PIPADOR REVISION

MRCOG Part 1 Revision Notes

Respiratory System Changes in Pregnancy

PHYSIOLOGY • LECTURE 131

VISUAL EXAMINATION REVISION NOTES

2026 Edition

131

MRCOG PART 1 REVISION NOTES | PHYSIOLOGY

Respiratory System Changes in Pregnancy

Airway and chest wall, lung volumes, ventilation, blood gases, breathlessness and clinical implications

↑ 40–50% Minute ventilation	**↑ 30–50%** Tidal volume (RR ≈ unchanged)	**↓ 20–30%** Functional residual capacity
↑ 20–30% O_2 consumption	**3.7–4.2 kPa** $PaCO_2$ (≈ 28–32 mmHg)	**18–22 mmol/L** HCO_3^- (renal compensation)

■ KEY FACTS: Learning objectives

- Describe anatomical changes of the upper airway and chest wall in pregnancy.
- Describe changes in lung volumes, ventilation, O_2 consumption and arterial blood gases, and their mechanisms.
- Explain physiological breathlessness and distinguish it from pathology.
- Apply these changes to anaesthesia, labour, respiratory disease and ABG interpretation.

131.1 Mechanisms — hormones and the gravid uterus

Progesterone ↑ sensitivity of respiratory centre to CO_2 ▶ ↑ **Tidal volume** (deeper, not faster breathing) ▶ ↑ Minute and alveolar ventilation ▶ **$PaCO_2$** ↓ → respiratory alkalosis ▶ **Renal HCO_3^- excretion** → pH 7.40–7.45

Factor	Effect
Progesterone	Lowers the CO_2 threshold and steepens the CO_2 response curve; smooth-muscle relaxation (↓ airway resistance)
Oestrogen	Mucosal oedema, hyperaemia and capillary engorgement of the upper airway; ↑ progesterone receptors in the respiratory centre
Relaxin	Relaxes costal ligaments → chest-wall widening
Gravid uterus	Raises the diaphragm (≈ 4 cm) → ↓ FRC, ERV and RV; supine position worsens this
↑ Metabolic demand	Fetus, placenta, ↑ cardiac and respiratory work → ↑ VO_2 and VCO_2

131.2 Upper airway and chest wall

Mucosa	Airway	Diaphragm	Chest wall
Oedema & engorgement: congestion, epistaxis	Mallampati ↑; smaller ETT (6.0–7.0 mm)	Rises ≈ 4 cm, but excursion INCREASES	Subcostal angle ≈ 68° → 103°; circumference ↑ 5–7 cm

Breathing becomes more **diaphragmatic**. Chest-wall changes begin before the uterus is large enough to explain them (hormonal). Airway resistance falls slightly (progesterone, relaxin), so **FEV_1, FEV_1/FVC and peak flow are unchanged** — a reduced value indicates disease.

131.3 Lung volumes

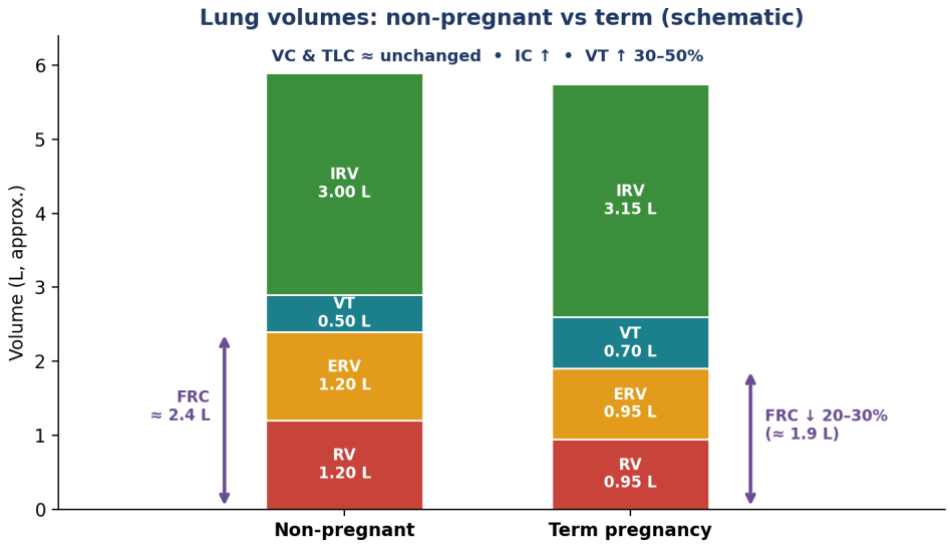


Figure 131.1 — Lung volumes in the non-pregnant state and at term

Parameter	Change	Approx. magnitude
Tidal volume	↑	30–50% (≈ +200 mL)
Inspiratory capacity	↑	5–10%
Inspiratory reserve volume	↔ / slight ↑	—
Expiratory reserve volume	↓	15–25% (≈ 200 mL)
Residual volume	↓	20–25% (≈ 200–300 mL)
FRC	↓	20–30% (≈ 400–700 mL); further ↓ supine
Vital capacity	↔	Unchanged
Total lung capacity	↔ / slight ↓	≈ 0–5%
FEV_1, FEV_1/FVC, PEFR	↔	Unchanged
Closing capacity	↔	Unchanged — but FRC may fall below it
DLCO	↔ / slight ↓	Small fall after first trimester

■ EXAM TIP

- The classic SBA trio: **VC unchanged, FRC decreased, tidal volume increased**. Spirometry (FEV_1, FEV_1/FVC, PEFR) is **unchanged** in normal pregnancy.

131.4 Ventilation and oxygen consumption

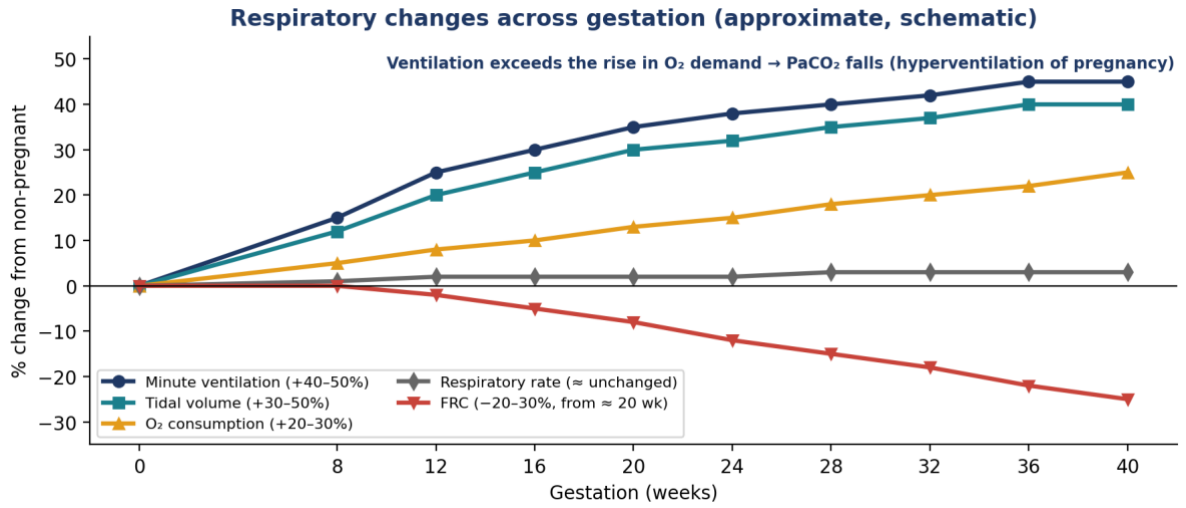


Figure 131.2 — Ventilatory changes across gestation

- **Minute ventilation ↑ 40–50%** (≈ 7.5 → 10.5 L/min) from the first trimester — almost entirely from ↑ **tidal volume**; RR is unchanged or rises by 1–2 breaths/min. **Alveolar ventilation ↑ 50–70%** (dead space proportion falls).
- **O_2 consumption ↑ 20–30%** (≈ 250 → 300+ mL/min) and CO_2 production rise — but ventilation rises **more** than metabolic demand, so $PaCO_2$ falls (true **hyperventilation**).
- Changes begin early (progesterone-driven), before significant metabolic demand — a classic exam point.

131.5 Arterial blood gases

Variable	Non-pregnant	Pregnant (3rd trimester)	Why
pH	7.35–7.45	7.40–7.45	Compensated respiratory alkalosis
$PaCO_2$	4.7–6.0 kPa (35–45 mmHg)	3.7–4.2 kPa (28–32 mmHg)	Hyperventilation
PaO_2	10.5–13.5 kPa	13–14 kPa (may ↓ supine at term)	↓ $PACO_2$ → ↑ PAO_2 (alveolar gas equation)
HCO_3^-	22–26 mmol/L	18–22 mmol/L	Renal compensation
Base excess	± 2	≈ −2 to −3	↓ Buffering capacity

Maternal $PaCO_2$ ≈ 4 kPa ▶ **↑ CO_2 gradient** fetus → mother ▶ Efficient fetal CO_2 clearance (fetal PCO_2 ≈ 5.5–6.5 kPa) ▶ Maternal ↑ 2,3-DPG offsets alkalotic left shift → **P50 ↑** → O_2 released to fetus

■ RED FLAGS

- A **'normal' $PaCO_2$ of 5–6 kPa in a pregnant woman is ABNORMAL** — it indicates CO_2 retention and impending respiratory failure (e.g. **severe/life-threatening asthma**, exhaustion, opioid or $MgSO_4$ toxicity). Escalate.
- Reduced HCO_3^- means less buffering — pregnant women develop **metabolic acidosis** faster (sepsis, DKA, haemorrhage).

131.6 Breathlessness of pregnancy

Physiological dyspnoea	Red flags — investigate
Common (60–70%), often 1st/2nd trimester	Sudden onset; pleuritic chest pain; haemoptysis

Physiological dyspnoea	Red flags — investigate
At rest or talking; awareness of deeper breathing	Tachypnoea (RR > 20), SpO_2 < 95%
Normal RR, SpO_2, examination and PEFR	Tachycardia, orthopnoea, PND, exertional syncope
Does not limit daily activity	Wheeze, crackles, fever, unilateral leg swelling
Mechanism: progesterone-driven ↑ VT and ↓ $PaCO_2$	Think PE, peripartum cardiomyopathy, asthma, pneumonia, pulmonary oedema, mitral stenosis

131.7 Anaesthetic and labour implications

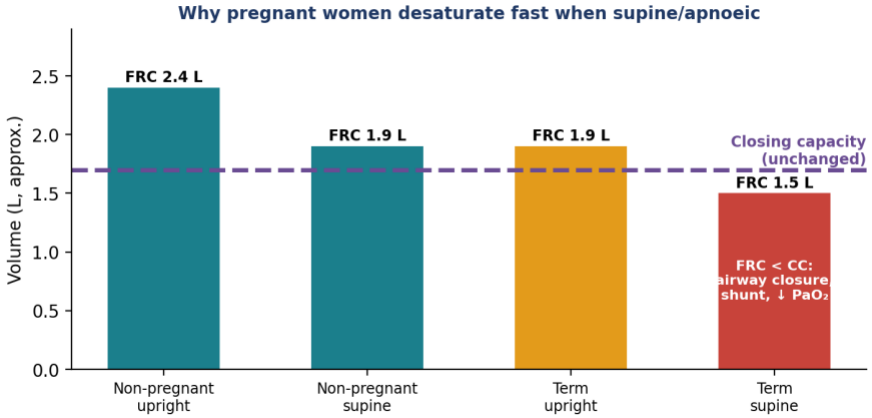


Figure 131.3 — FRC falls towards closing capacity at term, especially supine

Rapid desaturation
↓ FRC (O_2 store) + ↑ VO_2
→ preoxygenate, head-up

Difficult airway
Oedema, weight, breasts; failed intubation ↑

Aspiration
↓ LOS tone (progesterone), ↑ intragastric pressure

Faster uptake
Inhalational agents — ↑ VA, ↓ FRC, ↓ MAC

- **Aspiration (Mendelson's syndrome)** prophylaxis: H_2-receptor antagonist (ranitidine historically; now famotidine) or PPI ± **sodium citrate**; **rapid sequence induction**; regional anaesthesia preferred for caesarean section. Follow the **OAA/DAS obstetric difficult airway guidelines**.
- **Labour**: pain-driven hyperventilation can lower $PaCO_2$ to < 2.7 kPa → maternal alkalosis, left-shifted ODC, uterine vasoconstriction and hypoventilation between contractions; **O_2 consumption ↑ up to 40–100%** in the second stage. Epidural analgesia blunts these changes.
- **Postpartum**: lung volumes recover within days–weeks as the uterus involutes; ventilation and $PaCO_2$ return to normal by ≈ 6–12 weeks as progesterone falls.

131.8 Respiratory disease in pregnancy

Condition	Physiological link	Key management points
Asthma	⅓ improve, ⅓ worsen, ⅓ unchanged; $PaCO_2$ ≥ 4.6 kPa is concerning	Continue inhalers and oral steroids; poor control is the greater risk to the fetus
Pulmonary embolism	Hypercoagulability + stasis; baseline alkalosis masks gas changes	LMWH first; CTPA or V/Q (RCOG GTG 37b)
Pulmonary oedema	↓ Colloid oncotic pressure; pre-eclampsia, tocolytics (β-agonists), fluid overload	Restrict fluids (pre-eclampsia ≈ 80 mL/h), diuretics, O_2
Pneumonia / COVID-19	↓ FRC and ↑ VO_2 → earlier hypoxaemia	Target SpO_2 ≥ 94–95%; prone positioning possible; consider early delivery for maternal benefit
Cystic fibrosis / restrictive disease	Fixed ventilatory capacity cannot meet ↑ demand	FEV_1 < 50–60% predicted → high risk; pre-pregnancy counselling

Condition	Physiological link	Key management points
Amniotic fluid embolism	Sudden hypoxia, collapse, DIC	Supportive; early massive haemorrhage protocol

131.9 Must-know summary

■ **MNEMONIC / MEMORY AID**

'Deeper, not faster' — minute ventilation rises via tidal volume; RR unchanged.

'VC stays, FRC falls, TV rises'; **'Spirometry is normal'** (FEV_1, FEV_1/FVC, PEFR).

$PaCO_2$ ≈ 4 kPa, HCO_3^- ≈ 20, pH ≈ 7.44 — compensated respiratory alkalosis.