PIPADOR REVISION

MRCOG Part 1 Revision Notes

Development of the Kidney

EMBRYOLOGY • LECTURE 55

VISUAL EXAMINATION REVISION NOTES

2026 Edition

MRCOG Part 1 Revision Notes

Lecture 55: Development of the Kidney

Embryology • Visual revision edition

COLOUR CODE USED THROUGHOUT THESE NOTES

URETERIC BUD	METANEPHRIC BLASTEMA	VESSELS	GENITAL LINK	IMAGING / CLINICAL

LEARNING OBJECTIVES — tick off as you go

- ☐ Describe the pronephros, mesonephros and metanephros and their fates.
- ☐ Explain reciprocal induction and the two origins of each nephron.
- ☐ Describe ascent, rotation and the origin of accessory renal arteries.
- ☐ Link the kidney to the bladder, cloaca and genital tract.
- ☐ Recognise the main renal anomalies and their antenatal presentation.

1 Three Kidneys

IN ONE LINE: *Three kidneys form head-to-tail from intermediate mesoderm — only the third (metanephros) survives. The Wolffian duct's ureteric bud is what starts it.*

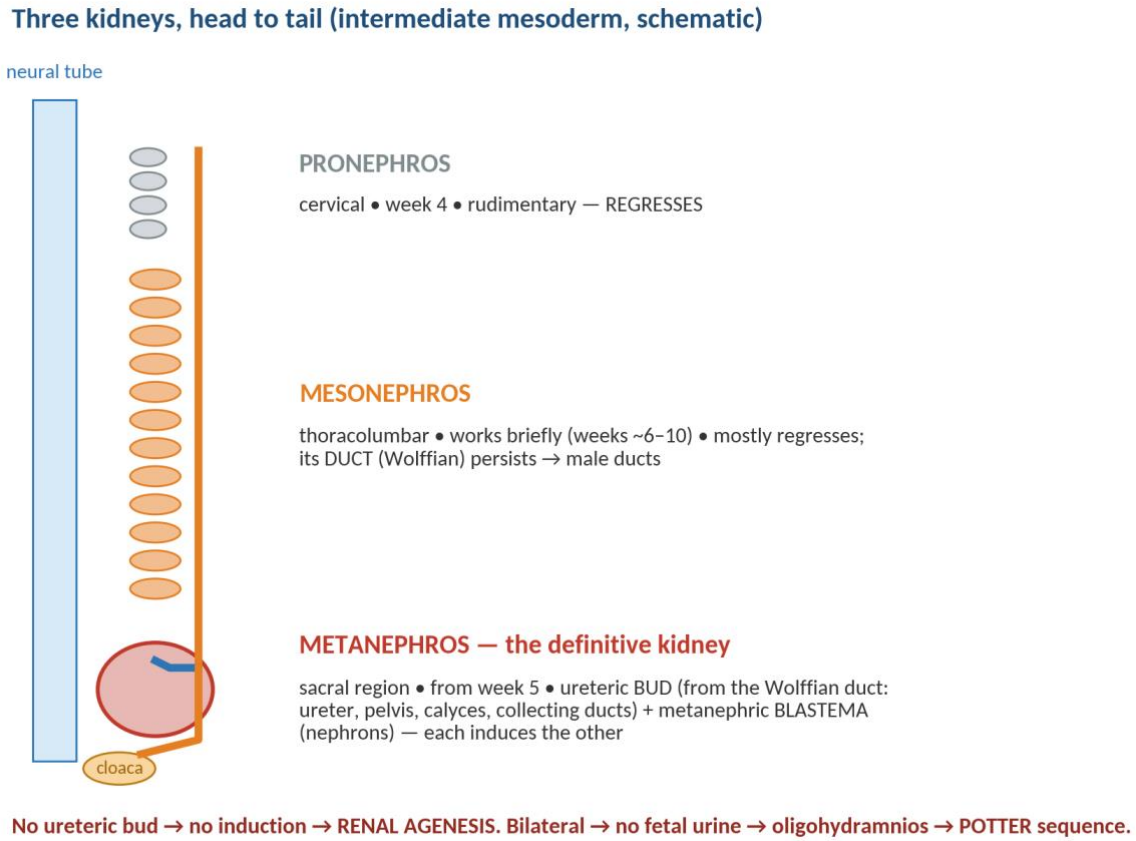


Figure 1. Pronephros, mesonephros, metanephros (from Lecture 48).

Kidney	When / where	Fate
Pronephros	Week 4, cervical	Non-functional; gone by the end of week 4
Mesonephros	Weeks 4–8, thoracolumbar	Makes a little urine (weeks ~6–10); mostly regresses. Male: efferent ductules + Wolffian duct derivatives. Female: remnants — epoöphoron, paroöphoron, Gartner's duct (cysts)
Metanephros	Week 5, sacral	Definitive kidney; urine from ~week 10

2 Metanephric Development

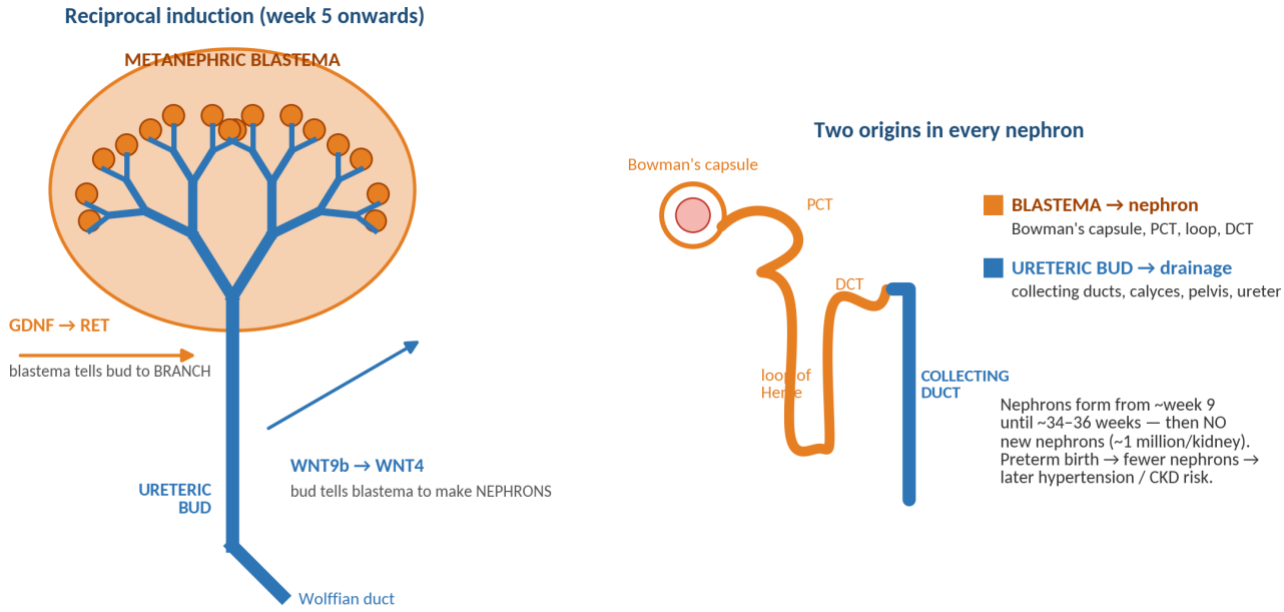


Figure 2. Reciprocal induction and the two origins of the nephron.

MNEMONIC / MEMORY HOOK

'The BUD DRAINS, the BLASTEMA FILTERS' — ureteric bud → collecting ducts, calyces, pelvis, ureter; blastema → glomerular capsule to distal tubule.

- Nephrons form from ~week 9 to ~**34–36 weeks** — after that the number is fixed (**~1 million per kidney**, wide range). Preterm and growth-restricted babies may have fewer nephrons → later **hypertension and CKD** risk.

3 Ascent and Rotation

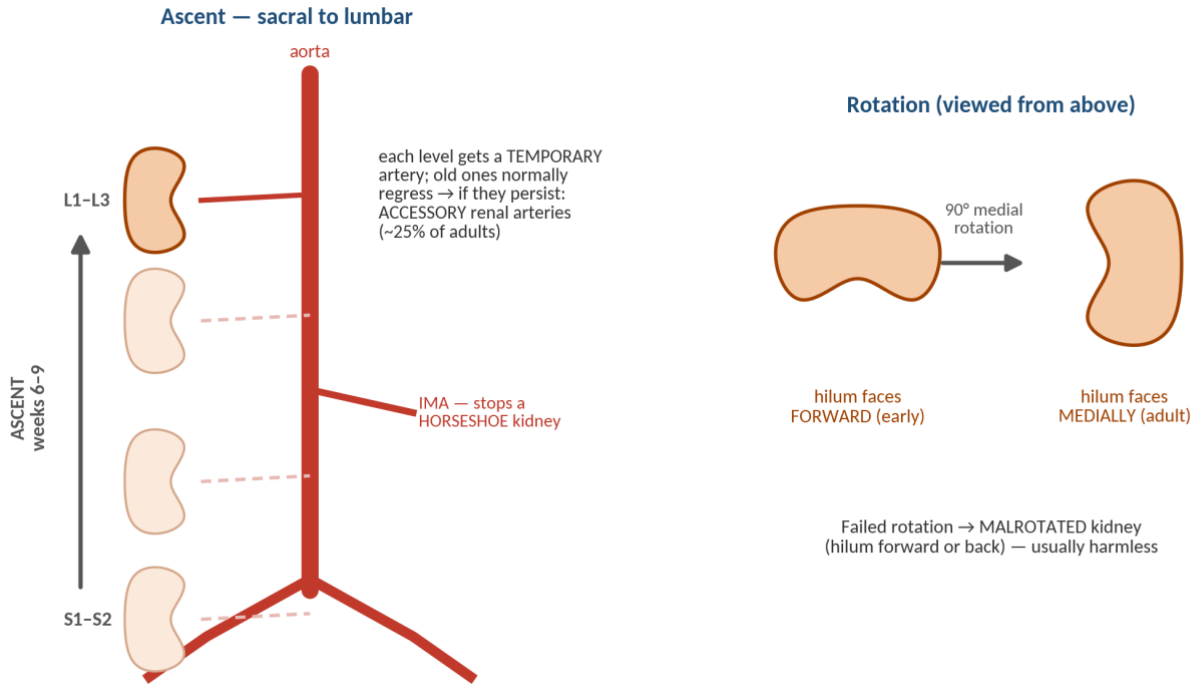


Figure 3. Ascent (weeks 6–9) and 90° rotation.

4 Function and the Lower Urinary Tract

- Urine from ~**week 10**; the **main source of amniotic fluid from ~16 weeks**. GFR at birth ~20 mL/min/1.73 m², adult level by ~2 years.

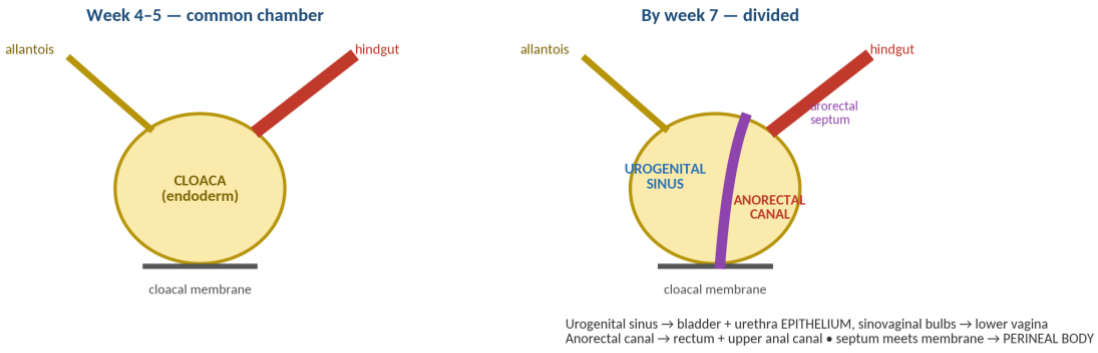


Figure 4. Cloaca divided by the urorectal septum (from Lecture 49).

- **Urogenital sinus** → bladder (upper part), pelvic urethra, phallic urethra. **Allantois → urachus → median umbilical ligament**.
- As the bladder grows, the ureter and Wolffian duct separate: **ureters open into the bladder** (trigone — classically from incorporated Wolffian duct), **Wolffian ducts into the prostatic urethra** (male) or regress (female).

5 Congenital Anomalies

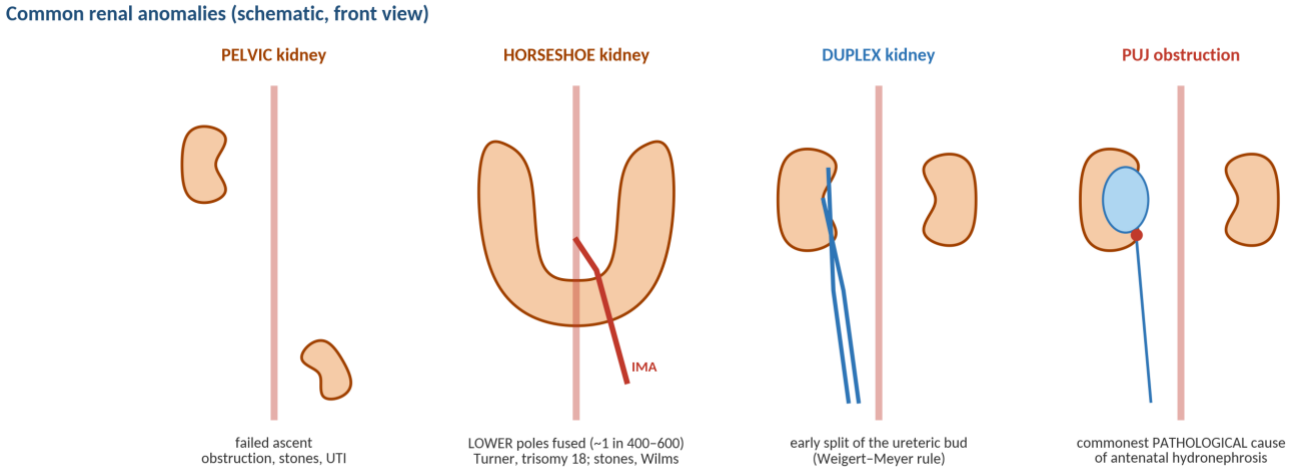


Figure 5. Common renal anomalies.

Anomaly	Key points
Renal agenesis	No bud or failed induction. Unilateral ~1 in 1000–2000 — other kidney hypertrophies; check the genital tract. Bilateral → Potter sequence, lethal
Pelvic kidney	Failed ascent — obstruction, stones, infection; can complicate pelvic surgery or labour
Horseshoe	Lower poles fuse; trapped under the IMA (~L3); ~1 in 400–600; Turner, trisomy 18; stones, obstruction, Wilms
Duplex / bifid ureter	Early split of the ureteric bud — Weigert–Meyer rule
PUJ obstruction	Commonest pathological cause of antenatal hydronephrosis (most mild dilatation is transient)
Vesicoureteric reflux	Short intramural tunnel → UTIs, scarring
Multicystic dysplastic kidney	Non-functioning cystic kidney, usually unilateral, involutes; check the other kidney (reflux, PUJ obstruction)
Bladder exstrophy / urachal remnants	Mesoderm fails to migrate → open bladder, epispadias, pubic diastasis • urachal cyst/sinus/fistula → umbilical discharge

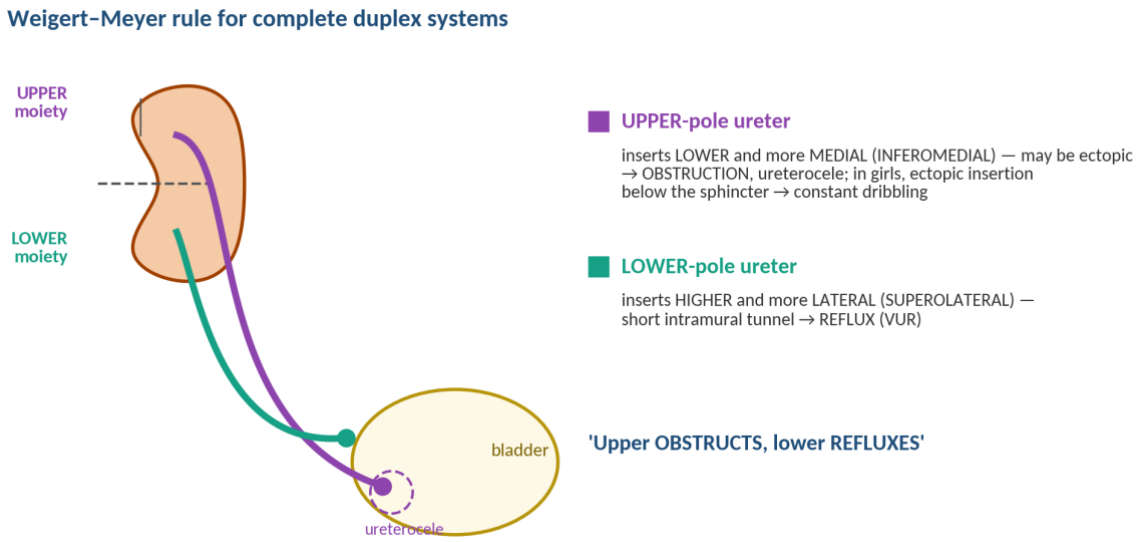


Figure 6. Weigert–Meyer rule.

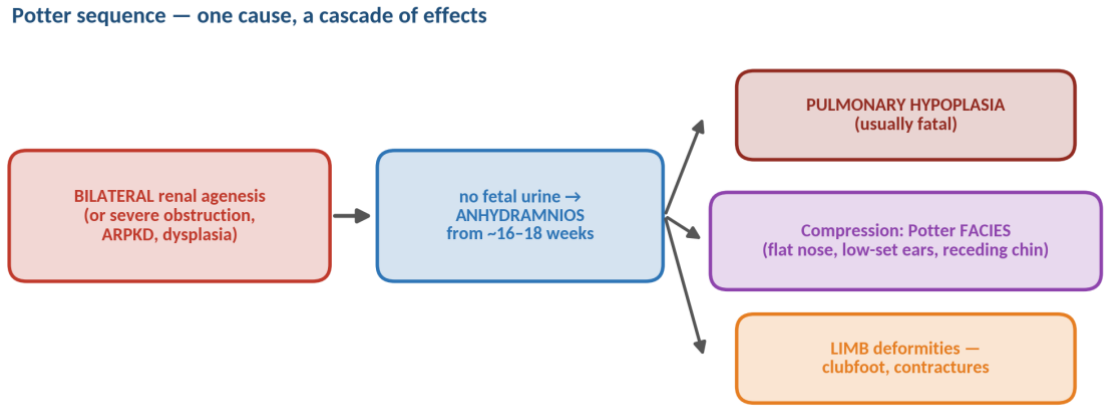


Figure 7. Potter sequence.

ARPKD

- **PKHD1** (chr 6), autosomal recessive
- **Fetal/neonatal**: big bright (echogenic) kidneys, **oligohydramnios**, pulmonary hypoplasia; liver fibrosis
- 25% recurrence

ADPKD

- **PKD1** (chr 16) or **PKD2** (chr 4), autosomal dominant
- Usually **adult**: hypertension, kidney failure, liver cysts, **berry aneurysms**
- 50% transmission

EXAM HOOK

Kidney and Müllerian ducts both come from intermediate mesoderm — so **always image the kidneys in a woman with a Müllerian anomaly** (MRKH: renal anomalies in ~30–40%; **MURCS** = Müllerian aplasia, Renal aplasia, Cervicothoracic Somite anomalies).

6 Antenatal Imaging

- Kidneys visible from ~12–14 weeks; checked at the 18^{+0}–20^{+6} anomaly scan. **Renal pelvis AP diameter** thresholds vary by guidance — commonly **≥ 7 mm at the anomaly scan** → third-trimester scan, **≥ 10 mm in the third trimester** → postnatal follow-up, **> 15 mm** significant.
- **Oligohydramnios** after ~16 weeks → think renal (agenesis, obstruction, ARPKD) — or PPROM, FGR. MRI can help when the view is poor.

★ PEARL

Bilateral renal agenesis → no urine → anhydramnios → **pulmonary hypoplasia** + Potter facies + limb deformities.

Horseshoe kidney — lower poles fused, **trapped by the IMA**, linked to **Turner syndrome**.

7 MRCOG Exam Pearls — Last-Minute Page

Numbers to know

Week 5 Metanephros begins	**Week 10** Urine production	**34–36 wk** Last nephrons	**~1 million** Nephrons per kidney
Weeks 6–9 Ascent	**~25%** Accessory renal arteries	**1:400–600** Horseshoe kidney	**~30–40%** MRKH with renal anomaly

HIGH-YIELD CHECKLIST

- ☐ Pro- → meso- → metanephros; all intermediate mesoderm.
- ☐ Metanephros = ureteric bud (drainage) + blastema (nephrons); GDNF–RET, WNT9b/WNT4.
- ☐ Nephrogenesis ends ~34–36 weeks; preterm → fewer nephrons.
- ☐ Ascent S1–2 → L1–3 (weeks 6–9); temporary arteries → accessory renal arteries.
- ☐ 90° rotation — hilum turns medially.
- ☐ Urine from week 10; main liquor source from 16 weeks.
- ☐ Bilateral agenesis → Potter sequence.
- ☐ Horseshoe (IMA, Turner); duplex (upper obstructs, lower refluxes).
- ☐ ARPKD perinatal (PKHD1) vs ADPKD adult (PKD1/PKD2).
- ☐ Müllerian anomaly → image the kidneys (MRKH, MURCS).

Self-assessment — cover the right-hand column

Question	Answer
Which kidney becomes the adult kidney?	Metanephros
What does the ureteric bud form?	Ureter, pelvis, calyces, collecting ducts
What does the blastema form?	Nephron — Bowman's capsule to distal tubule
Signal from blastema that makes the bud branch?	GDNF (via RET)
When does nephrogenesis stop?	~34–36 weeks
What stops a horseshoe kidney ascending?	Inferior mesenteric artery
Weigert–Meyer: which ureter refluxes?	Lower-pole ureter
Components of Potter sequence?	Pulmonary hypoplasia, Potter facies, limb deformities
Gene for ARPKD?	PKHD1
Why image the kidneys in MRKH?	Shared intermediate mesoderm origin — ~30–40% renal anomalies

8 References

- Sadler TW. Langman's Medical Embryology. 14th ed. 2019.
- NHS Fetal Anomaly Screening Programme Handbook (current edition).
- Nguyen HT et al. Multidisciplinary consensus on urinary tract dilation (UTD) classification. J Pediatr Urol 2014.