ELIGIBILITY

1. The candidate must meet the eligibility prerequisites for Fellowship outlined in the Fellowship Candidate Handbook.

2. Membership of the College must be achieved prior to the Fellowship examination.

3. Membership must be in Veterinary Radiology.

OBJECTIVES

To demonstrate that the candidate has attained sufficient knowledge, training, experience, and accomplishment to meet the criteria for registration as a specialist in veterinary radiology.

LEARNING OUTCOMES

The field of veterinary radiology includes the study of all domestic animals. There is no provision for sub-specialisation within the discipline.

The candidate will have a detailed\(^1\) knowledge of:

1. Anatomy and physiology (as related to veterinary radiology) of the canine, feline and equine species

2. Clinical and pathophysiologival features (as related to veterinary radiology of canine, feline and equine musculoskeletal disease

3. Radiation physics (as it applies to veterinary radiology)

\(^1\) Knowledge Levels:

**Detailed knowledge** – candidates must be able to demonstrate an in-depth knowledge of the topic including differing points of view and published literature. The highest level of knowledge.

**Sound knowledge** – candidate must know all of the principles of the topic including some of the finer detail, and be able to identify areas where opinions may diverge. A middle level of knowledge.

**Basic knowledge** – candidate must know the main points of the topic and the core literature.
3.1 forms of electromagnetic radiation, production of x-rays, interaction of x-rays with matter, components and function of the x-ray tube
3.2 x-ray artefacts

4. Ultrasound: the physical principles and application of diagnostic ultrasound, including the following:
   4.1 the physical characteristics of the ultrasound beam and the interaction of ultrasound with matter (including acoustic impedance, reflection, refraction, scatter, attenuation)
   4.2 the action of a piezoelectric crystal

5. CT and MRI: physics and practical application
   5.1 For CT: image formation, including CT construction and scanner types, image manipulation, and factors that affect spatial and contrast resolution of the image (factors that affect image quality).
   5.2 For MRI: a detailed knowledge of the formation and display of MR images is required; including understanding of T1, T2, PD weighted images, and other common sequences (e.g. fat saturation and fluid-attenuation sequences).

6. Radiation protection in veterinary medicine
   6.1 The radiation monitoring and safety equipment and regulations, and the candidate should be able to convey this information in a coherent matter to other veterinarians
   6.2 The relevant Australian or New Zealand laws and Codes of Practice as they apply to the use of ionising radiation.

7. The indications and contraindications for all studies of all modalities.

The candidate will have a sound knowledge of:

1. Anatomy and physiology (as related to veterinary radiology) of:
   1.1 Birds
   1.2 The embryology of the cardiovascular, urinary and neurological systems as it relates to development of congenital conditions of these systems.

2. Clinical and pathophysiological features (as related to veterinary radiology) of neurological and respiratory disease

3. Radiation physics (as it applies to veterinary radiology)
   3.1 Fluoroscopy and the image intensifier
   3.2 Radiographic contrast media (including mechanism, side effects, and dose).

4. Ultrasound: the physical principles and application of diagnostic ultrasound, including the following:
   4.1 various transducer types, including factors that affect transducer resolution and image formation a detailed understanding of Doppler, harmonic and compound ultrasound
   4.2 ultrasound artefacts
   4.3 ultrasound contrast media and their effects
5. CT and MRI: physics and practical application
   For CT:
   5.1 The factors that affect image display (including Hounsfield units)
   5.2 Image artifacts and CT contrast media.
   For MRI: MRI contrast media, including mechanisms, dose and side effects.

6. Radiation protection in veterinary medicine: the forms of particulate radiation and
   their interactions with matter (including x-rays, gamma rays, alpha particles,
   electrons, protons and neutrons)

7. Digital radiography including image formation, different capture devices,
   resolution and storage, the processing of PSP plates, the advantages and
   disadvantages of different types of digital radiography.

8. The principles of veterinary cardiology.

The candidate will have a basic knowledge of:

1. Anatomy and physiology (as related to veterinary radiology)
   of bovine, ovine, camels and pocket pet species.

2. Clinical and pathophysiological features (as related to veterinary radiology) of:
   2.1. the pathophysiology of equine alimentary disease.
   2.2. avian disease
   2.3. the relevant differences in clinical and pathophysiological features of
disease amongst all species.

3. Radiation physics (as it applies to veterinary radiology)
   3.1. the types of decay, the decay equation and generator systems, radiation
   detector systems (including those relevant to veterinary medicine, like
   photomultiplier tubes, scintillators and other counters.
   3.2. scintigraphic collimators and the construction and function of a gamma
   camera.
   3.3. factors that limit spatial and temporal resolution of scintigraphic images.
   3.4. the indications and techniques in radiation oncology.

4. Ultrasound: the biological effects

5. MRI:
   5.1. physics of magnetism as it relates to MRI
   5.2. magnet design, factors that affect MR safety and radiofrequency coil
   function.

6. Radiation protection in veterinary medicine
   6.1. atomic and nuclear physics (including atomic composition, structure and
   binding forces, forms of decay, half-life equation)
   6.2. the differences between direct and indirect ionization, and the biological
   effects associated with each form
   6.3. the mechanisms of acute and late radiation injury including the difference
   between deterministic and stochastic effects of radiation induced injury
   6.4. the term exposure (including equivalent dose, absorbed dose)
7. Digital radiography: artifacts associated with digital radiography

The candidate must be able to demonstrate the detailed level of expertise in:

1. Image acquisition, interpretation and reporting:
   1.1 radiographic images in all species
   1.2 CT and MRI for small animals

2. Sonography and sonology skills including both practical skills required to examine patients and interpretative and communication skills that demonstrate an ability to advise referring veterinarians of findings with a detailed knowledge of abdominal and thoracic sonography

3. Performing special radiologic and ultrasonographic procedures with a detailed knowledge of.
   3.1 the pharmacology of contrast media and their physiological effects.
   3.2 myelography, oesophagography, urinary contrast and fluoroscopic studies

4. Ultrasound guided biopsy techniques, including fine needle aspiration and percutaneous biopsy, with a detailed knowledge of the incidence of complications of these techniques

5. Critical evaluation of the current literature and concepts in the field of Veterinary Radiology.

The candidate must be able to demonstrate a sound level of expertise in:

1. Image acquisition, interpretation and reporting:
   1.1 CT and MRI in horses
   1.2 Scintigraphic studies in both small and large animals.

2. Sonography and sonology with a sound knowledge of
   2.1 musculoskeletal, vascular and small parts sonography
   2.2 echocardiography.

3. Performing special radiographic and ultrasonographic procedures with a sound knowledge of other less frequently performed procedures, including sinography, low-dose gastrograms and other gastrointestinal studies, selective and non-selective angiography and a basic knowledge of reproductive sonography (in dogs, cats and horses).

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2 Skill levels:
- **Detailed expertise** – the candidate must be able to perform the technique with a high degree of skill, and have extensive experience in its application. The highest level of proficiency.
- **Sound expertise** – the candidate must be able to perform the technique with a moderate degree of skill, and have moderate experience in its application. A middle level of proficiency.
- **Basic expertise** – the candidate must be able to perform the technique competently in uncomplicated circumstances.
EXAMINATIONS

Exam Format:
The examination will comprise of
a. Two written examinations of 180 minutes each
b. A practical examination comprising of 370 minutes
c. An oral examination comprising of at least 60 minutes, no longer than 120 minutes.

Written exams: Two (2) written examinations of 3 hours duration each (total of 6 hours).

Each examination will comprise of
- 4 x essay-type questions (requiring longer answers) of 30 minutes each, however, questions can be broken into multiple shorter parts. TOTAL TIME: 120 minutes
- 12 short-answer questions (5 minutes each) TOTAL TIME: 60 minutes

Candidates are required to answer showing reference to the literature (e.g. citing relevant studies that inform their answers). Ideally citations should include the primary author, journal abbreviation and publication year; in cases where this recall is not possible, as much detail as possible should be included.

Candidates will often be expected to use their own clinical experience in answering questions, demonstrating experience with modalities.

Perusal time of 20 minutes will be provided at the start of each written paper; candidates are recommended to use this time to help plan their essay answers.

Written Paper 1:
Designed to test the Candidate’s knowledge of the principles of Radiology as described in the Learning Outcomes. Answers may cite specific examples where general principles apply, but should primarily address the theoretical basis underlying each example.

Written Paper 2:
Designed to test the Candidate’s ability to apply the principles of Radiology to particular cases/problems or tasks, and to test the candidate’s familiarity with the current practices and current issues that arise from activities within the discipline of Veterinary Radiology in Australia and New Zealand.

Practical Examination:
- Two (2) examinations of 180 minutes (3 hours) duration writing time
- Each examination will have a five (5) minute rest break in the middle hour. During this break, the candidate will put down their pen, cease writing and turn their paper over. No talking will be allowed. Candidates may use the bathroom during this period.
- Each examination will last for 185 minutes (including rest breaks)
- No perusal time will be given.

Practical exam format:
- The case material presented will be in a digital format. At least one large monitor will be provided for viewing studies.
- The first examination will comprise of radiographic (XR) cases. 15 minutes will be allocated to each case (total of 12 cases in 180 minutes). 5 minutes of rest break will be allocated between questions 6-7.
- The second examination will comprise of advanced imaging (~ 40% CT, 40% MRI, 20% US and/or Nuclear Medicine). 20 minutes will be allocated to each case (20
minutes per CT and MR, with a combination of US/NM cases occupying the remaining time. 5 minutes of rest break will be allocated between questions 5-6.

- Approximately equal numbers of cases of thoracic, abdominal musculoskeletal and neurological body systems will be presented across both examinations.
- EFilm will be used as a universal DICOM Viewer. Candidates should be familiar with the basic functions (pan, zoom, magnify, alteration of window/level, flip orientation functions) of this viewer. Free versions are available to download from the internet.
- For XR, US, NM and MR studies, candidates will be presented with the appropriate images in an appropriate format to make a diagnosis.
- For CT studies, candidates will be presented in a format where the pathology is visible (candidates will not be expected to make reconstructions or multiplanar reformats in different windows to those presented).

Answer style:

- Each case presented in an exam section is worth a total of 20 points.
- Candidates will be provided with information about the study (whether XR, US, CT etc), signalment and limited history.
- Examiners are looking for a systematic evaluation of the study
  o Up to 8 points are awarded for the candidate's observation of imaging abnormalities.
  o Up to 8 points are awarded for a candidate's ability to interpret imaging findings in light of the patient's clinical history and signs (to conclude and/or provide a ranked list of differential diagnoses).
  o Up to 4 points are awarded for a candidate's ability to make appropriate patient management recommendations, including both imaging-related diagnostics and other pertinent diagnostic testing.
- Candidates should demonstrate an understanding of the pathophysiology of observed abnormalities and rational justification for the use of ancillary tests.
- The examiners need to clearly understand the candidate’s thought processes, prioritization and conclusions.
- Normal findings need not be described.
- Candidates should not comment on artifacts unless they are pertinent to interpretation of the study (i.e. they affect the study outcome)
- Individual candidate style will not affect the allocation of marks (e.g. descriptive sentences, vs. dot points can both be valid answers for the observation of imaging abnormalities or conclusions)
- Terminology should utilize the Nomina Anatomica Veterinaria, and not colloquial language.

Oral Examination:

Two formats of questions will be asked in the oral examination.

1. Evaluation of studies on EFilm (similar format to the practical examination). These questions aim to test how the candidate arrives at their radiographic conclusions.
   a. Candidates will be provided with information about the study (XR views, US of a region, CT of the abdomen, etc.), signalment and limited history.
   b. Candidates will be presented with the information required to make a diagnosis.
   c. The examiners need to clearly understand the candidate’s thought processes, prioritization and conclusions.
   d. Up to 8 points are awarded for the candidate's observation of imaging abnormalities.
   e. Up to 8 points are awarded for a candidate's ability to synthesize imaging findings with the patient's clinical history and signs. Candidates should demonstrate an
understanding of the pathophysiology of observed abnormalities and rational justification for the use of ancillary tests.

f. Up to 4 points are awarded for a candidate's ability to make appropriate patient management recommendations, including both imaging-related diagnostics and other pertinent diagnostic testing. The candidate may recommend and ask for further imaging studies. E.g. if it is appropriate after reading a radiographic study to recommend ultrasound, the candidate may ask whether such a study is available.

g. Normal findings need not be described.

h. Candidates should not comment on artifacts unless they are pertinent to interpretation of the study

2. Answering questions using PowerPoint images of projected material. Marks will be allocated according to the length of the question. These questions aim to test the breadth and depth of the candidate’s knowledge. Examples include

   a) A slide of two transverse images of an MRI study of a canine brain, pre and post contrast. “Describe briefly the pathology that you see. What are you differentials for this lesion” (The slides demonstrate a typical meningioma).

   b) A slide showing a spectral Doppler trace through a normal LVOT: “What is this slide depicting? What would you expect to see if a patient had aortic stenosis?”

   c) “What artefact is this?”

   d) An image depicting a brand of contrast medium. “What is this chemical? What are the indications for its use?”

A mixture of these two formats will be included in the oral exam.

**Additional notes for the Practical and Oral Examination**

In the practical and oral examinations, candidates should be provided with information about the study they are receiving (e.g. they will not be awarded marks for describing that a study is a three-view thoracic radiographic study, or an echocardiogram of a cat’s heart, etc.)

- e.g.
  Question 1: three-view thorax. History and signalment provided.
  Question 2: MRI brain, T1W pre and post, transverse, sagittal planes, T2W transverse sagittal plane, FLAIR, transverse plane, GRE transverse plane. History and signalment provided.
  Question 3: Thoracic CT: lung window, soft tissue window pre and post. Sagittal MPR (post contrast soft tissue window). History and signalment provided.

**TRAINING PROGRAMS**

Refer to the Fellowship Candidate Handbook, Section 3.3.

In addition to the stipulations of the Fellowship Candidate Handbook:

1. The Radiology Chapter requires a three year training program (144 weeks)

2. Clinical training should include primarily exposure to dogs, cats and horses with some exposure to ruminants, camelids, exotic animals and birds.

3. Clinical training should include the following: radiography, radiology, contrast procedures, fluoroscopy, digital radiography, sonography, sonology, scintigraphy, computerised tomography and magnetic resonance imaging.
4. The candidate should interpret a minimum 3000 radiological examinations of small animals (primarily dogs and cats), 500 radiological examinations of large animals (primarily horses), 1000 sonographic examinations, and a minimum of 100 examinations that demonstrate adequate knowledge and interpretive skills in CT, MRI and nuclear medicine.

The cases to be included in the case log will be those cases in which the candidate has produced a written report. If, for example, a case has an osteosarcoma of its radius and thoracic radiographs for a metastasis check then this may be counted as two cases if a report is produced for both regions.

The training program should be targeted, with achievable goals set by the Supervisor and candidate for each 6 months. It is anticipated that the first year should be spent initially learning some radiography, then concentrating on radiology and ultrasound with some exposure to the other modalities. The second year is spent consolidating the first with more CT, nuclear medicine with shifting emphasis in the third year to more CT and MRI and nuclear medicine with further consolidation of radiology and ultrasound. It should be expected that the candidate’s case log output is lower in the first year but that they become more independent and productive in their second and third years.

Sonography and Sonology Assessment:
The candidate’s supervisor will continually assess the Candidate’s development of sonography and sonology skills. If the Candidate’s skills were found to be less than satisfactory at the end of the third year of their approved training program, the Candidate will be required to undertake further training before being further assessed. The Candidate will not proceed to formal examinations until they have been determined to have adequate sonography and sonology skills. A pro-forma letter (Appendix 1) will be completed by the Candidate’s supervisor and submitted with the Fellowship training credentials documentation, to state whether the Candidate is considered technically proficient in ultrasound, and to justify the reasons for the assessment.

TRAINING IN RELATED DISCIPLINES
Refer to the Fellowship Candidate Handbook, 2.4.2.

Candidates for Fellowship in Veterinary Radiology must spend time as stipulated by the Fellowship Candidate Handbook in any four of the following related disciplines: Pathology, Small Animal Medicine, Canine Medicine, Feline Medicine, Cardiology, Small Animal Surgery, Equine Medicine, Equine Surgery, Neurology, Oncology.

EXTERNSHIPS
Refer to the Fellowship Candidate Handbook, Section 2.4.1.

ACTIVITY LOG SUMMARY

An Activity Log Summary should be provided for each imaging modality (Radiology, Ultrasound, Special Radiographic Procedures, CT, MRI and Nuclear Medicine) according to the template provided in Appendix 2. Each summary should be submitted with the annual supervisor’s report, with a cumulative total for the total training period. For each imaging modality, cases are recorded by species and the region.
imaged (as listed below). This allows the candidate and their supervisor to monitor their case load for each modality (e.g. numbers of canine abdominal ultrasounds, numbers of equine musculoskeletal radiographs, etc), and assess whether the targets mentioned above (section 4 under the ‘Training Programs’ heading) are being achieved.

**Radiology:**
- Thorax
- Abdomen
- Musculoskeletal/Neurological
- Other

**Ultrasound:**
- Thorax - non cardiac
- Thorax - cardiac
- Abdomen
- Musculoskeletal
- Small Parts (eg thyroid, eye, etc)
- Biopsies/FNA

**Special Radiologic Procedures:**
- Myelography
- Urinary contrast studies
- Oesophagrams
- Other contrast studies
- Fluoroscopy (non-contrast)

**CT:**
- Thorax
- Abdomen
- Musculoskeletal
- Neurological

**MRI:**
- Neurological
- Other

**Nuclear Medicine:**
- Musculoskeletal
- Thyroid
- Hepatic
- Other

**Species list for each modality:**
- Canine
- Feline
- Equine
- Production Animals (cows, sheep, goats, alpacas)
- Avian
- Other
Note that an imaging study of a region is considered a case. If multiple regions are imaged of a single patient (e.g. radiographs of a long bone and thorax for metastasis check) these would be considered two cases; one musculoskeletal and one thorax – non cardiac, provided both are reported.

**PUBLICATIONS**

Refer to the *Fellowship Candidate Handbook*, Section 2.10.

**RECOMMENDED READING LIST**

The candidate is expected to research the depth and breadth of the knowledge of the discipline. This list is intended to guide the candidate to some core references and source material. The list is not comprehensive and is not intended as an indicator of the content of the examination. Candidates at Fellowship level are expected to have library search skills and maintain a watching brief over relevant literature.

**Physics**


**Radiation Protection and Safety**

Relevant (to candidate) Australian State or New Zealand legislation and codes of practice governing the safe use of ionising radiation.

**Anatomy**


**Imaging**


Farrow CS (1994) Radiology of the Cat. Mosby, St. Louis.


Rantanen NW and McKinnon AO (1998) Equine Diagnostic Ultrasonography Williams and Wilkins


FURTHER INFORMATION
For further information contact the College Office

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Fax: International +61 (07) 3423 2977
Email: admin@acvs.org.au
Web: www.acvs.org.au
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EIGHT MILE PLAINS QLD 4113 Australia

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Appendix 1:
Ultrasound Proficiency Report, Radiology Fellowship (template)

Date:
Candidate’s name:
Fellowship Subject:

Supervisor’s name and qualifications:
Supervisor’s position:

This report certifies that I have continually assessed the Candidate’s development of sonography and sonology skills throughout the period of directly supervised training.

The Candidate has/has not [delete the inappropriate string] developed these skills to a satisfactory level during this time.

Comments:
[Please enter any comments that justify your assessment].

Supervisor’s signature.
### Appendix 2:

**ACTIVITY LOG SUMMARY: By Technical Procedure and Species**

**CANDIDATE:**

**SUMMARY FOR THE PERIOD OF:**

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### Nuclear Medicine

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Msk musculoskeletal
nc non-contrast
ncd non-cardiac
Ocs other contrast studies