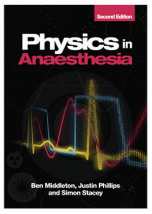
Chapter 25

# Magnetic resonance imaging




**Self-assessment questions**

These questions and answers, in both MTF and SBA formats, accompany *Physics in Anaesthesia 2e* and link back to the book for guidance.

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## Multiple true / false questions

*For each of the following questions, mark all answers as either true or false*

**1. Electromagnets in MRI scanners:**

- **a.** Are bathed in liquid nitrogen to keep their temperature below –250°C
- **b.** Contain superconducting coils with induced magnetic flux densities of 0.15–0.3 T
- **c.** Cause most of the hydrogen nuclei dipoles to align with the applied magnetic field
- **d.** Cause precession of hydrogen nuclei at the Larmor frequency
- **e.** Are 60 000 times weaker than the earth's magnetic field

**Reminder**

- Our bodies are made up of around 65% water meaning that we have an abundance of hydrogen nuclei.
- In MRI both magnetic fields and radio waves are used to map the amount and location of these nuclei (water) in the body, and with the signals generated, detailed images of the tissue structures can be produced.

**Pointer**

- Both the alignment (parallel vs anti-parallel) and the frequency of precession (spin) of hydrogen nuclei, under the applied magnetic field, are vital elements in an MRI's signal measurement.

**2. Coils within MRI scanners include:**

- **a.** A superconducting coil
- **b.** Gradient coils
- **c.** A radiofrequency coil
- **d.** Gadolinium chelates coils
- **e.** Copper coils

**Pointer**

- Copper is a material used in electromagnetic shielding in MRI because of its ability to absorb both magnetic and radio waves.
- Gadolinium chelates are contrast agents that, through enteral or parenteral administration, can strengthen localized magnetic fields.

**3. Gradient coils in an MRI scanner:**

- **a.** Allow the spatial localization of hydrogen nuclei in three dimensions
- **b.** Vary the magnetic field strength at different points within tissue being imaged
- **c.** Adjust the Larmor frequency of hydrogen nuclei based on their position
- **d.** Apply gradient fields in two dimensions
- **e.** Speed up the relaxation time of hydrogen nuclei

**Did you know?**

- There are generally three gradient coils in an MRI scanner, namely the *x*, *y* and *z* gradients.
- They are only applied in two dimensions, however, with *x* and *y* being transverse gradients and *z* longitudinal.
- It is the series of two-dimensional images ('slices') that produce the final high-resolution three-dimensional images of tissues.

## Single best answer questions

*For each of the following questions, select the single best answer – note that more than one answer may be true but only one option represents the best answer*

**1. The radiofrequency (RF) coil in an MRI scanner:**

**a.** Detects the RF photons excited hydrogen nuclei release when the pulse is switched off
**b.** Emits a RF pulse parallel to the magnetic field
**c.** 'Flips' hydrogen nuclei dipoles into lower energy states
**d.** Continuously emits radio waves during scanning
**e.** Is non-resonant with the Larmor frequency

**Reminder**

- *Figure 25.3* depicts the excitation and relaxation of hydrogen nuclei caused by the turning on and off of RF radiation.
- RF pulses are transmitted perpendicular to the magnetic field, flipping hydrogen nuclei into higher energy states (parallel to anti-parallel).
- RF photons are released by hydrogen nuclei when the RF pulse is switched off and the hydrogen nuclei return to their original aligned state (parallel).

**2. In a T2-weighted MRI scan which material produces the brightest signal?**

**a.** Fat
**b.** Bone
**c.** Muscle
**d.** Tissue oedema
**e.** Blood

**Did you know?**

- On an MRI of the brain, oedema would produce a high signal (white) on T2-weighted imaging and low signal (dark) on T1-weighted imaging.

**3. Which metal is considered the least safe in MRI scanners?**

**a.** Titanium
**b.** Copper
**c.** Gold
**d.** Cobalt–chromium
**e.** Iron

**Pointer**

- Material that is ferromagnetic is contraindicated in MRI scanners.
- Titanium, copper, gold and cobalt–chromium can be MRI-compatible.

**Did you know?**

- Titanium implants are used by orthopaedic surgeons.
- Cobalt–chromium can be found in coronary stents.
- Copper wiring is used in intra-uterine devices and pacemakers.

# Answers to questions for Chapter 25 – Magnetic resonance imaging

## Multiple true / false questions

*The following answers are true:*

**1.** c and d

**2.** a, b and c

**3.** a, b, c and d

## Single best answer questions

*The options below represent the single best answer, although other options may also be true:*

**1.** a

**2.** d

**3.** e