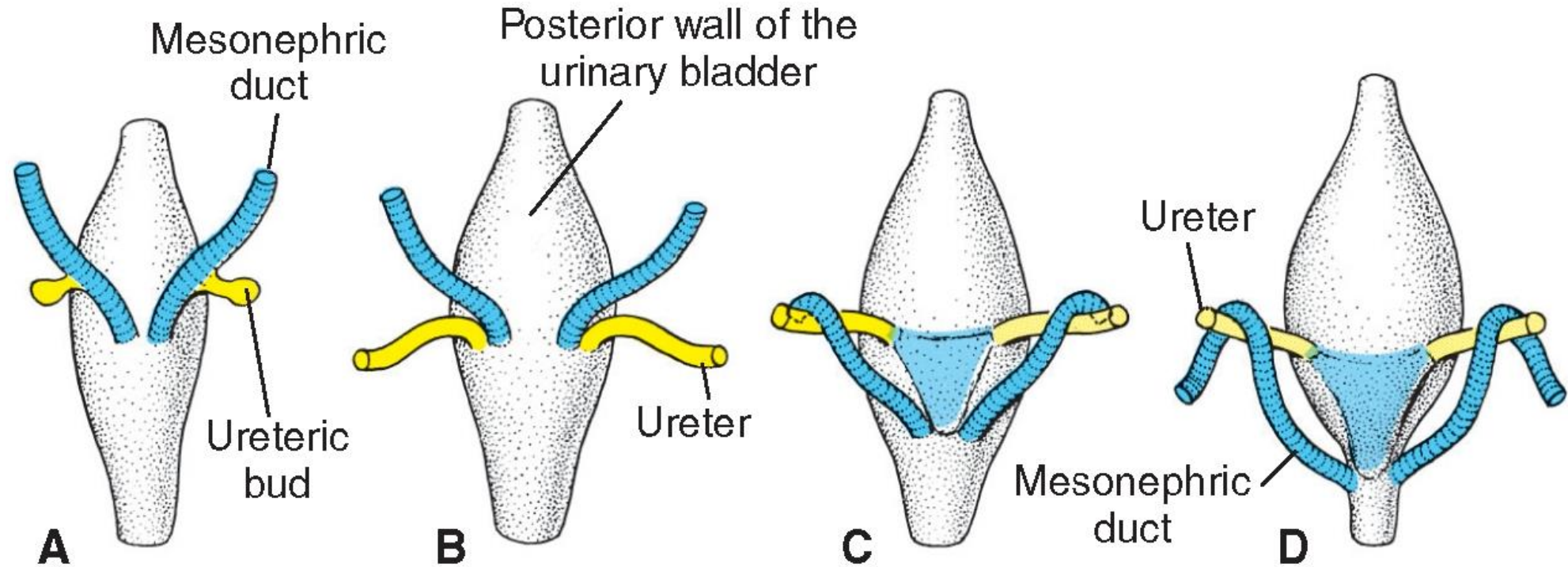
Male

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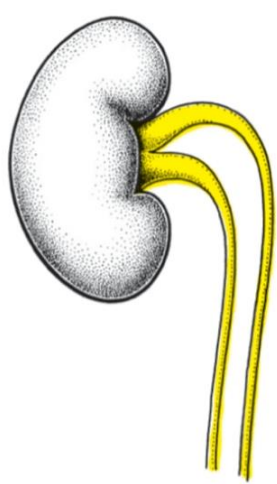
Female

Ureter, urinary bladder, ductus mesonephricus

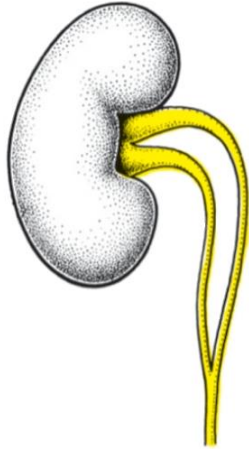


Ureters – developmental defects

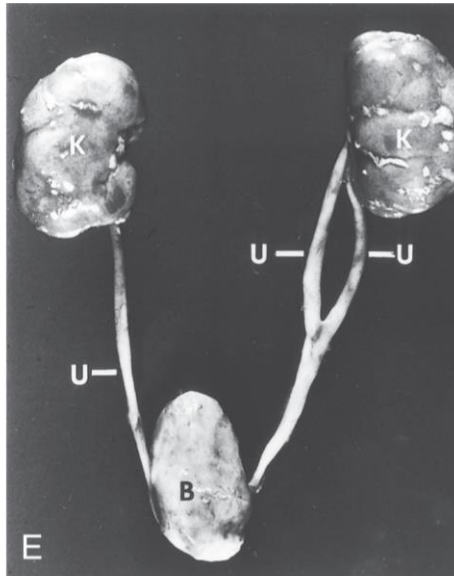
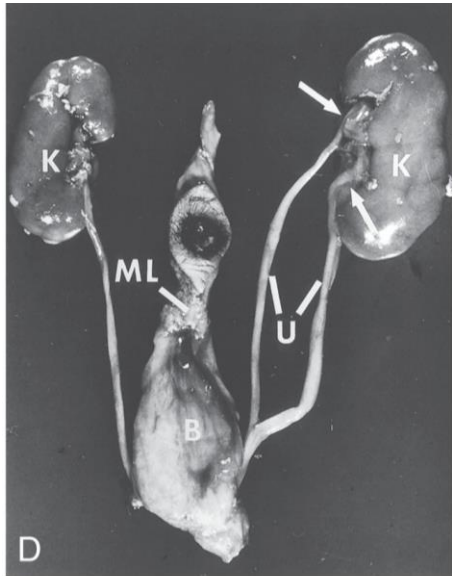
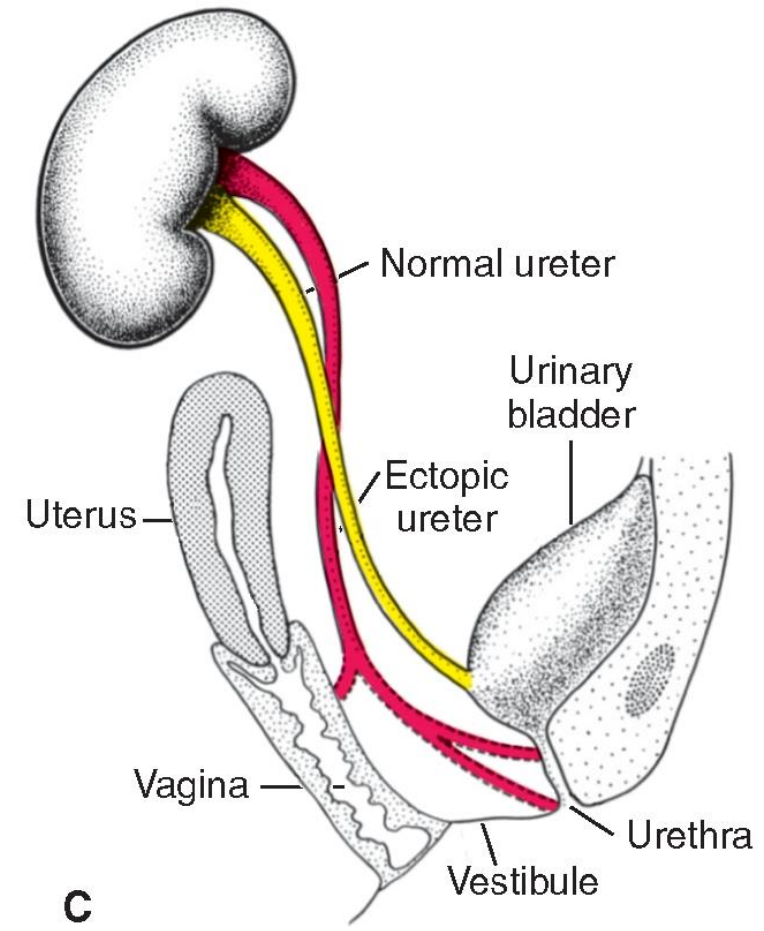
Ureter duplex



Ureter fissus

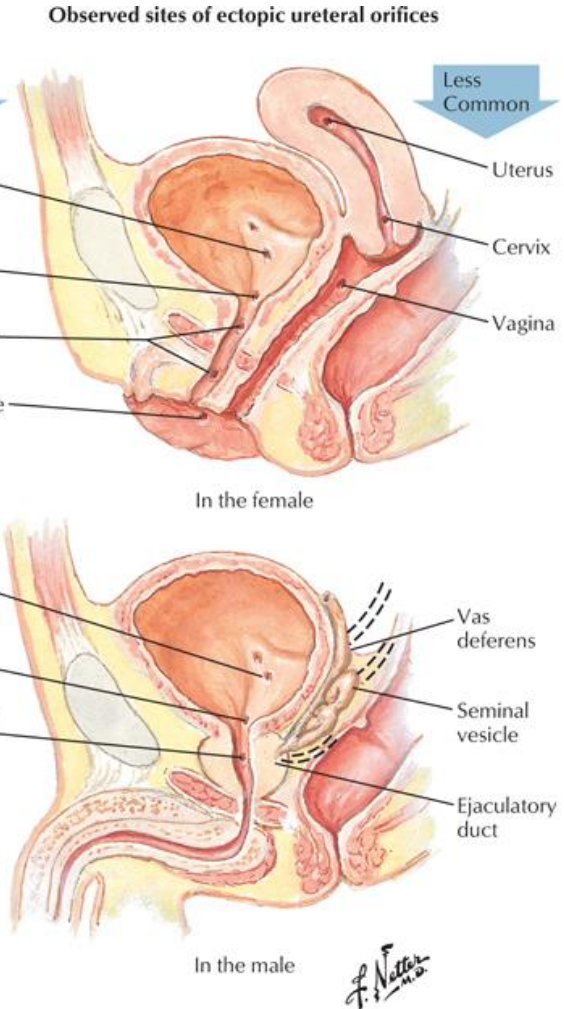
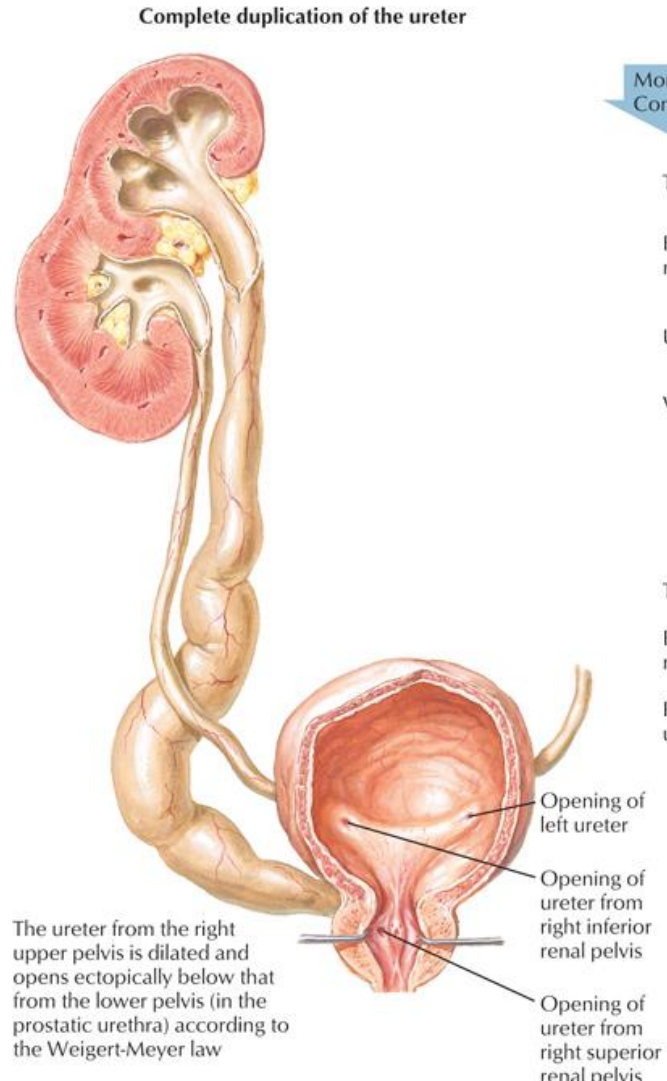
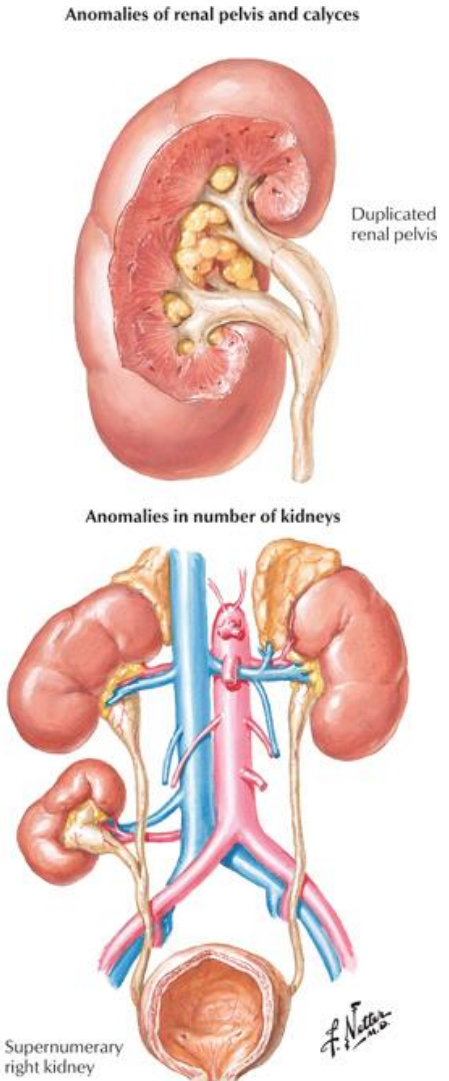
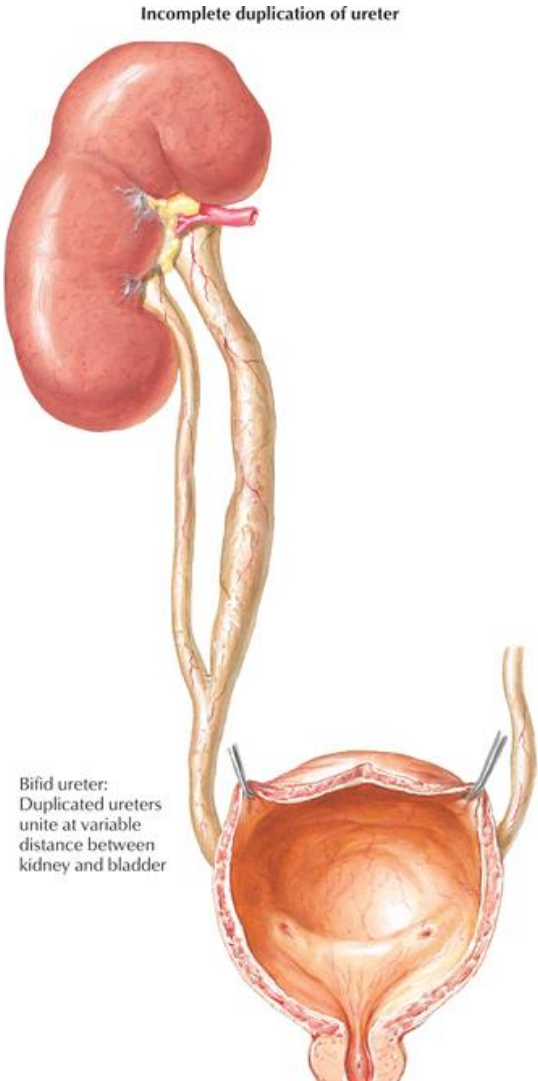


Ectopic ureter

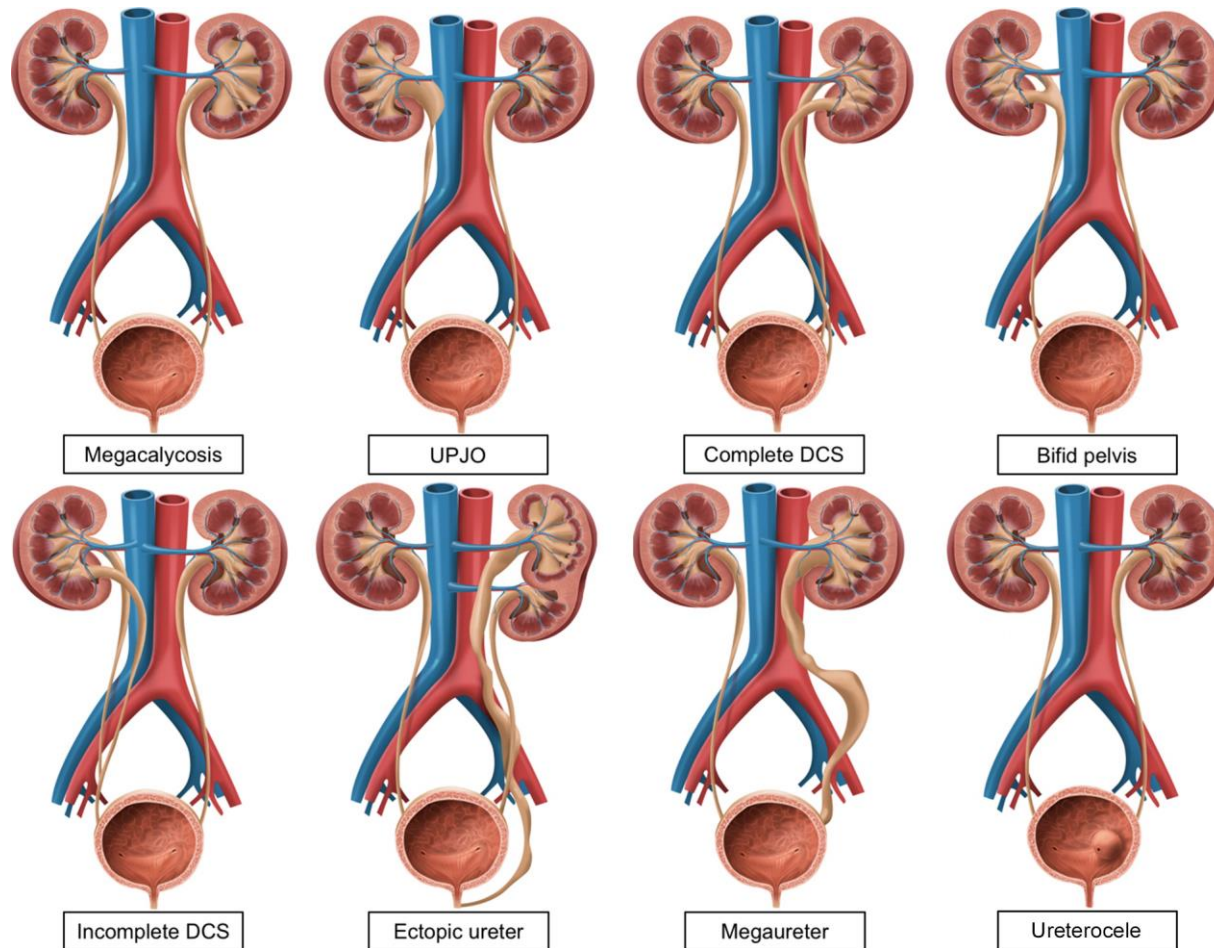


Ureters – developmental defects

Fistula congenita vesicouterina/vesicovaginalis



Ureters – developmental defects

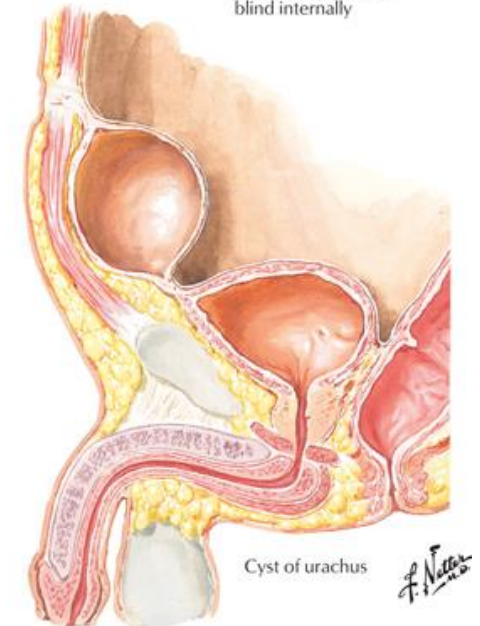
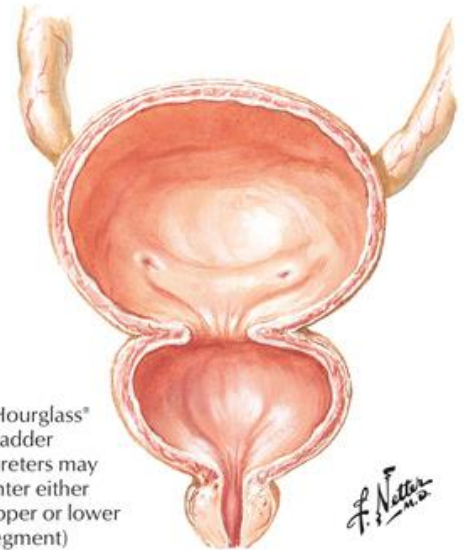
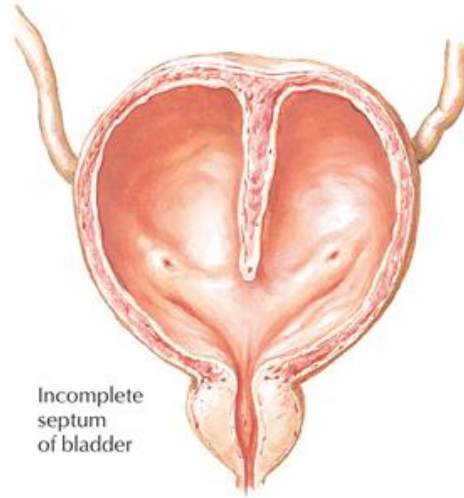
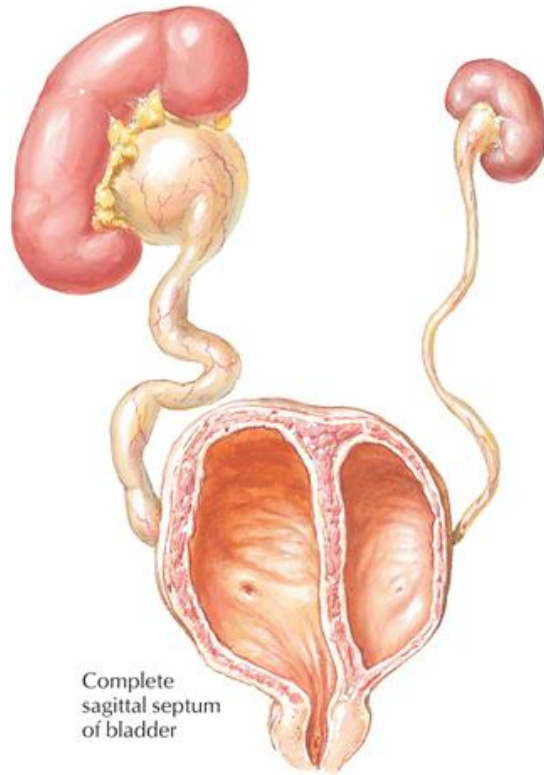


UPJO = ureteropelvic junction obstruction
DCS = duplex collecting system

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Urinary bladder – developmental defects



Urinary bladder – developmental defects

Exstrophy of the bladder

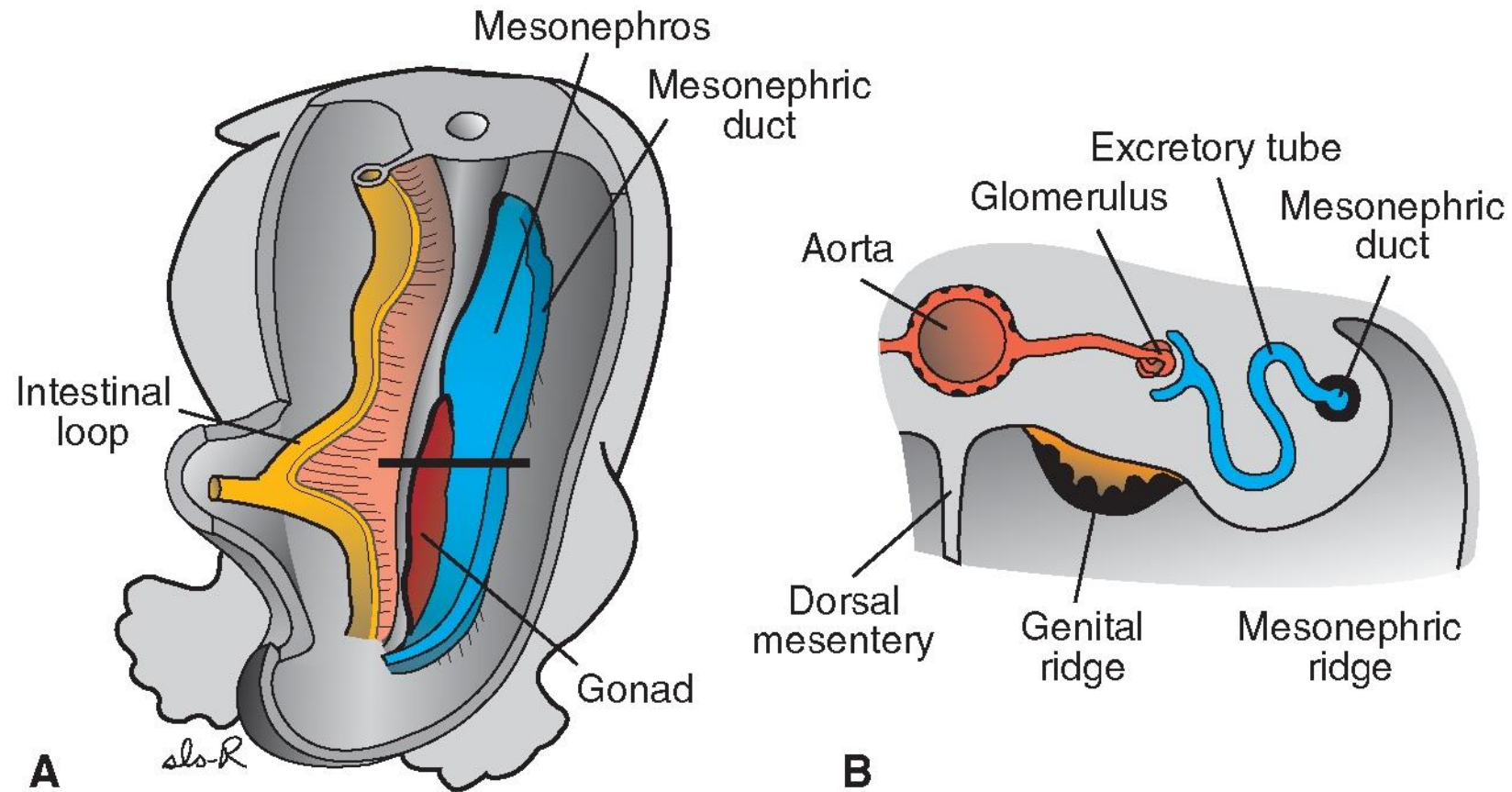


Exstrophy of cloaca

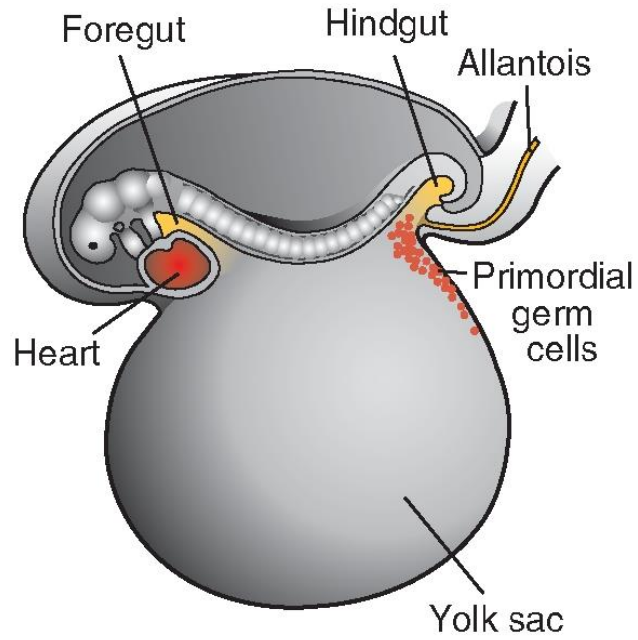


DEVELOPMENT OF THE REPRODUCTIVE SYSTEM

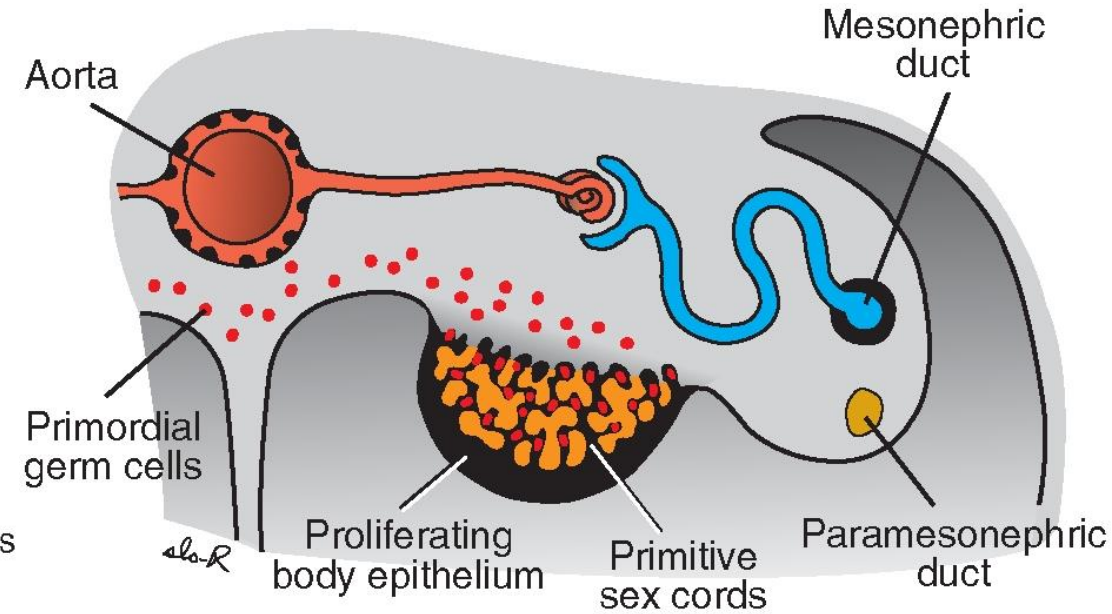
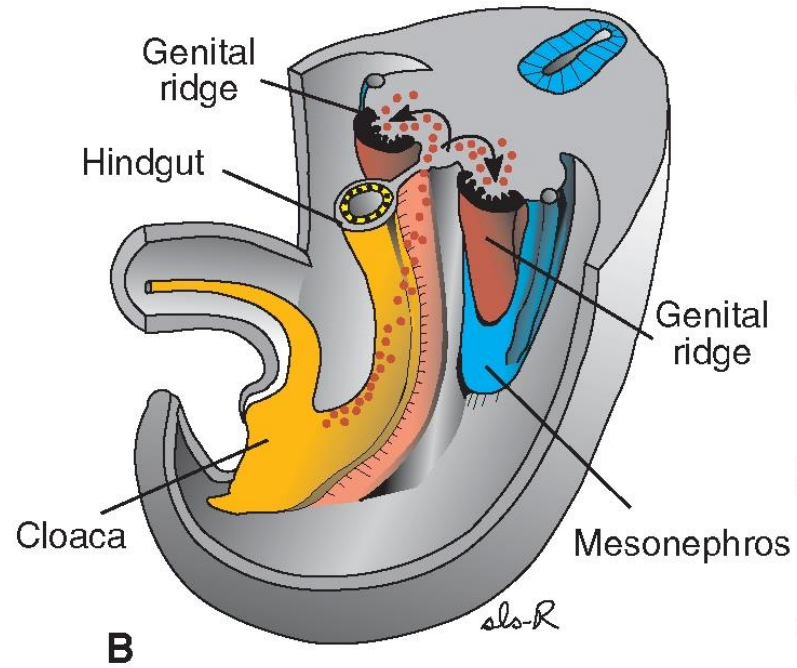
Indifferent gonad



Indifferent gonad

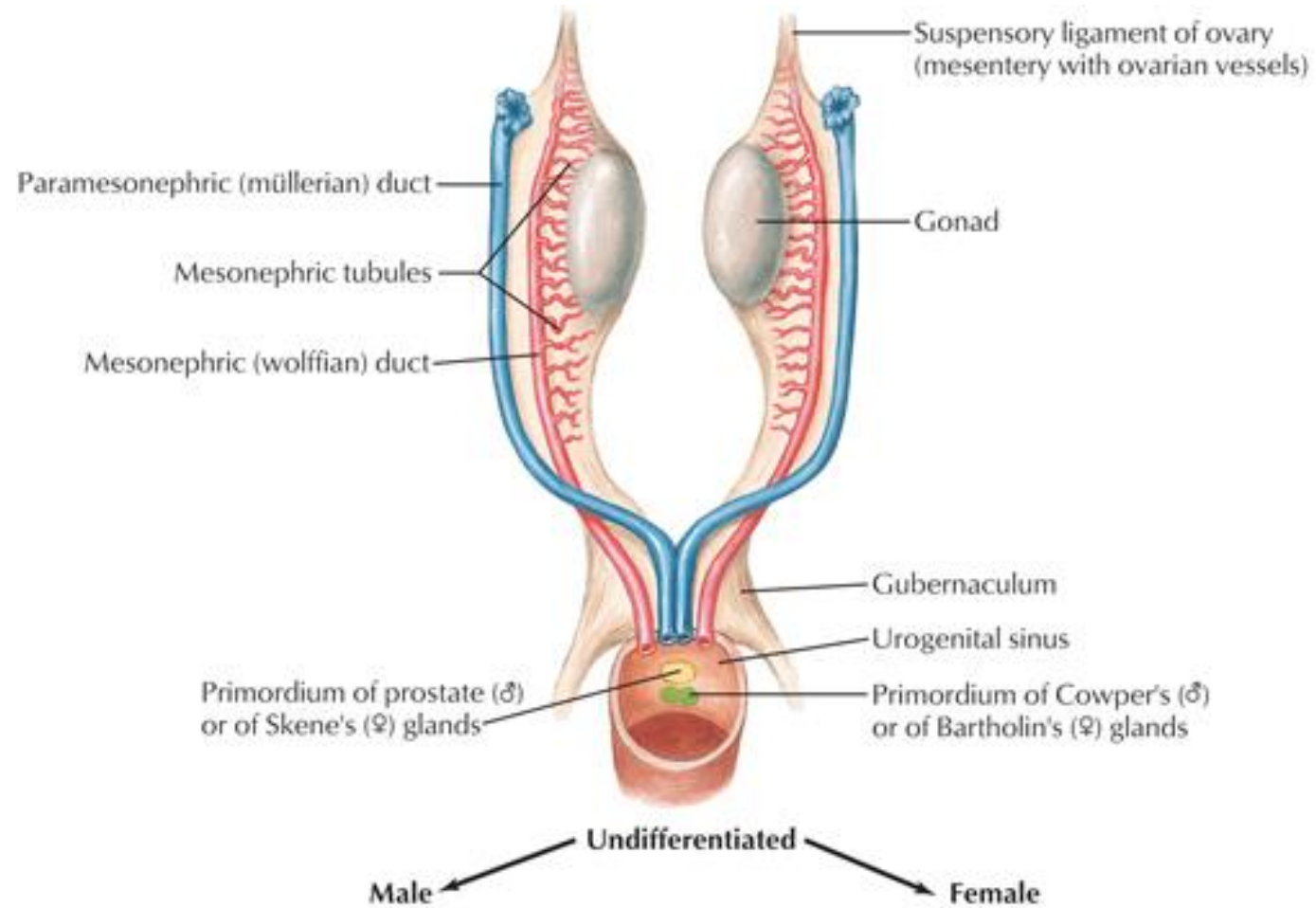


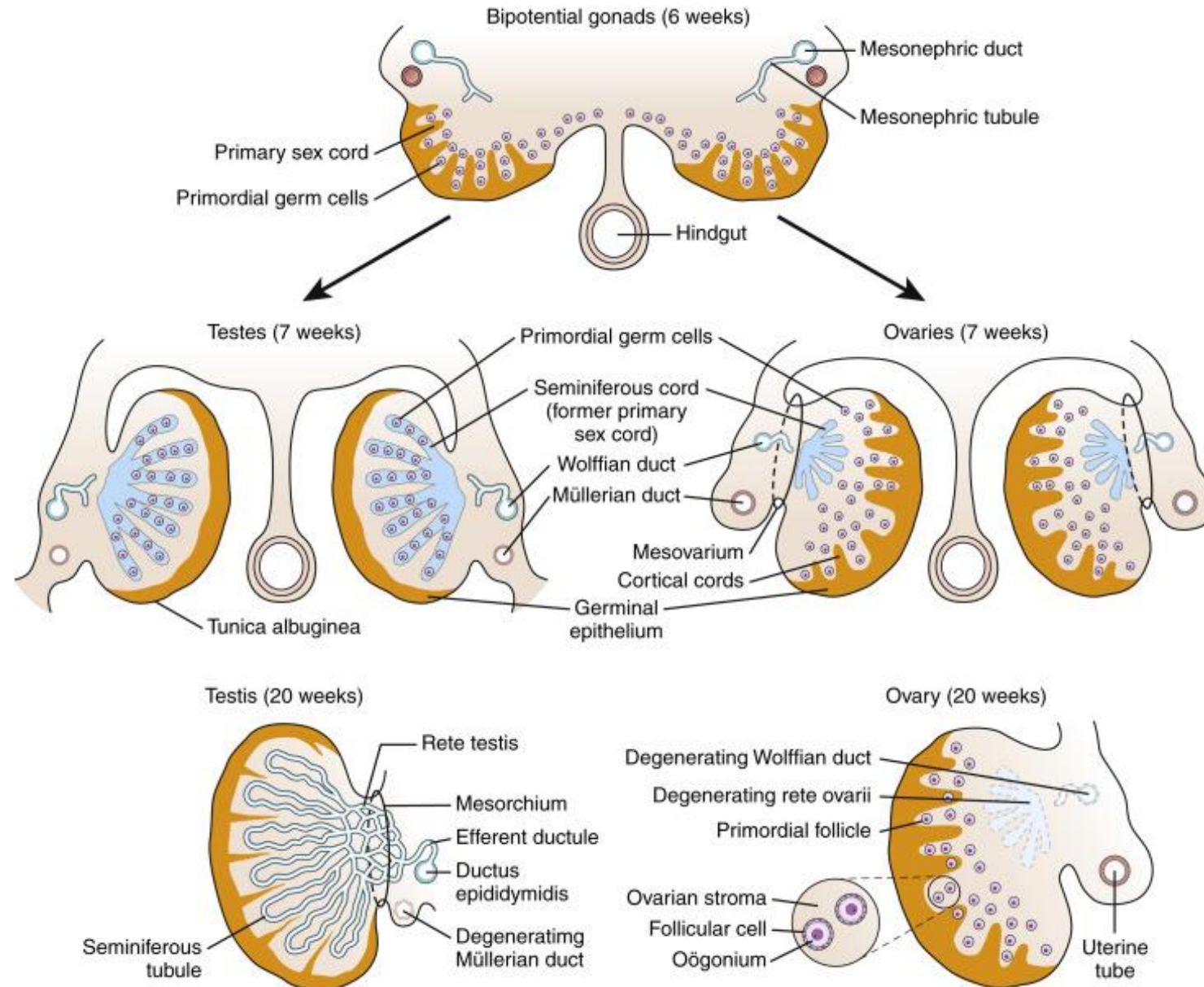
A
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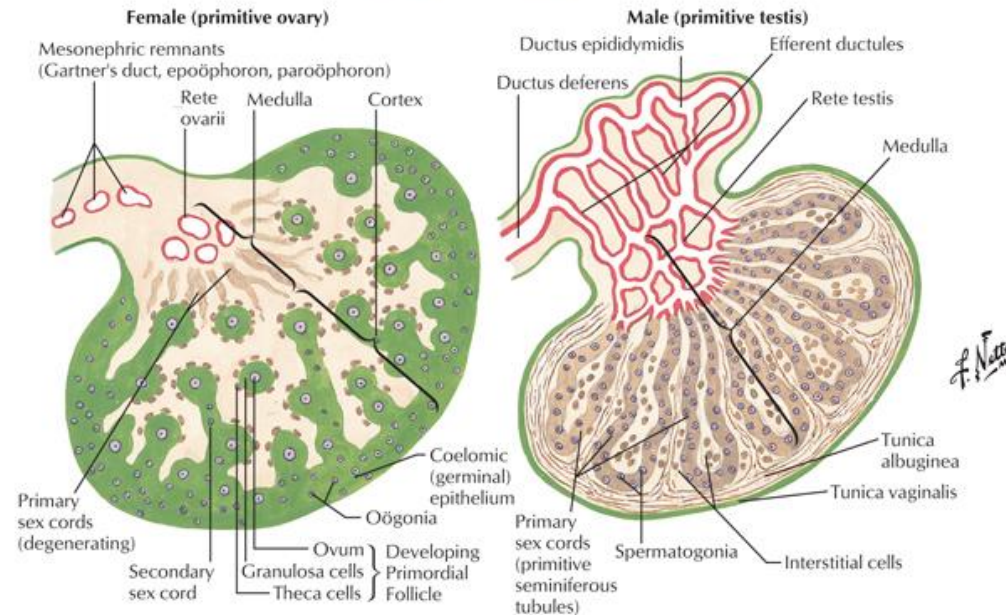
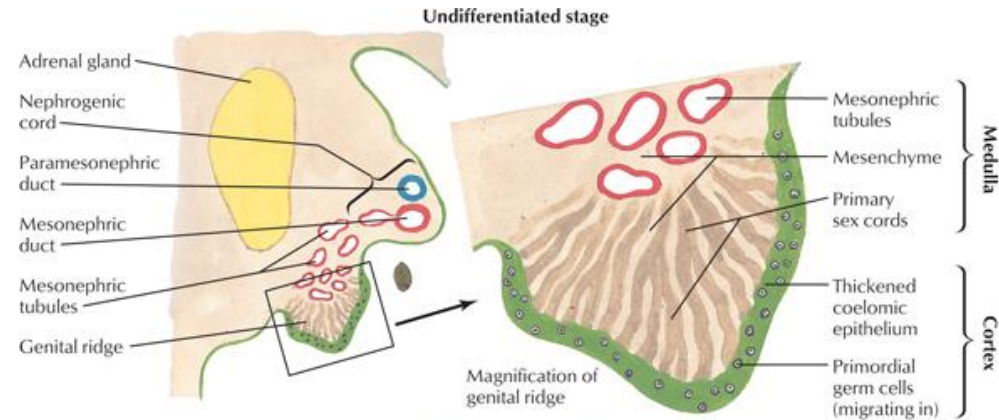
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Indifferent gonad

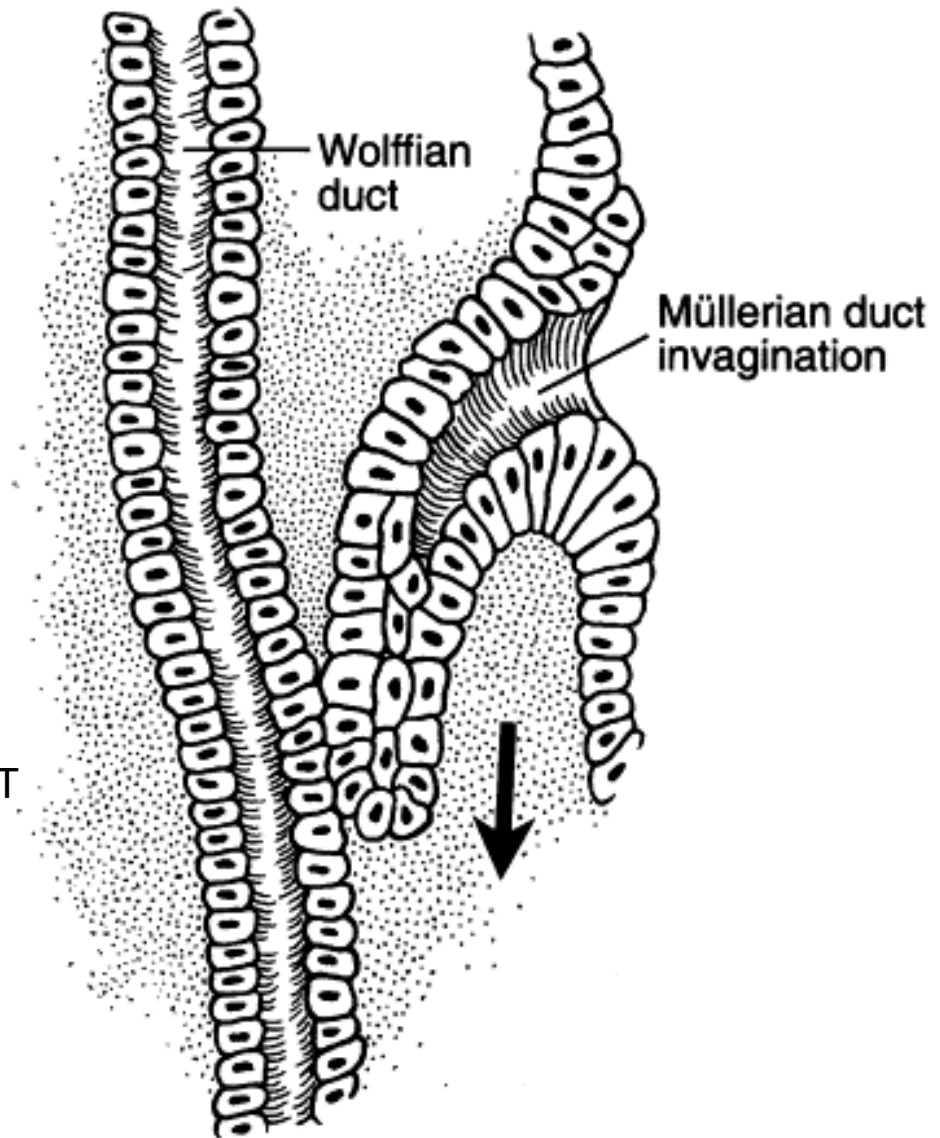




Indifferent gonad

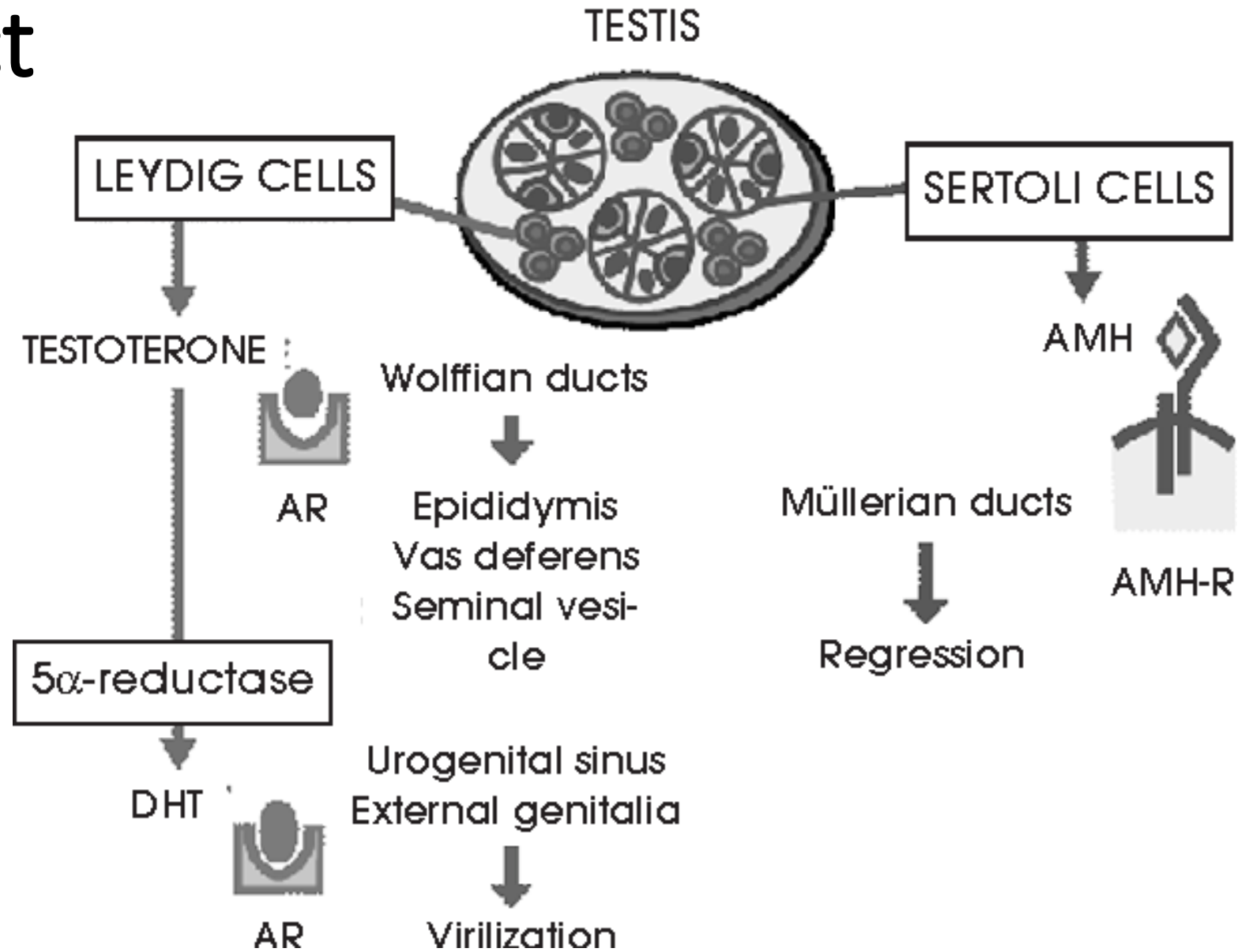


Mesonephric (Wolffian) and paramesonephric (Müllerian) duct



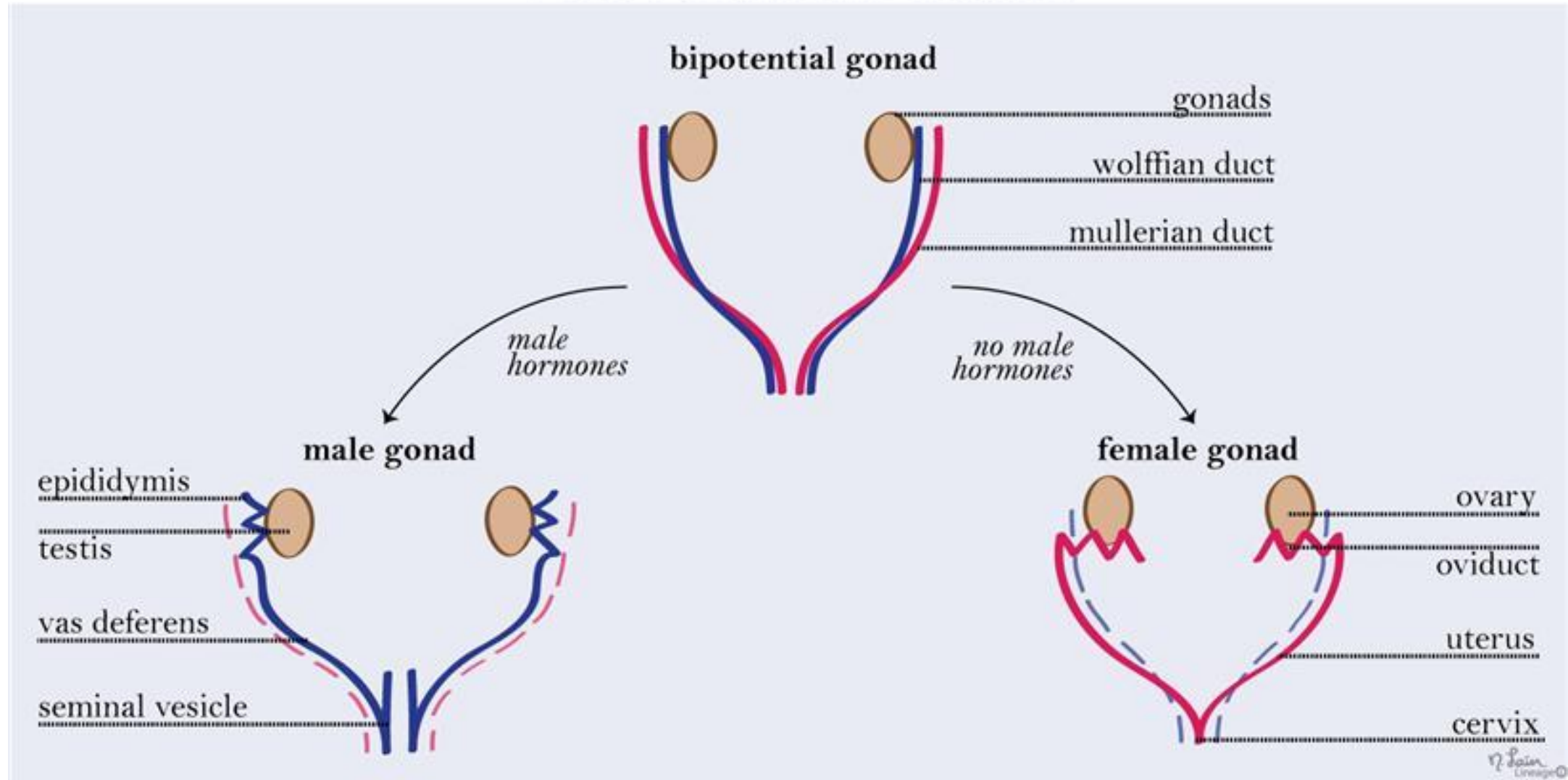
Paul C Lin, Kunwar P Bhatnagar, G.Stephen Nettleton, Steven T Nakajima, Female genital anomalies affecting reproduction, Fertility and Sterility, Volume 78, Issue 5, 2002, Pages 899-915, ISSN 0015-0282, [https://doi.org/10.1016/S0015-0282\(02\)03368-X](https://doi.org/10.1016/S0015-0282(02)03368-X).

Mesonephric (Wolffian) and paramesonephric (Müllerian) duct

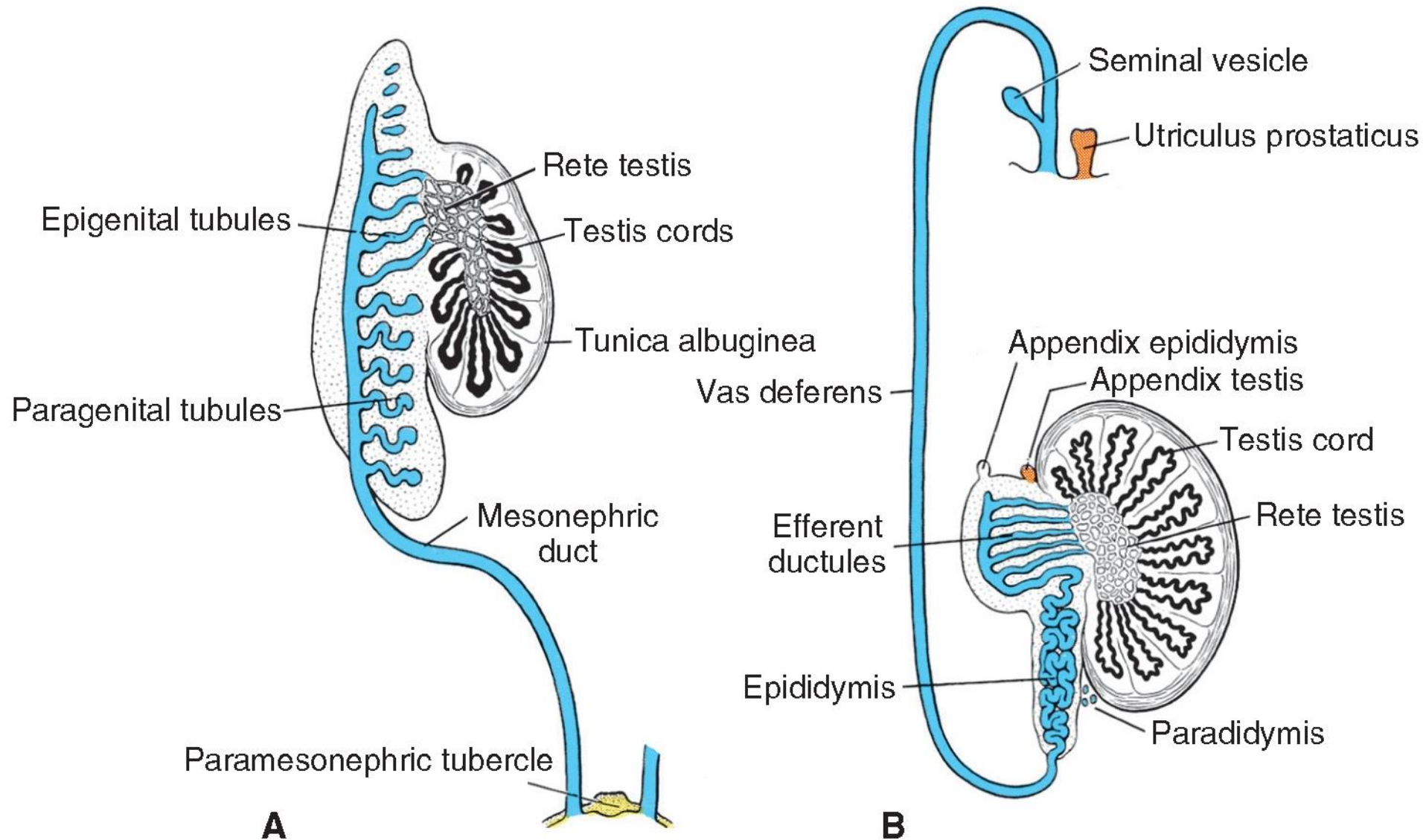


Rey, Rodolfo Alberto. "Anti-Müllerian hormone in disorders of sex determination and differentiation." *Arquivos brasileiros de endocrinologia e metabologia* 49 1 (2005): 26-36 .

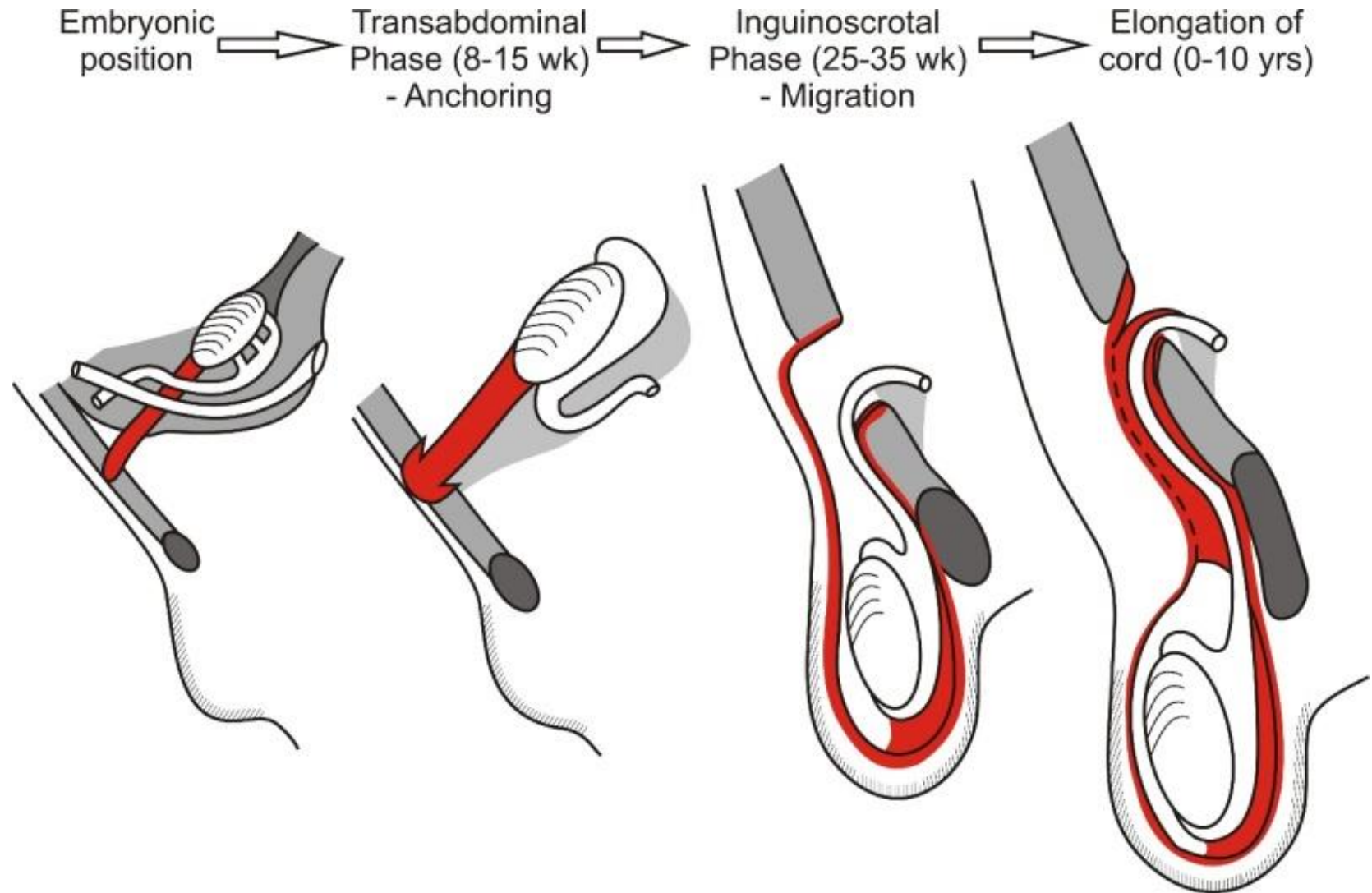
Male/Female Differentiation



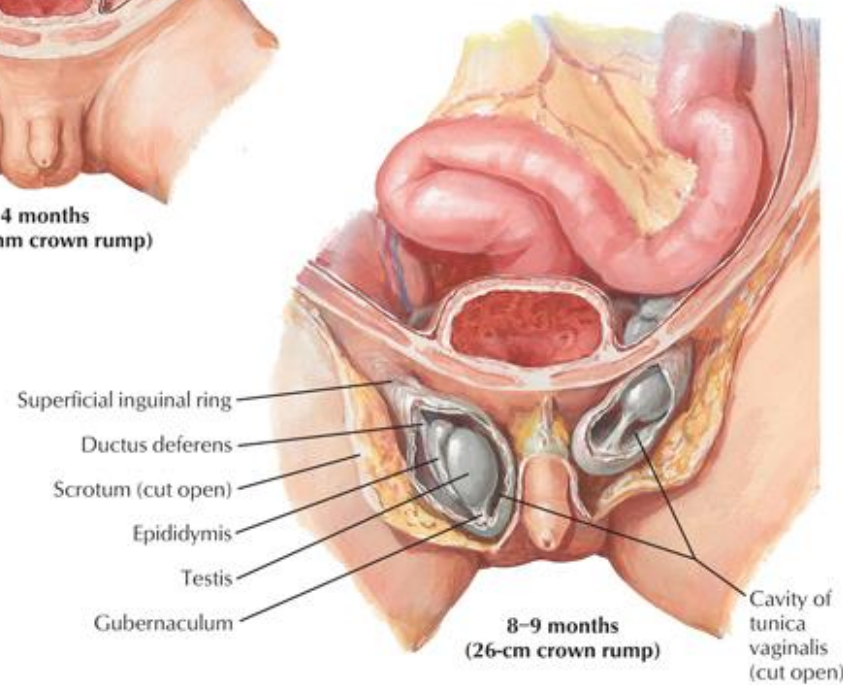
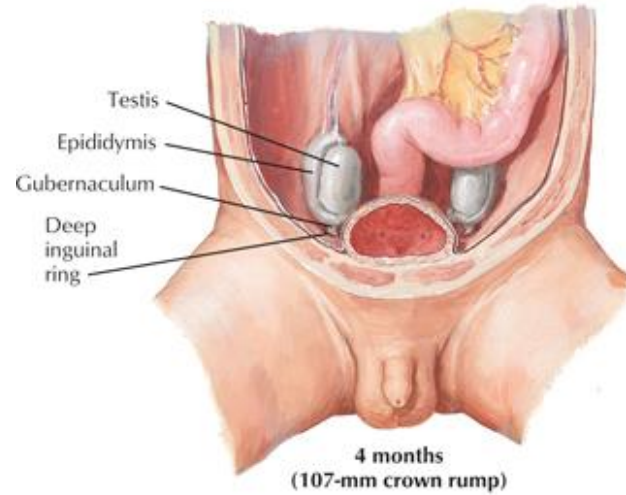
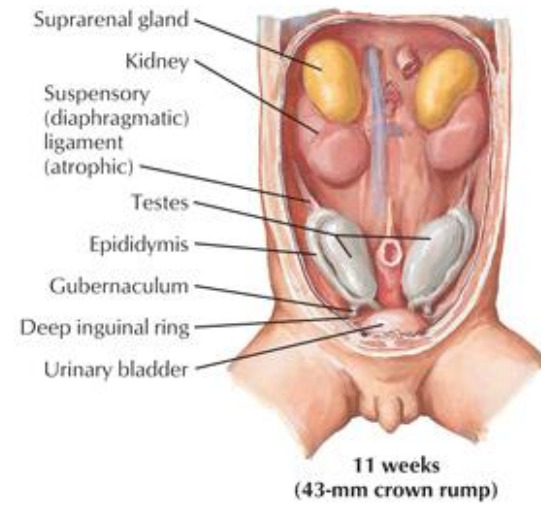
Testis, epididymis, ducts



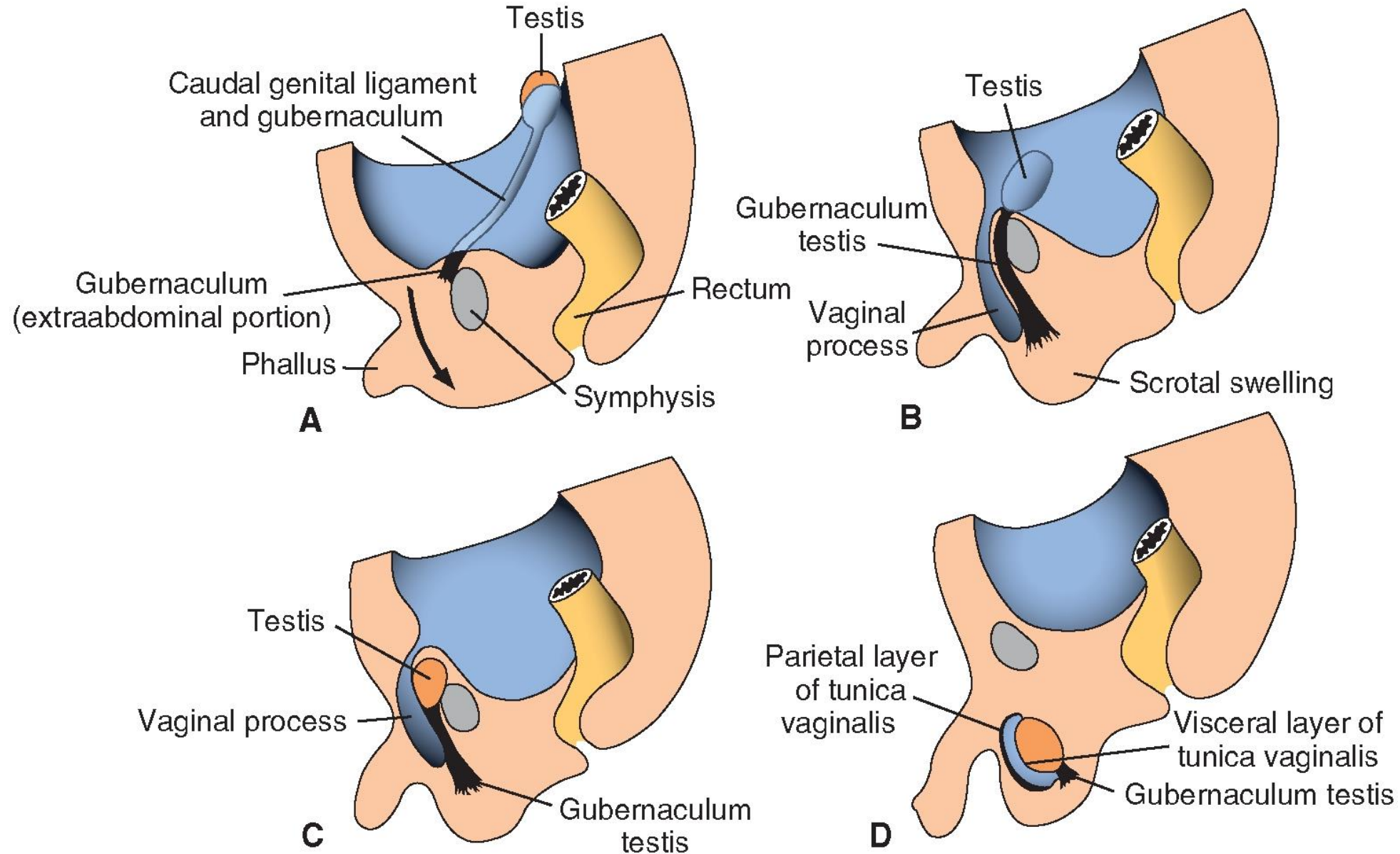
Testis descent



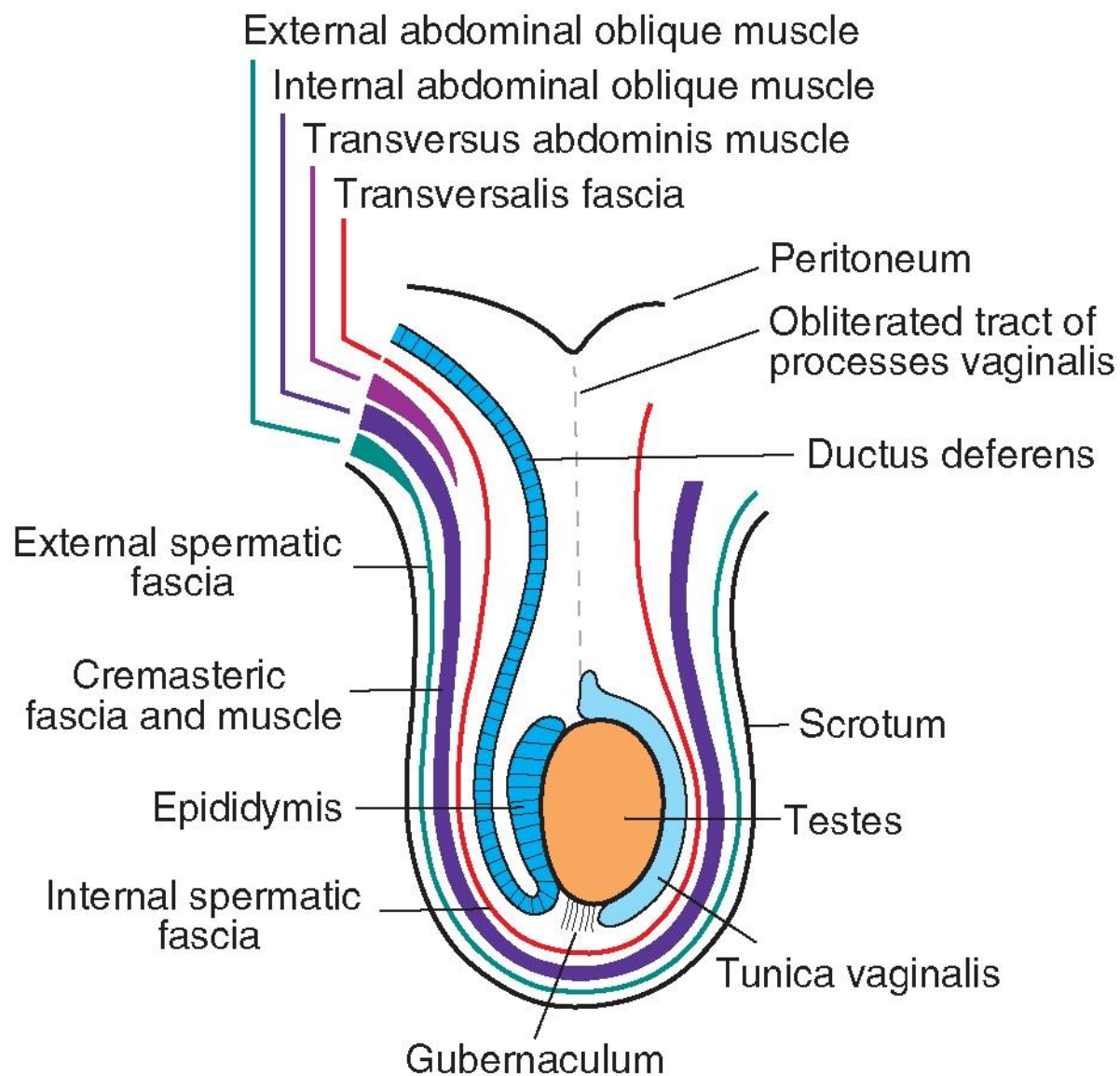
Testis descent



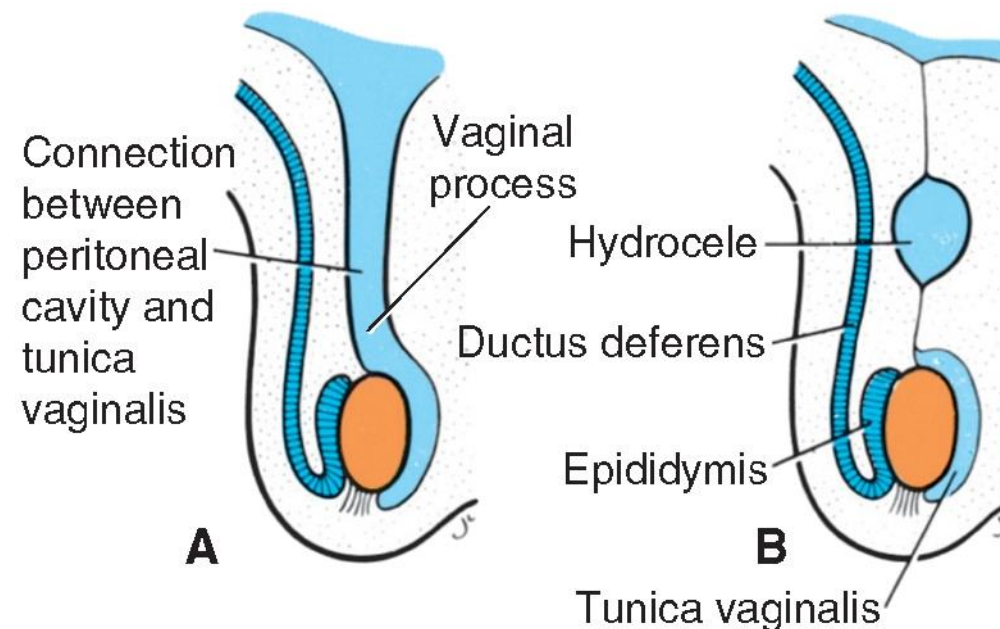
Testis descent



Scrotum



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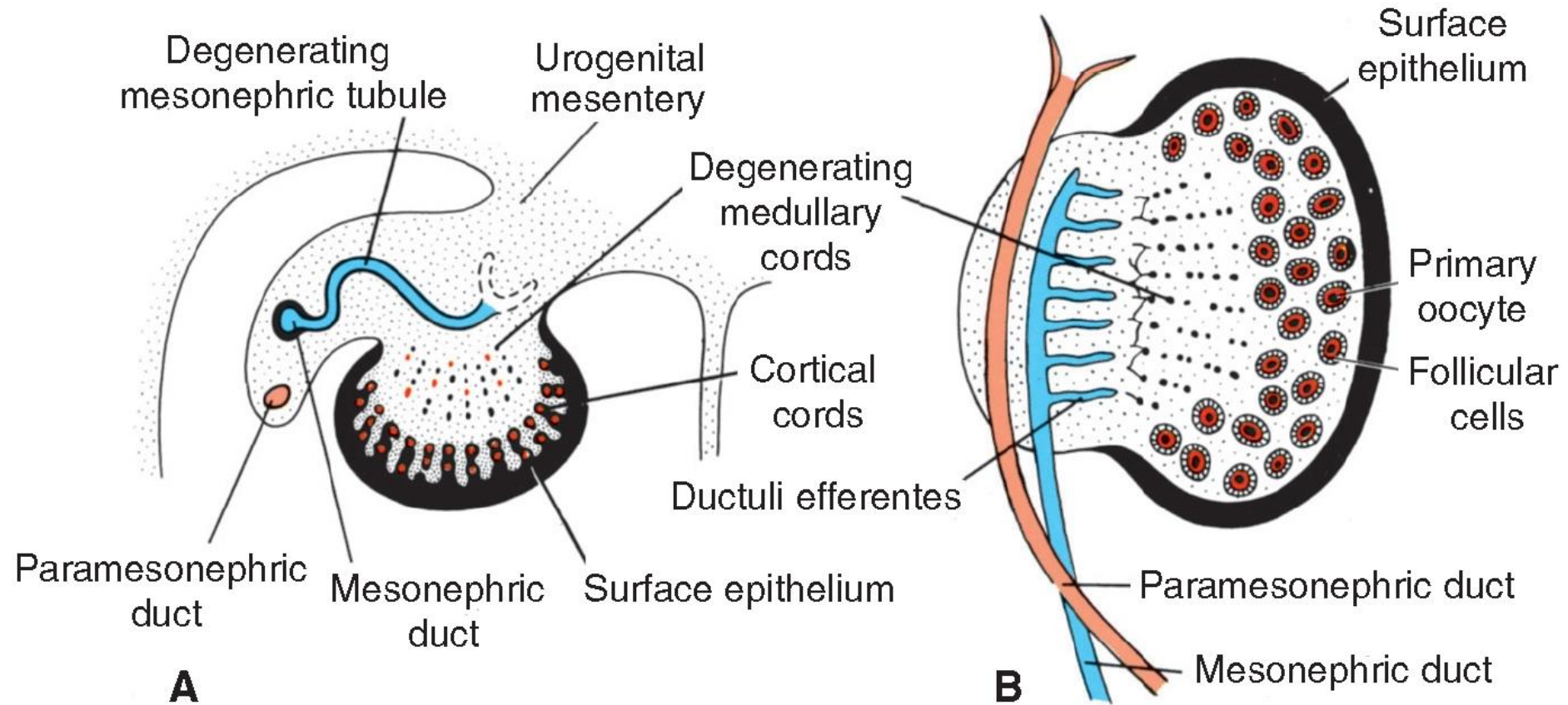


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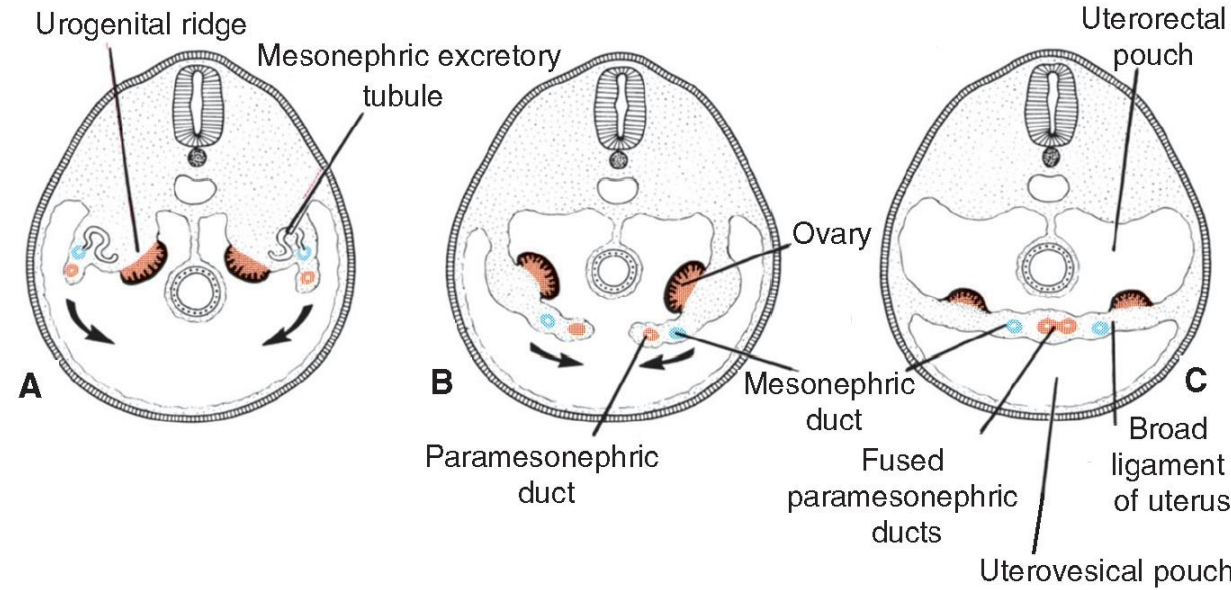
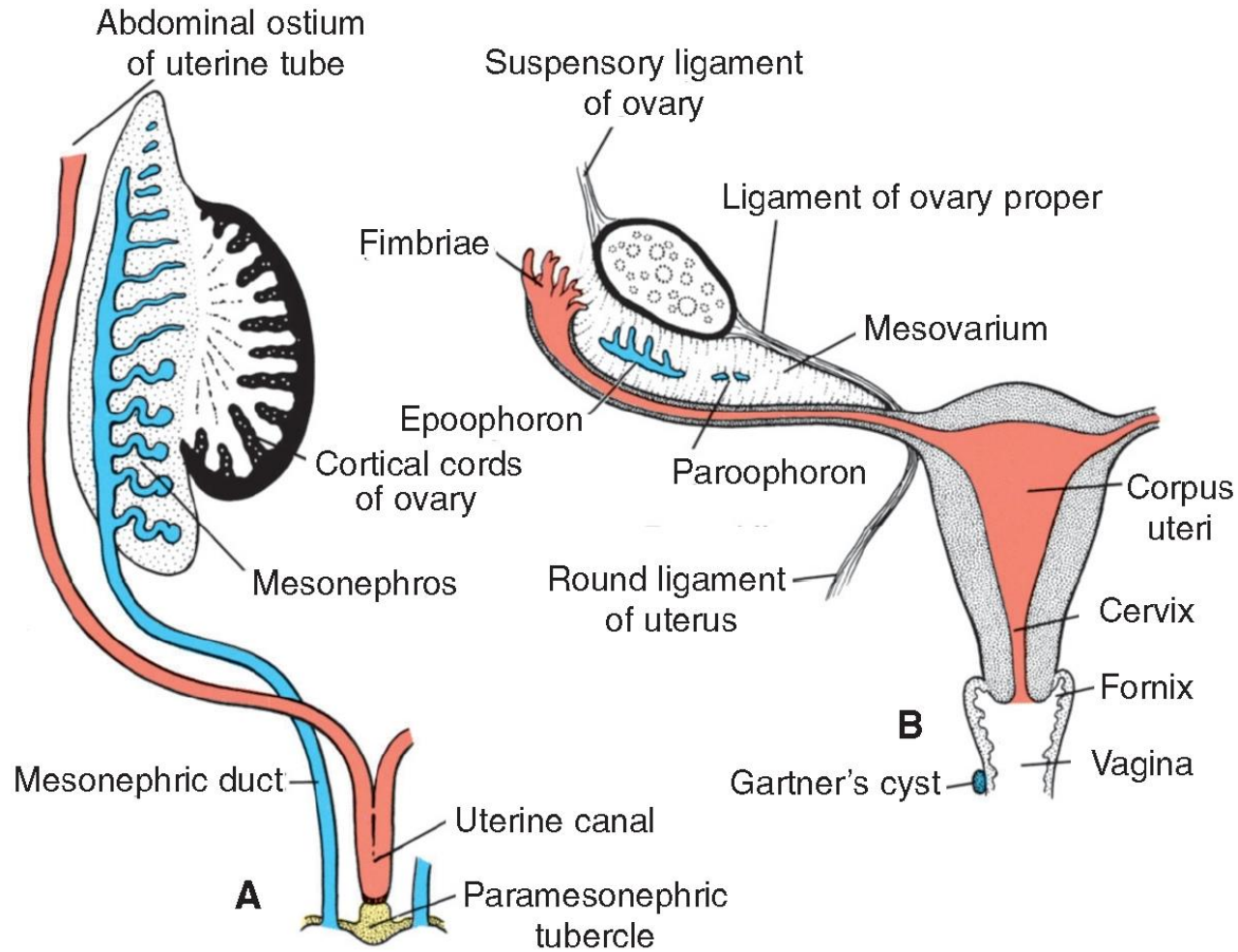
Inborn inguinal hernia

Hydrocele

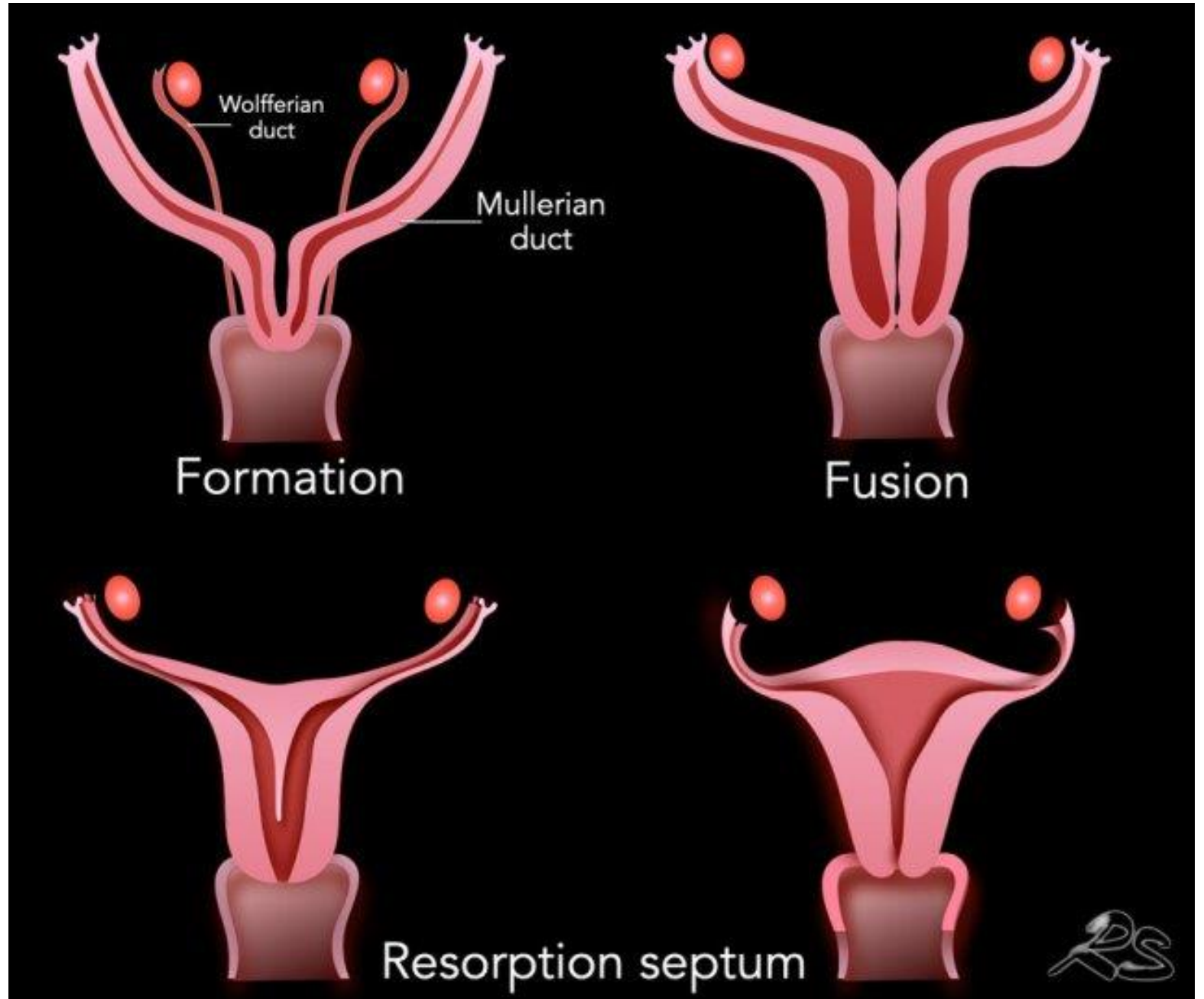
Ovary



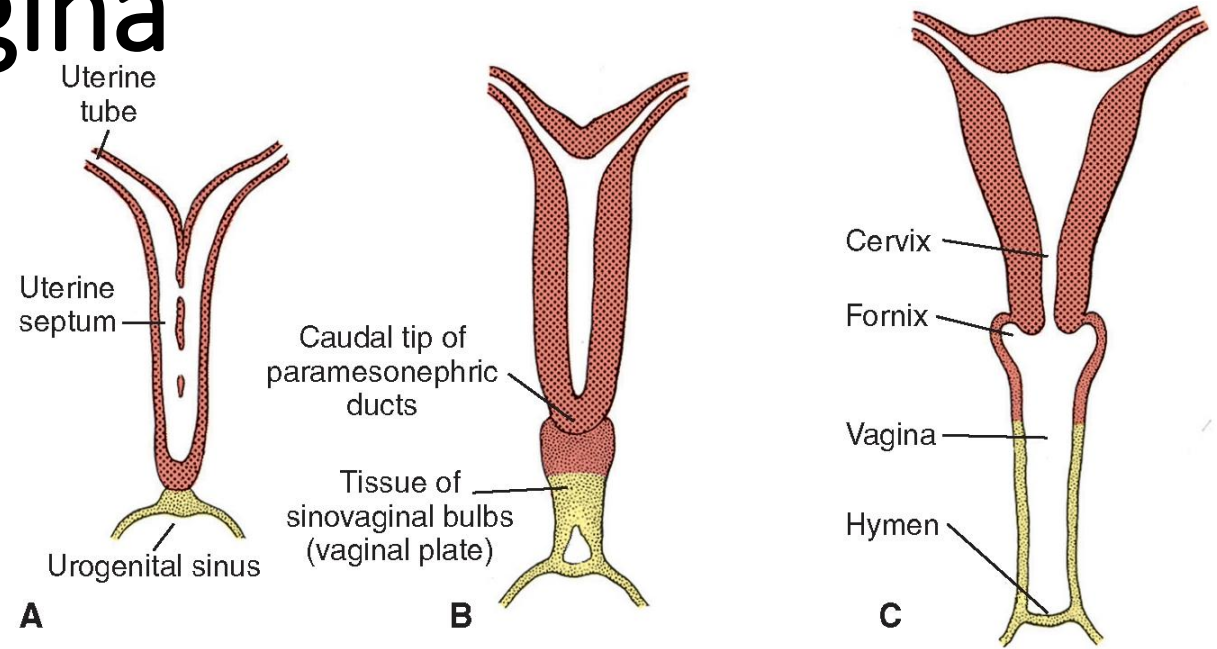
Ovary, uterus, vagina



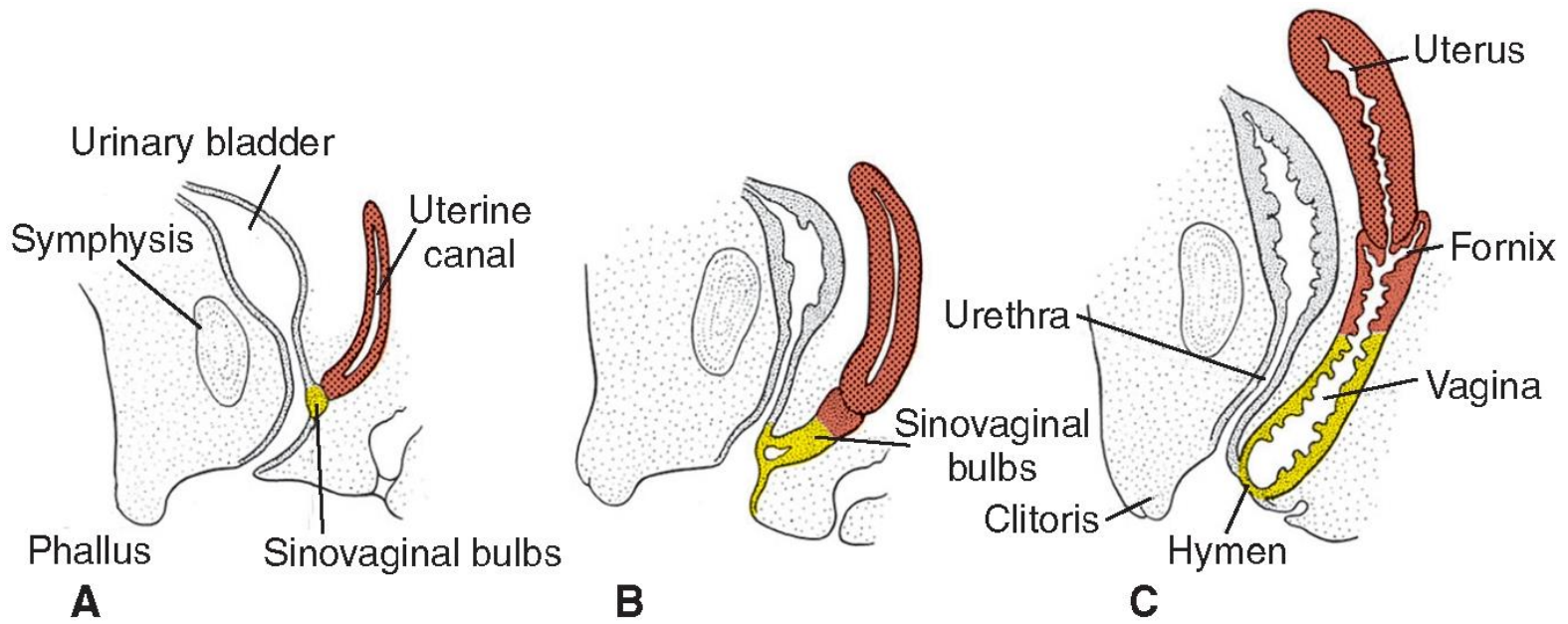
Uterus, vagina



Uterus, vagina

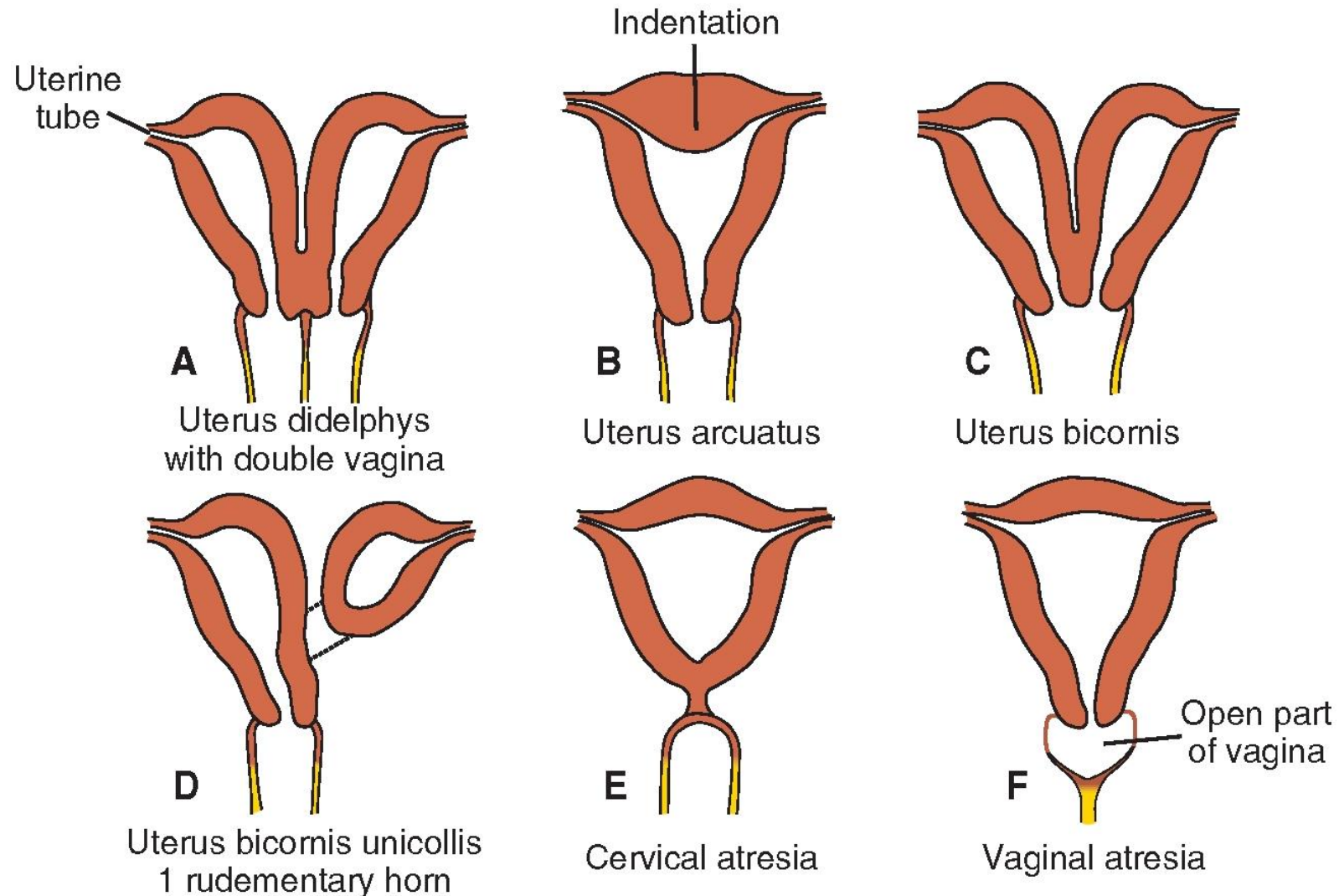


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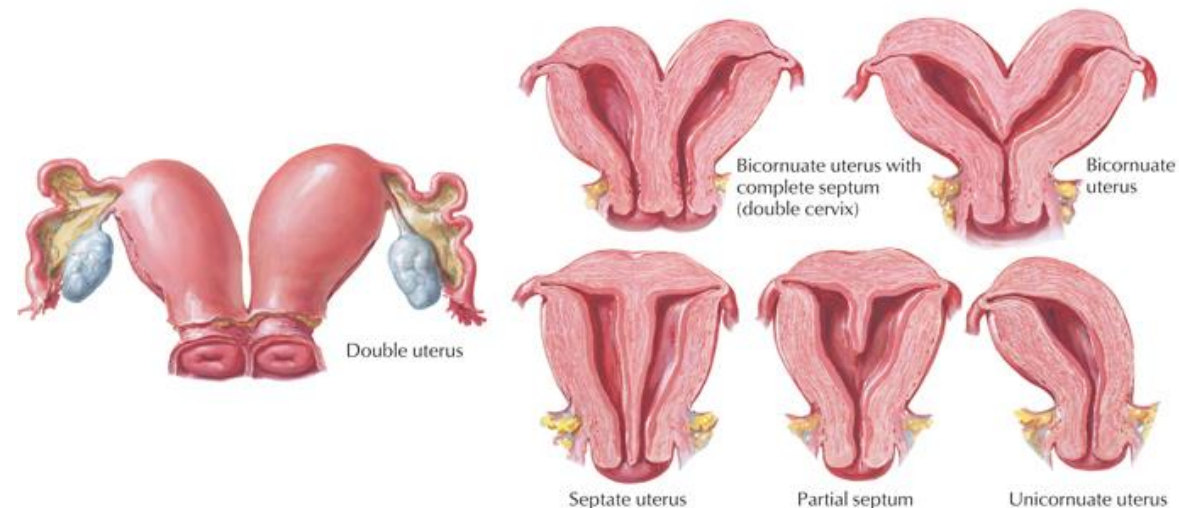
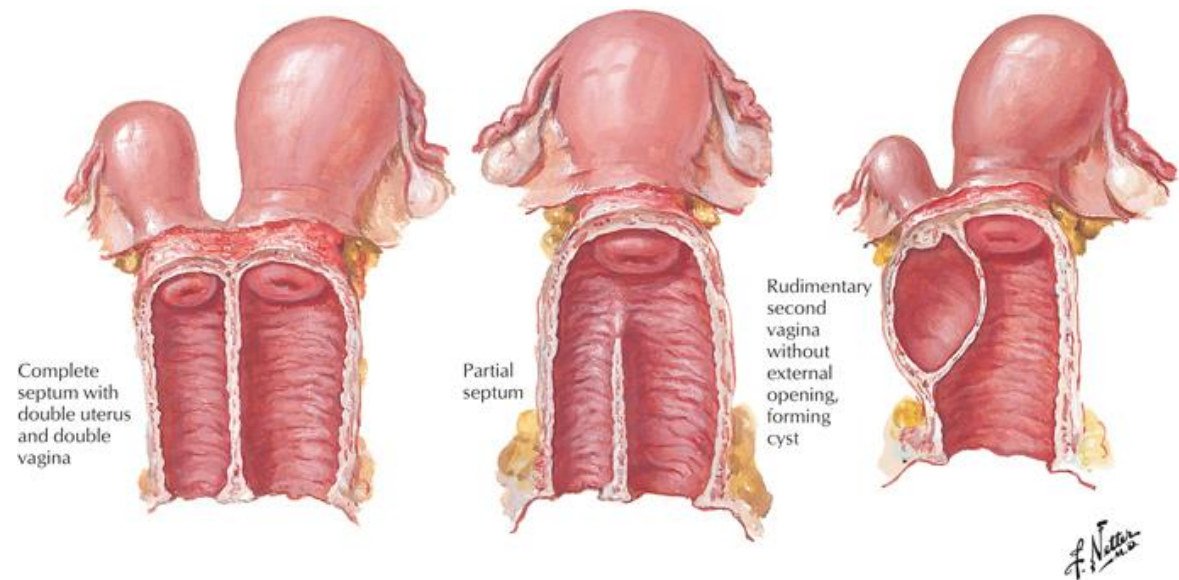


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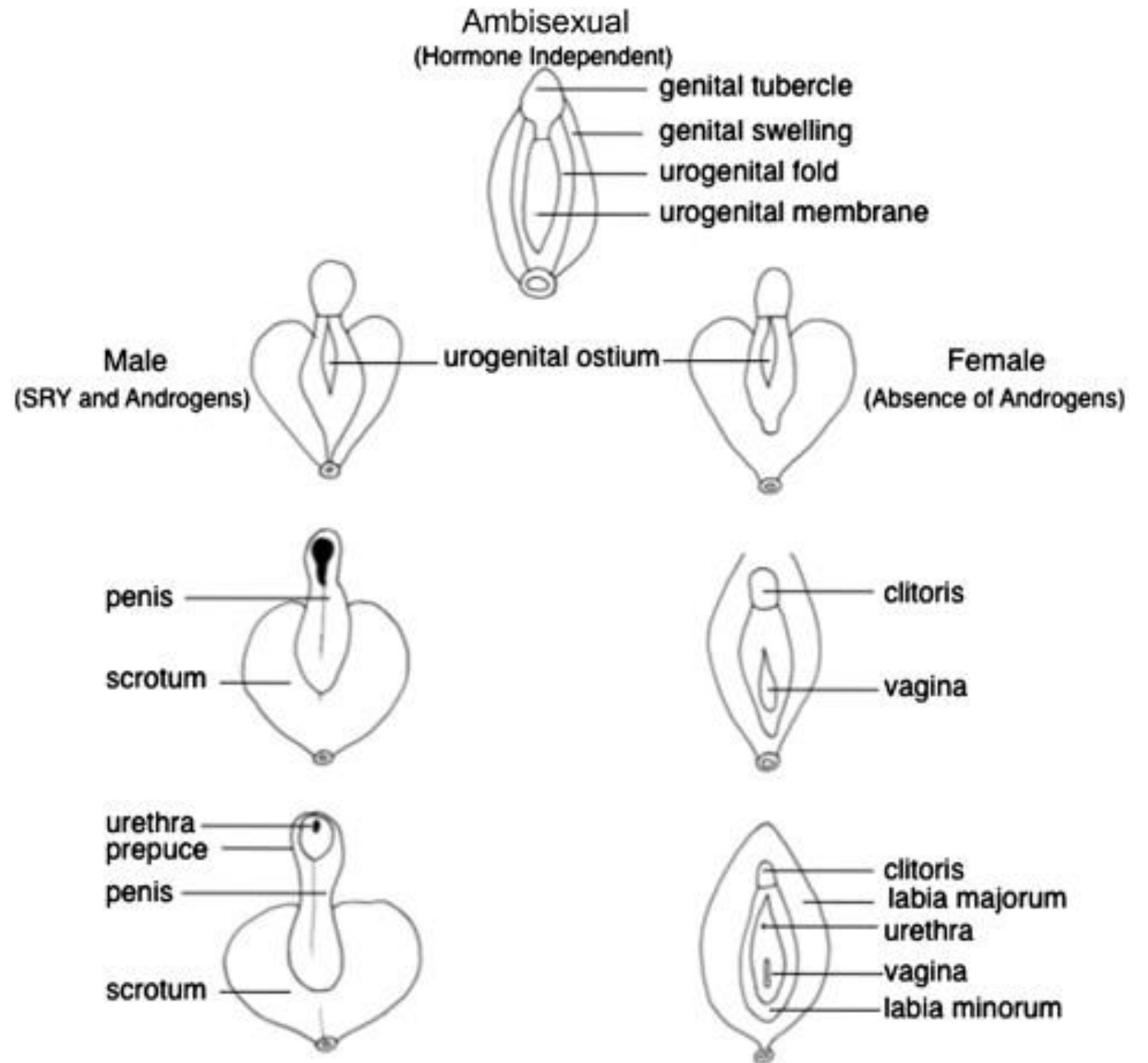
Developmental defects



Developmental defects

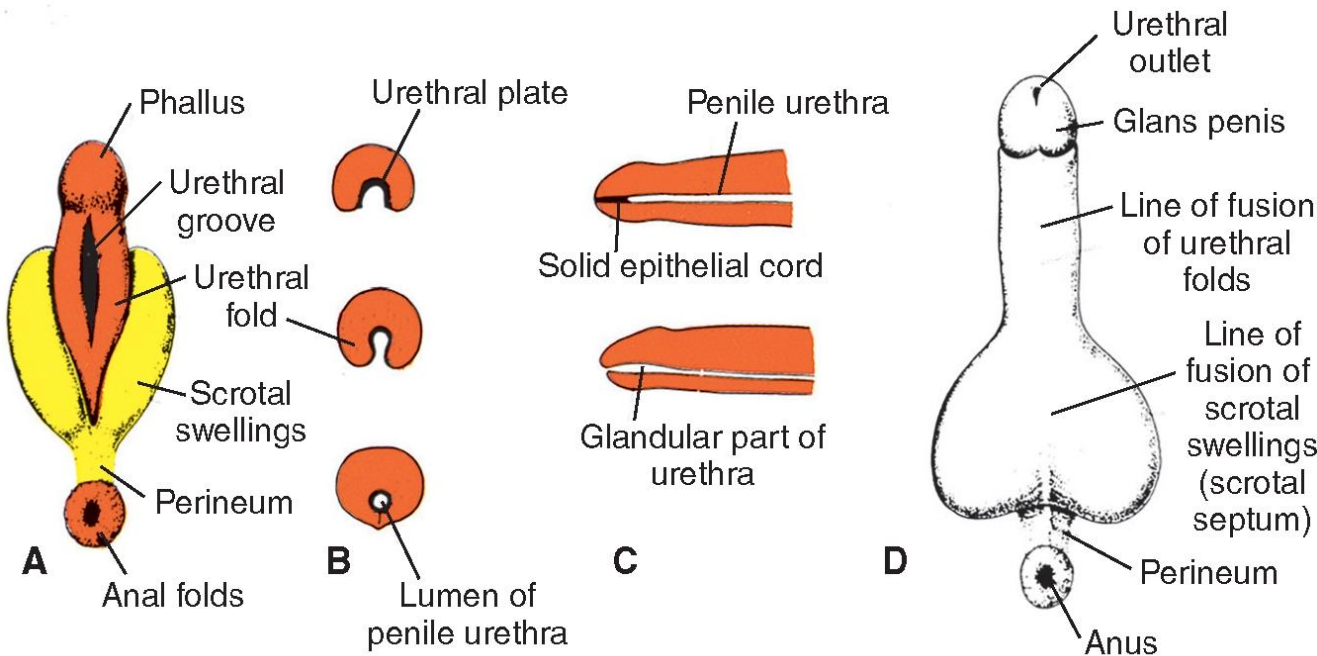
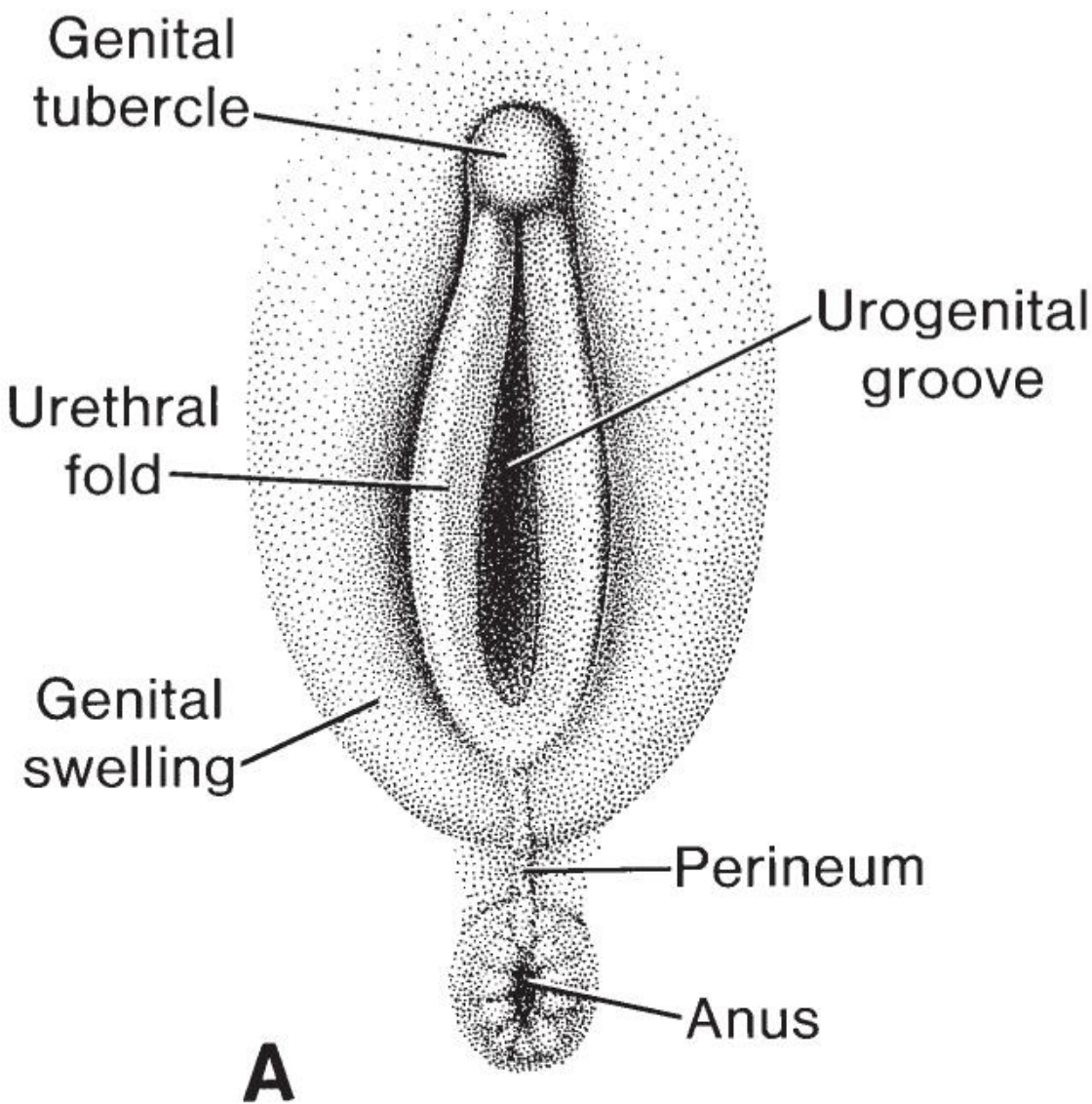


External genitalia

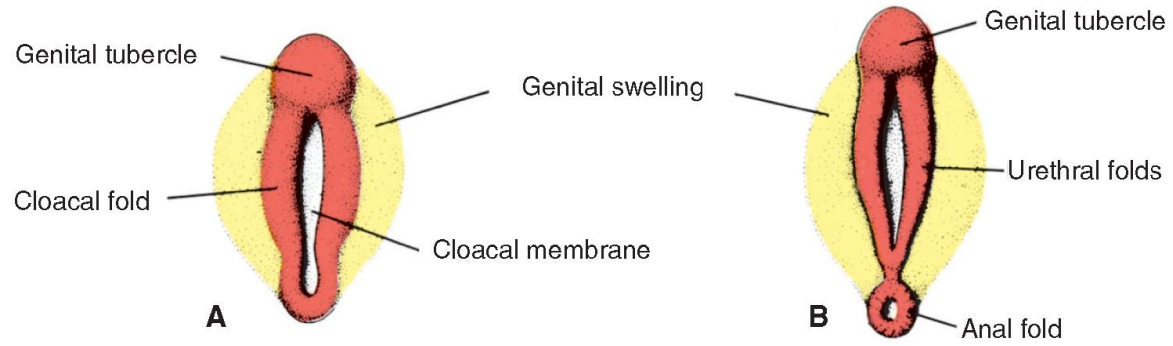


Sarah D. Blaschko, Gerald R. Cunha,
Laurence S. Baskin,
Molecular mechanisms of external
genitalia development,
Differentiation, Volume 84, Issue 3, 2012,
Pages 261-268, ISSN 0301-4681,
<https://doi.org/10.1016/j.diff.2012.06.003>.

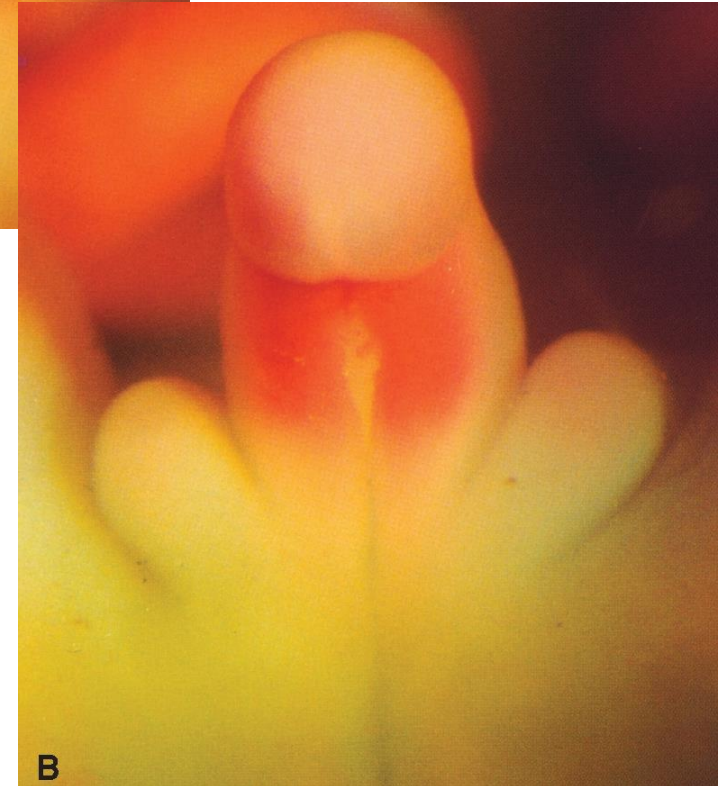
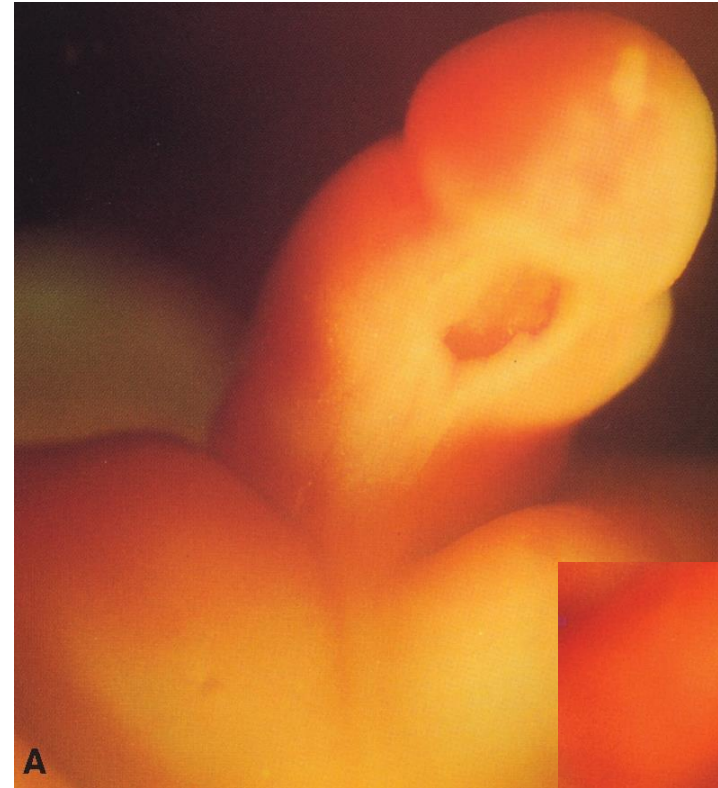
External genitalia



External genitalia

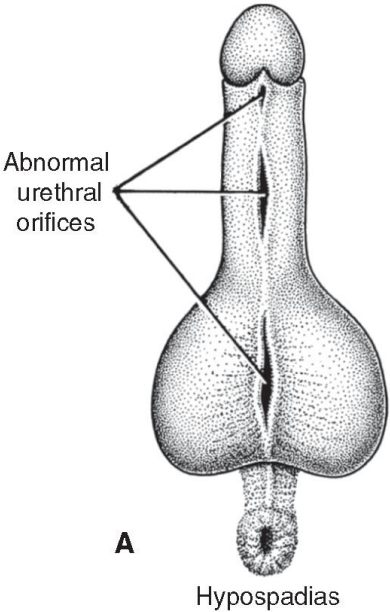
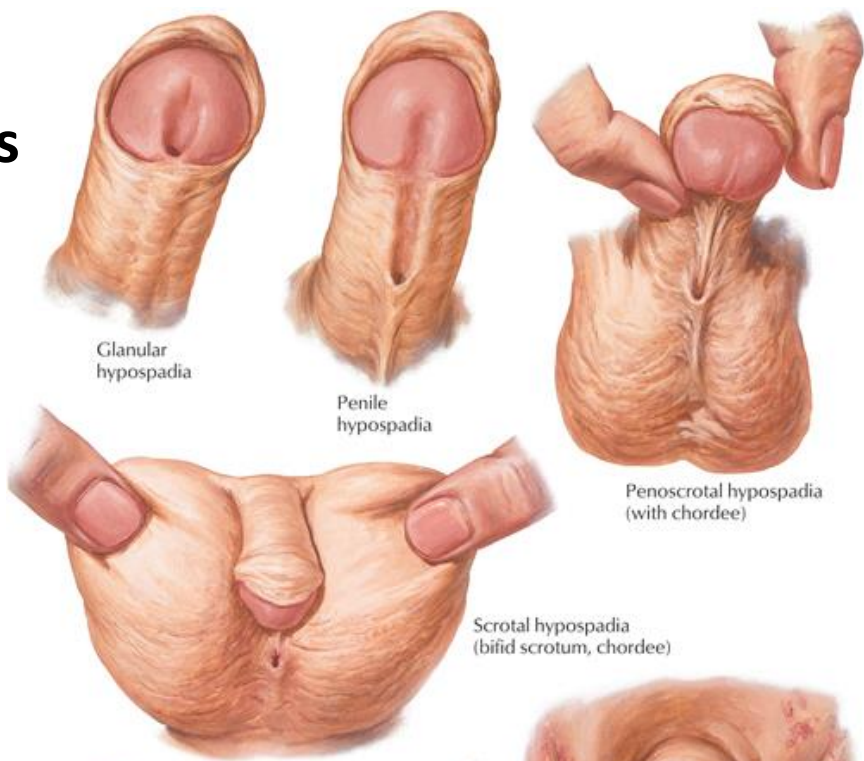


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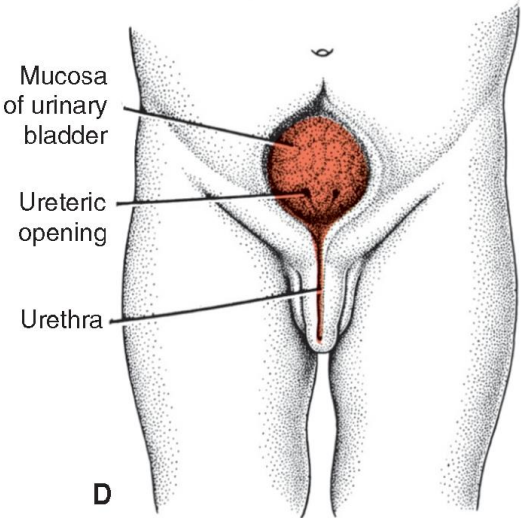
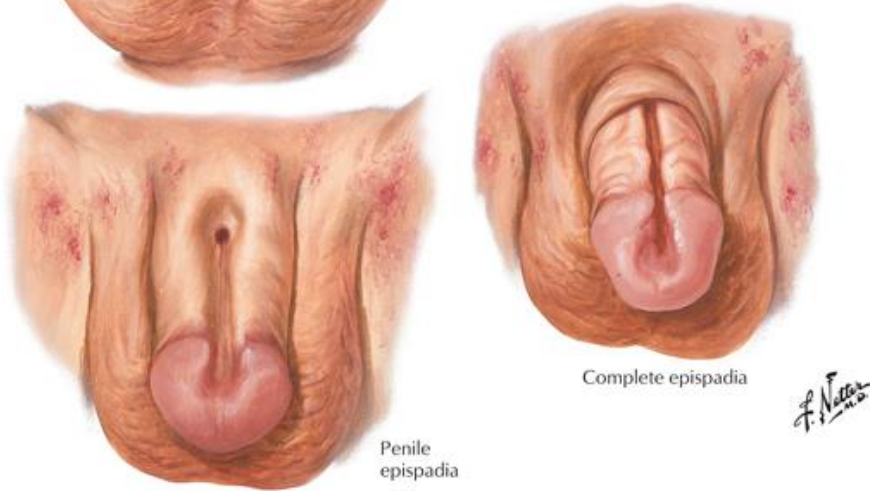


Developmental defects

Hypospadias



Epispadias



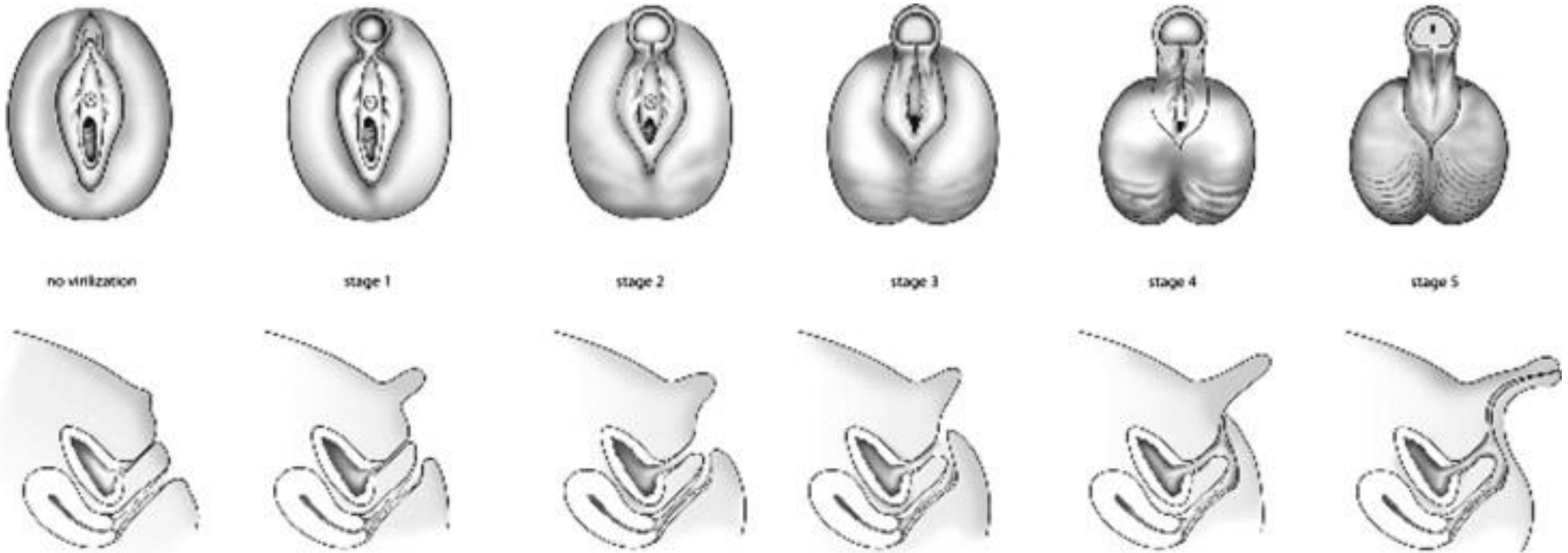


Greek physician Galen (130-c.201 AD) introduced the term “hypospadias.” Its origin is from the Greek word “hypo” which means under and “spadon” which denotes a rent or fissure

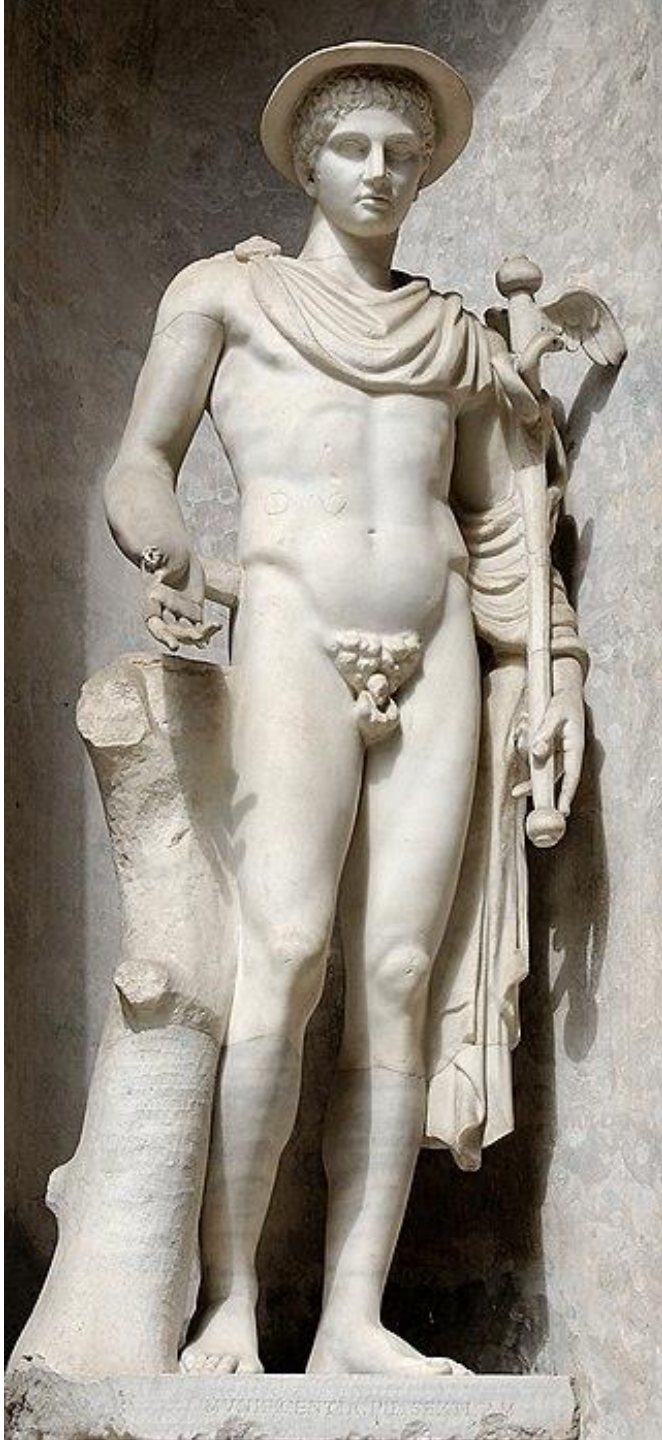
This is the case of the so-called “phallus-vulva” vase, dated back to circa 610 BC, which is part of the archaic Greek pottery of Chios and was discovered at Naucratis in Egypt in an unspecified sanctuary, probably belonging to Aphrodite

Laïos K, Karamanou M, Androutsos G. A unique representation of hypospadias in ancient Greek art. *Can Urol Assoc J*. 2012 Feb;6(1):E1-2. doi: 10.5489/cuaj.11155.

Ambiguous genitalia

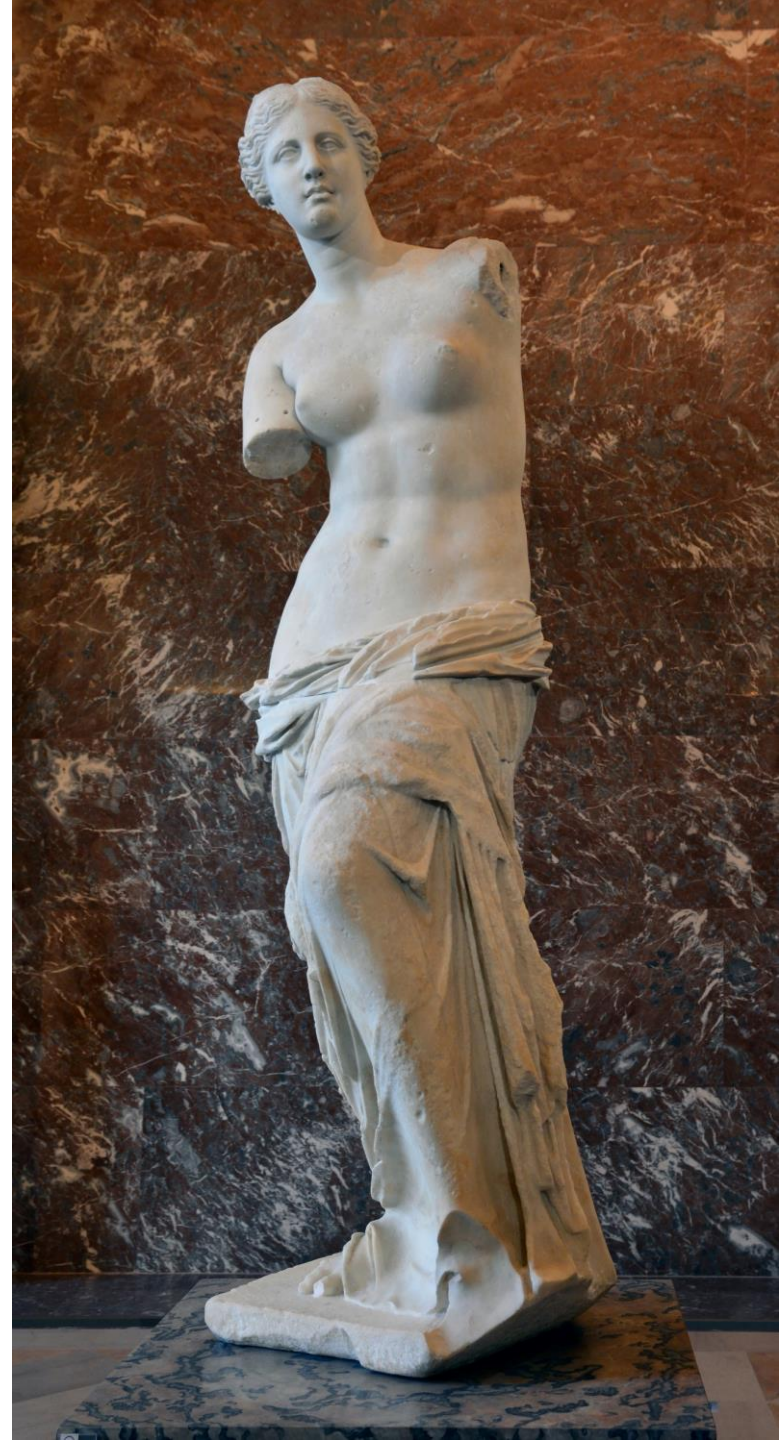


Carla Murphy, L. Allen, Mary Anne Jamieson, Ambiguous Genitalia in the Newborn: An Overview and Teaching Tool, Journal of Pediatric and Adolescent Gynecology, Volume 24, Issue 5, 2011, Pages 236-250, ISSN 1083-3188, <https://doi.org/10.1016/j.jpag.2011.02.004>.



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<https://commons.wikimedia.org/w/index.php?curid=54858474>





statue

100 / 200 (Ile s. ap. J.-C.)

Lieu de création : Italie

Lieu de découverte : Monte Porzio Catone = Tusculum - 1781
(Colonna, Casale Ciuffa)

MR 221 ; Ma 4866

Département des Antiquités grecques, étrusques et romaines

<https://collections.louvre.fr/en/ark:/53355/cl010278387>

