PIPADOR REVISION

MRCOG Part 1 Revision Notes

Minerals and Deficiency Disorders

PHYSIOLOGY • LECTURE 141

VISUAL EXAMINATION REVISION NOTES

2026 Edition

MRCOG PART 1 REVISION NOTES | PHYSIOLOGY

141 Minerals and Deficiency Disorders

Calcium, phosphate, magnesium, electrolytes, iodine and trace elements — physiology, pregnancy changes and deficiency states

≈ 1 kg	≈ 30 g	250 µg	0.7–1.0
Body calcium (99% in bone)	Calcium transferred to the fetus	Iodine per day in pregnancy (WHO)	Serum Mg^{2+} (mmol/L)

■ KEY FACTS: Learning objectives

- Classify minerals into macrominerals and trace elements.
- Describe calcium, phosphate and magnesium homeostasis and their changes in pregnancy.
- Describe iodine and thyroid physiology and the consequences of deficiency.
- Describe zinc, copper, selenium and other trace elements and their deficiency disorders.

141.1 Classification

Macrominerals	Trace elements
> 100 mg/day: Ca, PO_4, Mg, Na, K, Cl, S	< 100 mg/day: Fe, Zn, Cu, I, Se, F, Mn, Cr, Mo, Co

141.2 Calcium and phosphate

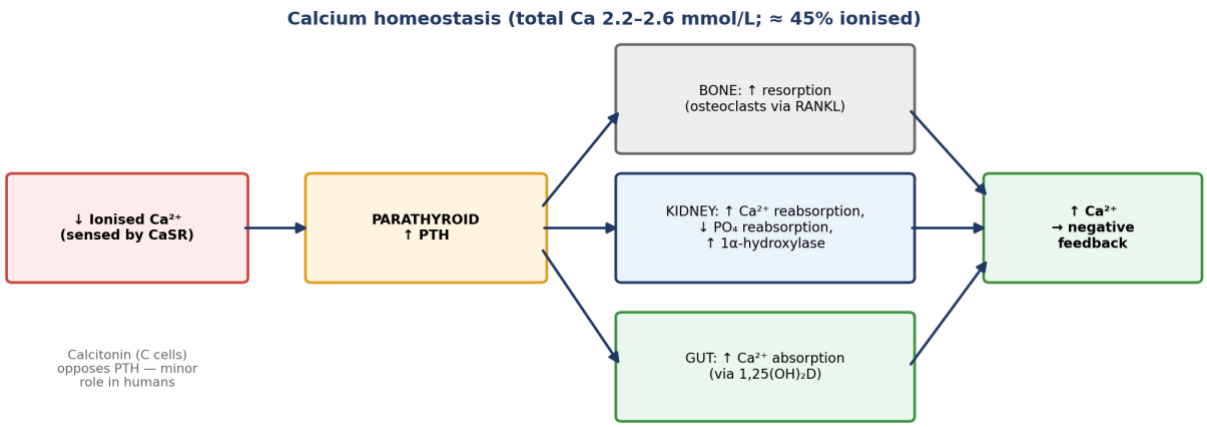


Figure 141.1 — Calcium homeostasis: PTH, vitamin D and calcitonin

	Calcium	Phosphate
Normal serum	Total 2.2–2.6 mmol/L (≈ 45% ionised, 40% albumin-bound); correct for albumin	0.8–1.5 mmol/L
Functions	Bone, muscle contraction, coagulation (factor IV), nerve conduction, secretion	Bone, ATP, 2,3-DPG, nucleic acids, buffering
UK RNI (women)	700 mg/day; + 550 mg in lactation	550 mg/day
Deficiency	Hypocalcaemia: tetany, Chvostek/Trousseau signs, long QT, seizures; osteoporosis, rickets/osteomalacia	Hypophosphataemia: refeeding syndrome, muscle weakness, respiratory failure, haemolysis

	Calcium	Phosphate
Excess	Hypercalcaemia: 'stones, bones, groans, moans', short QT	CKD; tumour lysis

Calcium in pregnancy and lactation

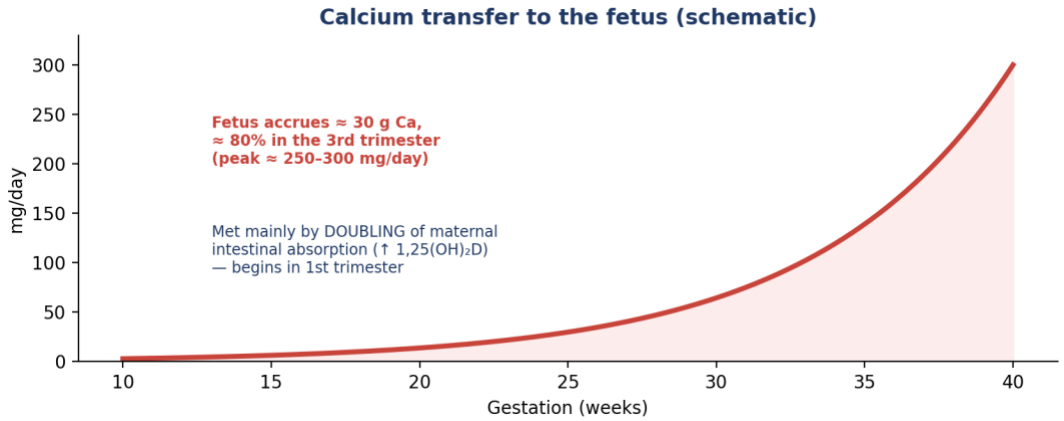


Figure 141.2 — Fetal calcium accretion is concentrated in the 3rd trimester

Variable	Change in pregnancy
Total serum calcium	↓ (falls with albumin)
Ionised calcium	Unchanged
1,25(OH)$_2$D	↑ ≈ 2-fold (kidney + placental 1α-hydroxylase) → intestinal Ca absorption doubles
PTH	Low-normal / ↓ (1st trimester)
PTHrP	↑ (placenta, breast) — drives placental Ca transport and lactational bone resorption
Calcitonin	↑ (may protect maternal skeleton)
Urinary calcium	↑ (absorptive hypercalciuria; ↑ GFR)
Lactation	Bone resorption (≈ 3–10% loss), recovered after weaning; independent of dietary calcium

■ **CLINICAL CORRELATION**

- **Neonatal hypocalcaemia**: maternal vitamin D deficiency, maternal diabetes, prematurity, asphyxia, **maternal hyperparathyroidism** (suppresses fetal PTH).
- **Calcium supplementation (1.5–2 g/day)** reduces pre-eclampsia risk where dietary intake is low (WHO); low-dose aspirin remains the UK prophylaxis (NICE NG133).

141.3 Magnesium

- ≈ 25 g in the body (≈ 60% bone; < 1% extracellular). Cofactor for > 300 enzymes (ATP reactions), Na^+/K^+-ATPase, **PTH secretion**; physiological Ca^{2+}-channel blocker and NMDA antagonist.
- **Hypomagnesaemia**: hyperemesis, diuretics, PPIs, alcohol, refeeding → tremor, seizures, **arrhythmias (torsades)**, refractory **hypokalaemia and hypocalcaemia** (↓ PTH secretion/action).
- **Hypermagnesaemia** — iatrogenic in obstetrics: **$MgSO_4$** (eclampsia, fetal neuroprotection < 32 weeks) with oliguria → loss of reflexes (> 5 mmol/L), respiratory depression (> 6–7.5), cardiac arrest (> 12). Antidote **10 mL 10% calcium gluconate** (Lecture 127).

141.4 Sodium, potassium and water

- Pregnancy: total body water ↑ 6–8 L; Na^+ retention ≈ 900 mmol; **osmostat resets** — plasma osmolality ↓ ≈ 10 mOsm/kg, **Na^+ ↓ ≈ 4–5 mmol/L**.

- **Hyponatraemia in labour**: large volumes of hypotonic fluid, oxytocin (ADH-like action), excessive oral water → maternal seizures and **neonatal hyponatraemia**. Monitor fluid balance; Na^+ < 130 mmol/L is significant.
- **Hypokalaemia**: hyperemesis, β_2-agonists, steroids, diuretics → arrhythmias, ileus.

141.5 Iodine

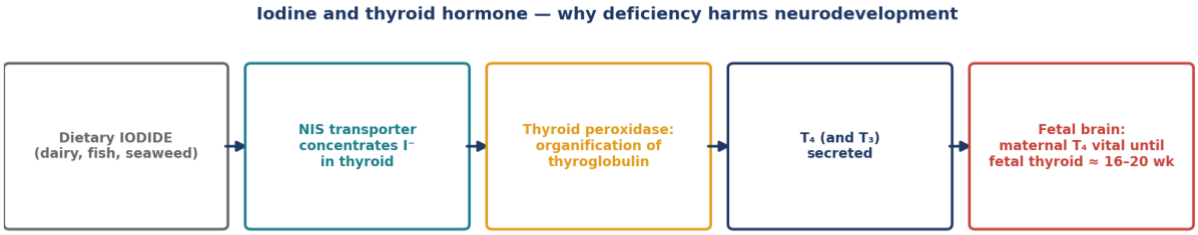


Figure 141.3 — Iodine, thyroid hormone synthesis and fetal brain development

Topic	Key points
Requirement	UK RNI 140 µg/day; WHO 250 µg/day in pregnancy and lactation (↑ maternal T_4 production ≈ 50%, ↑ renal iodide clearance with ↑ GFR, fetal transfer)
Sources	Dairy, sea fish, eggs, iodised salt (UK salt rarely iodised). Avoid kelp/seaweed supplements (excess)
Deficiency	Goitre, hypothyroidism; in pregnancy → miscarriage, stillbirth, cretinism (severe intellectual disability, deafness, short stature). Commonest preventable cause of intellectual disability worldwide; even mild deficiency is linked to lower child IQ
Pregnancy thyroid physiology	hCG stimulates TSH receptor → TSH ↓ in 1st trimester; TBG ↑ (oestrogen) → total T_4/T_3 ↑, free hormones ≈ normal; fetal thyroid functions from ≈ 10–12 wk but relies on maternal T_4 until mid-gestation
Excess	Wolff–Chaikoff effect, fetal goitre/hypothyroidism (amiodarone, iodinated contrast)

141.6 Other trace elements

Element	Function	Deficiency	Notes / excess
Iron	Hb, myoglobin, cytochromes	Microcytic anaemia, fatigue, pica, koilonychia	Lectures 134–135
Zinc	> 300 enzymes, DNA synthesis, immunity, wound healing, taste	Growth restriction, delayed puberty, hypogonadism, poor healing, diarrhoea; acrodermatitis enteropathica (inherited — periorificial rash, alopecia)	Excess ↓ copper absorption
Copper	Caeruloplasmin, cytochrome oxidase, lysyl oxidase (collagen), SOD	Anaemia, neutropenia, neuropathy; Menkes (X-linked, ATP7A — kinky hair)	Wilson's disease (AR, ATP7B — ↓ caeruloplasmin, liver/basal ganglia, Kayser–Fleischer rings); caeruloplasmin ↑ in pregnancy
Selenium	Glutathione peroxidase, deiodinases (T_4 → T_3)	Keshan disease (cardiomyopathy), Kashin–Beck (osteoarthropathy)	Excess (selenosis): hair/nail loss
Fluoride	Bone and tooth enamel (fluorapatite)	Dental caries	Fluorosis (mottled enamel)
Chromium	Potentiates insulin	Impaired glucose tolerance (parenteral nutrition)	—
Manganese / molybdenum / cobalt	Enzyme cofactors (arginase; xanthine oxidase); cobalt in B_{12}	Rare	Manganese toxicity — parkinsonism

141.7 Must-know summary

■ EXAM TIP

- Pregnancy: **total calcium ↓, ionised calcium unchanged**, **1,25(OH)$_2$D ↑ → absorption doubles**; fetus takes ≈ 30 g Ca, mostly 3rd trimester.
- Magnesium deficiency causes **refractory hypocalcaemia and hypokalaemia**; $MgSO_4$ toxicity → reflexes lost first; antidote calcium gluconate.
- Iodine requirement ↑ to **250 µg/day** (WHO); deficiency → **cretinism** — commonest preventable cause of intellectual disability.
- **Zinc**: acrodermatitis enteropathica; **copper**: Menkes (deficiency), Wilson's (overload); **selenium**: Keshan cardiomyopathy and T_4 → T_3 deiodination.

■ MNEMONIC / MEMORY AID

Hypercalcaemia — 'Bones, Stones, Abdominal Groans, Psychic Moans'. **$MgSO_4$ toxicity — 'Reflexes, Respiration, Rhythm'** (≈ 5 → 7 → 12 mmol/L).