



# The Magnetic Resonance Imaging Examination

The purpose of The American Registry of Radiologic Technologists® (ARRT®) Examination in Magnetic Resonance Imaging (MRI) is to assess the knowledge and cognitive skills underlying the intelligent performance of the tasks typically required of MRI technologists at entry into the profession. To identify the knowledge and skills covered by the examination, the ARRT periodically conducts practice analysis studies involving a nationwide sample of MRI technologists.<sup>1</sup> The results of the most recent practice analysis are reflected in this document. Every content category can be linked to one or more activities on the task inventory. The complete task inventory is available from our website [www.arrrt.org](http://www.arrrt.org).

The table below presents the four major content categories, along with the number and percentage of test questions appearing in each major category. The content specifications identify the knowledge areas underlying performance of the tasks on the task inventory. The remaining pages provide a detailed listing of topics addressed within each major content category.

This document is not intended to serve as a curriculum guide. Although ARRT programs for certification and registration and educational programs may have related purposes, their functions are clearly different. Educational programs are generally broader in scope and address subject matter not included in these content specifications.

Content Category	Percent of Test	Number of Scored Questions <sup>2</sup>
A. Patient Care	8%	17
B. Safety	8%	15
C. Image Production	56%	112
D. Procedures	28%	56
<b>Total</b>	<b>100%</b>	<b>200</b>

<sup>1</sup> A special debt of gratitude is due to the hundreds of professionals participating in this project as committee members, survey respondents and reviewers.

<sup>2</sup> Each exam includes up to an additional 20 unscored (pilot) questions embedded in the test. On the pages that follow, the approximate number of scored test questions allocated to each content category appears in parentheses.



## A. Patient Care (17)

### I. Patient Interactions and Management

#### A. Legal and Ethical Principles (4)

1. confirmation of exam requisition
  - a. verification of patient identification
  - b. comparison of request to clinical indications
2. legal issues
  - a. common terminology (\*e.g., negligence, malpractice)
  - b. legal doctrines (e.g., respondeat superior, res ipsa loquitur)
3. patient's rights
  - a. informed consent (written, oral, implied)
  - b. confidentiality (HIPAA)
  - c. American Hospital Association (AHA) Patient Care Partnership (Patient's Bill of Rights) (e.g., privacy, access to information, health care proxy, research participation)
4. ARRT Standards of Ethics

#### B. Infection Control (3)

1. terminology and basic concepts
  - a. types of asepsis
  - b. sterile technique
  - c. pathogens (e.g., fomites, vehicles, vectors)
  - d. hospital acquired infections
2. cycle of infection
  - a. pathogen
  - b. source or reservoir of infection
  - c. susceptible host
  - d. method of transmission (contact, droplet, airborne, common vehicle, vector-borne)
3. CDC Standard Precautions (general patient contact)
  - a. handwashing
  - b. gloves, gowns
  - c. masks
  - d. medical asepsis/disinfection

4. additional or transmission-based precautions (e.g., hepatitis B, HIV, tuberculosis)
  - a. airborne (e.g., negative ventilation)
  - b. droplet (e.g., mask)
  - c. contact (e.g., gloves, gown)
5. safe cleaning of equipment and disposal of contaminated materials
  - a. linens
  - b. needles
  - c. patient supplies
  - d. scanner, bore, coils, ancillary equipment

\*e.g., This is used here and in the remainder of this document to indicate examples of the topics covered, but not a complete list.

(Patient Care continues on the following page.)



## A. Patient Care (continued)

### C. Interpersonal Communications (3)

1. modes of communication
  - a. verbal, written
  - b. nonverbal  
(e.g., eye contact, touching)
2. challenges in communication
  - a. patient characteristics  
(e.g., cultural factors, physical or emotional status)
  - b. strategies to improve understanding
3. patient education
  - a. explanation of procedure  
(e.g., risks, benefits)
  - b. communication with patient during procedure
  - c. follow-up instructions
  - d. referral to other services
4. medical terminology

### D. Patient Assessment, Monitoring and Management (7)

1. routine monitoring
  - a. vital signs
  - b. physical signs and symptoms
  - c. sedated patients
  - d. claustrophobic patients
2. emergency response
  - a. reactions to contrast
  - b. other allergic reactions (e.g., latex)
  - c. cardiac/respiratory arrest (CPR)
  - d. physical injury, trauma or RF burn
  - e. other medical disorders  
(e.g., seizures, diabetic reactions)
  - f. life-threatening situations  
(e.g., quench, projectiles)
3. patient transfer and body mechanics
4. assisting patients with medical equipment
  - a. implantable devices (e.g., infusion catheters, pumps, pacemakers)
  - b. oxygen delivery systems
  - c. other (e.g., nasogastric tubes, urinary catheters)

### E. Pharmacology

1. contrast media types (FDA approved)
2. contraindications
3. laboratory values  
(e.g., BUN, creatinine, eGFR)
4. dose calculation
5. administration route



## B. Safety (15)

### I. MRI Screening and Safety

- A. Screening and Education (patients, personnel, non-personnel)
  - 1. biomedical implants
    - a. identify and document device, year, make, model
    - b. research and verify device labeling (MRI safe, MRI conditional, MRI unsafe)
    - c. identify device specific parameters
  - 2. ferrous foreign bodies
  - 3. medical conditions (e.g., renal function, pregnancy)
  - 4. prior diagnostic or surgical procedures
  - 5. topical or externally applied items (e.g., tattoos, medication patches, body piercing jewelry, monitoring devices)
  - 6. level 1 and level 2 MRI personnel

- B. Equipment Safety
  - 1. placement of conductors (e.g., ECG leads, coils, cables)
  - 2. cryogen safety
  - 3. ancillary equipment in proximity (MRI safe, conditional, unsafe)
  - 4. emergency procedures (e.g., quench, fire)
- C. Environment
  - 1. climate control (temperature, humidity)
  - 2. designated safety zones
  - 3. gauss lines
  - 4. magnetic shielding
  - 5. RF shielding
- D. Biological Considerations
  - 1. RF field
    - a. specific absorption rate (SAR)
    - b. biological effects
    - c. FDA guidelines
  - 2. static and gradient magnetic fields
    - a. biological effects
    - b. FDA guidelines
  - 3. acoustic noise



## C. Image Production (112)

### I. Physical Principles of Image Formation (40)

#### A. Instrumentation (8)

1. electromagnetism
  - a. Faraday's law
  - b. types of magnets (superconductive, permanent, resistive)
  - c. magnetic field strength
2. radiofrequency system
  - a. coil configuration
  - b. transmit and receive coils
  - c. transmit and receive bandwidth
  - d. pulse profile
  - e. phased array
3. gradient system
  - a. coil configuration
  - b. slew rate
  - c. rise time
  - d. duty cycle

#### B. Fundamentals (14)

1. nuclear magnetism
  - a. Larmor equation
  - b. precession
  - c. gyromagnetic ratio
  - d. resonance
  - e. RF pulse
  - f. equilibrium magnetization
  - g. energy state transitions
  - h. phase coherence
  - i. free induction decay (FID)
2. tissue characteristics
  - a. T1 relaxation
  - b. T2 relaxation
  - c. T2\* (susceptibility)
  - d. proton (spin) density
  - e. flow
  - f. diffusion
  - g. perfusion

3. spatial localization
  - a. vectors
  - b. X, Y, Z coordinate system
  - c. physical gradient
  - d. slice select gradient
  - e. phase-encoding gradient
  - f. frequency (readout) gradient
  - g. k-space (raw data)

#### C. Artifacts (10)

1. cause and appearance of artifacts
  - a. aliasing
  - b. Gibbs, truncation
  - c. chemical shift
  - d. magnetic susceptibility
  - e. radiofrequency, zipper
  - f. motion and flow
  - g. partial volume averaging
  - h. crosstalk
  - i. cross excitation
  - j. Moiré pattern
  - k. parallel imaging artifacts
2. compensation for artifacts

#### D. Quality Control (8)

1. slice thickness
2. spatial resolution
3. contrast resolution
4. signal to noise
5. center frequency
6. transmit gain
7. geometric accuracy
8. equipment handling and inspection (e.g., coils, cables, door seals)

(Image Production continues on the following page.)



## C. Image Production (continued)

### 2. Sequence Parameters and Options (38)

#### A. Imaging Parameters (22)

1. TR
2. TE
3. TI
4. number of signal averages (NSA)
5. flip angle (Ernst angle)
6. FOV
7. matrix
8. number of slices
9. slice thickness and gap
10. phase and frequency
11. echo train length
12. effective TE
13. bandwidth (transmit, receive)
14. concatenations  
(number of acquisitions per TR)

#### B. Imaging Options (16)

1. 2D/3D
2. slice order  
(sequential, interleaving)
3. spatial saturation pulse
4. gradient moment nulling
5. suppression techniques  
(e.g., fat, water)
6. physiologic gating and triggering
7. in-phase/out-of-phase
8. rectangular FOV
9. anti-aliasing
10. parallel imaging
11. motion correction imaging technique
12. filtering

### FOCUS OF QUESTIONS:

Questions will address the interdependence of the imaging parameters and options listed on the left, and how those parameters and options affect image quality and image contrast.

#### 1. Image Quality

- contrast to noise (C/N)
- signal to noise (S/N)
- spatial resolution
- acquisition time

#### 2. Image Contrast

- T1 weighted
- T2 weighted
- proton (spin) density
- T2\* weighted

(Image Production continues on the following page.)



## C. Image Production (continued)

### 3. Data Acquisition and Processing (34)

#### A. Pulse Sequences (20)

1. spin echo
  - a. conventional spin echo
  - b. fast spin echo (FSE)
2. inversion recovery
  - a. STIR
  - b. FLAIR
3. gradient recall echo (GRE)
  - a. conventional gradient echo
  - b. spoiled gradient echo
  - c. coherent gradient echo
  - d. steady state free precession
  - e. fast gradient echo
4. echo planar imaging (EPI)

#### B. Data Manipulation (7)

1. k-space mapping and filling  
(e.g., centric, spiral, keyhole)
2. fast fourier transformation (FFT)
3. post processing
  - a. maximum intensity projection (MIP)
  - b. multiplanar reconstruction (MPR)
  - c. subtraction
  - d. apparent diffusion coefficient (ADC) mapping

#### C. Special Procedures (7)

1. MRA/MRV
  - a. flow dynamics
  - b. time-of-flight
  - c. phase contrast
  - d. contrast enhanced
2. functional techniques
  - a. diffusion
  - b. perfusion
  - c. spectroscopy
3. dynamic imaging
4. contrast bolus detection
  - a. fluoro-triggering
  - b. timing bolus
  - c. automatic bolus detection



## D. Procedures (56)

### I. Neuro

- A. Head and Neck (14)
  - 1. brain
  - 2. head trauma
  - 3. brain for stroke
  - 4. brain for MS
  - 5. brain for seizure
  - 6. brain for CSF Flow
  - 7. pediatric brain
  - 8. IAC
  - 9. pituitary
  - 10. orbit
  - 11. soft tissue neck  
(e.g., parotids, thyroid)
  - 12. angiography
  - 13. spectroscopy
- B. Spine (12)
  - 1. cervical
  - 2. thoracic
  - 3. lumbar
  - 4. sacrum/coccyx
  - 5. brachial plexus

### 2. Body

- A. Thorax (7)
  - 1. chest
  - 2. breast
  - 3. angiography
- B. Abdomen (7)
  - 1. liver, spleen
  - 2. pancreas
  - 3. kidneys
  - 4. adrenals
  - 5. MRCP
  - 6. angiography
  - 7. enterography
- C. Pelvis (6)
  - 1. soft tissue pelvis  
(bladder, rectum, anus)
  - 2. female pelvis  
(uterus/cervix, ovaries, vagina)
  - 3. male pelvis  
(prostate, testes)
  - 4. angiography  
(iliac and run-off)

### FOCUS OF QUESTIONS

Questions about each of the studies listed on the left may focus on any of the following factors:

#### I. Anatomy and Physiology

- imaging planes
- pathological considerations
- protocol considerations
- patient considerations  
(e.g., pediatric, geriatric, bariatric)

#### 2. Patient Set-Up

- patient data input
- coil selection and position
- patient orientation
- landmarking
- physiologic gating and triggering

#### 3. Contrast Media

- effect on images

(Procedures continue on the following page.)





## D. Procedures (continued)

### 3. Musculoskeletal (10)

- A. Temporomandibular Joint
- B. Shoulder
- C. Elbow
- D. Wrist
- E. Hand/Fingers
- F. Thumb
- G. Hip
- H. Ankle
- I. Knee
- J. Fore Foot and Hind Foot
- K. Long Bones (humerus, forearm, femur, lower leg)
- L. Arthrography
- M. Angiography
- N. SI Joints
- O. SC Joints
- P. Sternum
- Q. Bony Pelvis

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