Introduction:

The ECVDI Study Guide is a guide for ECVDI residents preparing for the theoretical board examination, and is intended to give an indication of topics that may be covered in the examination. Examiners will base their question selection on the Small Animal and Large Animal Exam Content Outlines. 100% adherence to the objectives in this document is not guaranteed.

Anatomy and Physiology:

Imaging-related anatomy, normal imaging features and physiology

For the Large Animal Track, approximately 80% of exam questions will be related to large animal anatomy, with emphasis on the musculoskeletal system. For the Small Animal Track, approximately 95% of exam questions will be related to canine and feline anatomy and up to 5% may relate to other species.

1. General
   1.1. Emphasis will be placed on canine, feline and equine anatomy and physiology.
   1.2. Current anatomic nomenclature will be used in questions and expected in answers (Nomina Anatomica Veterinaria).
   1.3. Current international nomenclature of radiographic projections will be used in questions and expected in answers.

2. General musculoskeletal system
   2.2. Ages at which ossification centres fuse.
   2.3. Blood supply of long bones.
      2.3.1. Blood supply and differences between blood supply in immature and mature long bones.
      2.3.2. Differences in large animal versus small animal immature long bone blood supply.
   2.4. Physiology:
      2.4.1. Physiologic sequence and mechanism of normal fracture healing.

3. Axial skeleton
   3.1. Topographic features of vertebrae in all spinal segments.
   3.2. Topographic features of bones of the skull and mandible.
   3.3. Dental anatomy and the influence of age on dentition.
   3.4. Sinuses, nasal cavities, sinus communications and relationships.
   3.5. Topographic features of the pelvis.
   3.6. Formulae for the vertebral column, sternum and ribs (including cows).
3.7. Anatomical structures in transverse, sagittal, and dorsal plane (head, back and pelvis) as it pertains to CT and MR imaging.

4. **Appendicular skeleton**
   4.1. Topographic features of the long bones and joints as seen on cross sectional imaging modalities as well as radiographs (including avian).
   4.2. Proximal and distal attachments of the major muscles, tendons, and ligaments associated with the thoracic and pelvic limbs as it pertains to radiographic and cross-sectional images.
   4.3. Transverse and sagittal anatomy of the distal extremity, metacarpus/tarsus (equine), common calcaneal and biceps tendons (canine and equine) as it pertains to ultrasound imaging.

5. **Arthrology**
   5.1. Topographic features of joints of the head, vertebral column and limbs.
   5.1.1. Relationship, structure and function of ligaments and intervertebral discs of the vertebral column.
   5.1.2. Joints containing menisci and describe their function
   5.2. Sesamoid bones and their relationship to the joints.
   5.3. Structures that are accentuated on various radiographic projections (e.g. flexed lateral-medial carpus).
   5.4. Comparative arthrology of the bones and joint compartments for the stifle, carpus and tarsus between the three species.
   5.5. Physiology:
   5.5.1. Physiology of cartilage growth, development and repair.
   5.5.2. Physiology of normal synovial joints.

6. **Cardiovascular system**
   6.1. Embryology of the cardiovascular system to explain the development of common malformations of the heart and great vessels.
   6.2. Differences between foetal and neonatal circulation.
   6.3. Topographic anatomy of the heart
   6.4. Vascular supply to the brain.
   6.5. Vertebral vascular system.
   6.6. Branches of the thoracic and abdominal aorta.
   6.7. Blood supply of the canine and feline liver, spleen, kidneys, and pancreas.
   6.8. Anatomy of the portal venous system (hepatic) including the appearance on angiographic studies.
   6.9. Blood supply to thoracic and pelvic limbs including:
   6.9.1. Major arterial blood supply and venous drainage
   6.10. Angiocardiographic anatomy of the heart
   6.11. Echocardiographic anatomy in standard right and left parasternal short and long-
axis planes.
6.12. Physiology:
   6.12.1. Basic principles of cardiac haemodynamics, including flow, timing, and pressure relationships.
   6.12.3. Interrelationship and correlation of the above for the normal cardiac cycle and for abnormal cardiac conditions.
   6.12.7. Physiology of lymphatic production and flow.

7. Nervous system
   7.1. Anatomical relationships of spinal cord, spinal nerves and meninges including:
      7.1.1. Brachial and lumbosacral plexus
      7.1.2. Major components and innervations of the nerves that originate from these plexus
   7.2. Segmental spinal nerve origins, location of exit from the vertebral canal and the function of the spinal nerves.
   7.3. Ventricular system of the brain and its drainage.
      7.3.1. Production and flow of cerebrospinal fluid.
   7.4. Distribution of nerves in the distal extremity of the thoracic and pelvic equine limbs as related to common nerve blocks performed.
   7.5. Anatomy of the brain and brain stem, including the cranial nerves and spinal cord that can be recognized with cross-sectional imaging (CT, MRI or US).
   7.6. Principles of neurologic examination and lesion localization.
   7.7. Origin of cranial nerves and their function.
   7.8. Anatomy of the organs of special sense.

8. Digestive system
   8.2. Dental formula and Triadan tooth numbering system in dog, cat, horse and cow.
   8.3. Normal anatomic relationships of gastrointestinal tract with all other abdominal organs (including bovine).
   8.4. Comparative anatomy of the ileo-ceco-colic region.
   8.5. Anatomy of the liver, gallbladder, and pancreas.
      8.5.1. Comparative anatomy of the bile duct and pancreatic ducts.
   8.6. Normal sonographic anatomy of the gastrointestinal tract.
   8.7. Physiologic mechanisms of gastro-intestinal tract function (oral, oesophageal, gastric, intestinal, colonic) including:
      8.7.1. Propulsion and bolus formation, oesophageal and intestinal motility
      8.7.2. Hormonal control and alimentary reflexes (e.g., gastrocolic) as they apply to motility and secretion control
8.8. Normal exocrine and endocrine physiology of the pancreas.
8.9. Physiology of the hepatobiliary system.

9. **Respiratory system**
9.1. Oropharynx, nasopharynx, laryngeal cartilage and hyoid apparatus.
9.2. Guttural pouches and their anatomic relationships as viewed on routine radiographs and computed tomography or magnetic resonance – equine.
9.3. Bronchial tree and lung lobes and compare them between species.
9.4. Vascular supply of the lung.
9.5. Pleural layers.
9.6. Mediastinal anatomy and degree of development/fenestrations between species.
9.7. Avian air sac anatomy and connection with primary pulmonary structures (airways, lung, etc.).
9.8. Physiology
   9.8.1. Mechanics of ventilation, including: mechanism of air movement, pressure-volume relationships and air space divisions.
   9.8.2. Lung perfusion and physiologic responses to lung diseases.
   9.8.3. Methods of oxygen and carbon dioxide transport.

10. **Urogenital**
   10.1.1. Normal structures using ultrasonography, contrast enhanced radiographic or cross-sectional modalities.
10.2. Embryology of the urogenital system
   10.2.1. Development of the kidney, ureters, and urinary bladder
   10.2.2. Development of gonadal structures.
10.3. Avian normal urogenital anatomy.
10.4. Renal function
   10.4.1. Mechanism of urine production.
   10.4.1.1. Methods of renal function assessment.
   10.4.1.2. Role of the kidney in the maintenance of blood pressure/electrolytes.
   10.4.1.3. Renin-angiotensin-aldosterone pathways and their effects on renal function.
   10.4.1.4. Erythropoietin and endocrine functions.
10.4.2. Organ, hormonal and mineral inter-relationships including:
   10.4.2.1. Interrelations of kidneys, liver, intestine, bone, parathyroid and thyroid gland on Vitamin D, calcium and phosphate regulation.
10.5. Pressure, volume relationship among the ureters, bladder and urethra; neurophysiology of micturition, the detrusor reflex and vesicoureteral reflux.
10.6. Radiographically recognizable foetal ossification intervals (canine and feline).
10.7. Ultrasonographic findings of the uterus and foetuses during normal pregnancy
10.8. Physiology of the genital system

11. Miscellaneous
11.1. Effects of positioning and postural influences on the radiographic appearance of all body parts, and in particular the thorax and abdomen.
11.2. Effects of inspiration vs. expiration on anatomic relationships and appearances.
11.3. Location of lymph nodes and describe drainage patterns.
11.4. Cross-sectional and sagittal anatomy of the thorax and abdomen.
11.5. Anatomy of endocrine organs.
11.6. Physiology of endocrine organs including:
   11.6.1. Thyroid Gland
   11.6.1.1. Iodide trapping and organification into T3/T4.
   11.6.1.2. Pituitary-thyroid axis - homeostasis and negative feedback.
   11.6.1.3. Thyroid hormone function and effects on other organ systems.
   11.6.2. Pituitary Gland
   11.6.2.1. Homeostasis and regulation of pituitary gland via portal system and releasing factors/proteins or neurohypophyseal control of posterior pituitary.
   11.6.3. Adrenal Gland
   11.6.3.1. Epinephrine and norepinephrine production and regulation.
   11.6.3.2. Glucocorticoids - control and effects.
   11.6.3.3. Mineralocorticoids - control and effects.
   11.6.3.4. Physiologic effects of adrenal hormones on CNS, cardiovascular system, respiratory system and metabolic status.
Pathophysiology

- Pathophysiology contains both species independent and species-specific topics
- For the Large Animal Track, approximately 80% of exam questions will be related to large animal or species-independent pathophysiology
- For the Small Animal Track, approximately 95% of exam questions will be related to canine and feline or species-independent pathophysiology

1. Head and Neck (excluding CNS, including oesophagus)
   1.1. Pathophysiology of common diseases of the nasal cavity and paranasal sinuses
   1.2. Pathophysiology of common diseases of the oral cavity and associated structures (teeth, tongue, salivary glands, masticatory apparatus…)
   1.3. Pathophysiology of common diseases of the external and middle ear (including the tympanic bullae)
   1.4. Pathophysiology of oesophageal diseases
      1.4.1. Pathophysiology of oesophageal dysfunction including but not limited to: megaoesophagus, strictures, motility disorders, dysphagia, foreign body, oesophageal perforation.
      1.4.2. Pathophysiology of dysphagia
   1.5. Pathophysiology of the thyroid gland.

2. Thorax
   1. Anatomy and haemodynamic consequences of common congenital and acquired cardiovascular diseases including:
      2.1.2. Patent ductus arteriosus
   3. Atrial and ventricular septal defects
   4. Valvular stenosis
   5. Atrioventricular dysplasias
   6. Endocardial cushion defects and conotruncal defects
   7. Tetralogy and pentalogy of Fallot
   8. Persistent left cranial vena cava
   9. Valvular endocardiosis
   10. Cardiomyopathy
   11. Persistent right aortic arch
   12. Aberrant left subclavian artery
   13. Double aortic arch
   14. Aortic coarctation
15. Cor triatriatum dexter
16. Valvular endocarditis
17. Heartworm disease

3. Pericardial disease and its effect on cardiac function.
4. Clinical signs, anatomy, haemodynamic effects and pathophysiology of the following:
   4.3. Arteriovenous malformations
   4.4. Infarction of major vessels and downstream organs
   4.5. Aortic and venous embolism/thrombus
5. Calculation of pressure gradients in the diseased cardiovascular system on Doppler ultrasound using a modified Bernoulli equation.
6. Common causes of respiratory dysfunction including dyspnoea and stridor and their pathophysiologic effects on the thoracic wall, pleural space, upper respiratory system and bronchi, lungs, pulmonary vasculature and diaphragm
7. Pathophysiology of upper and lower airway obstruction
8. Pathophysiology of pulmonary parenchymal disease
9. Pathophysiology of pleural effusions
10. Pathophysiology of pulmonary thromboembolism

2. Abdomen
   2.1. Difference between vomiting and regurgitation in small animals
   2.2. Pathophysiology of ileus
   2.3. Intestinal transit times in disease states
   2.4. Causes and types of mechanical and functional ileus.
   2.5. Pathophysiology of gastric dilatation/torsion/volvulus complex in dogs
       2.5.3. Possible etiologic factors.
       2.5.4. Systemic and local pathophysiologic alterations resulting from gastric torsion/volvulus
   2.6. Applicable pathophysiology of small intestinal versus large intestinal diarrhoea
   2.7. Pathophysiology of the hepatobiliary system:
       2.7.3. Acute and chronic hepatitis
       2.7.4. Liver abscessation
       2.7.5. Cholangitis
       2.7.6. Cholecystitis
       2.7.7. Obstructive biliary disorders
       2.7.8. Biliary rupture and peritonitis
       2.7.9. Hepatic lipidosis
2.8. Clinical signs, anatomy, hemodynamic effects and pathophysiology of portosystemic shunts (acquired, single intrahepatic and single extrahepatic)
2.9. Pathophysiology of pancreatitis and types and behaviour of pancreatic tumours.
2.10. Pathophysiology of endocrine diseases associated with the pancreas.
2.11. Pathophysiology and causes of peritonitis
2.13. Pathophysiology of abnormal renal function:
   2.13.3. Acute vs. chronic renal failure
   2.13.4. Glomerulonephritis
   2.13.5. Interstitial nephritis
   2.13.6. Toxicities
   2.13.7. Infections
   2.13.8. Pyelonephritis
2.14. Abnormal pressure and volume relationship among the ureters, bladder and urethra including the neuropathophysiology of micturition, the detrusor reflex and vesicoureteral reflux.
2.15. Pathophysiology of lower urinary tract disease:
   2.15.3. Urolithiasis
   2.15.4. Cystitis
   2.15.5. Bladder rupture
   2.15.6. Feline lower urinary tract disease
2.16. Describe the congenital, neoplastic, functional problems, and systemic effects of ovarian disease.
2.17. Describe the pathogenesis, predisposing causes, and systemic effects of canine pyometra
2.18. Pathophysiology of prostate gland diseases.
2.19. Pathophysiology of testicular diseases.
2.20. Anatomy and developmental mechanism of malformations of the urogenital system including ectopic ureter, pseudohermaphrodites, renal agenesis, uterus masculinus, and cryptorchidism.
2.21. Pathophysiology of lymph node disease
2.22. Pathophysiology of the adrenal gland including:
   2.22.3. Tumours of the adrenal cortex and medulla
   2.22.4. Hyperadrenocorticism and hypoadrenocorticism
   2.22.5. Hyperaldosteronism
2.23. Pathophysiology of diseases of the lymphatic and mononuclear phagocytic systems
3. Central Nervous System
   3.1. Pathophysiology of pituitary disease including Cushing’s syndrome.
   3.2. Pathophysiology of common causes of localised spinal cord disorders in small animals including, but not limited to: intervertebral disc disease, haemorrhage, fibrocartilaginous embolism, neoplasia, developmental disorders, infection and trauma.
   3.3. Pathophysiology of common causes of localized spinal cord disorders in large animals including, but not limited to: developmental disorders, and trauma.

5. Musculoskeletal System
   5.1. Pathophysiology of bone disease including:
       5.1.1. Metabolic and congenital diseases
       5.1.2. Fracture healing (normal and pathological fracture healing)
       5.1.3. Infection and sequestration of bone
       5.1.4. Bone infarcts and avascular necrosis
       5.1.5. Periosteal and periarticular new bone formation
       5.1.6. Disuse osteopaenia
   5.2. Pathophysiology of joint disease including:
       5.2.1. Immune-mediated and infectious joint disease
       5.2.2. Degenerative joint disease
       5.2.3. Traumatic joint disease
       5.2.4. Osteochondrosis and osteochondritis dissecans
   5.3. Pathophysiology of common diseases of the musculoskeletal systems in horses for example:
       5.3.1. Navicular syndrome
       5.3.2. Laminitis
       5.3.3. Osteoarthritis
       5.3.4. Osteochondrosis of the tarsus, fetlock, stifle and shoulder joint.
   1. Wobbler syndrome
Physics, Safety and Instrumentation

Physics and safety of ionising radiation, ultrasound and MR; radiobiology; statistics in diagnostic imaging; image artefacts. Instrumentation, image formation, and methodology of contrast medium enhanced techniques of imaging modalities.

1. Basic Principles
   1.1. Basic Atomic and Nuclear Physics
      1.1.1. Atomic composition and structure and nuclear binding forces
      1.1.2. Nuclear decay charts and radioactive decay
      1.1.3. Line of stability and the line of unity
      1.1.4. Isotopes, Isobars, Isomers and Isotones
      1.1.5. Atomic number and atomic mass; calculation of neutron number
   1.2. Modes of Radioactive Decay (particulate and non-particulate emissions including neutrinos and anti-neutrinos)
      1.2.1. Negatron decay
      1.2.2. Alpha decay
      1.2.3. Electron capture
      1.2.4. Positron decay (annihilation reaction and photon formation)
      1.2.5. Isomeric transition
   1.3. Radioactive Decay terminology
      1.3.1. Decay constant and relationship with physical half-life
      1.3.2. Physical and biological half-life and the calculation of the effective half-life. Understand the concept of an effective half-life
      1.3.3. Average half-life
      1.3.4. Specific activity
   1.4. Physics and Chemistry of Radiation Absorption
      1.4.1. Difference between molecular excitation and ionization
      1.4.2. Difference between particulate and electromagnetic (nonparticulate) forms of radiation.
      1.4.3. Difference between the sites of origin of gamma rays and x-rays.
      1.4.4. Basic forms of particulate radiations and their interactions or potential interactions with matter, including: alpha particles, electrons, protons, and neutrons.
      1.4.5. Difference between direct and indirect forms of ionizing radiation injury
      1.4.6. Difference between direct and indirect actions of radiation
      1.4.7. Role of ionization and free radical formation in creating biological effects
   1.5. Molecular reactions and interactions of radiation with matter
      1.5.1. “Wave concept” and the “particle concept” for understanding electromagnetic radiation. Given two known values of electromagnetic radiation, be able to calculate the wavelength, energy or frequency of the radiation.
      1.5.2. Photoelectric and Compton interaction, pair production, and photodisintegration and the radiation energy and physical density (subject) ranges for which these
types of interactions are likely to occur.

1.5.3. Interactions between photons and matter and how and when they occur. Differences between them and their role in diagnostic radiology. This includes the basic interactions related to:

1.5.3.1. Absorption
1.5.3.2. Scattering
1.5.3.3. Transmission
1.5.3.4. Mass and linear attenuation coefficient

1.5.4. Exposure, dose equivalent, absorbed dose, weighting (quality) factor for electromagnetic and particulate radiation.

2. **Physics of Diagnostic Radiology**

   2.1. Physical properties of x-rays:
      2.1.1. Relationship of the speed of light, frequency and wavelength. Relationship of the x-ray wavelength and energy.
      2.1.2. Wavelength of diagnostic x-rays compared to other forms of electromagnetic radiation (electromagnetic spectrum)
      2.1.3. Electron orbits and energy levels
      2.1.4. Bremsstrahlung radiation and polychromatic (energetic) x-ray beam
      2.1.5. Characteristic radiation
      2.1.6. X-ray beam intensity and quality
      2.1.7. Effect on photographic emulsion
      2.1.8. Fluorescence and phosphorescence
      2.1.9. Inverse square law and calculations for determining new mAs factors when distance changes
      2.1.10. Interactions with matter and ionization of atoms and secondary scatter
      2.1.11. Half value layer, linear and mass attenuation coefficients

3. **Radiation Biology**

   3.1. Basic biology and radiobiology of the cell cycle.
   3.2. Difference in radiation response between acute and late responding tissues.
   3.3. Radiation induced cell death
      3.3.1. Mechanisms of electromagnetic radiation induced cell killing
      3.3.2. Basic mechanisms of acute and late radiation injury and cell killing
      3.3.3. Differences between apoptotic and mitotic cell death related to radiation induced cellular injury.
      3.3.4. Comparison of lethal damage, sub-lethal damage and potentially lethal damage
   3.4. Concept of L.E.T. (linear energy transfer) and how L.E.T. relates to R.B.E. (relative biological effectiveness) and the oxygen effect.
   3.5. R.B.E. and how R.B.E. may be influenced by other factors
   3.6. Phases of acute radiation syndrome, including the bone marrow, gastrointestinal and CNS radiation syndromes.
3.6.1. Prodromal symptoms, and clinical signs associated with acute radiation syndrome. Whole body dose range that results in acute radiation syndrome.

3.7. Effects of chronic radiation exposure
   3.7.1. Effects of radiation on the developing embryo/foetus in utero

3.8. Difference between “lethal dose” and “tolerance dose”

3.9. Difference between deterministic and stochastic effects related to radiation induced injury.

4. Radiation Protection
   4.1. Various radiation protection devices used for different types of radiation.
   4.2. A.L.A.R.A. concept and application to standards of radiation protection and safety.
   4.3. Barrier design, occupancy, workload, filtration, and beam limiting devices and personnel shielding for the design of radiology rooms and shielding within the room.
   4.4. Common patient exposure levels during radiographic and CT procedures.
   4.5. Radiation protection and safety when handling animals that have been given either diagnostic (99mTc, 111Indium) or therapeutic radiopharmaceuticals (131I) including:
      4.5.1. Care and handling of the radioisotopes and the radioactive patients
      4.5.2. Monitoring external and internal exposure of personnel
      4.5.3. The risks of exposure versus contamination

5. Radiation Monitoring
   5.1. Equipment and devices used for monitoring radiation and the basic principles involved.
   5.2. Appropriate use and limitations of personnel monitoring equipment (TLD monitors, pocket dosimeters and film badges) and interpretation of data obtained.
   5.3. European regulations and dose limits for occupational, non-occupational, general population, and foetal exposures.
      5.3.1. Patient versus operator exposure
      5.3.2. Effect of radiation safety factors: time, distance, shielding
      5.3.3. Lifetime cumulative exposures

6. Construction and function of the components of a diagnostic x-ray unit including:
   6.1.1. Tungsten usage for anodes and cathodes
   6.1.2. Cathode anatomy and function
   6.1.3. Characteristics of focal spots including: Actual vs. effective focal spots
   6.1.4. Line focus principle, large vs. small focal spots
   6.1.5. Requirements for magnification radiography
   6.1.6. Anode anatomy and function
      6.1.6.1. Rotation and stationary anodes
      6.1.6.2. Target angle
      6.1.6.3. Heat dissipation within the tube and tube housing
6.1.7. Inherent and added beam filtration
6.1.8. Milliamperage (mA) regulation
6.1.9. Voltage (kVp) regulation
6.1.10. X-ray tube housing and cooling elements
6.2. Construction (basics) and function of different generator types including:
   6.2.1. Alternating and direct current
   6.2.2. Transformers – anatomy and function
      6.2.2.1. Laws of transformers
   6.2.3. Filament versus high voltage circuits
   6.2.4. Rectification
      6.2.4.1. Semiconductors (basics)
   6.2.5. Generator types:
      6.2.5.1. Three phase generators
   6.2.6. Exposure timers (electronic, phototimers – automatic exposure control)
   6.2.7. Kilovoltage (including ripple effect, constant potential and high frequency)
   6.2.8. Differences between x-, gamma rays, kilo-, ortho- and megavoltage
6.3. Miscellaneous
   6.3.1. Cause and appearance of the Heel effect.
   6.3.2. Average KW ratings of X-ray tubes and X-ray generators.
   6.3.3. Different types and uses of collimators.
   6.3.4. Tube rating charts and anode cooling charts for routine radiology and fluoroscopy units.
   6.3.5. Principle of calculation of heat units.
   6.3.6. Normal line voltage and use of line voltage compensators.
   6.3.7. Principles of energy transfer in the production of a useful x-ray beam including those acting at the anode, cathode, glass envelope, within the transformer.
6.4. Use, limitations, care and construction of the following radiographic equipment:
   6.4.1. Callipers
   6.4.2. Cones and collimators
   6.4.3. Fluoroscopic input screens and output phosphors and their functions.
   6.4.4. Grids
      6.4.4.1. Parallel, cross, focused and Potter-Bucky grids.
      6.4.4.2. Grid ratio and their common values.
      6.4.4.3. Composition of grids.
      6.4.4.4. Influence grids exposure settings and affect image quality.
6.5. Principles, mechanics and usefulness of air-gap technique
   6.6.1. Components of the image intensifier and the production of an image.
6.7. Principle and technique of magnification radiography.
6.8. Digital Radiography
   6.8.1. Use of computers in radiology and the concepts of digital image formation, format, resolution and storage.
   6.8.2. Computer hardware characteristics (RAM, CPU, Graphics card, LAN-Adapter).
   6.8.3. Storage media and their capacity and general characteristics:
      6.8.3.1. Units of performance and storage (Bits and Bytes)
      6.8.3.2. HDD
      6.8.3.3. FDD
      6.8.3.4. CD/DVD
      6.8.3.5. MO-Disks
      6.8.3.6. Tape
      6.8.3.7. RAID (Redundant Array of Independent Drives)
   6.8.4. Pixel, voxel, matrix size and their relationships.
   6.8.6. Basic components and characteristics of PACS (picture archiving and communication system), including DICOM connectivity.
   6.8.7. Voice recognition software for reporting
   6.8.8. DR and CR systems
      6.8.8.2. Processing of a PSP imaging plate and mechanism of image production.
      6.8.8.3. Basic components and function of flat panel digital radiography detection systems including:
      6.8.8.3.1. Indirect conversion detectors
      6.8.8.3.2. Direct conversion detectors
      6.8.8.4. Difference between Thin Film Transistor (TFT) detectors and Charge Coupled Device (CCD) – based detectors.
      6.8.8.5. Factors contributing to spatial resolution and overall image quality (including image noise) in CR and DR.
   6.8.8.6. Evaluation of performance of imaging systems including:
      6.8.8.6.1. MTF
      6.8.8.6.2. DQE
   6.8.8.8. Advantages and disadvantages of digital systems (CR and DR) as compared to one another.
   6.8.8.9. Properties of H&D curves and comparison of the relative speed, latitude and contrast of different detector types from their characteristic curves.

6.9. Properties of the commonly used contrast media: Iopamidol, iohexol, iotrolan, iothalamate, ioxaglate, iobitridol, ioversol and various combinations of methylglucamine (meglumine) and sodium diatrizoate.
6.9.1. Chemical names.
6.9.2. Relative viscosities.
6.9.3. Anionic and cationic composition of the ionic and non-ionic contrast media.
6.9.4. Advantages and disadvantages of ionic and non-ionic contrast media.
6.9.5. Physiologic effects, including the toxicities, of contrast media.
   6.9.5.1. Management of adverse effects.
6.9.6. Physical and chemical properties of the different barium sulphate suspensions.
   6.9.6.1. Definition of w/v and w/w formulations.

6.10. Radiographic Quality and Artefacts
6.10.1. Characteristics of image quality:
   6.10.1.1. Contrast - including the differences between subject contrast, film contrast and radiographic contrast.
   6.10.1.2. Density (radiographic film optical density, base optical density, film fog).
   6.10.1.3. Detail, resolution (including full width half max measurements, FWHM) and sharpness.
   6.10.1.4. Latitude.
   6.10.1.5. Modulation transfer function.
6.10.1.6. Effects of the following factors on image quality:
   6.10.1.6.1. Geometric factors
      6.10.1.6.1.1. Distortion
      6.10.1.6.1.2. Magnification
      6.10.1.6.1.3. Object position
      6.10.1.6.1.4. Object size and shape
   6.10.1.6.2. Characteristics of controllable x-ray tube factors
      6.10.1.6.2.1. Focal spot size
      6.10.1.6.2.2. Object-film distance
      6.10.1.6.2.3. Target-film distance

6.11. Technique Chart Formation:
6.11.1. Importance and relationship of the following terms as they relate to technique chart formation:
   6.11.1.1. Focal-film distance
   6.11.1.2. Grids
   6.11.1.3. mA x time = mAs
   6.11.1.4. mAs vs. kVp
   6.11.1.5. Speed of screens and type of film
   6.11.1.6. Subject contrast
   6.11.1.7. Thickness of subject

6.12. Relationship between the following terms:
   6.12.1. mAs and radiographic density
   6.12.2. kVp and radiographic contrast
   6.12.3. kVp and radiographic density
7. **Physics of Diagnostic Ultrasound:**
   7.1. Physical characteristics of the ultrasound beam.
   7.2. Basic interactions of ultrasound with matter, including reflection, refraction, scattering and attenuation.
   7.3. Factors that affect lateral and axial resolution.
   7.4. Physical factors influencing the propagation of ultrasound in tissues and factors that influence acoustic impedance.
   7.5. Relationship between wavelength, frequency, impedance and the velocity of sound in tissues.
   7.6. Ultrasound beam formation and propagation particularly relative to the near field, focal zone and far field.
   7.7. Calculation of reflected interfaces within tissue and the pulse echo operation (including pulse repetition frequency, pulse duration and duty factor).
   7.8. Underlying principles and use of harmonic imaging including indications, contraindications and modes of action.
   7.9. Doppler Ultrasound
      7.9.1. Doppler principle and be able to calculate the velocity of blood flow given various parameters related to the Doppler frequency shift.
   7.10. Safety: Biological effects and safety concerns of Diagnostic Ultrasound

8. **Construction and function of the components of a diagnostic ultrasound unit** including:
   8.1.1. Basic components of an Ultrasound unit.
   8.1.2. Components of an ultrasound transducer and their functions including:
      8.1.2.1. Housing
      8.1.2.2. Backing block
   8.1.3. Piezoelectric effect.
      8.1.3.1. Materials used for Piezo-Crystals.
      8.1.3.2. Curie temperature and its significance in manufacturing the crystals.
   8.1.4. Definition of Q-factor.
   8.1.5. Characteristics of various transducer types:
      8.1.5.1. Electronic versus mechanical
      8.1.5.2. Linear, curved, phased array
      8.1.5.3. Multifrequency transducers
   8.1.6. Methods of Image Formation and Display
      8.1.6.1. Various modes of displaying ultrasound data.
      8.1.6.2. Real-time imaging systems.
      8.1.6.3. Use and functions of the controls for real-time equipment:
         8.1.6.3.1. Gain
         8.1.6.3.2. TGC
         8.1.6.3.3. Frame rate
         8.1.6.3.4. FOV
8.1.6.3.5. Depth range
8.1.6.3.6. Acoustic power
8.1.7. Definition of the following terms and their effect on the displayed image:
8.1.7.1. Frame Rate
8.1.7.2. Image depth
8.1.8. Doppler Ultrasound
8.1.8.1. Transducer characteristics, instrumentation, and controls.
8.1.8.1.1. PRF (pulse repetition frequency)
8.1.8.1.2. CW (continuous wave) vs. PW (pulsed wave)
8.1.8.1.3. CD (colour Doppler)
8.1.8.1.4. Power Doppler
8.1.8.1.5. Tissue Doppler
8.1.8.2. Clinical applications of Doppler and basic interpretation principles.
8.1.8.2.1. Analysis of arterial wave forms using pulsatility index, resistive index and A/B ratios.
8.1.8.2.2. Doppler energy and Colour Power Doppler imaging techniques.
8.1.9. Composition, properties and uses of the different contrast media used in Ultrasound:
8.1.9.1. Agitated NaCl
8.1.9.2. Microbubbles
8.1.10. Principle of harmonic properties of ultrasound contrast media

9. **Construction and function of the components of a diagnostic Computed Tomography unit** including:
9.1. Principles of cross-sectional image formation including the concept of filtered back projection.
9.2. Various types of detectors and orientations used in CT scanners (“generations”).
9.2.1. Underlying principles of detectors (see radiation protection).
9.3. Physical principles and basic mechanics of helical CT scanners and the advantages and disadvantages.
9.3.1. Pitch for single and multi-detector-row helical scanners.
9.4. Image Reconstruction and Display:
9.4.2. Iterative methods of reconstruction.
9.4.3. Analytical methods of reconstruction.
9.5. Hounsfield units and their limitations and use.
9.6. Window level and window width and their application in image display.
9.7. Effect of matrix size, image depth, field of view, slice thickness, mA, and kVp on image quality.
9.8. Basic principles of cone-beam CT
10. **Physics of Magnetic Resonance Imaging**

10.1. Basic Principles:
   10.1.1. Nuclear structure, angular momentum, magnetism and magnetic dipole moment.
   10.1.2. Basic principles and parameters associated with MRI, including the following terminology:
      10.1.2.1. Larmor frequency
      10.1.2.2. Magnetisation vectors
      10.1.2.3. Radiofrequency pulse
      10.1.2.4. Free induction decay
      10.1.2.5. Spin-spin relaxation time
      10.1.2.6. Spin-lattice relaxation time
      10.1.2.7. Pulse sequence
      10.1.2.8. Chemical shift and paramagnetic substance
      10.1.2.9. Contrast media and magnetic susceptibility

10.2. Safety concerns of MRI.

11. **Construction and function of the components of a diagnostic Magnetic Resonance Imaging unit** including:

11.1. Instrumentation:
   11.1.1. Basic mechanics and advantages of the different types of magnets used for MRI (permanent, resistive, superconductive).
   11.1.2. Basic differences between a horizontal magnet design and a vertical (open) magnet design.
   11.1.3. Basic differences between commonly used receiver coil types (surface, quadrature, array) and their use.
   11.1.4. Function of the various components of the MRI scanner.
   11.1.5. Factors that can create image artefacts, including the effect of commonly used veterinary surgical implants.
   11.1.6. MR terminology and the role these factors play in MR image formation:
      11.1.6.1. TR, repetition time
      11.1.6.2. TE, echo time
      11.1.6.3. Excitation or flip angle
      11.1.6.4. FOV, field of view
      11.1.6.5. Slice thickness and slice gap
      11.1.6.6. Number of averages or excitations
      11.1.6.7. Slice selection, phase and frequency encoding gradients

11.2. Clinical Utility/Indications/Procedures
   11.2.1. General method for acquiring the following pulse sequences and their common clinical uses:
   11.2.2. T1-weighted pulse sequence
11.2.3. T2-weighted pulse sequences (including fast spin echo T2 imaging)
11.2.4. Proton density pulse sequence
11.2.5. Gradient echo pulse sequence
11.2.6. Fat suppression techniques (fat saturation, STIR)
11.2.7. MR angiography (time of flight, phase contrast)
11.2.8. FLAIR (fluid attenuated inversion recovery)

11.3. MRI contrast media:
11.3.2. Hazards and complications of administering contrast media.
11.3.3. Mode of action of MR contrast media.

12. Construction and function of the components of instrumentation pertaining to Nuclear Medicine Imaging (SA and LA tracks differ in this section) including:

12.1. Large Animal Track Only: Nuclear medicine generator systems
12.1.1. Production of radionuclides by the parent-daughter decay system (generator systems).

12.2. Large Animal Track Only: Radiation Detectors:
12.2.1. Scintillation Detectors - Gamma Camera
12.2.2. Gamma camera head and function of its components including the NaI crystal, photocathode, and photomultiplier tubes.
12.2.3. Basic mechanics and function of the preamplifier, amplifier, and pulse height analyser.
12.2.4. Basic mechanics and function of rate scalers, cathode ray tube, and analogue digital converter (ADC).
12.2.5. Structure and use of collimators including low energy-all purpose, diverging, converging, medium energy, pinhole, high resolution, and high sensitivity.

12.3. Large Animal Track Only: Gamma Cameras – Resolution/QC:
12.3.1. Common procedures used in quality control.
12.3.2. Factors that limit spatial and temporal resolution.

12.4. Large Animal Track Only: Digital Image Processing:
12.4.1. Types of acquisitions including frame mode, list mode, static, dynamic, and gated (ECG synchronized).
12.4.2. Image depth – bit, byte and word.
12.4.3. Effect of matrix size on image quality, frame rate and storage capacity.
12.4.4. Types of background correction.
12.4.5. Cross talk and its quantitative effect on ROI.
12.4.6. Underlying principles and use of regions of interest (ROI), time activity curves and basic filtering operations including smoothing, edge detection, temporal and spatial operations.

12.5. Small and Large Animal Tracks: Radionuclides – Energy and half-life of the following radionuclides:
12.5.1. Technetium 99-m
12.5.2. Iodine 123
12.5.3. Iodine 131

12.6. **Small and Large Animal Tracks:** Radiopharmaceuticals - Indication, routes of administration, mechanisms of location and route of excretion for the following radiopharmaceuticals:

12.6.3. 123I, 131I – thyroid scintigraphy.

13. **Statistics in Diagnostic Imaging**

13.1. Methods of comparing various imaging systems or methods to each other in terms of diagnostic accuracy.

13.1.1. The principles of a “gold standard”
13.1.2. Receiver operating characteristic curve analysis
13.1.3. The kappa statistic
13.1.4. Sensitivity, specificity and accuracy
13.1.5. Positive and negative predictive values.

14. **Artefacts in Diagnostic Imaging**

14.1. Origin and appearance of the following CR/DR artefacts:

14.1.1. Quantum mottle
14.1.2. Saturation
14.1.3. Planking
14.1.4. Fading
14.1.5. Light leak (CR plate)
14.1.6. Dirty light guide
14.1.7. Faulty transfer
14.1.8. Misplacement
14.1.9. Border detection
14.1.10. Dead pixels
14.1.11. Moire
14.1.12. Uberschwinger/Halo
14.1.13. Density threshold

14.2. Cause, appearance and correction of the following possible ultrasound artefacts:

14.2.1. Section thickness
14.2.2. Reverberation
14.2.3. Comet tail
14.2.4. Ring down
14.2.5. Range ambiguity
14.2.6. Refraction
14.2.7. Mirror image
14.2.8. Side and grating lobe
14.2.9. Propagation speed error
14.2.10. Shadowing
14.2.11. (Edge) shadowing
14.2.12. Enhancement (through transmission)
14.2.13. Electronic noise
14.2.15. Anisotropism

14.3. Cause, appearance and correction of the following possible CT artefacts:
14.3.1. Motion
14.3.2. Artefacts caused by high-density material
14.3.3. Partial volume
14.3.4. Beam hardening
14.3.5. Edge gradient artefact
14.3.6. Aliasing
14.3.7. Detector nonlinearity and detector failure
14.3.8. Truncation
14.3.9. Helical artefacts
14.3.10. Point spread effect & blooming
14.3.11. Edge enhancement and rebound artefact
14.3.12. Photon starvation

14.4. Cause, appearance and correction of the following possible MRI artefacts:
14.4.1. Signal wraparound (aliasing)
14.4.2. Slice overlap (cross-excitation)
14.4.3. Truncation (ringing / Gibbs-artefact)
14.4.4. Noise and RF-interference
14.4.5. Partial volume averaging
14.4.6. Chemical shift
14.4.7. Motion
14.4.8. Flow artefact
14.4.9. Susceptibility
14.4.10. Magic angle

14.5. **Large Animal Track Only**: Cause, appearance and correction of the following possible scintigraphic artefacts:
14.5.1. Motion
14.5.2. Edge packing
14.5.3. Crystal abnormality
14.5.4. Radionuclide contamination (urine, injection site, etc.)
14.5.5. Non-functioning PM tube, defective or uncoupled light pipe
14.5.6. Improper energy calibration
14.5.7. Contaminated gamma camera face
14.5.8. Improper delay from injection to imaging
14.5.9. Inadequate count density
14.5.10. Improper matrix size
14.5.11. Blockage of technetium uptake by drugs and contrast media
14.5.12. Poor technetium-radiopharmaceutical binding
        Improper collimator for isotope used (e.g., low energy all-purpose collimator with Indium)
Imaging features – basic knowledge

Topics listed in this section represent knowledge essential for large and small animal imaging tracks. Candidates are expected to know basic imaging features in small and large animals (dependent on track). Basic knowledge is defined as what is included in general diagnostic imaging textbooks. For the small animal track, approximately 95% of questions will pertain to canine and feline imaging. For the large animal track, approximately 80% of questions will pertain to large animal imaging.

Small Animal Imaging Features:

1. Head and neck
   1. Radiography
      1.1. Radiographic appearance of common diseases of the skull, nasal cavity and paranasal sinuses.
      1.2. Radiographic appearance of common diseases of the oral cavity and associated structures.
      1.3. Radiographic appearance of common diseases of the external and middle ear
      1.4. Radiographic appearance of common oesophageal diseases

2. CT and MR: indications, scanning protocol, principles of interpretation and appearance of common disease for regions in small animals:
   2.1. Nasal cavities and paranasal sinuses
   2.2. Oral cavity and associated structures
   2.3. External and middle ear
   2.4. Thyroid gland

3. Scintigraphy scanning protocol and principles of interpretation of Technetium pertechnetate imaging of normal and pathological states of the thyroid gland

2. Thorax
   1. Radiography
      1.1. Appearance of common diseases of the cardiovascular system
      1.2. Appearance of common laryngeal, tracheal, pulmonary, mediastinal and pleural space disease in small animals, including technique and positioning

   2. CT
      2.1. Indications, scanning protocol, principles of interpretation and appearance of common thoracic diseases.
3. **TFAST (Thoracic Focussed Assessment with Sonography for Trauma, Triage and Tracking)**
   3.1. Ultrasonographic appearance of common diseases of the thoracic cavity

2. **Abdomen (including lymphatic system)**
   1. **Radiography**
      1.1. Radiographic appearance of common diseases of the abdomen in small animals
      1.2. Indications and contra-indications, technical aspects, complications, standard imaging protocols (including positioning) and principles of interpretation for:
         1.2.1. Upper GI series
         1.2.2. Positional radiographs
         1.2.3. Excretory urography
         1.2.4. Cystography (positive, negative and double contrast)
         1.2.5. Urethrogram
   2. **Ultrasonography**: Indications, selection of particular equipment, scanning protocol, principles of interpretation, and appearance of common disease in the following organ systems in small animals:
      2.1. **AFAST (Abdominal Focussed Assessment with Sonography for Trauma, Triage and Tracking)**
         1. Peritoneal cavity including diaphragm
         2. Hepatobiliary tract
         3. GI tract
         4. Pancreas
         5. Spleen
         6. Genitourinary tract
         7. Adrenal glands
         8. Lymph nodes
         9. Abdominal vasculature including splanchnic vascular beds
         10. Contrast-enhanced ultrasound
   2. **CT**:
      2.1. Indications, scanning protocol, principles of interpretation and appearance of common diseases of the abdomen (especially renal, adrenal, hepatic and pelvis) and CT angiography of diseases and malformations of the hepatic vasculature

2. **Central Nervous System**
   2.1. **Myelography**
      2.1.1. Indications and contra-indications, technical aspects, complications, standard
imaging protocols (including positioning) and principles of interpretation for appearance of common diseases of the vertebral column and spinal cord.

2.2. CT and MR: Indications, scanning protocol, principles of interpretation and appearance of common disease in small animals for:
   2.2.1. Brain
   2.2.2. Vertebral column and spinal cord

3. Musculoskeletal System
   3.1. Radiography
      3.1.1. Appearance of common congenital, developmental and acquired musculoskeletal system disease in small animals
   3.2. CT: Indications, scanning protocol, principles of interpretation and appearance of common disease in small animals for:
      3.2.1. Appendicular skeleton
      3.2.2. Axial skeleton

4. Interventional Procedures
   4.1. Indications, protocol, principles of interpretation, including evaluation of outcome and complications of:
      4.1.1. Fine needle aspirates (FNA)
      4.1.2. Tissue biopsy
      4.1.3. Percutaneous pyelography
      4.1.4. Diagnostic / therapeutic centesis
      4.1.5. Diagnostic injection (e.g. splenoportography)

Large Animal Imaging Features:

1. Head and neck
   1. Radiology
      1.1. Radiographic appearance of common diseases of the skull, nasal cavity and paranasal sinuses in large animals.
      1.2. Radiographic appearance of common diseases of the oral cavity and associated structures in large animals.
      1.3. Radiographic appearance of common oesophageal diseases in large animals
   2. CT and MR: Indications, scanning protocol, principles of interpretation and appearance of common disease for:
      2.1. Nasal cavities and paranasal sinuses
2.2. Oral cavity and associated structures

2. Thorax
   2.1. Radiographic appearance of common diseases of the cardiovascular system in large animals
   2.2. Radiographic appearance of common diseases of the larynx, trachea, lungs, mediastinum and pleural space in large animals, including technique and positioning

3. Abdomen (including lymphatic system)
   3.1. Radiography
       3.1.1. Radiographic appearance of common abdominal diseases (including ileus and meconium impaction in foals, sand impaction and enteroliths in horses, and traumatic reticuloperitonitis in ruminants)

4. Central Nervous System
   4.1. Radiography
       4.1.1. Imaging features of common causes of localized vertebral and spinal cord disorders in large animals for example developmental, traumatic and degenerative disorders.

5. Musculoskeletal System
   1. Radiography: Imaging features of common diseases of the musculoskeletal systems including, for example:
      1.1. Navicular syndrome
      1.2. Laminitis
      1.3. Osteoarthritis
      1.4. Osteochondrosis of the tarsus, fetlock, stifle and shoulder joint.
      1.5. Wobbler syndrome

2. Interventional Procedures
   2.1. Indications, protocol, principles of interpretation, including evaluation of outcome and complications of:
      2.1.1. Fine needle aspirates (FNA)
      2.1.2. Tissue biopsy
      2.1.3. Diagnostic / therapeutic centesis
In-depth knowledge of pathophysiology, clinical and imaging features in small animals (Small Animal Track only)

This section contains topics that are considered essential for the specialist in small animal imaging. Expected depth of knowledge includes knowledge of the current literature pertinent to diagnostic imaging. The following list should be considered as studying guidelines but might not be exhaustive. Questions might be asked on any small animal imaging feature and associated pertinent clinical findings currently published in the literature.

1. **Head and neck**
   1.1. Pathophysiology and clinical findings
      1.1.1. Biological behaviour of tumours of the head and neck including local invasiveness, metastatic potential and common metastatic appearance
      1.1.2. Describe the mode of action/duration of antithyroid medications.
      1.1.3. Describe the systemic effects of I-131 in cats treated for feline hyperthyroidism.
   1.2. Radiography
      1.2.1. Describe and recognise the radiographic appearance of diseases of the head and neck
      1.2.2. Indications, contra-indications, technical aspects, complications, standard imaging protocols (including positioning) and principles of interpretation of oesophagography (including evaluation of swallowing) in small animals.
      1.2.3. Differences between various contrast media and methods for evaluation of oesophageal function and oesophageal diseases
   1.3. CT and MR:
      1.3.1. Indications, scanning protocol, principles of interpretation and appearance of diseases of the head and neck in small animals.
   1.4. Ultrasonography
      1.4.1. Indications, selection of particular equipment, scanning protocol, principles of interpretation, and appearance of diseases of the head and neck
   1.5. Scintigraphy
      1.5.1. Procedures, proper radiopharmaceuticals to be used, scanning protocol, and principles of interpretation of thyroid scintigraphy in small animals

2. **Thorax**
   2.1. Pathophysiology and clinical signs
      2.1.1. Common clinical signs for congenital and acquired cardiovascular diseases in small animals.
      2.1.2. Pathophysiology of canine and feline heart worm infections.
2.1.3. Biological behaviour of common tumours of the cardiovascular and respiratory system in small animals including local invasiveness, metastatic potential and paraneoplastic syndrome

2.2. Radiography
   2.2.1. Radiographic appearance of diseases of the cardiovascular system in small animals
   2.2.2. Radiographic appearance of laryngeal, tracheal, pulmonary, mediastinal and pleural space disease in small animals, including technique and positioning.

2.3. For the following contrast procedures, list the indications and contraindications, technical aspects, complications, standard imaging protocols (including positioning) and principles of interpretation:
   2.3.1. Angiocardiography (selective and non-selective)
   2.3.2. Expected alterations in cardiac pressure and blood gas evaluation (oximetry) in common diseases and congenital heart defects.

2.4. Describe and recognise selective and nonselective angiocardiographic studies of the common cardiovascular diseases.

2.5. Ultrasonography
   2.5.1. Indications, selection of particular equipment, scanning protocol, principles of interpretation, and appearance of disease of the heart and peripheral vascular beds.
   2.5.2. Indications, selection of equipment, scanning protocol, principles of interpretation, and abnormal Doppler patterns for Doppler ultrasound.
   2.5.3. Indications, selection of particular equipment, scanning protocol, principles of interpretation, and appearance of diseases of the larynx, trachea, lung, pleural cavity and mediastinum in small animals.

2.6. CT and MRI
   2.6.1. Indications, scanning protocol, principles of interpretation and appearance of thoracic disease.

3. Abdomen
3.1. Pathophysiology and clinical signs:
   3.1.1. Biological behaviour of common tumours of the abdomen, lymphatic system and bone marrow in both small animals including local invasiveness and metastatic potential
3.2. Radiography
   3.2.1. Radiographic appearance of the diseases of the abdomen in small animals
   3.2.2. Radiographic appearance of foetal death and how the signs develop (dog and cat).
3.2.3. Indications and contra-indications, technical aspects, complications, standard imaging protocols (including positioning) and principles of interpretation for:

3.2.3.1. Gastrography (positive, negative and double contrast)
3.2.3.2. Colonography (positive and negative)
3.2.3.3. Cystography, urethrography, vaginourethrography
3.2.3.4. Intravenous pyelonephrography

3.2.4. Diagnostic imaging procedures to evaluate various gastric and intestinal transit times/function

3.2.5. Differences between various contrast media and methods for evaluation of gastric or intestinal transit times/function

3.2.6. Indications and contraindications, technical aspects, complications, standard imaging protocols (including positioning) and principles of interpretation for lymphangiography.

3.3. Ultrasonography

3.3.1. Indications, selection of particular equipment, scanning protocol, principles of interpretation, and appearance of abdominal disease in small animals:

3.4. CT and MRI

3.4.1. Indications, scanning protocol, principles of interpretation and appearance of diseases of the abdomen, including angiography (single and multiphase angiographic protocols)

4. **Central Nervous System**

4.1. Pathophysiology and clinical signs:

4.1.1. Describe the biological behaviour of tumours of the nervous system including local invasiveness, and metastatic potential

4.1.2. Indications, contra-indications, technical aspects, complications, standard imaging protocols (including positioning) and principles of interpretation for myelography in small animals

4.2. Ultrasonography

4.2.1. Indications, selection of particular equipment, scanning protocol, principles of interpretation, and appearance of disease in the CNS (ventricular system, brain)

4.3. CT and MR: Indications, scanning protocol (imaging planes, desirable slice thickness, and use of contrast including single and multiphase angiographic protocols), principles of interpretation and appearance of diseases of the central and peripheral nervous system
1. **Musculoskeletal System**

2. Pathophysiology and clinical signs
   2.1. Biological behaviour of tumours of the musculoskeletal system in small animals including local invasiveness, metastatic potential.

3. Radiography
   3.1. Radiographic appearance of congenital, developmental and acquired musculoskeletal system disease in small animals.

4. Ultrasonography
   4.1. Indications, selection of particular equipment, scanning protocol, principles of interpretation, and appearance of diseases of the musculoskeletal system in small animals.

5. CT and MR
   5.1. Indications, scanning protocol (imaging planes, desirable slice thickness, and use of contrast), principles of interpretation and appearance of disease of the pelvis and limbs in small animals.

6. Scintigraphy
   6.1. Procedures, proper radiopharmaceuticals to be used, scanning protocol, and principles of interpretation of the skeletal system in small animals.
In-depth knowledge of pathophysiology, clinical and imaging features in large animals (Large Animal Track only)

This section contains topics that are considered essential for the specialist in large animal imaging. Expected depth of knowledge includes knowledge of the literature pertinent to diagnostic imaging. The following list should be considered as studying guidelines but might not be exhaustive. Questions might be asked on any large animal imaging feature and associated pertinent clinical findings published in the literature.

1. **Head and neck**
   1.1. Pathophysiology and clinical findings
      1.1.1. Clinical signs, haemodynamic effects and pathophysiology of phlebitis of commonly affected veins in horses
      1.1.2. Pathophysiology of the diseases of the equine paranasal sinuses and guttural pouches.
   1.2. Radiography
      1.2.1. Radiographic appearance of diseases of:
         1.2.1.1. Nasal cavity and paranasal sinuses
         1.2.1.2. Oral cavity and associated structures
         1.2.1.3. Tympanic bullae and temporohyoid joints
         1.2.1.4. Oesophagus
         1.2.1.5. Guttural pouches
         1.2.1.6. Equine laryngeal diseases, including post-surgery changes.
      1.2.2. Indications and contraindications, technical aspects, complications, standard imaging protocols (including positioning) and principles of interpretation of angiography of the internal carotid in the horse with guttural pouch mycosis
      1.2.3. Indications and contra-indications, technical aspects, complications, standard imaging protocols and principles of interpretation of oesophagography in large animals.
   1.3. CT and MR: Indications, scanning protocol, principles of interpretation and appearance of disease of:
      1.3.1. Nasal cavities and paranasal sinuses
      1.3.2. Oral cavity and associated structures
      1.3.3. Hyoid apparatus and temporohyoid joint
      1.3.4. External and middle ear
1.4. Ultrasonography: Indications, selection of particular equipment, scanning protocol, principles of interpretation, and appearance of disease in the following organ systems:

1.4.1. Neck
1.4.2. Ocular/Orbit
1.4.3. Jugular vein
1.4.4. Larynx

2. Thorax

2.1. Pathophysiology and clinical findings
   2.1.1. Biological behaviour of common tumours of the respiratory system in large animals including local invasiveness, metastatic potential and common metastatic appearance

2.2. Radiography
   2.2.1. Radiographic appearance of diseases of the cardiovascular system in large animals
   2.2.2. Radiographic appearance of diseases of the larynx, trachea, lungs, mediastinum and pleural space in large animals
   2.2.3. Indications, contraindications, technical aspects, complications, standard imaging protocols and principles of interpretation of the following contrast procedures:
      2.2.3.1. Angiography of the equine distal limb
      2.2.3.2. Angiography of the internal carotid in the horse with guttural pouch mycosis

2.3. Ultrasonography
   2.3.1. Indications, selection of particular equipment, scanning protocol, principles of interpretation, and appearance of disease of the heart and peripheral vascular beds.
   2.3.2. List the indications, selection of equipment, scanning protocol, principles of interpretation, and abnormal Doppler patterns for Doppler ultrasound.
   2.3.3. Indications, selection of particular equipment, scanning protocol, principles of interpretation, and appearance of disease of the larynx, trachea, lung, pleural cavity and mediastinum in large animals.

3. Abdomen

3.1.1. Pathophysiology and clinical findings
   3.1.1.1. Pathophysiology of postoperative ileus in horses
   3.1.1.2. Pathophysiology of umbilical infections in foals and ruminants

3.1.2. Radiography
3.1.2.1. Indication for abdominal radiography and radiographic appearance of abdominal diseases in large animals

3.1.2.2. Indications, contra-indications, technical aspects, complications, standard imaging protocols (including positioning) and principles of interpretation for colonography in foals

3.1.3. Ultrasonography: Indications, selection of particular equipment, scanning protocol, principles of interpretation, and appearance of disease in the following organ systems in large animals:

3.1.3.1. Peritoneal cavity including diaphragm

3.1.3.2. GI tract

3.1.3.3. Abdominal vasculature

3.1.3.4. Principles of evaluation of pregnancy

3.1.3.5. Liver

3.1.3.6. Urogenital system

3.1.3.7. Splanchnic vascular beds

4. Central Nervous System

4.1. Pathophysiology and clinical findings

4.1.1. Clinical signs and diagnostic tests for common equine neurologic infectious diseases

4.2. Radiography

4.2.1. Indications, contra-indications, technical aspects, complications, standard imaging protocols (including positioning) and principles of interpretation for myelography in large animals

4.3. CT and MR: Indications, scanning protocol, principles of interpretation and appearance of disease in large animals for regions:

4.3.1. Brain

4.3.2. Vertebral column and spinal cord

5. Musculoskeletal System

5.1. Pathophysiology and clinical findings

5.1.1. Principles of locomotion and concept of lameness in the horse

5.1.2. Flexion tests and local diagnostic blocks in the horse

5.1.3. Clinical signs and response to local, regional and intraarticular anaesthesia in musculoskeletal disorders in horses

5.1.3.1. Predisposition for specific musculoskeletal injuries in relation to activity in horses
5.1.4. Pathophysiology of:
   5.1.4.1. Overuse bone trauma and stress fractures in horses
   5.1.4.2. Angular deformities in foals
   5.1.4.3. Diseases of the hoof and lamina
   5.1.4.4. Navicular syndrome
   5.1.4.5. Acute tendon injuries, chronic tendon overuse and enthesiopathy

5.2. Radiography
   5.2.1. Radiographic appearance of diseases of the musculoskeletal system
   5.2.2. Indications, contraindications, technical aspects, complications, standard imaging
           protocols (including positioning) and principles of interpretation for angiography
           of the equine distal limb
   5.2.3. Indications, technique and radiographic appearance of diseases in special oblique
           and sky-line views in the horse and in the bovine.

5.3. Ultrasonography
   5.3.1. Principles of interpretation and appearance of aortic and iliac thrombosis on
           transrectal ultrasound in horses for 2D gray-scale ultrasonography.
   5.3.2. Indications, selection of particular equipment, scanning protocol (including
           examination in flexion and dynamic ultrasonography when applicable), principles
           of interpretation, and appearance of disease in the limbs and axial
           musculoskeletal structures
   5.3.3. Indications, material and technique for ultrasound-guided injections of
           musculoskeletal structures in horses (including vertebral column and sacro-iliac
           joints)

5.4. CT and MR
   5.4.1. Indications, scanning protocol (including single and multiphase contrast studies),
           principles of interpretation and appearance of disease in the limbs and axial
           musculoskeletal structures

5.5. Scintigraphy
   5.5.1. Procedures, proper radiopharmaceuticals to be used, scanning protocol, and
           principles of interpretation of the skeletal system in large animals