PIPADOR REVISION

MRCOG Part 1 Revision Notes

MRI

MEDICAL PHYSICS • LECTURE 509

VISUAL EXAMINATION REVISION NOTES

2026 Edition

509

MRCOG PART 1 REVISION NOTES | MEDICAL PHYSICS

MRI

MRI physics, relaxation, sequences, contrast, safety (including pregnancy) and O&G applications

1.5–3 T	T1	T2	No ionising radiation
Clinical field strength	Fat bright	Fluid bright	Safe in pregnancy (no gadolinium)

■ KEY FACTS: Learning objectives

- Define MRI, magnetic field strength, precession, Larmor frequency, T1 and T2 relaxation, TR and TE.
- Explain how MR signal and images are generated, the main sequences and contrast agents.
- Describe MRI safety (including pregnancy and gadolinium) and its applications in O&G.

509.1 Key definitions

Term	Definition
Magnetic resonance imaging (MRI)	Imaging using a strong magnetic field and radiofrequency (RF) pulses to detect signals from hydrogen nuclei (protons)
Tesla (T)	Unit of magnetic field strength — clinical scanners 1.5 T or 3 T (Earth's field ≈ 0.00005 T)
Precession	Wobbling rotation of proton spins around the magnetic field direction
Larmor frequency	Precession frequency $\omega = \gamma B_0$ (≈ 42.6 MHz/T for hydrogen; ≈ 64 MHz at 1.5 T)
T1 relaxation (spin–lattice)	Recovery of longitudinal magnetisation after the RF pulse — fat recovers quickly (short T1)
T2 relaxation (spin–spin)	Decay of transverse magnetisation — water/fluid decays slowly (long T2)
TR / TE	Repetition time (between RF pulses) / echo time (pulse to signal readout) — set image weighting
Gadolinium	Paramagnetic contrast agent shortening T1 — enhancing tissues appear bright on T1

■ IN PLAIN ENGLISH: MRI

MRI turns the body's hydrogen atoms into tiny radio transmitters. The strong magnet lines them up, a radio pulse knocks them over, and as they **relax back** they emit signals. Different tissues relax at different rates, giving superb soft-tissue contrast — **without ionising radiation**.

509.2 Physics of MR signal

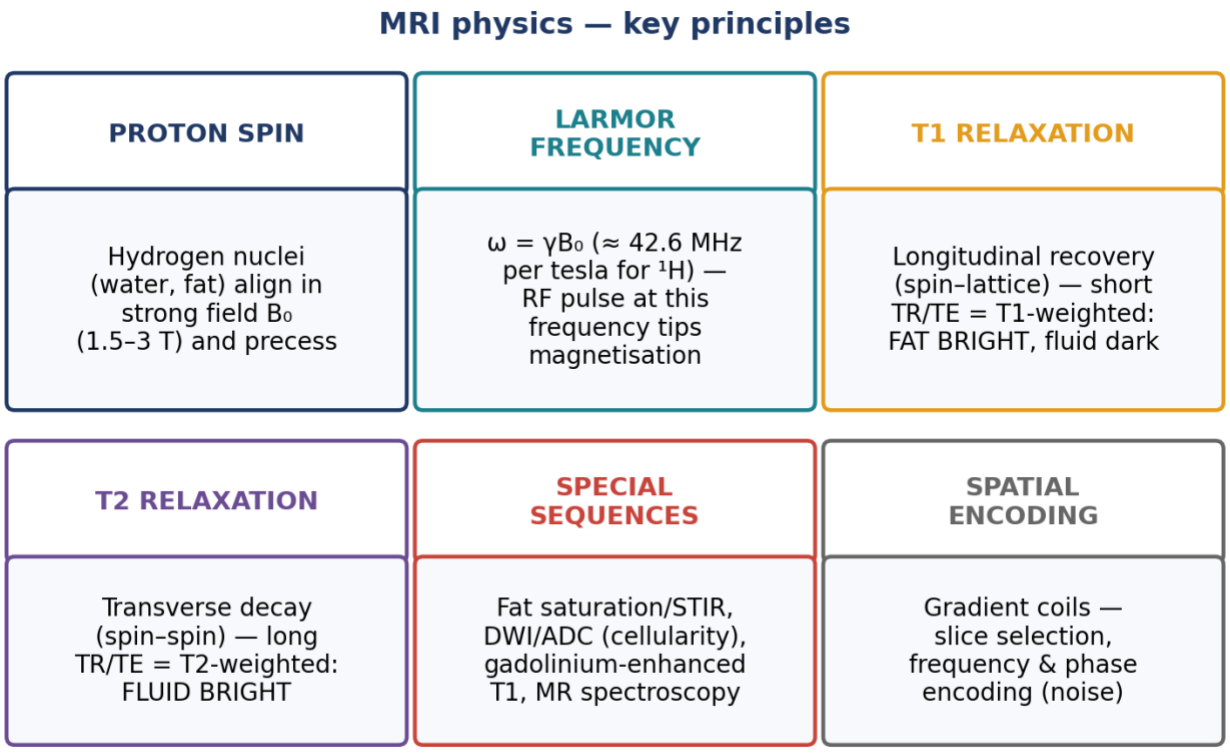


Figure 509.1 — MRI physics principles

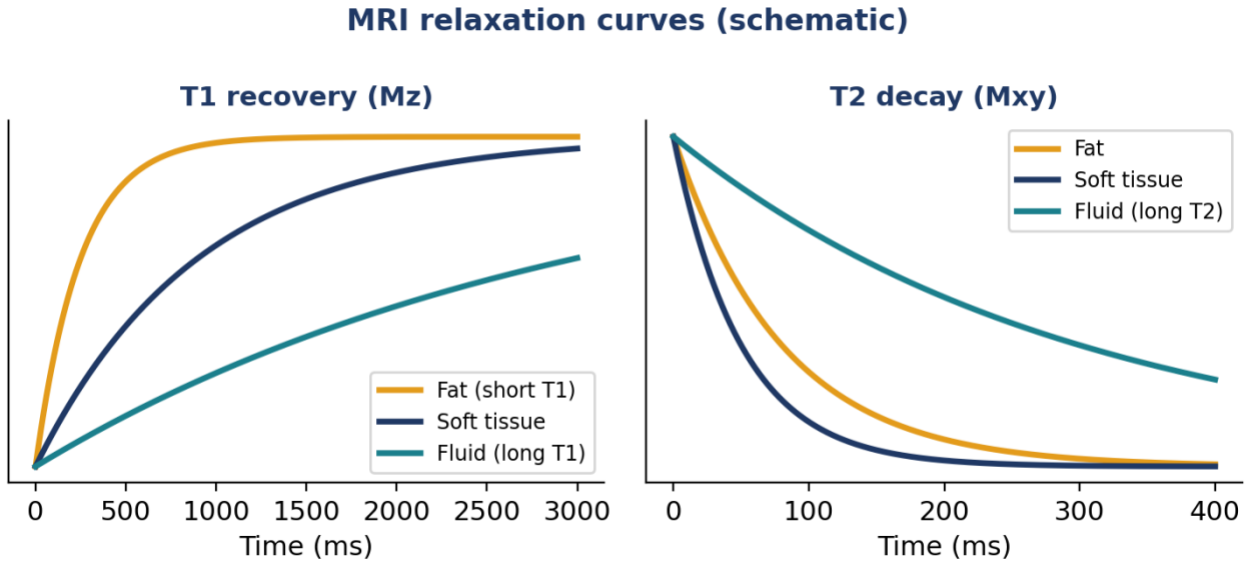


Figure 509.2 — T1 recovery and T2 decay

■ KEY EQUATIONS

Larmor equation: $\omega_o = \gamma \times B_o$

T1-weighted image: short TR (< 800 ms) and short TE (< 30 ms)

T2-weighted image: long TR (> 2,000 ms) and long TE (> 80 ms)

Proton density: long TR, short TE

509.3 Sequences and appearances

Sequence	Appearance / use
T1-weighted	• Fat bright, fluid dark • Blood products (methaemoglobin) bright — endometrioma, haemorrhagic cyst • Post-gadolinium enhancement
T2-weighted	• Fluid bright • Best uterine zonal anatomy (endometrium bright, junctional zone dark, outer myometrium intermediate) • Cervical stroma dark
Fat suppression (fat-sat, STIR)	Suppresses fat — distinguishes fat (dermoid) from blood (endometrioma remains bright on fat-sat T1)
T2 'shading'	Endometrioma — low T2 signal from concentrated blood products
Diffusion-weighted imaging (DWI) / ADC	Restricted diffusion in cellular tumours/abscess — tumour detection, nodes, sarcoma vs fibroid
Dynamic contrast-enhanced	Perfusion characteristics (O-RADS MRI for adnexal masses)
MR spectroscopy / angiography	Specialised uses

509.4 Safety

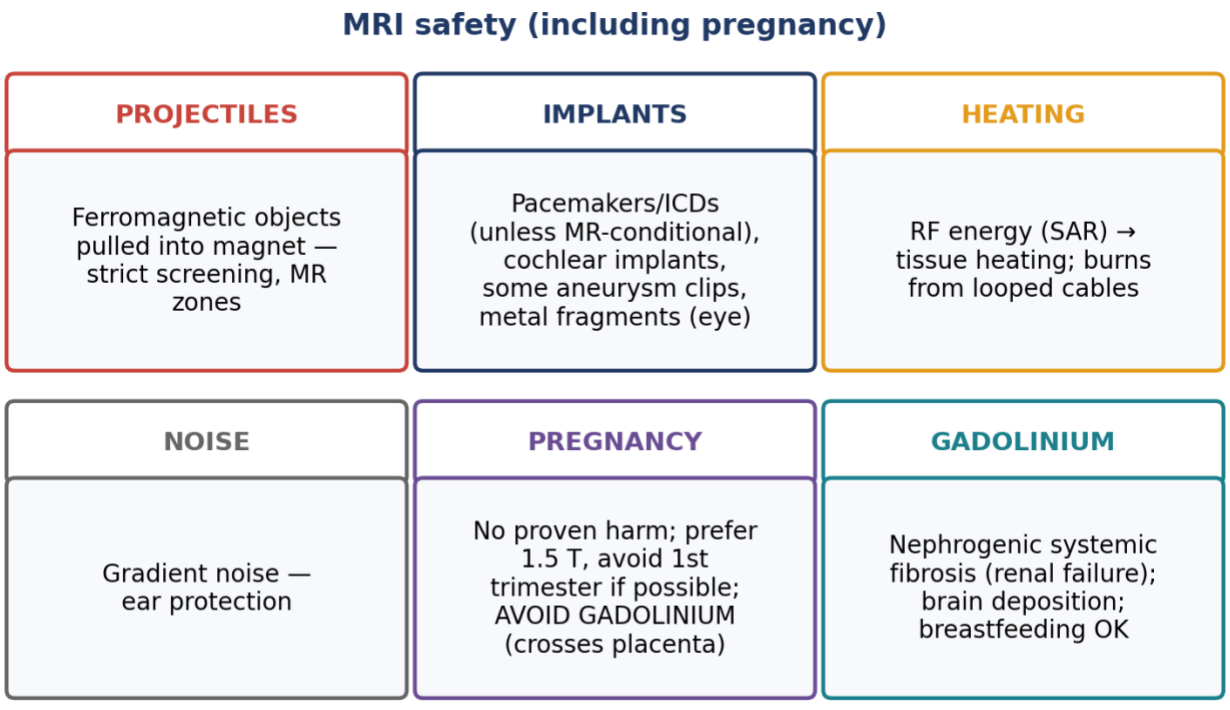


Figure 509.3 — MRI safety

- Screening questionnaire for every patient and staff member; MR safety zones; implants classified MR safe / MR conditional / MR unsafe.
- **Pregnancy**: no proven fetal harm at 1.5–3 T
  - Concerns are theoretical heating and acoustic noise — prefer 1.5 T and avoid elective scanning in the first trimester

  - **Avoid gadolinium** unless essential (crosses placenta; possible association with stillbirth/skin conditions in one large cohort).
- **Gadolinium**: nephrogenic systemic fibrosis with severe renal impairment (low with macrocyclic agents)
  - Small brain deposition
  - Compatible with breastfeeding.
- Claustrophobia (≈ 5%), noise (ear protection), heating/burns (SAR limits, avoid skin-to-skin loops).

509.5 O&G applications

Area	Use of MRI
Cervical cancer	Local staging — tumour size, parametrial and vaginal invasion (FIGO 2018), radiotherapy planning
Endometrial cancer	Depth of myometrial invasion, cervical stromal involvement
Uterus	Adenomyosis (junctional zone ≥ 12 mm), fibroid mapping (before myomectomy/UAE), leiomyosarcoma features, müllerian anomalies
Adnexa	Indeterminate masses on USS (O-RADS MRI), endometrioma vs dermoid, torsion in pregnancy
Endometriosis	Deep endometriosis (rectovaginal, bowel, bladder, ureter) — surgical planning
Obstetrics	Placenta accreta spectrum, fetal CNS (ventriculomegaly, corpus callosum), appendicitis in pregnancy, pelvimetry (breech)
Urogynaecology	Dynamic pelvic floor MRI, fistula, urethral diverticulum

■ COMMON PITFALLS

Assuming all implants are MR-unsafe (many are MR conditional) — or the reverse.

Routine gadolinium in pregnancy.

Using CT for local staging of cervical cancer (MRI superior).

509.6 Must-know summary

■ EXAM TIP

- MRI: protons in strong field (1.5–3 T) precess at Larmor frequency; RF pulse → relaxation signals.
- T1 (short TR/TE): fat bright, fluid dark, blood bright; T2 (long TR/TE): fluid bright, zonal anatomy; DWI for cellularity; fat-sat separates fat from blood.
- Safety: ferromagnetic projectiles, implants, heating, noise; pregnancy — safe without gadolinium (prefer after 1st trimester).
- O&G: cervical/endometrial staging, adenomyosis, fibroids/sarcoma, deep endometriosis, adnexal masses, placenta accreta, fetal brain.

■ MNEMONIC / MEMORY AID

'T1 = Fat is Fab (bright); T2 = Water is White'.