PIPADOR REVISION

MRCOG Part 1 Revision Notes

Structural Changes in the Newborn

ANATOMY • LECTURE 35

VISUAL EXAMINATION REVISION NOTES

2026 Edition

MRCOG Part 1 Revision Notes

Lecture 35: Structural Changes in the Newborn

Anatomy • Visual revision edition

COLOUR CODE USED THROUGHOUT THESE NOTES

OXYGENATED	MIXED	DEOXYGENATED	URACHUS / DUCTS	OTHER SYSTEMS

LEARNING OBJECTIVES — tick off as you go

- ☐ Describe the fetal circulation and its three shunts.
- ☐ Explain the changes in pulmonary and systemic resistance at birth.
- ☐ State when and why each shunt closes, and its adult remnant.
- ☐ Describe renal, gut, thermal, haematological and immune changes after birth.
- ☐ Recognise PDA, PFO, PPHN, TTN and urachal / vitelline anomalies.

1 The Fetal Circulation

IN ONE LINE: *Placenta for gas exchange; lungs and liver largely bypassed — a PARALLEL circulation that must become SERIES within minutes of birth.*

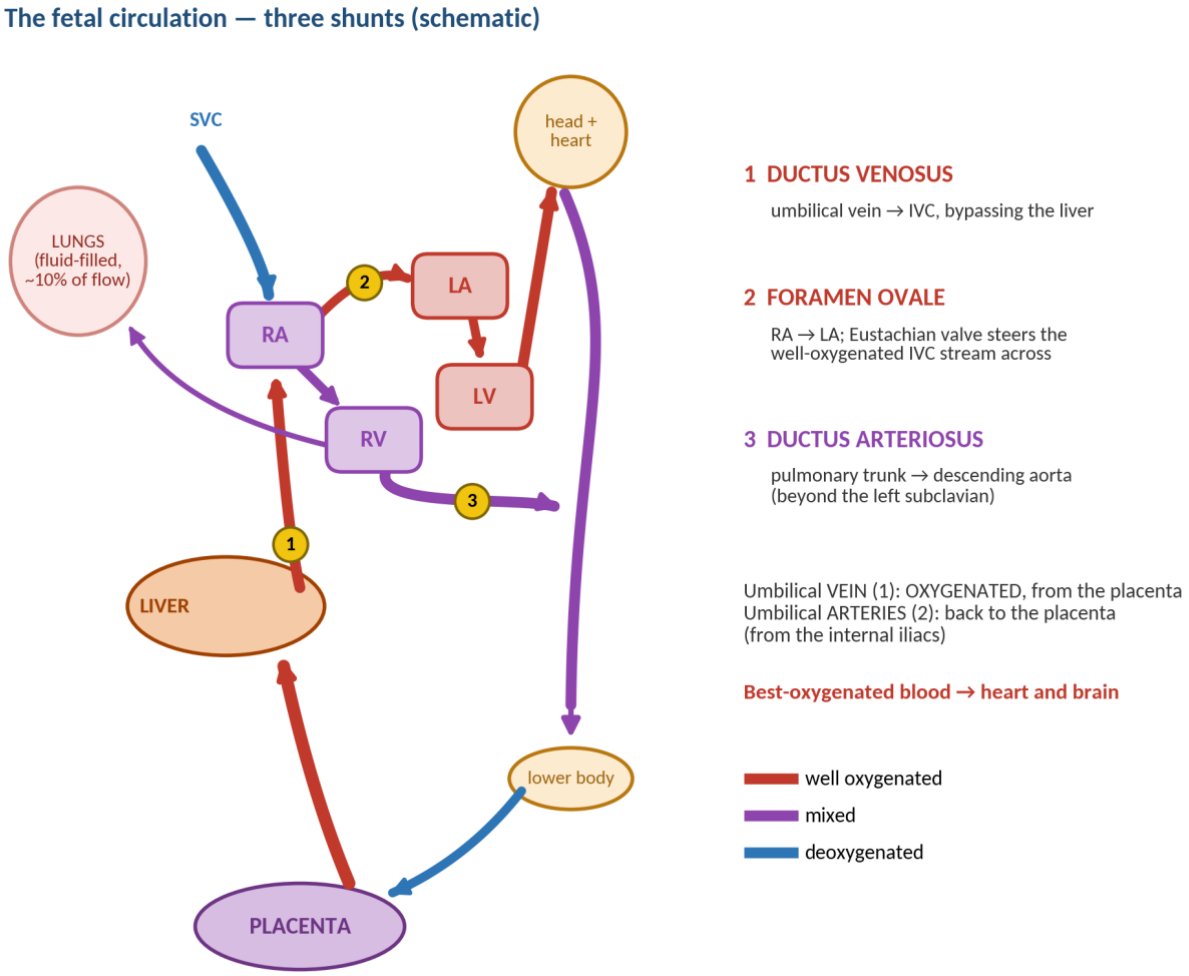

Figure 1. Fetal blood flow and the three shunts.

#	Route
1	Umbilical vein (the one vessel carrying oxygenated blood, sO_2 ~80–85%) → liver; a large share bypasses it through the ductus venosus → IVC
2	IVC → right atrium; the Eustachian valve steers the better-oxygenated stream through the foramen ovale → LA → LV → ascending aorta → heart and brain
3	SVC blood → RA → RV → pulmonary trunk; only ~10% reaches the fluid-filled, high-resistance lungs; the rest crosses the ductus arteriosus → descending aorta (beyond the left subclavian)
4	Descending aorta → lower body → two umbilical arteries (from the internal iliacs) → placenta

2 What Happens at Birth

LUNGS OPEN — PVR FALLS

- **First breath**: cold, touch, mild hypoxia/hypercarbia after cord clamping
- Opening pressure ~ −40 to −60 cmH_2O inflates the alveoli
- Lung fluid squeezed out in the birth canal and absorbed via lymphatics (slower after caesarean → **TTN**)
- **Pulmonary vascular resistance falls** ~10-fold: expansion, ↑ O_2, ↓ CO_2, NO, prostacyclin

PLACENTA GONE — SVR RISES

- Cord clamping removes the low-resistance placenta → **systemic resistance roughly doubles**
- Pulmonary venous return rises → **left atrial > right atrial pressure**
- Shunt flow reverses, then the shunts close

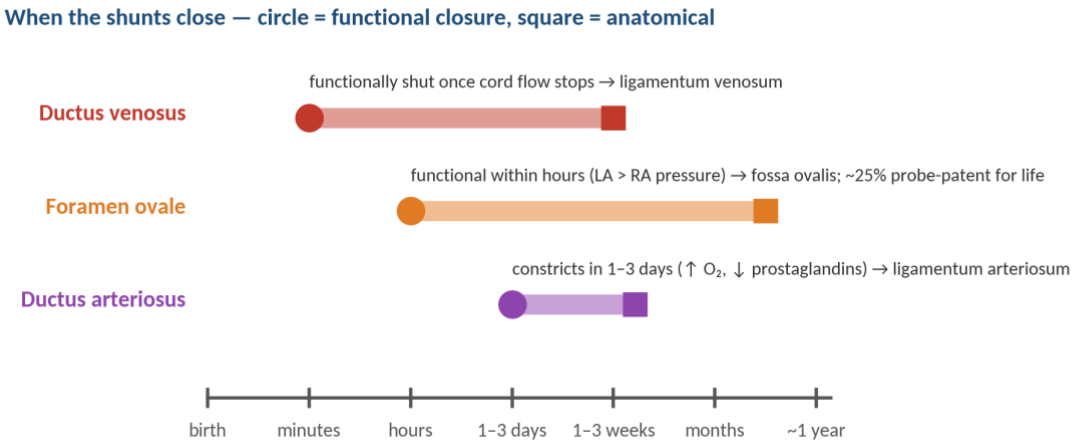

Figure 2. When each shunt closes.

Shunt	Why it closes
Ductus venosus	Umbilical venous flow stops at cord clamping; fibroses over 1–3 weeks
Foramen ovale	LA pressure > RA pressure pushes the septum primum flap against the septum secundum — functional within hours; anatomical fusion over months; ~25% remain probe-patent
Ductus arteriosus	Rising PaO_2 (main stimulus) and falling prostaglandin E_2 (placenta gone, lungs metabolise it) → constriction in 1–3 days; fibrosis over 1–3 weeks

3 Fetal Structures and Their Adult Remnants

FETAL STRUCTURE	ADULT REMNANT	
Umbilical VEIN	LIGAMENTUM TERES	free edge of the falciform ligament → porta hepatis
Ductus VENOSUS	LIGAMENTUM VENOSUM	fissure between caudate and left lobe
Foramen OVALE	FOSSA OVALIS	on the right atrial side of the septum
Ductus ARTERIOSUS	LIGAMENTUM ARTERIOSUM	left recurrent laryngeal nerve hooks round it
Umbilical ARTERIES (×2)	MEDIAL umbilical ligaments	proximal parts stay open as the SUPERIOR VESICAL aa.
URACHUS (allantois)	MEDIAN umbilical ligament	single, midline, bladder → umbilicus

'Three shunts → three ligaments/fossa': venosum, ovalis, arteriosum. MEDIAL = arteries (paired), MEDIAN = urachus (single).

Figure 3. What each fetal channel becomes.

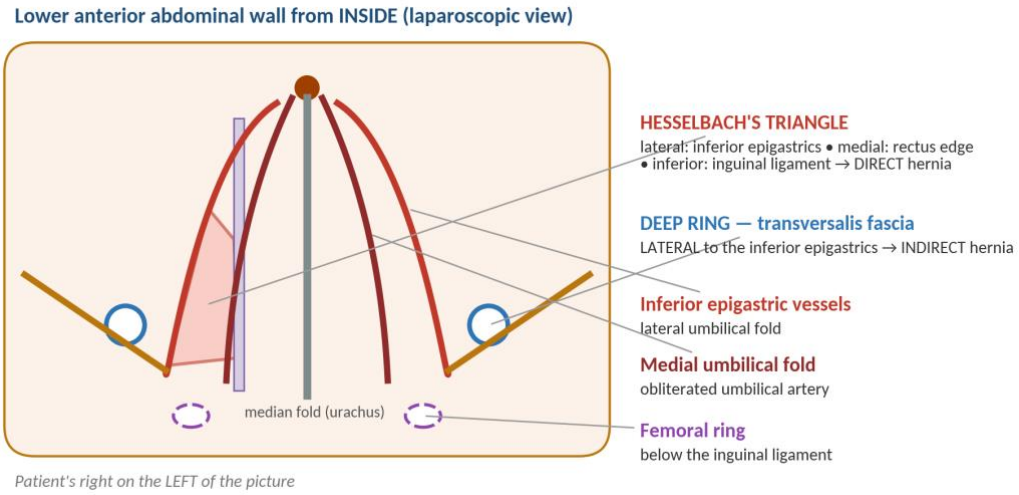

Figure 4. Umbilical folds on the inside of the abdominal wall (from Lecture 25).

MNEMONIC / MEMORY HOOK

Three shunts → venosum, ovalis, arteriosum. MEDIAL umbilical ligaments = the two umbilical **arteries**; **MEDIAN** umbilical ligament = the single **urachus**.

4 When the Transition Fails

PATENT DUCTUS ARTERIOSUS

- Preterm babies, congenital rubella
- Continuous 'machinery' murmur, bounding pulses, wide pulse pressure
- **Indometacin, ibuprofen or paracetamol** (block prostaglandin synthesis); surgical/transcatheter closure
- **Duct-dependent heart disease**: keep it OPEN with **prostaglandin E_1 (alprostadil)**

PPHN (persistent fetal circulation)

- PVR fails to fall → right-to-left shunting at the duct and foramen → severe hypoxaemia
- Meconium aspiration, sepsis, diaphragmatic hernia, lung hypoplasia
- Oxygen, ventilation, surfactant, **inhaled nitric oxide**

TTN + PFO

- **Transient tachypnoea**: slow lung-fluid clearance, especially after caesarean without labour; settles in 24–48 h
- **Patent foramen ovale** (~25% of adults): usually silent; route for **paradoxical embolism**

URACHAL + VITELLINE REMNANTS

- **Patent urachus**: urine from the umbilicus; also cyst, sinus, diverticulum
- **Vitelline duct**: **Meckel's diverticulum** (commonest), cyst, umbilico-ileal fistula, fibrous band → volvulus

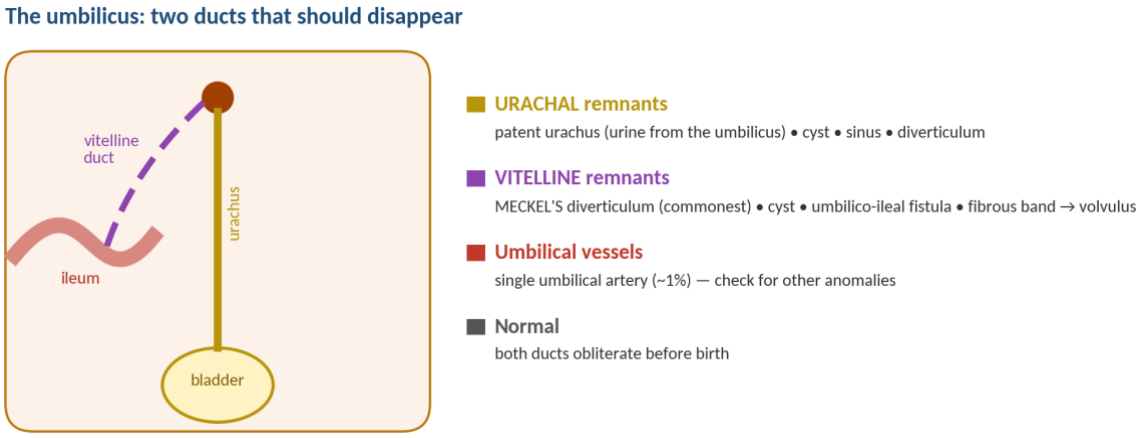

Figure 5. Remnants at the umbilicus.

5 Other Systems After Birth

System	Changes
Kidneys	Renal blood flow rises; most babies pass urine within 24 h (virtually all by 48 h); GFR low, reaching adult values (per surface area) by 1–2 years; preterm tubules lose sodium
Gut + liver	Meconium within 24 h in most term babies (later in preterm); reflux common (immature LOS); low glucuronyl transferase → physiological jaundice peaking around days 3–5
Temperature	Big surface area, thin skin, little fat → rapid heat loss. No shivering: brown fat (between the scapulae, axillae, around the kidneys) uses UCP-1 (thermogenin) for non-shivering thermogenesis. Cold → hypoglycaemia, ↑ O_2 use, PPHN
Immunity	IgG crosses the placenta (mostly third trimester) — protection for ~6 months; IgM does not — raised cord IgM suggests congenital infection; breast milk gives secretory IgA, lactoferrin, lysozyme

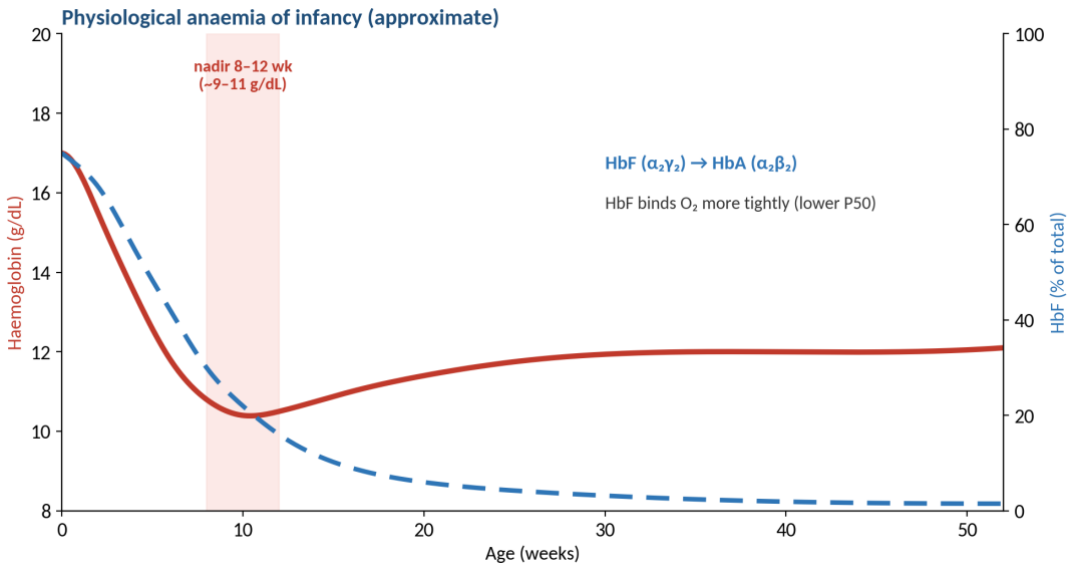

Figure 6. Haemoglobin and HbF over the first year.

- **HbF ($\alpha_2\gamma_2$)** has a higher O_2 affinity (lower P50) than **HbA ($\alpha_2\beta_2$)**; it falls to < 5% by ~6 months. Hb is high at birth, then falls to a nadir of ~9–11 g/dL at 8–12 weeks — the **physiological anaemia of infancy**.

> ★ **PEARL**
>
> Every fetal channel leaves a named remnant: ligamentum **teres** (umbilical vein, in the falciform ligament), ligamentum **venosum**, fossa **ovalis**, ligamentum **arteriosum**, **medial** umbilical ligaments (arteries), **median** umbilical ligament (urachus).
>
> The proximal umbilical arteries stay open as the **superior vesical arteries**.

6 MRCOG Exam Pearls — Last-Minute Page

Numbers to know

3 Fetal shunts	**~10%** Fetal output to the lungs	**~10×** Fall in PVR at birth	**1–3 days** Ductus arteriosus constricts
~25% Probe-patent foramen ovale	**8–12 wk** Hb nadir	**< 5%** HbF by ~6 months	**24 h** Urine + meconium in most

HIGH-YIELD CHECKLIST

- ☐ One umbilical vein (oxygenated), two umbilical arteries (from internal iliacs).
- ☐ Shunts: ductus venosus, foramen ovale, ductus arteriosus.
- ☐ Best-oxygenated blood → heart and brain via the foramen ovale.
- ☐ At birth: PVR ↓, SVR ↑, LA > RA pressure.
- ☐ Duct closes with ↑ O_2 and ↓ PGE_2; kept open by PGE_1; closed by NSAIDs/paracetamol.
- ☐ Remnants: teres, venosum, ovalis, arteriosum, medial and median umbilical ligaments.
- ☐ PPHN: failed fall in PVR → treat with iNO.
- ☐ TTN after caesarean; PFO in ~25%.
- ☐ Brown fat + UCP-1 — no shivering.
- ☐ HbF → HbA; Hb nadir 8–12 weeks.
- ☐ IgG crosses the placenta; IgM does not.
- ☐ Urachal and vitelline (Meckel's) remnants at the umbilicus.

Quick-fire self-test — cover the right-hand column

Question	Answer
Which umbilical vessel carries oxygenated blood?	Umbilical vein
What does the ductus venosus bypass?	The liver
What steers IVC blood through the foramen ovale?	Eustachian valve
Main stimulus for ductus arteriosus closure?	Rising arterial O_2
Drug to keep the duct open?	Prostaglandin E_1 (alprostadil)
Adult remnant of the ductus venosus?	Ligamentum venosum
Adult remnant of the umbilical arteries?	Medial umbilical ligaments (+ superior vesical aa.)
Adult remnant of the urachus?	Median umbilical ligament
Main treatment for PPHN?	Inhaled nitric oxide (with ventilation)
How does a newborn make heat?	Brown fat (UCP-1)
Which immunoglobulin crosses the placenta?	IgG

7 References

- Sadler TW. Langman's Medical Embryology. 14th ed. 2019.
- Rennie JM, editor. Rennie & Roberton's Textbook of Neonatology. 5th ed. 2012.
- Resuscitation Council UK. Newborn Resuscitation and Support of Transition of Infants at Birth. 2021.