The Royal College of Pathologists

Pathology: the science behind the cure

Curriculum for specialty training in veterinary clinical pathology

April 2018

Contents

INTRODUCTION

Veterinary clinical pathology includes the core areas of:

1. Clinical Biochemistry and Other Testing (including biochemistry, endocrinology, ELISA tests, blood gas and acid-base evaluation, and protein electrophoresis)
2. Haematology/Coagulation
3. Urinalysis
4. Miscellaneous Topics (including the light microscope, miscellaneous equipment, Pharmaceutical/Toxicological Pathology and other types of testing)
5. Cytology/Histology
6. Laboratory Quality and Management

In addition to the core areas mentioned above, an understanding of medical microbiology, virology and histology is needed since these areas are important in the differentiation of infectious and noninfectious conditions and in the diagnosis of infectious diseases. Furthermore, they are often included in the same buildings and/or resource allocations as veterinary clinical laboratories. Veterinary microbiology and veterinary anatomic pathology are specialties in their own right and there are separate curricula and examination processes for these specialties within the Royal College of Pathologists. These areas should not be neglected during the course of study because of their importance in disease diagnosis and relationships to interpretation of various other laboratory results.

The foundation training should emphasize the common domestic species (dogs, cats, horses, and farm animals [cattle, sheep, pigs, goats]). Knowledge of common birds kept as pets, as well as ferrets, rabbits, hamsters, gerbils and other small exotic pets and zoo animal and wildlife laboratory medicine is expected, but will not receive the emphasis that the common domestic species will receive in the examination.

TRAINING IN VETERINARY CLINICAL PATHOLOGY

Training in veterinary clinical pathology is expected to be work-based experiential training during which the trainee is prepared to do a job, as well as to pass the examinations and earn the credential of FRCPath. As a work-based program it may be conducted in a variety of types of organisations, but it is expected that trainees and supervisors will receive support from the organisation appropriate for any organisation undertaking training of veterinary clinical pathologists. This should include time for trainee/supervisor interactions, but it should also be understood that trainees will have to undertake responsibility for independent study and other activities on their own time.

ENTRY REQUIREMENTS

All persons undertaking training in veterinary clinical pathology who wish to be eligible to take the Royal College of Pathologists Examinations in veterinary clinical pathology will have a veterinary degree from a university eligible for membership in the Royal College of Veterinary Surgeons and be registered members of the Royal College of Veterinary Surgeons. They must be enrolled in a training program supervised by a Fellow of the Royal College of Pathologists (Veterinary Clinical Pathology).

A period of clinical experience is considered desirable.

DURATION OF TRAINING

The minimum duration of training is three years. There is no maximum time for training but it is anticipated that most candidates will be able to complete their training within 4-5 years. It is anticipated that a trainee in a 3 year program would take the Royal College of Pathologists Part 1 examination in veterinary clinical pathology at the conclusion of the second year and the Part 2 examination near the end of the third year. For those in 4 or 5 year programs, this would correspond to taking the Part 1 examination at the conclusion of the second or third year and the Part 2 examination near the end of the fourth or fifth years, respectively.

Stages of Training and Learning
Generally trainees in clinical pathology are expected to go through 3 stages of training and learning.

Stage A (Direct Supervision Stage)
This stage includes an initial orientation to laboratory medicine and is characterised by a high level of supervision and feedback from the training supervisor. The duration of this stage of training will depend, in part, on the aptitudes and experience of the trainee and may differ for the core areas. It is important that the trainee has a clear understanding of the expectations and goals to be achieved during this stage of training and the process for deciding progression to Stage B.

Stage B (Self–Referral Stage)
This stage is characterised by increasing independence in the working environment, with knowledge of when additional supervision and feedback should be requested and when the trainee should be able to conduct the job with less direct supervision. This is the joint responsibility of the supervisor and trainee to determine how and when this should be conducted. The duration of this stage of training will depend, in part, on the aptitudes and experience of the trainee and may differ for the 5 core areas. The trainee should be able to recognize and refer to the supervisor or other senior staff any cases or situations for which they would like additional input or feedback. This should be on a timely basis and not neglected.

The goals for this stage of training should be clearly specified for the trainee and determination of how trainees will progress to the next stage of training and learning (Stage C) should be clear. In many cases, an audit of work that has been done without direct supervision and review of the types of cases and situations still being identified by the trainee for self-referral to more senior persons within the organisation for feedback and input will be appropriate to determine if sufficient progress is being made to progress to the next stage of training.

Stage C (Full Working Stage)
This stage is characterised by the ability of the trainee to do a variety of full working tasks with little or no direct supervision. It is still important for the trainee to recognise those cases or situations in which additional input and feedback is needed and take these to appropriate people within the organisation for help. Additional goals for amount of work produced, speed/time management and working practices should be provided and clearly understood and agreed by the trainee and the supervisor.

TRAINING REGULATIONS

LESS THAN FULL-TIME TRAINING

It is accepted that in some training environments and under some circumstances training will occur as a less than full time activity for well-founded individual reasons.

Less than full time trainees should accept two important principles:

- less than full time training shall meet the same requirements (in depth and breadth) as full-time training
- the total duration and quality of less than full time training of specialists must be not less than those of a full-time trainee.

RATIONALE

Clinical Governance

Clinical governance is expected from all organisations participating in training individuals in veterinary clinical pathology. Clinical governance is defined as 'a framework through which organisations are accountable for continuously improving the quality of their services and safeguarding high standards of care, by creating an environment in which excellence in clinical care will flourish.' This curriculum was developed as part of the clinical governance appropriate for veterinary clinical pathology within the Royal College of Pathologists.

EQUALITY AND DIVERSITY

The Royal College of Pathologists is committed to the principle of diversity and equality in employment, membership, academic activities, examinations and training as underpinned by the Equality Act 2010.

Integral to our approach is the emphasis we place on our belief that everyone should be treated in a fair, open and honest manner. Our approach is a comprehensive one and reflects all areas of diversity, recognising the value of each individual. We aim to ensure that no one is treated less favourably than another on the grounds of sex, race, age, sexual orientation, gender reassignment, disability, pregnancy & maternity, religion and belief, and marriage and civil partnership. Our intention is to reflect not only the letter but also the spirit of equality legislation.

Further detail is available in the College's Equality and Diversity policy available on the College website.

Purpose of the curriculum

The purpose of the curriculum for specialty training in veterinary clinical pathology is to set the standards required by The Royal College of Pathologists for attainment of Fellowship of the College and to ensure that successful candidates are fully prepared to work independently as a veterinary clinical pathologist.

The balance between practical laboratory and clinical training will be influenced by educational background, personal interests and guidance from supervisors.

Clinical pathology is an important bridge between the basic sciences and clinical medicine, and laboratory results are of increasing importance in the identification of health and disease, diagnosis, prognosis and monitoring of disease progression and/or response to treatment. An in-depth understanding of the pathophysiologic bases for clinical signs and laboratory findings is vital to understanding the

clinicopathologic bases for health and disease and the laboratory results associated with these. The concept of One Health, emphasizing the interdependence of human and animal health and the need to work together, is of particular importance in clinical pathology since many of the emerging and ongoing diseases and their diagnoses have a laboratory-based component. Comparative medicine, including comparisons with humans and other species, is of particular importance in clinical pathology and in the application of evidence-based medicine in clinical pathology practice.

Veterinary clinical pathologists may practice in a variety of roles, including, but not limited to Academia, Laboratory Medicine (commercial, research, or university laboratories), Research, the Pharmaceutical/Toxicological Industry, Wildlife/Conservation, Laboratory Management or independent consultant positions. The general principles and competencies of clinical pathology training are applicable in all of these types of positions. Exposure to a variety of types of positions is desirable during training. Specific skills for pharmaceutical/toxicological pathology and metabolic profiling done to assess herd health should be introduced during training, although these make up only a small part of the material that may be presented in the examination.

In addition to the core areas mentioned above, an understanding of medical microbiology (including bacteriology, virology and mycology) and molecular testing is needed since it is important in the differentiation of infectious and noninfectious conditions and in the diagnosis of infectious diseases. Veterinary microbiology is a specialty in its own right and there is a curriculum and examination process for this within the Royal College of Pathologists. It should not be neglected during the course of study because of its importance in infectious disease diagnosis and relationship to interpretation of various other laboratory results.

The foundation training should emphasize the common domestic species (dogs, cats, horses, and farm animals [cattle, sheep, pigs, goats]. Knowledge of common birds kept as pets, as well as ferrets, rabbits, hamsters, gerbils and other small exotic pets and zoo animal and wildlife laboratory medicine is expected, but will not receive the emphasis that the common domestic species will receive in the examination.

CONTENT OF LEARNING

This curriculum is presented to provide a standard for training in veterinary clinical pathology and guidance for the areas to be covered by the examinations of the Royal College of Pathologists in veterinary clinical pathology. It provides an overview of general competencies thought by Fellows of the Royal College of Pathologists (veterinary clinical pathology) to be of importance to clinical pathologists in their ongoing roles as Scholars/Scientists, Clinical Pathologists/Laboratorians and Veterinary Medical Professionals.

The competencies which should be acquired in order to:

1. Undertake the Royal College of Pathologists examinations in veterinary clinical pathology. Completion of the examinations (FRCPath Part 1 and Part 2) will enable each veterinarian who has successfully passed both examinations to be designated as a Fellow of the Royal College of Pathologists (veterinary clinical pathology) and use the post nominal abbreviation of FRCPath. There is no post nominal available to use following successful completion of the Part 1 examination. The FRCPath credential is not awarded without mastery of a large

body of knowledge and demonstration of competencies, knowledge and skills, and actions and attitudes deserving of this achievement.

2. Provide a basis for ongoing professional practice of clinical pathology following certification as FRCPath (veterinary clinical pathology). Being awarded FRCPath represents a high standard and is not awarded lightly. Examiners are aware that this represents a level of work that reflects a high standard of training that prepares trainees for a professional career in veterinary clinical pathology in the variety of jobs for which this credential is sought.

This curriculum is provided so that trainees and their supervisors can review the competencies determined by the Fellows of the Royal College of Pathologists in veterinary clinical pathology as being important for the training of clinical pathologists. Undoubtedly, there will be some areas of importance that are not included in the current version of the curriculum, but which, as identified, can be added in the future as part of the ongoing quality improvement process.

The information provided is to aid trainees and their supervisors in identification of those areas that should be covered during the training period, and to indicate the competencies which the trainee should acquire and the knowledge and skills expected.

To help with the ease of reading and general presentation of information, all sections are presented in approximately the same format but will have differences specific to the core area addressed.

RESPONSIBILITIES OF THE SUPRVISOR AND THE TRAINEE

The supervisor of the training program has responsibility for the design and implementation of the training program in their organisation. They should provide ongoing frequent (at least monthly) informal assessments of the progress of the trainee by discussions, review of work produced by the trainee, and by providing opportunities to learn the variety of competencies outlined in this curriculum. If there are some areas in which the organisation is deficient in case material or expertise, efforts should be made to supplement these areas by provision of specially archived cases, slides or materials, participation in formal or informal courses and/or visits to other institutions to gain experience and/or perspective regarding the areas in which their home training organisation may not be strong. The supervisor is responsible for the stages of training and learning as outlined in this document, and working with the trainee to enable them to progress through these stages. The supervisor has the final responsibility for determining when the trainee is likely to be ready to sit the FRCPath Part 1 and Part 2 examinations since the supervisor has to sign the application form for these examinations.

The trainee is responsible for knowing the competencies outlined and ensuring that material is provided or sought out in order to master the material, and achieve the knowledge and skills outlined for each core area. The trainee is responsible for ensuring that all paperwork and applications for the examinations are provided to the Royal College of Pathologists. The trainee is responsible for knowing the stages of training and learning as outlined in this document, and working with the supervisor to ensure that they are making progress that will enable them to progress through these stages, culminating in the FRCPath Part 1 and Part 2 examinations to become a Fellow of the Royal College of Pathologists in veterinary clinical pathology.

If there are other clinical pathologists within the organisation, it is important for the trainee to be exposed to a variety of persons, working methods, philosophies and viewpoints during their training. Clinical pathologists or senior scientists or technicians other than the supervisor can oversee various aspects of training, as determined by the organisation and its training program.

The example provided by the supervisor is the most powerful influence upon the standards of conduct and practice of a trainee. The supervisor and trainee should have joint responsibility for ensuring that:

- both are familiar with the curriculum relevant to the year/stage of training of the post
- the trainee has day-to-day supervision appropriate to the stage of training
- the trainee is making the necessary progress during the post
- the trainee is aware of the assessment system during training and the examination, and undertakes it according to requirements
- the supervisor or other appropriate person acts as a mentor to the trainee and encourages both professional and personal development
- they both agree a training plan for the trainee
- regular more formal formative/supportive appraisals with the trainee are undertaken (at least two per year, approximately every six months) and both parties agree to the outcome of these sections and keep a written record.
- regular inspection of the trainee's training progress is undertaken, and trainees are informed of their progress and encouraged to discuss any deficiencies in the training program
- ensuring that records of such discussions are kept and that improvements are made in the training program based on ongoing feedback from the trainee (s) and supervisor.

TEACHING AND LEARNING METHODS

Trainees are expected to achieve the competencies outlined in this curriculum by a variety of learning methods. These may include formal and informal courses and/or on-the-job learning. Other activities that are beneficial include:

- **Learning with peers** - through online forums, trainee groups within the same organization, or groups including trainees from several organisations
- **Participation in slide conferences, rounds and journal clubs** - these may be part of the training program or undertaken by trainees on their own time, depending on the design of the training course
- **Attendance at veterinary meetings with an emphasis on various aspects of clinical pathology** - this may include attendance at and/or presentations at meetings of various sizes and composition
- **Teaching clinical pathology** - this may include training of technicians, veterinary students, presentations/training for practicing veterinarians or animal owners, as well as presentations to other trainees in veterinary clinical pathology
- **Participation in mock examinations** - this may or may not be part of the training program designed by the training organization. It is recommended that all supervisors give trainees experience in answering questions typical of those to be found on the examination in an environment mimicking that of the examination. If this is not provided by the training organisation, there may be opportunities to participate in mock examinations at other location(s). Mock examinations have been found to be very helpful in providing exposure to

examination conditions, pressures and types of questions, and their use is encouraged for all trainees.

- **Participation in courses** - this may include courses given at the organisation or institution at which the training is provided, attendance at online courses (e-learning) or presentations, webinars or courses given by or at other organisations/institutions
- **Learning from laboratory staff** - this may include working with and/or observing technicians in various departments of the laboratory, as well as working with other personnel or pathologists or staff as part of the training program
- **Independent self-directed learning** - trainees will use this time in a variety of ways depending upon their stage of learning.
  Suggested activities include:
  - reading, including web-based material
  - maintenance of personal portfolio (files for ongoing reference, examples of problem-solving activities, self-assessment, reflective learning, personal development plan)
  - audit and research projects
  - reading journals
  - achieving personal learning goals including and exceeding the essential, core curriculum
  - communication and consultation skills through supervision, observed consultations and formal training

CURRICULUM REVIEW AND UPDATING

The curriculum will be evaluated and monitored by The Royal College of Pathologists as part of continuous feedback from Examiners, Specialty Advisors, trainers and trainees. The curriculum will be formally reviewed in the first instance within 2 years of publication. In reviewing the curriculum, opinions will be sought from the Colleges, the Trainees Advisory Committee, and its Fellows and Registered Trainees.

After the initial 2 year time period, this curriculum will be reviewed approximately every 5 years and updated by the veterinary clinical pathologists on the Special Advisory Committee for veterinary pathology, as needed, based on ongoing feedback from Fellows of the Royal College of Pathologists and veterinary clinical pathology trainees, as provided to this Committee.

The curriculum was approved by the Council of The Royal College of Pathologists on 4 June 2018.

GENERAL COMPETENCIES FOR VETERINARY CLINICAL PATHOLOGISTS

General competencies for veterinary clinical pathologists are provided below. Some of these aspects do not lend themselves to the examination process, but are included to provide an overview of the clinical pathology profession and practice.

Roles that veterinary clinical pathologists have, regardless of their job position, include those of:

A. Scholar and Scientist
B. Laboratorian/Clinical Pathologist/Veterinary consultant
C. Veterinary Medical Professional

Trainees in veterinary clinical pathology are aiming to become the practicing clinical pathologists of the future. The all-encompassing goal of clinical pathology practice is to provide for the best possible care of veterinary patients by applying knowledge and skills competently and ethically, providing leadership, and analyzing complex situations within which it may not be possible to know all factors with certainty.

There are number of competencies and outcomes that are applicable to the veterinary clinical pathologist as a Scholar and Scientist, Laboratorian/Clinical Pathologist/Veterinary consultant and as a Veterinary Medical Professional.

A. Competencies/Outcomes as a Scholar and Scientist:

1. Understand the pathophysiologic bases for and aetiopathogenesis of disease, with an understanding of comparative pathology across a variety of species.
2. Understand the One Health concept and importance of inter-relationships between human and animal disease, and the importance of the veterinary clinical pathologist in recognition of emerging diseases.
3. Appreciate the importance of clinical pathology in determination of health and disease, disease diagnosis, determination of prognosis, monitoring of health and disease and monitoring of response to treatment(s).
4. Appreciate the unique position of pathology and clinical pathology as the interface between clinical medicine and the basic sciences.
5. Ability to critically appraise the literature and other sources of information (including people, presentations, books, journals, the internet or other sources) in order to distinguish between reputable and reliable sources of information and those that should be disregarded or upon which less emphasis should be placed. Should be able to critically evaluate journal articles and presentations and other sources of information with regard to the techniques, analyses, interpretation and conclusions.
6. Ability to organise, synthesise and translate information to and from the 'language of the laboratory' to communicate it to and with a variety of audiences, including other veterinarians at a variety of levels and positions in practice, veterinary nurses, laboratory technicians, laboratory managers, owners and other lay persons as stakeholders in the practice of veterinary medicine.

B. Outcomes and Competencies as a Laboratorian/ Clinical Pathologist/ Veterinary Consultant

7. Appreciate the role of the clinical pathologist as an interpreter of meaning, educator, and consultant for laboratory testing and interpretation of laboratory results.
8. Appreciate the role of the clinical pathologist as the link between the clinician and the laboratory, and the sometimes conflicting role as an advocate for the laboratory, the patient and the clinician.
9. Understand methods and principles underlying modern laboratory analyses of various types, with the ability to help troubleshoot technical and/or quality-related issues associated with the instruments within the laboratory and apply appropriate quality assurance and quality control.
10. Ability to communicate well and interact appropriately with others - in writing, verbally, (in person, including presentations or teaching), and on the telephone. This includes working as part of a team and in showing initiative and ability to work independently, as needed.
11. Ability to make accurate interpretations of laboratory data (from various areas and across various areas in order to tie together a variety of laboratory data) and provide useful information to laboratory clients. This should include basic

analytical thought processes and synthetic abilities and the ability to provide differential diagnoses, where appropriate, with communication regarding the order of most likely probability.

12. Understand the principles of quality assurance and quality control, with ability to apply these in the various departments and ability to help troubleshoot problems, implement solutions and monitor results of ongoing quality improvements. This should include the processes of quality planning, quality assessment, quality control and continuous quality improvement.
13. Understand and apply basic statistical techniques useful in the laboratory, most often in relation to QA and QC method/instrument validation but also in basic research using laboratory data.
14. Understand the processes of and importance of assay, instrument and method validation appropriate for different types of testing within the laboratory.
15. Understand issues regarding Information Technology (IT) and Laboratory Information Systems (LIMS) - including security, backup and basic functions.
16. Understand general health and safety regulations and specifically those items of importance in the veterinary laboratory. This includes a good working knowledge of zoonotic diseases (those that may pass from animals to humans) and reverse zoonotic diseases (those that may pass from humans to animals) and those that may occur in both humans and animals due to shared environment and opportunities for exposure to pathogens.

C. Outcomes and Competencies as a Veterinary Medical Professional

17. Ability to recognise and work within personal competencies and to seek additional help, advice or guidance, when and as needed.
18. Able to organise workload and demonstrate good time management skills in the workplace, including service, teaching and/or research, or other job tasks. This should include the ability to work as part of a team, as well as taking initiative and personal responsibility when working independently.
19. Understand personal strengths and weaknesses and personality type, and how this affects goal-setting, approach to the profession, personal and professional conduct, with a view to providing a good work-personal life balance and good mental health throughout a working life.
20. Understand the ethics and values expected in the practice of veterinary clinical pathology and veterinary medicine, in general.
21. Be able to use a variety of methods and techniques to undertake ongoing study for board examination as part of the training program, ongoing continuing professional development and a commitment to life-long learning.
22. Ability to identify ongoing continuing professional development needs, make good choices in choosing continuing educational opportunities to meet these needs, and to reflect upon their importance and effect on behavior and practices.

These general competencies may or may not be easily assessed by examination but are presented here to provide an overview of for those undertaking training of veterinary clinical pathologists and the importance of considering the roles of the veterinary clinical pathologist as a scholar and scientist, as laboratorians/veterinary clinical pathologists/veterinary consultants and as veterinary medical professionals.

Specific competencies in the core areas of clinical pathology

Specific competencies in each of the core areas are presented below, with notation of the knowledge and skills needed to demonstrate mastery of the competency in veterinary clinical pathology practice.

There are a set of general attitudes and actions that apply for virtually all of the competencies listed. These include:

- Appreciation of the need for and philosophy underlying the competency required
- Ability to apply the competency on an ongoing basis in the practice of veterinary clinical pathology
- Ability to discuss the competencies, knowledge and skills with others, at a level appropriate for the audience or persons with whom the discussion is conducted (i.e. laboratory clients, laboratory staff, other clinical pathologists, etc.)

Each core area has a short introductory section, followed by a table listing competencies and knowledge and skills expected to demonstrate the competency.

FRCPath Curriculum Revision Committee

We hope this curriculum will provide guidance for trainers and trainees in veterinary clinical pathology and help them in the process of developing day-one competencies important for the veterinary clinical pathologists during and completing their residency training and in preparation for credentialing examinations.

If you have feedback regarding the curriculum, any error, omissions or other things that you think should be included or improved, please contact the Royal College of Pathologists, Training and Curriculum Department, which can put you in touch with the current members of the Special Advisory Group for veterinary clinical pathology who will be charged with future revisions of the curriculum.

We appreciate the hard work and multiple revisions undertaken by the Veterinary Clinical Pathology Curriculum Development Committee members listed below (in alphabetical order), as well as feedback from the Fellows of the Royal College of Pathologists (Veterinary Clinical Pathology) in developing this document. We wish to thank the staff of the Royal College of Pathologists, particularly Ms Gemma D'Silva and Ms Jenny Maddocks in the Training Department. We would also like to thank Dr. Martina Becker (Germany) and Dr. Asger Jensen (Denmark), Dr. Ernst Leidinger (Austria) and Dr. Sharon Dial (USA) for their review of this document and their invaluable comments and feedback. Members of the Royal College of Pathologists Veterinary Clinical Pathology Curriculum Development Committee are (in alphabetical order):

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Common Competencies

CORE AREA: BIOCHEMISTRY AND OTHER TESTING

Biochemistry and Other Testing (including endocrinology, blood-gas analysis, Enzyme-linked Immunoassay (ELISA) testing and serum and urine protein electrophoresis is included in this section.

The subsections for the Biochemistry and Other Testing core area are (1) Pre-analytical considerations, (2) Analytical considerations, (3) Post-analytical considerations, (4) Reporting, (5) Acid-Base/Blood gas and electrolyte testing, (6) Quality assurance and quality control and (7) Protein electrophoresis.

Subsection 1: PRE-ANALYTICAL CONSIDERATIONS

Competency: Methods of sample collection

Knowledge and skills

Describe and explain specimen collection methods

Describe and explain the importance of the correct specimen for the test to be run (e.g. serum vs heparinised plasma vs EDTA plasma)

Describe and explain those tests which should be run on a fasted sample

Access information about and discuss the protocols used for dynamic testing (including bile acid stimulation test, ACTH stimulation test, dexamethasone suppression test, TRH stimulation test, etc.)

Competency: Sample handling, submission, storage and other considerations

Knowledge and Skills

Describe and explain the effects of handling time from collection to separation, and storage temperatures and intervals between storage and testing (especially important for endocrinology testing) on test results

Describe and apply quality control and quality assurance techniques appropriate for pre-analytical considerations for biochemistry and endocrine testing

Competency: Physiological and drug effects

Knowledge and Skills

Describe and explain the effects of ‘stress’ on test results

Describe and explain the physiologic status associated with various tests and their interpretation (including testing for ovarian remnants, ‘rig’ test, etc.)

Describe and explain the effects of drugs or supplements on tests and drug/supplement-free intervals needed for multiple tests or repeat endocrine tests

Describe and apply quality control and quality assurance techniques appropriate for pre-analytical considerations for biochemistry and endocrine testing

Subsection 2: ANALYTICAL CONSIDERATIONS

Competency: Principles of the common instrumentation

Knowledge and Skills

Describe and explain the general principles of common instrumentation (including automated chemistry analyzers [wet and dry chemistry], ion selective electrodes, blood–gas instruments, electrophoresis instruments, chemiluminescence, radioimmuno-assay, high pressure liquid chromatography, mass spectrometry, osmometry, ELISA plate readers, and point-of-care chemistry analysers)

Describe and explain the principles of the measurement of sodium, chloride, potassium, ionised calcium and ionized magnesium with ion sensitive electrodes

Describe and explain those tests which should be run on a fasted sample

Describe and explain the principles of automated instruments (including colourimetry, ultraviolet and fluorescence spectrophotometery, immunoluminescense, immunoturbidimetry and nephlometry)

Describe and explain the principles of routine calibration

Describe and explain instrument/method validation appropriate for commonly used instruments/methods

Discuss and apply statistical and nonstatistical quality control appropriate for commonly used instruments

Describe and explain the types of instruments/methods commonly used for point-of-care testing

Describe and explain the principles of instrumentation used for osmometry

Describe and explain the principles of ELISA assays and the instrumentation available for use with ELISA plates

Describe and explain the principles of radio-immunoassay and immunofluorescence (used for endocrinology testing)

Describe and explain the principles of blood gas instruments and test parameters (pH, pO_2, pCO_2, and HCO_3^- measurement for arterial and venous blood-gas analyses)

Competency: Assays for measurands found on testing panels for common species (dog, cat, horse, ruminants)

Knowledge and Skills

Describe and explain colourimetric methods for total protein, albumin, creatinine, urea, total calcium, magnesium, phosphate, bilirubin, cholesterol, triglycerides

Describe and explain enzyme kinetic methods (colourimetric substrate) for ALP, amylase, bile acids, gamma glutamyl transferase (GTT), lipase and NAD –NADH UV changes for Alanine aminotransferase (ALT), aspartate aminotransferase (AST), Creainine Kinase (CK), glutamine dehydrogenase(GLDH), glucose and Immunoturbidimetric assays for Cystatin, Serum Amyloid A (SAA) and C-reactive protein (CRP)

Describe and explain automated immunoturbidimetric assays commonly applied for SAA and other immunoturbidimetric assays

Describe and explain ELISA assays, their advantages and disadvantages and limitations

Competency: Interferences commonly encountered

Knowledge and Skills

Describe and explain the types of interferents commonly encountered with endocrine and biochemistry testing (haemolysis, lipaemia, hyperbilirubinaemia or other) and the tests which are affected by these

Provide advice to help avoid interferents in specimens submitted for biochemistry and endocrine testing

Competency: Half-lives of enzymes in serum

Knowledge and skills

Identify how to access information about and use information about half-lives of enzymes in serum to help guide interpretation and repeated testing recommendations

Competency: Common causes of analytical error

Knowledge and Skills

Describe and explain advantages and disadvantages and limitations of various types of assays for biochemistry and endocrine testing

Describe and explain possible interferents and the tests affected by these for biochemistry and endocrine testing

Recognise and discuss common causes of analytical errors with biochemistry and endocrine testing

Competency: Method validation and comparison

Knowledge and Skills

Able to conduct instrument/method validation testing for biochemistry tests and endocrine assays

Able to recognize when comparison across instruments/methods is valid and when differences are to be expected based on different instruments/methods

Competency: Quality control and quality assurance

Knowledge and Skills

Able to discuss and apply appropriate quality control and quality assurance for the analytical phase of biochemistry testing and hormone assays

Subsection 3: POST-ANALYTICAL CONSIDERATIONS

Competency: Results, reference intervals, breed specific values

Knowledge and skills

Able to evaluate, determine and/or improve general or breed-specific reference intervals for biochemistry and other types of testing

Construct and appropriately use population-based and individualised (subject-based) reference intervals(based on biologic variation)

Subsection 4. REPORTING

Competency: Results interpretation and reporting

Knowledge and skills

Demonstrate knowledge of the common types of profiles used for reporting results (e.g. short vs extended profile) or organ-specific profiles (e.g. liver, renal, etc.) and species differences in types of measurands tested for and reported (e.g. equine enzymes)

Interpret biochemistry results in relation to endocrinology, urinalysis and haematology and other laboratory results

Demonstrate the ability to interpret common endocrine tests in relation to organ systems such as thyroid, adrenal–pituitary axis, endocrine pancreas, parathyroid, etc.

Appreciate the fact that reporting styles and approaches may vary between laboratories

Report and interpret biochemistry and endocrine assay results with a high level of expertise

Correlate the biochemistry and endrocrinology findings with results of other types of testing, and in the context of clinical signs and other clinical evaluations

Subsection 5: ACID-BASE/BLOOD GAS AND ELECTROLYTE TESTING

Competency: Acid-base/blood gas and electrolytes

Knowledge and Skills

Interpret acid-base/blood gas and electrolyte changes and anion gap in relation to metabolism

Recognise and discuss the likely effects of acid-base and electrolyte changes on other measurands

Determine if appropriate compensation for various acid-base abnormalities and durations of conditions (acute vs chronic) is present

Demonstrate the ability to indicate differential diagnoses for simple acid-base and mixed acid-base disorders

Determine when complex or mixed acid-base conditions are present and likely differential diagnoses

Subsection 6: QUALITY CONTROL AND QUALITY ASSURANCE

Competency: Quality control and quality assurance

Knowledge and Skills

Able to design, implement, and evaluate quality assurance and quality control for various types of acid-base and electrolyte testing

Able to take appropriate actions and follow up based on quality assurance and quality control results

Subsection 7: PROTEIN ELECTROPHORESIS

Competency: Methods for serum protein electrophoresis (SPE)

Knowledge and Skills

Describe the principles of and methods for agarose gel electrophoresis and capillary zone electrophoresis, detailing their advantages and disadvantages

Generate, review and improve Standard Operating Procedures (SOPs) for protein electrophoresis of serum

Competency: Specimen requirements and effects of interference

Knowledge and Skills

Describe and explain the requirements for sample collection, handling, transport and storage

Recognise mechanisms by which common interferents affect SPE (haemolysis, jaundice, lipaemia) and their effects on the interpretation of results

Recognise and interpret differences that may occur with the use of serum and plasma for SPE (particularly fibrinogen)

Competency: Electrophoretic patterns that are species specific or method specific

Knowledge and Skills

Able to recognize that the same protein groups in different animal species have slight to moderate differences in migration patterns

Able to discuss and explain the species-specific variations in migration patterns

Able to recognise that the same sample will lead to different electrophoretic protein bands when migrating through different electrophoretic media (agarose gel electrophoresis vs capillary zone electrophoresis)

Competency: Interpretation of electrophoretic tracings

Knowledge and Skills

Identify the proteins that are major contributors to each protein fraction in an electrophoretic trace

Calculate concentrations of protein fractions from the electrophoretic trace and total protein concentration

Recognise those analytical factors that affect the measured concentration of a protein fraction

Recognise normal and common abnormal electrophoretic patterns in the common domestic species (dog, cat, horse)

Describe and explain the appropriate use and interpretation of electrophoretic patterns in screening for disease, list differential diagnoses based on the electrophoretic pattern

obtained, and advise when SPE can be used to monitor the effectiveness of treatment and disease progression or resolution

Describe and explain the pathophysiology of and differential diagnoses for monoclonal, biclonal, oligoclonal, and polyclonal gammopathies

Competency: Immunoelectrophoresis

Knowledge and Skills

Describe and explain the principles and methodologies for immunofixation electrophoresis (IFE) and immunosubtraction electrophoresis (IST)

Able to interpret the results of immunoelectrophoresis and to understand how these techniques complement agarose gel electrophoresis and capillary zone electrophoresis

Recognise the prozone effect in IFE and explain how this might be overcome

Competency: Method for urine electrophoresis

Knowledge and Skills

Discuss and explain the requirement for urine protein concentration prior to agarose gel electrophoresis

Discuss and explain the requirement for selection of dyes which are more sensitive for staining globulins than SPE techniques

Competency: Effects of interference on urine electrophoresis (UPE)

Knowledge and Skills

Recognise the effect of haemolysis and point of application artefact on UPE agarose gel electrophoretic tracings

Competency: Interpretation of electrophoretic tracings

Knowledge and Skills

Describe and explain the pathophysiology of glomerular proteinuria (selective and non-selective), tubular proteinuria and overflow proteinuria. Able to recognise UPE traces associated with these types of proteinuria

Competency: Bence-Jones proteinuria

Knowledge and Skills

Describe and explain the use of sulfosalicylic acid, the heat test and UPE as screening tests for Bence-Jones proteinuria

Describe and explain the use of immunofixation electrophoresis for confirmation of a Bence-Jones proteinuria

Describe and explain the pathophysiology of Bence-Jones proteinuria and list differential diagnoses associated with the detection of Bence-Jones proteinuria in the common domestic species (dog, cat, horse)

CORE AREA: HAEMATOLOGY AND COAGULATION

The Haematology and Coagulation core area includes the following subsections: (1) Introductory concepts, (2) Haematology and coagulation procedures and laboratory techniques, (3) Quality control and assurance, (4) Haematopoiesis, (5) Red blood cells (6) White blood cells, (7) Platelets, (8) Haemostasis/Coagulation, (9) Bone marrow examination, (10) Bone marrow disorders, (11) Immunohaematology and transfusion medicine, (12) Haematological neoplasia (13) Haematotoxicity.

Subsection 1: INTRODUCTORY CONCEPTS

Competency: Specimens submitted to a laboratory
Knowledge and Skills
Discuss and explain the different types of blood samples and their appropriate collection, transport, storage and processing; mechanisms of the different anticoagulants and types of tubes for collection and their effects on laboratory results in haematology and coagulation

Competency: Quality of laboratory results
Knowledge and Skills
Recognise, troubleshoot and educate others about causes of pre-analytical/analytical/post-analytical errors Describe and explain concepts referring to sensitivity, specificity, precision, accuracy and detection limit/cut-off values of laboratory methods in the context of the multiple tests in haematology and coagulation testing

Competency: Reference intervals, comparison of assays, predictive values of laboratory assays and ROC curves and other analytical and statistical techniques
Knowledge and Skills
Describe and explain reference intervals, comparison of assays, predictive values, ROC curves and other statistical concepts in haematology and coagulation (see laboratory management section for further details)

Subsection 2: HAEMATOLOGY AND COAGULATION PROCEDURES AND LABORATORY TECHNIQUES

Competency: Principles of patient preparation prior to sampling and selection of appropriate transport tubes

Knowledge and Skills

Describe the ideal duration of fasting and the suitability of different anticoagulants for different species and laboratory tests

Competency: Macroscopic examination of blood samples

Knowledge and Skills

Describe and explain the distinction between normal and abnormal findings, and recommend and interpret results of further testing

Competency: Principles and pitfalls of automated blood cell counting and sizing techniques

Knowledge and Skills

Describe and explain the principles of automated blood cell counting and sizing techniques

Describe and explain the limitations and pitfalls of automated blood cell counting and sizing techniques for a variety of species using the most common haematology analysers

Interpret patterns on cyto/scattergrams/histograms available from various haematology analysers

Competency: Principles of blood film preparation, staining procedures and development of an organised examination

Knowledge and Skills

Demonstrate and discuss different techniques of blood film preparation and their applicability

Discuss and explain different stains used on haematology films and the expected microscopic characteristics

Recognise and discuss special stains and indications for their use in haematologic evaluations

Recognise and interpret normal and abnormal findings on a blood smear

Competency: Report generation

Knowledge and Skills

Able to provide detailed haematology reports appropriate for the test or reason for haematologic evaluation (i.e., routine Full Blood Count, Pathologist Review of Haematology, Haematologic evaluation in conjunction with other testing)

Competency: Specialised diagnostic testing for haematology/coagulation
Knowledge and Skills
Describe and explain indications for, principles of, sample requirements for, potential interferences and limitations of specialised tests (such as thromboelastography, PARR, flow cytometry, etc.)

Subsection 3: QUALITY CONTROL AND QUALITY ASSURANCE

Competency: Specimens submitted to a laboratory
Knowledge and Skills
Identify, discuss and advise clients about different types of blood samples and their appropriate collection, transport, storage and processing; mechanisms of the different anticoagulants and types of tubes for collection and their effects on laboratory results in haematology and coagulation

Competency: Effects of interferents
Knowledge and Skills
Recognise the effect of haemolysis and other potential interferents with haematology and coagulation testing

Competency: Quality of laboratory results
Knowledge and Skills
Recognise, troubleshoot and educate others about causes of pre-analytical/analytical/post-analytical errors Demonstrate the ability to apply concepts referring to sensitivity, specificity, precision, accuracy and detection limit/cut-off values of laboratory methods in the context of the multiple tests in haematology and coagulation testing

Competency: Statistical and nonstatistical QC appropriate for haematology and coagulation testing
Knowledge and Skills
Design, implement, evaluate and troubleshoot ongoing statistical and nonstatistical QC appropriate for haematology and coagulation testing

Competency: External Quality Assessment (EQA) for haematology and coagulation testing
Knowledge and Skills
Interpret EQA reports for haematology and coagulation testing Describe and explain appropriate actions based on unacceptable performance on EQA events

Subsection 4: HAEMATOPOIESIS

Competency: Ontogeny of haematopoetic system and normal anatomy of haematopoietic tissues
Knowledge and Skills
Discuss the fetal and adult sites of blood cell production Recognise and describe the organisation of bone marrow and species differences

Competency: Regulation of haematopoiesis
Knowledge and Skills
Describe and explain the principles of regulation of erythropoiesis, leukopoiesis and thrombopoiesis at the cellular, biochemical and molecular level

Competency: Stem Cell Biology
Knowledge and Skills
Describe and explain haematopoietic stem cells and progenitor cells and their homing to the marrow; mesenchymal stem cells; roles of stem cells in cancer

Competency: Haematopoietic Microenvironment
Knowledge and Skills
Describe and explain the roles of various elements, including stromal cells, endothelial cells, extracellular matrix, growth factors, and cellular adhesion molecules; understand the term ‘niche’ as applied to haematopoiesis

Competency: Veterinary applications of Cluster of Differentiation (CD) Antigens
Knowledge and Skills
Demonstrate the ability to access information about the types of CD antigens and their structures, tissue/cell distribution, and the physiological roles of the principle veterinary CDs Demonstrate the ability to select appropriate CD antigens in the diagnostic workup of haematopoietic neoplasms, including selection of appropriate markers and interpretation of results

Competency: Factors affecting haematopoiesis

Knowledge and Skills

Recognise and explain effects of species, gender, reproductive status, age, breed, drugs, toxins and hormones on haematopoiesis and interpret haematological data in the context of these factors

Competency: Evaluation of haematopoietic function

Knowledge and Skills

Integrate, interpret and report information from peripheral blood examination and cytological and histological bone marrow evaluations

Recognise appropriate research techniques based on the stated goals and species in journal articles, books and presentations

Subsection 5: RED BLOOD CELLS

Competency: Erythrocyte and haemoglobin structure and function

Knowledge and Skills

Discuss and explain the overall erythrocyte and membrane structure, haemoglobin structure/synthesis/metabolism, and iron metabolism

Competency: Erythrocyte biochemistry

Knowledge and Skills

Demonstrate the ability to access information about and explain the mechanisms of membrane transport, carbohydrate metabolism, Embden-Meyerhof pathway and ATP production, DPG pathway and oxygen affinity to haemoglobin, oxidants and oxidative injury, pentose phosphate pathway and protection against oxidant and methemoglobin formation and reduction

Competency: Erythrokinetics and erythrocyte destruction

Knowledge and Skills

Describe and explain reticulocyte response, RBC lifespans, mechanisms of RBC clearance and destruction in the different domestic species, laboratory animals and most common exotic species

Competency: Erythrocyte morphology

Knowledge and Skills

Recognise normal erythrocyte morphology and distribution

Able to recognize abnormal features and explain the underlying mechanisms/causes of variation in RBC morphology in various species

Competency: Approach to laboratory and clinical diagnosis of anaemia

Knowledge and Skills

Recognise the clinical manifestations of anaemia

Identify, grade and classify anaemias and apply diagnostic approaches

Describe and explain the kinetics of a regenerative response in the different species

Competency: Detection and confirmation of erythrocytosis and polycythemia

Knowledge and Skills

Describe and explain the causes and pathogeneses of relative and absolute erythrocytosis, associated clinical signs, and diagnostic approach

Competency: Iron Disorders

Knowledge and Skills

Interpret available tests for evaluation of iron disorders

Describe and explain causes, clinical features and laboratory features of absolute iron deficiency

Describe and explain causes and expected laboratory results in cases of functional iron deficiency

Describe and explain causes of microcytic and hypochromic anaemias other than iron deficiency

Describe and explain the causes of primary and secondary copper deficiencies, and of iron loading, and expected haematological results

Competency: Porphyrias and porphynurias

Knowledge and Skills

Demonstrate the ability to access information about porphyrin synthesis pathways, pathogenesis of porphyrias and porphynurias, expected clinical and laboratory findings

Demonstrate the ability to classify disorders as erythropoietic and hepatic porphyrias, their subtypes and inheritance mechanisms

Competency: Hereditary erythrocyte enzyme abnormalities

Knowledge and Skills

Demonstrate the ability to access information about genetic defects, pathogenesis, breed predispositions, laboratory findings and specific testing for the diagnosis of canine, feline and equine hereditary erythrocyte enzyme abnormalities

Competency: Erythrocyte membrane defects

Knowledge and Skills

Describe and explain the pathogenesis, clinical signs, laboratory findings, ultrastructural features and diagnostic approaches to haemolytic anaemias and other abnormalities caused by hereditary red cell membrane defects in domestic animal species

Competency: Congenital dyserythropoiesis

Knowledge and Skills

Demonstrate the ability to access information about specific entities identified in domestic species, their inheritance mechanism, and clinical, morphological, ultrastructural and bone marrow manifestations

Competency: Aetiology and pathogenesis of anaemia

Knowledge and Skills

Describe and explain the general concepts applying to anaemia, its classification by marrow responsiveness, erythrocyte indices and pathophysiological mechanisms

Describe and explain infectious causes of anaemia, expected laboratory results and aetiological diagnosis

Describe and explain the pathogenesis, manifestations and diagnosis of immune-mediated anaemias in the dog, cat, ruminants and horse

Describe and explain causes and expected findings in anaemias associated with oxidative injury in the domestic species

Describe and explain the pathophysiology of anaemia of inflammatory, neoplastic, renal and endocrine diseases

Competency: Pure red cell aplasia and aplastic anaemia

Knowledge and Skills

Describe and explain the causes, pathogenesis, clinical and haematological features, differential diagnoses and tentative confirmatory testing needed for a diagnosis of pure red cell aplasia and aplastic anaemia

Subsection 6: WHITE BLOOD CELLS

Competency: Blood film examination (leukocytes)

Knowledge and Skills

Identify and describe normal and abnormal WBC in peripheral blood films

Identify leukocytes in blood films from a wide variety of species; recognise morphological deviations from the norm evident by light microscopy and understand clinical significance thereof; appropriately designate cells as ‘unclassified’

Competency: Leukocyte ultrastructure

Knowledge and Skills

Identify the principle structures of leukocytes in electron micrographs

Competency: Leukocyte development

Knowledge and Skills

Demonstrate the ability to access information about granule development, morphology, contents and function; expression of differentiation markers and receptors; comparative aspects

Competency: Leukocyte function

Knowledge and Skills

Describe and explain leukocyte functions and cellular mechanisms thereof, including the role of cell surface molecules; their role in different types of disease process; mechanisms by which pathogens and tumour cells circumvent leukocyte function, and understanding of leukocyte function testing

Competency: Congenital and acquired leukocyte disorders

Knowledge and Skills

Recognise leukogram and/or WBC morphological changes expected in acute and chronic inflammation, infectious diseases, immune-mediated disorders dysmyelopoiesis, haematological neoplasia and paraneoplastic syndrome, and those associated with certain endocrine disorders, drugs and toxins; identification of infectious agents within WBC

Recognise congenital disorders at both light microscopy and ultrastructural examination, when applicable

Competency: Comparative aspects

Knowledge and Skills

Describe and explain the leukocyte responses in the principle domestic species, as well as in rabbits, ferrets, rodents, camelids, avian and reptiles, and able to discuss basic concepts of leukocyte responses in fish and amphibians

Interpret leukogram and read blood films and bone marrow aspirates from a wide variety of species, with ability to apply first principles when faced with less familiar species

Subsection 7: PLATELETS

Competency: Platelet morphology and structure

Knowledge and Skills

Recognise and describe normal and abnormal light microscopic features and membrane, cytoplasmic, cytoskeleton and granules structure/components

Competency: Platelet metabolism

Knowledge and Skills

Demonstrate the ability to access information about principles of platelet energy production and other metabolic particularities

Competency: Platelet biochemistry, signal transduction and function

Knowledge and Skills

Demonstrate the ability to access information about platelet receptors and activation pathways, platelet-leucocyte interactions and procoagulant activity

Competency: Platelet kinetics and laboratory evaluation of thrombocytopenia and Thrombocytosis

Knowledge and Skills

Discuss the process of megakaryocytopoiesis and platelet production, circulating lifespan and senescence, species differences, mechanisms of thrombocytopenia and thrombocytosis

Discuss and conduct the laboratory investigation of thrombocytopenia and thrombocytosis and further relevant tests

Competency: Essential thrombocythaemia and reactive thrombocytosis

Knowledge and Skills

Describe and explain the causes of thrombocytosis, how to differentiate essential thrombocythemia from reactive thrombocytosis and other chronic myeloproliferative diseases

Competency: Immune and non-immune mediated thrombocytopenia

Knowledge and Skills

Describe and explain the potential clinical presentations, pathogenesis, and laboratory tests/clinical pathology findings associated with immune and non-immune mediated thrombocytopaenia

Describe and explain the treatment and possible outcomes of primary immune-mediated thrombocytopaenia in various domestic species

Describe and explain the underlying causes of secondary immune-mediated thrombocytopaenia and pathogenesis of allo-immune thrombocytopaenias

Competency: Von Willebrand disease

Knowledge and Skills

Describe and explain the disease mechanisms, disease subtypes, affected species and breeds, inheritance and expression patterns of von Willebrand disease

Describe and explain the von Willebrand factor assay and basics of the clinical management of von Willebrand disease

Describe and explain the use of genetic testing for von Willebrand disease and its use in informed breeding decisions

Competency: Inherited intrinsic platelet disorders

Knowledge and Skills

Describe and explain various underlying genetic defects and the pathophysiology at the functional level

Describe and explain the biochemical and molecular laboratory tests to differentiate intrinsic and extrinsic platelet disorders and the expected results for each disorder

Describe and explain the basics of patient management (blood products) when platelet disorders are present

Competency: Evaluation of platelet function

Knowledge and Skills

Describe and explain the basic principles, applicability, drawbacks and interpretation of the different available tests and techniques to evaluate platelet function

Competency: Acquired platelet dysfunction

Knowledge and Skills

Describe and explain the causes and mechanisms of acquired platelet hypo- and hyperfunction and associated laboratory test results

Subsection 8: HAEMOSTASIS/COAGULATION

Competency: Principles of haemostasis and related laboratory testing

Knowledge and Skills

Describe and explain the different phases of primary and secondary haemostasis and fibrinolysis

Describe and explain the commonly used anticoagulants and appreciate their interactions in a global approach to haemostasis

Describe, explain and appropriately select screening tests and specialised tests for haemostatic disorders

Competency: Acquired coagulopathies

Knowledge and Skills

Describe and explain the pathogenesis of, and clinical and laboratory evaluations of acquired coagulopathies

Competency: Hereditary coagulopathies

Knowledge and Skills

Describe and explain the different types of inherited coagulopathies, associated genetic defects/inheritance mechanisms, clinical manifestations and appropriate laboratory tests

Able to conduct investigations for and diagnose hereditary coagulopathies

Competency: Thrombotic disorders

Knowledge and Skills

Describe and explain the causes, pathophysiology and principles, and expected results of laboratory tests of hypercoagulability

Competency: Disseminated intravascular coagulation(DIC)

Knowledge and Skills

Describe and explain the causes, pathogenesis, and laboratory results needed for a diagnosis of disseminated intravascular coagulation

Describe and explain the basics of treatment of DIC

Competency: Vascular diseases

Knowledge and Skills

Describe and explain the different types of vascular diseases with particular emphasis on vasculitis and the relationship with coagulopathy

Subsection 9: BONE MARROW EXAMINATION

Competency: Indications for bone marrow investigation

Knowledge and Skills

Describe and explain the indications for bone marrow sampling (including peripheral blood abnormalities, staging of neoplastic conditions, investigation of body iron stores, search for occult disease including infectious agents, or to investigate unexplained biochemical changes)

Describe and explain the limitations of and contraindications for bone marrow evaluation

Competency: Bone marrow sample techniques, sample handling and sample preparation

Knowledge and Skills

Describe and explain sampling sites, equipment, techniques, slide preparation and sample submission for both cytological and histopathological examination of bone marrow

Recognise artifacts associated with poor sample handling and histologic processing and sectioning

Explain and appropriately select the special stains that may be used routinely or upon request for evaluation of bone marrow cytology and histology specimens

Competency: Interpretation of bone marrow aspirate cytological specimens

Knowledge and Skills

Prepare a cytological evaluation of bone marrow aspirates (including ability to reject poor quality samples, recognise breed and species variations, and abnormalities in cell number and morphology)

Determine when a 500-cell differential count is necessary

Describe and explain how erythroid, myeloid and platelet kinetics affect bone marrow findings versus blood film examination

Produce an organised, thorough, succinct written report, including an assessment of cellularity, estimated or calculated myeloid:erythroid (ME) ratio, description of prevalence and morphological changes in the different lineages, presence of any unexpected cells or microorganisms, and any other pertinent findings

Provide a succinct overall interpretation within the context of signalment, history, clinical and haematologic findings, and results from other diagnostic procedures

Describe and explain suggestions for further relevant tests

Competency: Interpretation of bone marrow histopathology

Knowledge and Skills

Describe and explain the indications for bone marrow histology (core biopsy)

Describe and explain the advantages/disadvantages compared with cytological bone marrow examination

Conduct histological evaluation of bone marrow core biopsy specimens, recognising adequate specimen size, appearance and section quality

Produce an organised, thorough, succinct written report, including an assessment of cellularity, description of prevalence and morphological changes in the different lineages, presence of any unexpected cells or microorganisms and any other pertinent findings

Produce a succinct overall interpretation, within the context of signalment, history, clinical and haematological findings, bone marrow aspirate cytology findings and results from any other diagnostic procedures

Able to provide appropriate suggestions for further relevant tests

Subsection 10: BONE MARROW DISORDERS

Competency: Generalised decreases in haematopoietic cells

Knowledge and Skills

Recognise hypocellular/aplastic bone marrow and know possible causes

Recognise necrosis and potential artefactual factors

Describe and explain pathological and artefactual conditions that could reduce cellularity of bone marrow cytology and histology samples

Describe and explain the limitations of cytology and histology in assessing bone marrow cellularity

Competency: Erythroid hyperplasia

Knowledge and Skills

Distinguish appropriate from inappropriate erythroid hyperplasia

Recognise ineffective erythropoiesis and know the possible causes

Discuss appropriate further investigations (including imaging, EPO, FeLV testing, Coombs' test, etc.)

Competency: Dysgranulopoiesis

Knowledge and Skills

Recognise abnormal granulocyte maturation/morphology and/or ineffective granulopoiesis

Describe and explain possible causes and appropriate further investigations

Recognise similarity of pattern to marked appropriate granulopoiesis

Competency: Megakaryocyte disorders

Knowledge and Skills

Recognise appropriate and inappropriate megakaryocyte hyperplasia, selective megakaryocyte hypoplasia and dysmegakaryocytopoiesis, and discuss possible causes and further testing recommendations

Competency: Disorders of monocytes/macrophages

Knowledge and Skills

Recognise inflammation with a predominance of macrophages and know possible causes and appropriate further tests

Describe and recognize organisms within macrophages

Interpret the significance of increased phagocytosis of other cells – e.g. in immune mediated cytopenias, haemophagocytic syndrome etc

Describe and explain neoplastic conditions and differentiate from non-neoplastic histiocytic proliferations

Competency: Bone marrow inflammation

Knowledge and Skills

Recognise limitations of bone marrow cytology and histology in the diagnosis of bone marrow inflammation

Describe and explain possible causes of myelonecrosis and acute inflammation, fibrinous inflammation, chronic/granulomatous inflammation, and haematopoietic cell injury, and expected cytological/histological changes

Recognise and interpret other non-neoplastic bone marrow pathology

Competency: Haematopoietic and non-haematopoietic neoplasms

Knowledge and Skills

Recognise haematopoietic neoplasms and metastatic neoplastic cells

Describe and explain the limitations of bone marrow examination in the detection of haematopoietic and non-haematopoietic neoplasia

Discuss and recognise possible primary bone neoplasms

Subjection 11: IMMUNOHAEMATOLOGY AND TRANSFUSION MEDICINE

Competency: Erythrocyte antigens and blood groups

Knowledge and Skills

Describe and explain innate and acquired immunity, the distinction between humoral and cellular immunity and the role of cellular and non-cellular components

Describe and explain the major blood groups in the principle domestic species, including approximate incidence, molecular structure, clinical significance, and applications in breeding programmes, blood transfusion and plasma transfusion

Competency: Blood typing and cross matching

Knowledge and Skills

Describe and explain the principles and practical aspects of major and minor cross-matching

Explain to practitioners when blood typing is indicated

Interpret primary results (able to 'read' blood typing cards, immunochromatographic strips, etc.)

Describe and explain when results are likely to be inaccurate

Competency: Other tests used in immunohaematology

Knowledge and Skills

Describe and explain the Coombs' test, direct immunofluorescence, flow cytometry assay, tests for anti-nuclear antibodies, anti-neutrophil antibodies and anti-platelet antibodies, including principle and practical aspects such as sample collection and processing, interpretation of primary results (able to 'read' direct antibody test reactions within microtiter plates, capillary/gel tubes or immunochromatograpic strips, flow cytometry scattergrams, etc.) and know causes of false positive and false negative results

Competency: Disorders due to immune-mediated blood cell destruction

Knowledge and Skills

Describe and explain the pathophysiology, clinical presentation and diagnosis of primary and secondary immune-mediated haemolytic anaemia, neutropenia and thrombocytopenia, and of neonatal isoerythrolysis

Competency: Immunodeficiency disorders

Knowledge and Skills

Describe and explain the clinical significance and relevant diagnostic tests for inherited neutrophil defects, severe combined immunodeficiency syndromes, serum immunoglobulin deficiencies, complement deficiency, viral immune deficiency disorders, and failure of passive transfer of immunoglobulins

Able to access information on research tests not widely commercially available (e.g. neutrophil function tests and lymphocyte assays)

Competency: Principles of transfusion medicine

Knowledge and Skills

Describe and explain the principles of whole blood and component banking in dogs and cats, including ethics, donor selection and screening, sample collection, preparation and storage, and quality control

Describe and explain the principles of transfusion medicine, including indications, cross-matching techniques, choice of product (including alternatives to blood and blood products), administration and patient monitoring, including clinical signs and clinicopathological changes indicative of transfusion reactions and non-immune complications

Describe and explain the general principles of transfusion medicine in small and large animals and exotic species

Subsection 12: HAEMATOLOGICAL NEOPLASIA

Competency: Cell cycle control in haematopoietic cells

Knowledge and Skills

Describe and explain the cell cycle and the relationship between cell cycle and cancer

Competency: Epidemiology of haematopoietic neoplasia

Knowledge and Skills

Describe and explain haematopoietic neoplasia epidemiology based on reference populations, and haematopoietic neoplasia risk assessment in dogs, cats, horses and cattle for different haematopoietic neoplasms

Competency: Genetics of haematopoietic neoplasia

Knowledge and Skills

Demonstrate the ability to access information about the genetic bases of certain haematopoietic neoplasms and available tests

Competency: Transforming retroviruses

Knowledge and Skills

Describe and explain the role of retroviruses in the pathogenesis of haematological neoplasms in domestic species

Competency: Bone marrow derived sarcomas

Knowledge and Skills

Describe and explain basic/general information about and mechanisms of bone marrow–derived sarcomas

Competency: Classification of leukaemia and lymphoma

Knowledge and Skills

Describe and explain basic/general information about the different systems of classification of lymphoid neoplasms, as well as of chronic and acute myeloid and lymphoid neoplasms

Apply commonly used systems of classification to clinical cases

Competency: General features of leukaemia and lymphoma

Knowledge and Skills

Recognise the general features of leukaemias and lymphoma in haematology and bone marrow specimens

Describe and explain appropriate differential diagnoses and recommend further tests for the most definitive classification and diagnosis

Competency: Myelodysplastic syndromes

Knowledge and Skills

Recognise likely myelodysplastic syndromes and discuss their significance in the common domestic species

Describe and explain recommendations for further testing or monitoring of myelodysplastic syndromes

Apply current classification systems for identification of various myelodysplastic syndromes

Competency: Acute and chronic myeloid leukaemia

Knowledge and Skills

Describe and explain the diagnostic approach for identification of acute and chronic myeloid leukaemia

Recognise the constellation of clinical, laboratory, haematological and bone marrow findings needed for the identification of acute and chronic myeloid leukaemias

Competency: Plasma cell tumours

Knowledge and Skills

Describe and explain the diagnostic approach for identification of noncutaneous plasma cell tumours

Recognise the constellation of clinical, laboratory, haematological and bone marrow findings needed for the identification of non-cutaneous plasma cell tumours in the

common domestic species

Competency: Histiocytic proliferative diseases

Knowledge and Skills

Describe and explain the diagnostic approach for identification of histiocytic proliferative diseases in the common domestic species

Recognise the constellation of clinical, laboratory, haematological and bone marrow findings needed for the identification of histiocytic proliferative diseases in the common domestic species

Subsection 13: HAEMATOTOXICITY

Competency: Clinical haematotoxicity

Knowledge and Skills

Describe and explain possible causes, pathophysiology, clinical presentation and diagnosis of blood cell disorders induced in the peripheral blood and in bone marrow by therapeutic drugs, toxins and infectious agents

Demonstrate the ability to communicate findings clearly to clients, including discussion of expected, idiosyncratic, transient and permanent changes induced by therapeutic drugs, and implications for treatment regimes

Describe and explain the role of the clinical pathologist in the support of critical care patients

Competency: Haematotoxicity studies

Knowledge and Skills

Describe and explain the study design and methods used for preclinical haematotoxicity studies

Describe and explain the mechanisms of drug-induced blood cell disorders

Interpret data sets and discuss implications

Describe and explain the role of the clinical pathologist in the development of pharmaceuticals

CORE AREA: URINALYSIS

The Urinalysis core area includes subsections of (1) Specimen Collection, (2) Specimen Handling and Submission, (3) Specimen Analysis, (4) Urinalysis Quality Control and Quality Assurance, (5) Urine Specimen Reporting and (6) Correlation with Other Types of Testing.

Subsection 1: SPECIMEN COLLECTION

Competency: Methods of urine collection (free catch, catheterised urine, cystocentesis urine specimens)

Knowledge and Skills

Describe and explain the methods of urine collection and their advantages and disadvantages for various types of testing and clinical purposes

Competency: Specimen additives (boric acid, fixation by ethanol or formalin) and their effects of urine specimens

Knowledge and Skills

Describe and explain the additives that may be used for urine specimens (boric acid, formalin or ethanol fixation) and their advantages and disadvantages or limitations for various purposes

Describe and explain the effects of additives on urine specimens and tests that can be run on urine

Subsection 2: SPECIMEN HANDLING AND SUBMISSION

Competency: Specimen handling and submission practices

Knowledge and Skills

Describe and explain the effects of submission of urine specimens at room temperature and with refrigeration/chilling (ice packs)

Describe and explain the optimal and recommended maximum intervals for evaluation of various urine parameters and features following collection

Describe and explain the effects of delays in analysis associated with expected intervals for common methods of specimen transport to the laboratory (courier, postal or other intervals)

Describe and explain the parameters that will require special mention or notation of effects of delayed submission

Subsection 3: SPECIMEN ANALYSIS

Competency: Evaluations commonly conducted on urine specimens

Knowledge and Skills

Describe and explain the tests commonly conducted on urine specimens (including urine macroscopic evaluation, routine urine sediment evaluation, cytologic evaluation, urine protein:creatinine ratio and quantitative urine culture and antibiotic sensitivity profiles)

Demonstrate the ability to correctly use the terminology and criteria for the macroscopic description of urine appearance

Describe and explain the parameters commonly evaluated by dipstick analysis and indications for dipstick analysis

Describe and explain the methods and principles employed for dipstick analyses for urine

Describe and explain the causes of false positive and false negative results on urine dipstick evaluations encountered with various species

Describe and explain the methods used for routine urine sediment evaluation and semi-quantitative designations used by technicians evaluating urine specimens in veterinary laboratories, and indications for urine sediment evaluation

Describe and explain the limitations of urine specific gravity determination by refractometer and indications for refractometer urine specific gravity determination

Describe and explain the expected inter-observer and intra-observer variation in refractometer urine specific gravity

Describe and explain the indications for determination of a urine protein:creatinine ratio

Describe and explain the different methods used for protein and creatinine determination in urine and the formula for calculating a urine protein:creatinine ratio; able to calculate a urine protein:creatinine ratio given data on urine creatinine and urine protein

Describe and explain the indications for urine microbiologic investigations

Describe and explain the methods used for culture and identification of microorganisms in urine

Describe and explain the preferred specimens for and interpretation of results of quantitative urine culture

Describe and explain the methods of determination of urine bacteria antibiotic sensitivity profiles and their advantages and disadvantages

Describe and explain results of Minimum Inhibitory Concentration (MIC) for antibiotic sensitivity profiles in urine

Interpret the likely significance of common bacterial and fungal organisms isolated in urine

Demonstrate the ability to research the likely significance of uncommon bacterial and fungal organisms isolated from urine

Competency: Special tests that can be conducted on urine

Knowledge and Skills

Describe and explain additional tests that can be conducted on urine (including urine cortisol, creatinine ratio, antibacterial substances evaluation, urine bladder tumour antigen testing, PCR for infectious agents, fungal antigen testing, urine electrolytes and fractional excretion of electrolytes, Bence-Jones protein determination, and other types of testing)

Describe and explain the methods used for determination of urine cortisol and creatinine, calculation of the urine cortisol:creatinine ratio and interpretation of results

Describe and explain the method used for antibacterial substances evaluation and its significance in urine

Describe and explain the method used for urine bladder tumour antigen testing in dogs and its limitations, advantages and disadvantages compared to other techniques for detection of urinary neoplasia

Describe and explain the basis for genetic tests associated with the presence of bladder cancer in dogs

Describe and explain those fungal organisms commonly involved in systemic infections for which urine antigen testing is available, their sensitivity and specificity and interpretation

Describe and explain the methods used for determination of urine electrolytes, the fractional excretion of electrolytes in urine, indications for this type of analysis and the interpretation of the results

Describe and explain the indications for evaluation for Bence-Jones protein in urine

Describe and explain the method used for Bence-Jones protein determination in urine and limitations associated with it

Describe and explain infectious agents for which PCR testing is available on urine and circumstances when urine PCR testing is appropriate

Subsection 4: URINALYSIS QUALITY CONTROL AND QUALITY ASSURANCE

Competency: Quality assurance and quality control appropriate for refractometry

Knowledge and Skills

Describe and explain quality control appropriate for refractometers

Able to troubleshoot problems with refractometer urine specific gravity determinations

Describe and explain expected intra- and inter-observer variation for urine refractometer specific gravity determinations

Describe and explain the expected correlation between routine urinalysis conducted by trained technicians and urine cytology evaluated by a trained clinical pathologist

Describe and explain the expected variation between refractometers of the same or different types (applicable when more than one refractometer is used within the laboratory)

Describe and explain appropriate QC and QA to assess agreement between trained technicians determining urine macroscopic descriptions, routine microscopic urinalysis, and dipstick analyses

Discuss the appropriate QC and QA for urine cytologic evaluations conducted by a trained clinical pathologist

Competency: Quality control/quality assurance appropriate for standardisation of macroscopic descriptions of urine

Knowledge and Skills

Describe and explain and able to train technicians to standardise the macroscopic descriptions of urine

Design and conduct audits for evaluation of the standardisation of macroscopic descriptions of urine

Competency: Quality control/quality assurance appropriate for urine dipstick evaluations

Knowledge and Skills

Demonstrate the ability to access information about the available external quality assessment programs for urinalysis

Describe and explain the advantages of participation in an external quality assurance program for urine dipstick evaluations

Competency: Quality control/quality assurance appropriate for routine sediment evaluation of urine

Knowledge and Skills

Demonstrate the ability to train technicians to conduct routine sediment evaluation of urine

Design and conduct audits for evaluation of the standardisation of routine sediment evaluation of urine

Competency: Quality control/quality assurance appropriate for urine cytology evaluation

Knowledge and Skills

Describe and explain the expected correlation between semi quantitative assessments of routine urine sediment evaluation and urine cytologic evaluations

Describe and explain the advantages and disadvantages and limitations of routine urine

sediment evaluation and urine cytology for detection and identification of various findings in urine

Competency: Quality control/quality assurance appropriate for the biochemical analysis of urine protein (micro protein determination) and creatinine for urine protein: creatinine ratio

Knowledge and Skills

Describe and explain the quality control and quality assurance procedures appropriate for determining urine microprotein and creatinine concentrations and calculation of the urine protein:creatinine ratio

Competency: Quality control and quality assurance applied to other tests commonly conducted on urine

Knowledge and Skills

Describe and explain the quality control and quality assurance applying to other tests commonly conducted on urine in veterinary species (including urine cortisol:creatinine ratio, urine bladder tumour antigen, and microbiologic detection and identification of infections and antibiotic sensitivity profiles, fractional excretion of electrolytes, Bence-Jones protein determination and other types of testing)

Subsection 5: URINALYSIS REPORTING

Competency: Reporting of tests on urine

Knowledge and Skills

Demonstrate the ability to provide appropriate comments, semi-quantitative assessments and interpretation of a variety of types of urine results from a variety of species

Subsection 6: CORRELATION WITH OTHER TESTING

Competency: Urinalysis as a part of the minimum database and in investigation of specific diseases and conditions

Knowledge and Skills

Describe and explain the importance of and type of information that can be achieved with routine urinalysis, and its contribution to the patient database, diagnosis of disease and disease/treatment monitoring

Competency: Importance of urinalysis and indications for urinalysis based on the presence of other diseases or clinical or laboratory findings

Knowledge and Skills

Demonstrate the ability to make recommendations for the need for urine testing based on the presence of various diseases or clinical or laboratory findings

CORE AREA: MISCELLANEOUS TOPICS

This core area includes topics or items that do not easily fit within the other core areas, which overlap many areas in the laboratory or which were felt to deserve separate mention.

The Miscellaneous Topics core area includes subsections on (1) Light microscopy, (2) Miscellaneous laboratory equipment, (3) Pharmaceutical/toxicologic pathology, (4) Other aspects of laboratory testing and (5) Case Reporting/Write-ups

Subsection 1: LIGHT MICROSCOPY

The light microscope is currently an important tool for a clinical pathologist. This may change in the future with the advent of digital technologies, but light microscopic analysis is not yet obsolete! The light microscope is used on a daily basis in the microscopic assessment of haematology samples, urinalysis samples, cytology samples and histopathological specimens. A clinical pathologist may spend their full working day using a light microscope. It is therefore important that there is a good understanding of the principals of light microscopy and how to set up and maintain a microscope for optimal usage and comfort.

Competency: Importance of optimum ergonomics at the light microscope work station

Knowledge and Skills

Demonstrate the ability to adjust the light microscope for the individual height of the user

Demonstrate correct posture whilst working with a light microscopy

Competency: Kohler illumination

Knowledge and Skills

Describe and explain the importance of Kohler illumination necessary to view a sample under bright field conditions - providing an even light source avoiding the source of light being in the same plane as the object of study

Demonstrate the ability to adjust a microscope for Kohler illumination

Competency: Correct set up of an upright light microscope

Knowledge and Skills

Demonstrate the ability to correctly adjust the eyepiece interpupillary distance and focus

Demonstrate the ability to adjust condenser aperture diaphragm for optimal contrast

Describe and explain the role of the iris diaphragm and able to adjust it according to the objective lens which is in use

Competency: Objective lenses

Knowledge and Skills

Describe and explain the types of lenses which are available for routine microscopy, including achromat, fluorite, apochromat, plan, immersion lenses and their advantages and disadvantages

Describe and explain the limitations and pitfalls of using the dry 40 X objective lens with the need for a coverslip to be placed on the slide, and the hazard of switching between dry 40x objective and oil objectives

Demonstrate the ability to maintain objective lenses, including removal of oil from the dry objective lens

Competency: Filters

Knowledge and Skills

Demonstrate the ability to use a daylight blue filter to provide a “white” background to a sample

Competency: LED versus Halogen light sources

Knowledge and Skills

Describe and explain the advantages of LED versus halogen light sources (current move away from halogen towards LED light sources)

Competency: Polarised light microscopy

Knowledge and Skills

Describe and explain the principles of polarisation of light

Describe and explain the applications of polarised light for observation of cytologic and histologic specimens

Demonstrate the ability to use a polarising filter appropriately

Competency: Light microscopic examination of fluids

Knowledge and Skills

Demonstrate setting up the microscope for examination of a fluid sample such as a wet sediment urine slide or saline agglutination test

Demonstrate the ability to drop the condenser and/or close the iris diaphragm to provide optimal contrast of the specimen

Competency: Maintenance of a light microscope

Knowledge and Skills

Describe and explain the importance of regular servicing of a microscope, depending upon use

Describe and explain the importance of having the dust cover in place when microscope is not in use

Demonstrate the ability to perform routine maintenance (routine cleaning) for the light microscope

Subsection 2: MISCELLANEOUS LABORATORY EQUIPMENT

Competency: General Knowledge about miscellaneous laboratory equipment

Knowledge and Skills

Demonstrate the ability to access information about and have general familiarity with the variety of miscellaneous equipment used within the laboratory (including hoods, centrifuges, automated pipettors, plate readers, etc.)

Describe and explain the advantages and disadvantages of various types of miscellaneous equipment

Competency: Health and Safety

Knowledge and Skills

Describe and explain the health and safety requirements for the use of various miscellaneous laboratory equipment

Identify those pieces of equipment that require periodic inspections (electrical or other), calibration, cleaning, disinfection, or monitoring as part of ongoing due diligence for health and safety

Competency: General maintenance and cleaning requirements

Knowledge and Skills

Demonstrate the ability to access information about the general maintenance and cleaning requirements and calibration (if needed) for miscellaneous laboratory equipment

Competency: Equipment lifespan, replacement and budgeting

Knowledge and Skills

Demonstrate familiarity with the typical expected lifespans of various types of equipment, the requirements for replacement, and the budgeting that is associated with these aspects

Subsection 3: PHARMACEUTICAL/TOXICOLOGIC PATHOLOGY

Competency: Principles of GLP (Good Laboratory Practice) and legislation applying to pharmaceutical/toxicologic testing done worldwide

Knowledge and Skills

Describe and explain the general principles of GLP regulations and other legislation applying to pharmaceutical/toxicologic testing done worldwide

Competency: Basic principles of study design for pharmaceutical/toxicologic testing

Knowledge and Skills

Describe and explain the basic principles of study design for pharmaceutical/toxicologic testing

Describe and explain the advantages and disadvantages of alternative designs relative to the information being sought

Competency: Veterinary species commonly used for pharmaceutical/toxicologic testing

Knowledge and Skills

Describe and explain the veterinary species commonly used for pharmaceutical/ toxicologic testing

Describe and explain the alternatives to live animal testing in pharmaceutical/toxicologic testing

Describe and explain the reasons for selection of various species

Competency: Purpose(s) of testing done for pharmaceutical/toxicologic testing

Knowledge and Skills

Describe and explain the type of information usually being sought by various types of pharmaceutical/toxicologic testing

Describe and explain the purpose of various types of information in obtaining approval for drugs or other treatments or substances being tested in pharmaceutical/toxicologic studies

Competency: Types of specimens obtained for pharmaceutical/toxicologic testing

Knowledge and Skills

Describe and explain the types of specimens obtained

Describe and explain the advantages/disadvantages of various sites and methods of specimen collection

Describe and explain the limitations of specimens collected from various sites and various species for pharmaceutical/toxicologic assessment

Competency: Important aspects of pre-analytical, analytical and post-analytical factors affecting results obtained in pharmaceutical/toxicologic studies

Knowledge and Skills

Describe and explain the principles of specimen collection, handling, preservation and delivery to the laboratory in order to minimise pre-analytical error

Describe and explain the principles of specimen analysis and problems associated with low volume specimens or special types of specimens that may be obtained in order to minimise analytical error and ensure that accurate and representative results are obtained

Describe and explain the principles of data capture, identification, recording, records and documents, and reports commonly used in pharmaceutical/toxicologic studies

Competency: Principles of analysis and interpretation of data obtained from representative pharmaceutical/toxicologic studies

Knowledge and Skills

Describe and explain the important features for analysis and interpretation if given results and limited background information from a representative study

Describe and explain the basic principles of analysis and interpretation of data

Competency: Production of and information that should be covered in reports on pharmaceutical/toxicologic studies

Knowledge and Skills

Recognise the information important to include in a report on a pharmaceutical/ toxicologic study

Describe and explain the ramifications of missing, inappropriate or extraneous information in documents and reports

Subjection 4: OTHER ASPECTS OF LABORATORY TESTING

Competency: General knowledge about other types of testing

Knowledge and Skills

Describe and explain other types of testing conducted by the laboratory internally or sent out to other laboratories, especially when relevant for interpretation of or correlation with results generated in the traditional core areas of clinical pathology (including biochemistry and endocrine; haematology and coagulation; cytology and histology; urinalysis)

Provide basic advice to clients of the laboratory about other types of testing and/or refer them to the correct persons for further information about test availability, selection and interpretation, as needed

Demonstrate awareness of the criteria used for choosing laboratories for submission of other types of testing not done in the training laboratory (‘send out’ tests)

Competency: Consultation with specialists or those with expertise in other areas of testing

Knowledge and Skills

Describe and explain cases in conjunction with specialists or those with expertise in other areas of testing, internally or at other laboratories

Demonstrate familiarity with the aspects of quality control and quality assurance important in other areas of testing

Describe and explain the principles and techniques used in other areas of testing

Recognise when additional consultation with specialists or those with expertise in other areas of testing is needed

Competency: Flow of specimens through the laboratory

Knowledge and Skills

Describe and explain the flow of specimens through the laboratory and how other types of testing are handled, internally or as 'send outs' to other laboratories

Competency: Comments or information provided with other types of testing

Knowledge and Skills

Describe and explain comments provided by specialists or those with expertise in other types of testing that may accompany results from other areas within the laboratory or tests sent out to other laboratories

Recognise whether comments provided by other laboratories or areas of testing are altered by, approved by, or omitted as part of the routine reporting in the laboratory in which training is conducted

Describe and explain the differences in style, wording and information provided by other areas of testing conducted in the same laboratory, or received from other laboratories to which testing may be sent

Competency: Reporting of results received from other areas or laboratories

Knowledge and Skills

Demonstrate awareness of the procedures and processes used to ensure that results received from other areas of testing or other laboratories to which specimens are sent are promptly reported (within turnaround time guidelines)

Demonstrate awareness of double-checking accuracy of entry of results from other areas of testing (through manual entry, scanning or electronic reporting or other means) or from other laboratories to which specimens are sent

Subsection 5. Case Reporting and Case Write-ups

Case reporting and case write-ups are covered as a separate section since the processes and synthetic ability to integrate information from multiple laboratory tests is greater than the sum of the individual laboratory tests of which profiles are composed. Cases with extensive serial testing or sequential testing of various types may pose additional challenges in interpretation as new results are obtained. The evaluation of cases and case write-ups are included as an important part of the Part 2 examination, and are one of the important ways that clinical pathologists add value to the laboratory reporting and help clinicians understand the significance of the laboratory and clinical findings.

Competency: Pattern recognition

Knowledge and Skills

Recognise patterns in test profile results reflecting common and uncommon diseases in the common domestic species and common diseases in exotic and zoo species

Access information about common diseases in various species, as needed

Recognize when consultation with an expert in a particular disease or condition or consultation with other specialists is needed

Demonstrate identifying and discussing the possible significance of individual results or profile results that do not fit with commonly observed patterns associated with diseases or conditions

Describe and explain the confidence in the interpretation(s) provided based on the patterns of results observed

Describe and explain results that require further investigation to confirm suggested findings or provide additional information about diagnosis, prognosis or monitoring of disease progression or treatment

Competency: Significance of results

Knowledge and Skills

Describe and explain the significance of results based on various clinical decision limits and/or cut-off values appropriate for the species and suspected disease condition(s)

Describe and explain the possible significance of results that are within or outside of the 95% population-based reference intervals commonly provided or recommended cut-off values, intervals or individualised (subject-based) reference intervals

Describe and explain the uncertainty of measurement associated with results that are close to a reference interval limit, recommended cut-off values or result intervals

Provide differential diagnoses, if appropriate, for the presentation and results that are obtained, indicating the degree of likelihood or confidence in these possibilities

Describe and explain biologic variation and use of biologic variation data and individualized reference intervals (subject-based reference intervals) that may indicate a change in serial results that is highly unusual for the individual, but which may be within reference interval

Describe and explain the significance of changes in serial results based on biologic variation data, including dispersion, critical number of specimens for determination of homeostatic set points and reference change value

Describe and explain the significance of changes in serial results, dispersion and critical number of specimens for homeostatic set points and reference change value

Describe and explain the significance of changes in individual or serial results associated with traditional 95% population-based reference intervals

Describe and explain the significance of results based on prognostic indicators in the literature for the common domestic species

Competency: Synthesis and reporting of results

Knowledge and Skills

Demonstrate the ability to write clear, concise reports that provide useful information for the submitting veterinarian, addressing normal and abnormal results

Demonstrate interpretations and recommendations if new or additional laboratory results or other findings that contribute significantly to the case are obtained, or changes in clinical findings evolve

Demonstrate the ability to write clear, concise reports that relate the laboratory findings to the reported clinical signs and history provided with the submission

Clearly indicate in the report the interpretation, its basis and the degree of confidence in the interpretation

Demonstrate appropriate differential diagnoses, with an indication of those most important for initial investigation and likelihood of contributing to the clinical and laboratory findings

Competency: Recommendations for further testing

Knowledge and Skills

Recommend further testing to confirm a suggested diagnosis, provide a prognosis, monitor disease progression and/or monitor response to treatment , as appropriate

CORE AREA: CYTOLOGY AND HISTOLOGY

The Cytology and Histology core area includes subsections on (1) Theory and practice of cytology and histology in the veterinary laboratory, (2) Processes and progress of cytology and histology specimens through the laboratory, (3) Collection of cytology and histology specimens, (4) Handling and submission of cytology and histology specimens, (5) Cytology and histology specimen processing, (6) Cytologic specimen evaluation and reporting (7) Histologic specimen evaluation and reporting, (8) Cytology and histology audits, (9) Health and Safety, Quality Control and Quality assurance and (10) Other items related to cytology and histology.

Cytology is one of the areas in which clinical pathologists often excel and may provide a large part of the working day for many clinical pathologists in commercial laboratory, university or diagnostic (state or federally funded, often with regulatory oversite of reportable animal diseases) laboratory practice. Clinical pathologists are expected to achieve an extremely high standard of interpretive skills across a wide variety of types of specimens, sites of collection and species. Clinical pathologists are expected to be knowledgeable about a variety of collection methods, specimen handling, staining, interpretation, ways to improve suboptimal collections, and ancillary testing that complements or adds value to the cytologic interpretation (including microbiology, serology, PCR testing, immunocytochemistry, flow cytometry, PARR or other types of testing).

Histology is included in this curriculum because of its importance in complementing or confirming cytologic findings and interpretations, its use for correlative testing as part of quality control and quality assurance for cytology, and as a basis for learning about the origin of various cell types and the architecture that may be reflected in cytologic preparations. The clinical pathologist is also in the unique position of being the logical person to interpret bone marrow core biopsy histologic preparations because of expertise in and knowledge of the haematologic and bone marrow aspirate cytology findings, and need to interpret the core biopsy in conjunction with these findings in order to provide the most comprehensive information.

The inclusion of histology is not meant to make clinical pathologists proficient in the interpretation of a large variety of histologic specimens, sites and species, but to gain an appreciation for the challenges associated with obtaining histologic specimens, the strengths and limitations of histologic evaluation, the relationships between cytology and histology, and the ability to contribute to ongoing quality control and quality assurance utilising cytologic and histologic specimens, results of other types of testing, and clinic feedback about patient and disease progress.

Although not all veterinary laboratories will have access to or the ability to conduct digital imaging of cytology and/or histology specimens, certain staining techniques or other aspects mentioned in this section, knowledge of the theory, use, the challenges, advantages and disadvantages and the techniques should be acquired, as well as knowledge of the more standard techniques universally available.

Subsection 1: THEORY AND PRACTICE OF CYTOLOGY AND HISTOLOGY IN THE VETERINARY LABORATORY

Competency: Bases for the use of cytology and histology

Knowledge and Skills

Describe and explain the pathophysiologic bases for the use of cytology and histology in the detection of health and disease, diagnosis, and monitoring of disease progression and/or response to treatment

Describe and explain when it is appropriate to use cytology and/or histology

Describe and explain the strengths and weaknesses, advantages and disadvantages, and limitations of cytology (small and large volume washings, aspirates, non-aspirate punctures, scrapings, impression smears, brushings, etc.) and histology (punch biopsies, tru-cut biopsies, endoscopic biopsies, excisional and incisional biopsies, etc.) for various organs/systems

Describe and explain cytologic and histologic specimen collection strategies appropriate for different types of lesions and sites

Subsection 2: PROCESSES AND PROGRESS OF CYTOLOGY AND HISTOLOGY SPECIMENS THROUGH THE LABORATORY

Competency: Progress of cytologic and histologic specimens through the laboratory (from submission through handling, aliquoting or sharing between departments, processing, staining, assignation and delivery to the clinical pathologist, report generation, reporting to the client and communications with the client about cytology and/or histology, second opinions, specimen storage, tissue archiving and slide archiving)

Knowledge and Skills

Appreciate that the above aspects and processes may differ between different laboratories

Describe and explain the complexity of handling cytologic and histologic submissions, and the knowledge level and expertise within the laboratory that is needed for this to occur

Subsection 3: COLLECTION OF CYTOLOGY AND HISTOLOGY SPECIMENS

Competency: Cytologic and histologic specimen collection

Knowledge and Skills

Describe and explain how to collect various types of cytologic or histologic specimens from a variety of sites, including methods, instruments and materials needed

Describe and explain the use of imaging to guide cytologic and histologic specimen collection

Describe and explain comparing and contrasting cytologic collection methods (such as

aspiration vs needle only non-aspiration; impression smears vs aspirate smears, etc.)

Describe and explain the process for sample collection for body cavity fluids, synovial fluid, cerebrospinal fluid (CSF), bronchoalveolar lavage/tracheal wash, prostatic wash, bone marrow aspirate and use of EDTA anticoagulant to prevent clotting of fluid samples

Describe and explain different histologic collection methods (tru-cut biopsies, incision or excisional biopsies, endoscopic biopsies, bone marrow core biopsies and other types of collections) appropriate for various organs and types of lesions

Describe and explain how to mark suspect histologic borders with indelible ink or sutures and draw the attention of the trimming personnel to these sites of importance during tissue trimming and orientation

Demonstrate the ability to provide advice about the appropriate fixatives for various types of cytologic and histologic specimens (40% ethanol or 10% buffered formalin for cytology fluids for H&E or Papanicolaou or other wet-fixed staining; 10% buffered formalin for histology; acetone-fixed slides for some immunocytochemistry stains, etc.)

Demonstrate the ability to advise clients on ways to improve cytologic or histologic specimens when suboptimal specimen collections are identified

Describe and explain the advantages, disadvantages, limitations and possible complications of various types of cytologic and histologic collections

Identify common pitfalls encountered during cytologic and histologic specimen collection (such as sample contamination, iatrogenic haemorrhage, risk of iatrogenic damage e.g. pneumothorax when sampling pleural cavity, needle tract tumour implantation, blood pressure issues on aspiration from phaeochromocytoma, etc.)

Subsection 4: HANDLING AND SUBMISSION OF CYTOLOGIC AND HISTOLOGIC SPECIMENS

Competency: Cytologic and histologic specimen handling and submission

Knowledge and Skills

Describe and explain correct packaging of samples for submission to the laboratory

Demonstrate the ability to provide advice about appropriate paperwork needed for submission of cytologic and histologic specimens (including submission form, import/export licenses [if needed] or other forms)

Describe and explain how slides for submission should be labelled and correlated with the corresponding submission form(s)

Able to discuss and identify the effects of formalin fume contamination on cytologic slides submitted alongside formalin-fixed histology specimens

Describe and explain the effects of sample storage and delay in processing associated with routine or delayed transport to the laboratory

Describe and explain appropriate sample handling and submission techniques for

different types of cytologic and histologic specimens in your laboratory

Describe and explain that there may some differences in the requirements for cytologic and histologic specimens between laboratories

Subsection 5: CYTOLOGIC AND HISTOLOGIC SPECIMEN PROCESSING

Competency: Cytologic and histologic specimen processing

Knowledge and Skills

Identify the laboratory processes, policies and procedures used for aliquoting or sharing of specimens, if needed, between departments or locations for various types of testing

Describe and explain the types of tests and methods used for analysis of various types of body fluids (usually including macroscopic descriptions of the fluids, erythrocyte and nucleated cell counts, refractometer total protein and urine specific gravity, dipstick evaluations, or other types of tests) and how these are generated, communicated to the clinical pathologist and reported to the submitting veterinarian

Describe and explain preparing appropriate sample preparations (cytospin, direct smears, sediment smears, impression smears, filter concentration, or other types of preparations) for various types of cytologic specimens and sites

Describe and explain the theory and challenges of histologic processing, sectioning, slide preparation and digital imaging

Describe and explain commonly used cytologic staining techniques (e.g. Papanicolaou, New methylene blue, Romanowksy stains, special cytochemical or immunologic stains) and the value of using them for various samples

Describe and explain the adjunct techniques that can augment cytological evaluations (including cell blocks, serologic testing, common PCR tests, virus isolation, protein electrophoresis, PARR, flow cytometry, immunocytochemistry)

Describe and explain how to make buffy coat smears for the cytologic evaluation of bloody fluid specimens

Describe and explain the theory behind and principles of using serum coated or charged slides to improve cell yield from low cellularity fluid samples or certain types of histologic sections

Demonstrate familiarity with (by observation of) tissue dissection or trimming and practices within your laboratory for tissue preparation, embedding, sectioning and mounting of tissue sections

Demonstrate the ability to participate in technical staff and client education or continuing professional education regarding cytologic and histologic submissions, their collection, handling, processing, staining, reporting and other factors

Competency: Body fluid analysis as part of cytologic evaluations

Knowledge and Skills

Describe and teach others to describe the macroscopic appearance of fluid specimens

(to include colour, turbidity, viscosity, presence of clots or particulate material)

Demonstrate the ability to measure and teach others to measure refractometer total protein for body fluids (abdominal, pleural, pericardial, synovial)

Describe and explain the effects of different methods for urine protein:creatinine ratio determination and its interpretation

Describe and explain the methods of microprotein determination for CSF and its interpretation

Describe and explain the methods for manual and automated cell counts for body fluid analysis (red blood cell count, nucleated cell count) and their interpretation

Describe and explain the advantages and disadvantages and limitations of manual and automated cell counts for body fluid analysis

Describe and explain the methods for determining the mucin clot test and viscosity for synovial fluids and their interpretation

Competency: Cytologic and histologic staining

Knowledge and Skills

Describe and explain the theory and practical aspects of cytologic staining (including the use of New Methylene Blue, Romanowsky stains, Haematoxylin and Eosin, and Papanicolaou staining for cytology specimens) and special cytochemical stains that can be applied to cytologic preparations (including Perl's Prussian Blue, Gram's Stain, Periodic Acid Schiff/Haematoxylin, Gomori's Methenamine Silver or other Silver Stains, Alkaline phosphatase stain, Rhodamine Red stain, Congo Red stain, Ziehl-Nielsen stain or others commonly used)

Describe and explain the theory and practical aspects of histologic staining (H&E and special histochemical stains and immunohistochemistry stains or markers)

Describe and explain the differences in various cytologic and histologic stains that can occur within and between laboratories

Identify causes of abnormal/unsatisfactory staining of cytologic specimens (e.g. sample too thick, improper stain contact time, precipitate, incorrect pH, unclean slides, exposure to formalin fumes, etc.)

Subsection 6: CYTOLOGIC SPECIMEN EVALUATION AND REPORTING

Competency: Examination techniques for cytologic preparations (glass slides and digital imaging)

Knowledge and Skills

Demonstrate the ability to set up a light microscope and adjust for Kohler illumination

Demonstrate the ability to scan and assess cytologic specimens and determine if these are adequate for interpretation

Describe and explain the effects of different collection, handling and preparation techniques for cytology and how these will affect the examination of these preparations

Describe and explain digital imaging and the strengths and weaknesses, advantages and limitations for cytologic specimens (experience of digital imaging may not be available for all veterinary laboratories, but knowledge of the theory is expected)

Competency: Cytology reporting

Knowledge and Skills

Identify and discuss the reasons for various section headings commonly used in cytology reports (Clinical Summary, Description, Interpretation and Comment)

Describe and explain the importance of provision of a succinct and pertinent Clinical History as a source for the information that is known by the pathologist at the time of cytologic evaluations

Describe and explain the importance of a well-organised, concise but thorough description of the cytologic features in recording those things seen by the pathologist at the time of case evaluation

Describe and explain the fact that the description section of reports should differ little amongst experienced pathologists, but that different pathologists may reach different interpretations, depending on experience, interests or training

Describe and explain the importance of an Interpretation section within the report

Describe and explain the importance of a comment section within the report which helps clarify the degree of confidence associated with the interpretation and its significance, differential diagnoses (if appropriate), prognosis (if possible), and any suggestions for further testing, monitoring or general treatment recommendations (if appropriate)

Competency: Develop competencies of reporting

Knowledge and Skills

Demonstrate the ability to accurately, concisely but thoroughly describe features in cytologic specimens, interpret these findings and comment appropriately upon them, showing a high level of synthetic and discriminatory ability across a variety of specimen types

Develop critical thinking and reasoning skills with good written and oral communication skills to be able to interpret the findings and communicate in a concise and timely manner the findings to the clients

Demonstrate the ability to assess and critically assess a submission to determine that the correct tests have been booked in and are being run

Describe and explain troubleshooting, and resolve any problems identified in the submission

Demonstrate the ability to write a clear, concise and thorough description of cytological specimens, using appropriate language/terminology and format for the laboratory

Describe and explain reasonable differential diagnoses from the description of the cytologic preparations

Demonstrate the ability to clearly communicate to the client the results of cytologic evaluations and any limitations of the samples

Describe and explain the use of appropriate terminology and modifiers with interpretation to indicate the probability of and confidence in the interpretation

Describe and explain the significance of modifiers and the effects this will have on the diagnosis

Describe and explain further testing/sampling and the reasons for it

Describe and explain the findings by telephone, videoconference, email or written further comments with the client if this is needed/requested

Describe and explain further testing that will confirm or rule out differentials and be able to explain the reasoning for the recommendations of these further tests

Describe and explain the need for a standardised approach to slide examination and its role in ensuring that all aspects of the specimen are evaluated

Identify and discuss the cytological features of normal body tissues and fluids from skin and subcutis including ears, haemolymphatics, GI tract, respiratory tract, liver, urinary and reproductive tracts, musculoskeletal, eyes and CNS, endocrine and neuroendocrine systems

Describe and explain reactive/hyperplastic and dysplastic changes and identify neoplastic changes, including identifying criteria of malignancy in cytologic preparations

Identify metastases or have suspicion of metastatic sites and the significance of normal or atypical cells in abnormal locations

Demonstrate the ability to categorise body cavity fluids, and understand the cellularity and additional measurements important for categorisation

Identify normal findings in rarely sampled fluids such as ocular fluids and CSF, and understand the significance of changes in cellularity and/or solutes of these fluids

Identify cytological features and criteria for evaluating canine vaginal smears to determine the stage of oestrus and to categorise any pathological changes, including inflammation and infection

Recognise common cytologic contaminants including glove powder (starch granules), ultrasound and lubricating gels, pollen, glass slide fragments, squames from fingerprints, etc.

Able to identify oropharyngeal contamination (tracheal wash, BAL) and surface contamination (impression smears); able to comment appropriately on how to minimize these and their possible significance

Demonstrate the ability to correlate cytologic findings with other types of testing with a high level of competence and sophistication

Demonstrate the ability to evaluate, interpret and comment on bone marrow aspirates with a high degree of competence and sophistication and correlate the histologic findings with those of haematology and other types of laboratory testing

Demonstrate the ability to communicate clearly the degree of confidence associated with an interpretation

Demonstrate clarity of expression by use of unambiguous terminology whenever possible

Describe and explain using good judgment in recognition of cases where second opinions or further input from colleagues, or other experts in the species or organ of interest may be of benefit

Describe and explain the principles behind criteria for cytological grading of various tumours or conditions, the requirements behind this and the advantages and disadvantages or limitations of cytological grading compared to histologic grading

Describe and explain how cytological grading may be used in the clinical management of veterinary patients

Describe and explain the process of referring cases as needed for second opinions or further input, with inclusion of these findings in a final report summary or further comment

Competency: Reports generation and delivery

Knowledge and Skills

Describe and explain the processes, procedures and policies regarding report generation and delivery to the submitting veterinarian within your laboratory

Describe and explain how processes, procedures and policies may be different in

different laboratories

Subsection 7: HISTOLOGIC SPECIMEN EVALUATION AND REPORTING

Competency: Examination techniques (glass slides and digital imaging)

Knowledge and Skills

Demonstrate the ability to set up a light microscope and adjust for Kohler illumination

Describe and explain scan and assess histologic sections of various types and determine if these are adequate for interpretation

Describe and explain how different collection, handling and preparation techniques for histology will affect the examination of these preparations

Describe and explain digital imaging and the strengths and weaknesses, advantages and limitations for histologic specimens (Experience of digital imaging may not be available for all veterinary laboratories, but knowledge of the theory is expected)

Competency: Histology reporting

Knowledge and Skills

Discuss the various section headings commonly used in histology reports (Clinical Summary, Description, Interpretation and Comment)

Describe and explain the importance of provision of a succinct and pertinent clinical history so that information known to the pathologist at the time of histologic evaluations is known

Describe and explain the importance of a well-organised, concise, but thorough description of the histologic features in recording those things seen by the pathologist at the time of case evaluation

Describe and explain the fact that the Description section of reports should differ little amongst experienced pathologists, but that different pathologists may reach different interpretations, depending on experience, interests or training

Describe and explain the importance of an Interpretation section within the report

Describe and explain the importance of a Comment section within the report which helps clarify the degree of confidence associated with the interpretation and its significance, differential diagnoses (if appropriate), prognosis (if possible), and any suggestions for further testing, monitoring or general treatment recommendations (if appropriate)

Competency: Develop competencies of reporting (note: Clinical pathologists are not expected to routinely report histologic specimens, but need to develop the competencies described in this section as part of their ability to appreciate histologic evaluations, their correlation with cytologic specimens and their importance in quality assurance for cytologic reporting)

Knowledge and Skills

Demonstrate the ability to accurately, concisely but thoroughly describe features in histologic specimens, interpret these findings at a basic level and comment appropriately upon them, showing a level of expertise that is sufficient for understanding tissue architecture and features unavailable in cytologic preparations

Write a clear, concise and thorough description of histologic sections, using appropriate language/terminology and format for the laboratory

Formulate and discuss reasonable differential diagnoses from the description of the sections at a basic level of synthetic and interpretive ability

Elaborate and discuss the histologic findings reported by others by telephone, videoconference, email or written further comments with the client if this is needed/requested

Recognise when further consultation with a anatomic pathologist is needed to explore the reasons for interpretations, correlations with cytologic specimens and/or correlations with other types of laboratory testing

Describe and explain the need for a standardised approach to slide examination and its role in ensuring that all aspects of the specimen are evaluated

Identify and discuss the histologic features of normal body tissues and fluids from skin and subcutis including ears, haemolymphatics, GI tract, respiratory tract, liver, urinary and reproductive tracts, musculoskeletal, eyes and CNS, endocrine and neuroendocrine systems

Describe and explain the skills needed to identify reactive/hyperplastic and dysplastic changes and neoplastic changes and criteria of malignancy in histologic preparations

Identify metastases or have suspicion of metastatic sites and the significance of normal or atypical cells in abnormal locations

Evaluation, interpretation and comment on bone marrow core biopsies with a moderate to high degree of competence and sophistication, and correlate the histologic findings with those of haematology and other types of laboratory testing

Identify situations when consultation with an anatomic pathologist experienced with bone marrow core biopsies may be of benefit

Describe and explain the principles behind criteria for histologic grading of various tumours or conditions, the tissue requirements and the advantages and disadvantages or limitations of histologic grading

Describe and explain how histologic grading may be used in the clinical management of veterinary patients

Demonstrate clarity of expression by use of unambiguous terminology whenever possible

Competency: Report generation and delivery

Knowledge and Skills

Describe and explain processes, procedures and policies regarding histology report generation and delivery to the submitting veterinarian within your laboratory

Appreciate that processes, procedures and policies may be different in different laboratories

Subsection 8: CYTOLOGIC AND HISTOLOGIC AUDITS

Competency: Cytologic and histologic audits

Knowledge and Skills

Describe and explain the theory and principles behind the use of audits in training, ongoing evaluation of competency for technicians and pathologists, and in follow-up for improvement activities for cytology and histology

Able to participate in the design, conduct and evaluation of cytology audits in conjunction with an experienced auditor pathologist

Describe and explain the skills and principles of auditing as a tool for quality assurance, quality control and ongoing improvements in the cytology and histology departments

Demonstrate the ability to educate technicians and other staff about the philosophy behind, use of and goals of audits as part of a quality management system

Subsection 9: HEALTH AND SAFETY, QUALITY CONTROL AND QUALITY ASSURANCE

Competency: Health and safety requirements involved in the cytology and histology departments within the laboratory

Knowledge and Skills

Identify and discuss the health and safety requirements for personnel working within the laboratory with fixed and unfixed cytologic and histologic specimens

Identify and discuss the potentially hazardous chemicals and substances that are involved with cytologic and histologic specimens, their processing and staining

Identify and discuss the correct disposal of chemicals, solutions, stains and biologic specimens for cytology and histology

Identify and discuss the appropriate personal protective equipment needed for handling cytology and histology specimens at various stages within the laboratory

Describe and explain the potential zoonoses that may be involved in handling cytologic and histologic specimens at various stages within the laboratory

Competency: Quality assurance and quality control for cytology and histology

Knowledge and Skills

Review and improve (if necessary) standard operating procedures, process maps, health and safety recommendations and risk assessments applicable to cytology and histology specimens, from submission to the laboratory, through handling, processing, interpretation and archiving of submitted materials, report generation, report delivery and communications with clients regarding these aspects

Describe and explain the various types of quality control and quality assurance applied to the technical aspects of body fluid analysis (as described above), as well as those for cytologic and histologic processing prior to staining

Demonstrate the ability to design, implement and evaluate internal and external quality control and quality assurance for cytologic and histologic testing, including laboratory pre-analytical (e.g. appropriate submissions and submission process, stain quality, instrument maintenance and calibration of appropriate instruments), analytical and post-analytical phases

Demonstrate the ability to assess quality specifications and quality goals for cytology and histology submissions, reporting, and turnaround time and able to adequately document these results

Design and implement appropriate audits and document the results, including correlation of cytopathology and histology specimens, correlation with clinical findings and/or follow-up information about patient and disease progress

Interpret quality control and quality assurance data (such as cell counts on an automated instrument, calibration of refractometer, commonly collected metrics) applicable to cytologic specimens and their progress through the laboratory

Interpret the results of cytology data comparisons (such as automated and manual cell counts, different types of staining, different types of preparations or other applications where comparison is appropriate)

Subsection 10: OTHER ITEMS RELATING TO CYTOLOGY AND/OR HISTOLOGY

Competency: Proliferation markers commonly used with cytologic and histology specimens

Knowledge and Skills

Describe and explain the basic principles of and types of markers used to detect indices of cell proliferation (e.g. AgNor, KI-67 and others)

Competency: Electron microscopy and its use with cytology and histology

Knowledge and Skills

Describe and explain the basic principles of electron microscopy examinations (scanning and transmissions) and when these may be useful in evaluation of cytologic and histologic specimens

Competency: Microbiology that may accompany cytology and histology specimens (bacteria, viruses, protozoa)

Knowledge and Skills

Recognise and discuss common pathogens associated with various tissues and organ systems

Interpret the significance of common organisms in various types of cytologic and histologic specimens and sites

Demonstrate the ability to research uncommon organisms obtained from various types of cytologic and histologic specimens and sites

Describe and explain when PCR techniques or immunologic identification of infectious agents may be useful for identification or confirmation of organisms in cytologic and histologic specimens

Competency: Flow cytometry and its use with cytologic specimens

Knowledge and Skills

Describe and explain the basic principles of flow cytometric analysis and the type(s) of specimens and conditions of submission

Identify and discuss the circumstances under which flow cytometry may be of benefit with various types of cytologic specimens

Competency: PARR and its use with cytologic specimens

Knowledge and Skills

Describe and explain the basic principles of PARR

Identify and discuss the circumstances under which PARR may be of benefit with various types of cytologic specimens

CORE AREA: LABORATORY QUALITY AND MANAGEMENT

The Laboratory Management core area includes subsections in (1) laboratory statistics, (2) general quality concepts and quality planning, (3) quality control, (4) quality assurance/proficiency testing, (5) population-based and subject-based reference intervals and laboratory applications of biologic variation data, (6) method validation and (7) point of care testing. The trainee is expected to be able to effectively communicate with others within the laboratory about these aspects, as well as presenting information to practitioners at a level appropriate for their degree of understanding.

Some aspects of laboratory management, including personnel management, evaluation of professional and technical staff, budget development and financial report generation and interpretation are not included in this curriculum or in the examinations. These aspects of laboratory management are considered to be outside the remit and scope of this document since these are not competencies that most trainees are expected to have immediately upon completion of their training. Introduction to these aspects is considered to be an important part of resident training, but will not be covered in this curriculum. An appreciation for the aspects of personnel management, budgeting and financial planning is likely to be helpful in identifying individuals with an aptitude for and interest in progressing in laboratory management career pathways.

Subsection 1: LABORATORY STATISTICS

Competency: Commonly used statistical calculations

Knowledge and Skills

Generate statistical calculations, including mean, standard error of the mean, SD, CV, confidence intervals, observed total error and sigma metric or other calculations used in your laboratory

Generate calculations using spreadsheets, calculators on the internet, and/or statistical analysis packages

Competency: Commonly conducted statistical analyses

Knowledge and Skills

Demonstrate the ability to access information about assumptions associated with different statistical techniques, including assumptions underpinning the use of these techniques and circumstances in which they should be used

Demonstrate the ability to make correct choices regarding the type of statistical analysis to be applied for various purposes and types of data

Recognise appropriate and inappropriate use of various statistical techniques (including the presence or absence of addressing assumptions) in the laboratory, in presentations and in review of scientific literature

Describe and explain the importance of the correct statistical applications in study design, data analysis, interpretation and conclusions

Competency: Descriptive statistics

Knowledge and Skills

Generate basic descriptive statistics, graphs and plots appropriate for the analyses being undertaken

Recognise appropriate or inappropriate use of descriptive statistics in the laboratory, in scientific papers and presentations

Competency: Distribution of experimental and biological data and recognition of outliers

Knowledge and Skills

Describe and explain the distribution of experimental and biologic variation data using appropriate techniques

Apply statistical and nonstatistical techniques to help identify outliers

Recognise appropriate or inappropriate use of statistical techniques and data presentation in scientific studies and studies of or using biologic variation data

Describe and explain the importance of appropriate design, presentation, analysis and interpretation in understanding the data of biologic variation and its use in presentations and in scientific papers

Competency: Sensitivity, specificity, positive and negative predictive values of tests and the effect of the pre-test probability of disease

Knowledge and Skills

Perform calculations for these aspects on a variety of laboratory data

Appreciate, discuss and explain the effects of pre-test probability of disease and its effect on positive and negative predictive values

Competency: Reference intervals and reference interval transference validation

Knowledge and Skills

Review, revise and generate traditional 95% population-based reference intervals and individualised (subject-based) reference intervals based on biologic variation data

Demonstrate the ability to undertake and interpret the results of reference interval transference validation

Describe and explain the importance of reference intervals as an aid to laboratory diagnosis

Competency: Statistics, metrics and other information in external quality assessment (EQA) reports

Knowledge and Skills

Evaluate ongoing external quality assessment reports and interpret the information commonly included in these reports

Describe and explain the statistics commonly present in External Quality Assessment reports and their significance

Competency: Quality specifications for External Quality Assessment

Knowledge and Skills

Describe and explain applying appropriate quality specifications for external quality assessment events and take appropriate action if the desired standard of performance is not achieved

Demonstrate the ability to write a summary of EQA performance, design appropriate corrective/preventive actions based on the findings, and implement and report the results of actions taken to address substandard performance

Competency: Applications of biologic variation data

Knowledge and Skills

Demonstrate the ability to undertake calculations and apply the biologic variation concepts as quality specifications/goals, in evaluation of the use of population-based reference intervals by index of individuality and analysis of serial results by reference change value

Demonstrate the ability to calculate and use dispersion when using clinical guidelines and cut-off values based on expert recommendations

Statistical programs/spreadsheets

Knowledge and Skills

Able to use a statistical program to do statistical analyses

Competency: Measurement Uncertainty (MU)

Knowledge and Skills

Demonstrate calculating MU for common laboratory tests

Recognise contributions of multiple variances (pre-analytical, analytical and post-analytical) to MU

Competency: Statistic techniques and assumptions

Knowledge and Skills

Demonstrate reviewing papers, presentations and internal documentation utilising statistical techniques and determine the strengths and weaknesses of the design, techniques used and interpretations of the results

Competency: Relating statistical significance to clinical or medical significance

Knowledge and Skills

Demonstrate applying tests of statistical and consideration of clinical/medical significance to a variety of types of laboratory data

Recognise appropriate or inappropriate evaluation of statistical and clinical/medical significance in presentations and scientific papers

Subsection 2: GENERAL QUALITY CONCEPTS AND QUALITY PLANNING

Competency: Quality management systems

Knowledge and Skills

Describe and explain total quality management, LEAN and six sigma management, ISO certification and other systems and philosophies for laboratory management

Evaluate and explain the applications of quality management systems in the veterinary laboratory, advantages and disadvantages of these approaches and their complementary features

Describe and explain the philosophical approaches and different emphases of different quality management systems

Competency: Quality culture

Knowledge and Skills

Identify aspects contributing to the quality culture within the laboratory and participate in discussions, working groups or other efforts to enhance the quality culture

Describe and explain the importance of the establishment of a quality culture within the laboratory with emphasis on quality standards, process improvement and lack of 'blame'

Describe and explain factors contributing to development, maintenance and valuing of the quality culture on an ongoing basis within the laboratory

Competency: Common components of quality management systems

Knowledge and Skills

Identify the components of laboratory quality management

Demonstrate the ability to include in quality planning the common components of laboratory management, including documents and documentation, personnel, instrumentation, laboratory information systems, environment, health and safety, and quality systems

Describe and explain the importance and relationships of the components of laboratory management on an ongoing basis in the laboratory

Describe and explain relationships of these components and their contributions to the overall functioning of the laboratory

Competency: Quality planning, assessment, control, and continuous improvement

Knowledge and Skills

Generate a quality plan and contribute to the review, revision or improvement of any existing quality plan

Describe and explain the components that should be included in a quality plan as a statement of intent of the laboratory

Show contributions to quality planning and processes involved in assessment, control and continuous improvement on an ongoing basis in the laboratory

Competency: Quality standards

Knowledge and Skills

Describe and explain quality standards at all levels of the laboratory, including ISO standards, and quality specifications based on expert recommendations (ASVCP, other), biologic variation data and state-of-the-art instrument/method performance

Recognise elements common to various laboratory standards, as well as differences in structure and emphasis of various approaches (LEAN, Six Sigma, Total Quality Management or others)

Recognise the advantages and disadvantages of various quality specifications/goals

Experience with the chosen standards and quality specifications applied within the training laboratory and remain abreast of performance based on these

Competency: Process mapping for quality improvement

Knowledge and Skills

Demonstrating the production of process maps for various aspects within the laboratory

Demonstrate the ability to draw conclusions and make suggestions based on the process maps generated

Experience with process mapping and interpretative skills and their use in making recommendations and implementing improvement plans

Competency: Standard Operating Procedures (SOPs) and Policies

Knowledge and Skills

Review, revise, and generate SOPs and Policies within the laboratory

Competency: Laboratory and training audits

Knowledge and Skills

Show the ability to assist an experienced manager/auditor in designing and conducting an audit in a particular area of the laboratory

Demonstrate experience in assisting in writing a summary report of the audit with

recommendations based on the audit findings

Describe and explain the judicious use of audits in the laboratory

Competency: Document Control

Knowledge and Skills

Evaluate, contribute to and/or help improve the current document control process within the laboratory

Demonstrate and explain applying principles of good document control on an ongoing basis within the laboratory

Competency: Laboratory health and safety

Knowledge and Skills

Describe and explain the current regulations applicable at the site of training, with an emphasis on those specific for the veterinary laboratory

Demonstrate acting responsibly with regard to health and safety within the laboratory

Describe and explain the need to provide an example for others with regard to health and safety within the laboratory

Show awareness of potential pathogens, diseases and risks associated with various behaviours and circumstances within the laboratory

Demonstrate knowledge of important zoonotic and reverse zoonotic diseases that may occur in the veterinary laboratory

Demonstrate the ability to educate clients and internal staff regarding risk reduction in association with zoonotic and reverse zoonotic diseases

Competency: Instrument/method selection (actual experience in instrument and method selection may not be available in all sites during training)

Knowledge and Skills

Identify various aspects important in instrument and method selection

Describe and explain the process of evaluation and selection of various aspects of instrument and methods

Competency: Risk Assessment (particularly with regard to health and safety and general laboratory quality assessments)

Knowledge and Skills

Generate a risk assessment for various processes, procedures or items within the veterinary laboratory and make recommendations to reduce risks to acceptable levels

Competency: Laboratory information system (LIMS) and information technology (IT)

Knowledge and Skills

Describe and explain the importance of LIMS and IT in the modern veterinary laboratory

Describe and explain the basis for data safety, security and patient information security

Describe and explain the complexities involved in choosing, maintaining and continuously improving the LIMS and IT capabilities within a veterinary laboratory

Competency: Documentation within the quality system

Knowledge and Skills

Review, design and use the documents described by the laboratory quality plan or that are in place in the laboratory

Demonstrate participation in nonconformity identification and problem-solving, as well as improvement opportunity identification, implementation and monitoring

Describe and explain the need for sufficient, but not excessive, documentation as an important part of the quality system

Competency: Key Quality Indicators

Knowledge and Skills

Describe and explain determining Key Quality Indicators specific for your training laboratory and implement their use within the laboratory

Describe and explain the use of Key Quality Indicators based on expert recommendations, identified problems or known tests of high importance in the laboratory

Competency: Harmonisation and standardisation of laboratory testing

Knowledge and Skills

Identify opportunities for harmonisation and/or standardisation within the laboratory and participate in their implementation, if available

Describe and explain the importance of standardisation and harmonisation in achieving standard interpretation of results between and within laboratories and the use of cut-off values

Subsection 3: QUALITY CONTROL

Competency: Statistical and non-statistical quality control

Knowledge and Skills

Demonstrate the ability to apply statistical and non-statistical quality control appropriate for various laboratory tests

Describe and explain the importance of statistical and non-statistical quality control and its role in assuring reliable and accurate results to provide the best possible patient care

Competency: Quality goals for veterinary laboratory testing

Knowledge and Skills

Describe and explain quality goals based on a variety of methods, including biologic variation, total error, measurement uncertainty and/or state-of-the-art instrument performance

Describe and explain the different purposes and methods by which quality specifications can be derived

Competency: Control rules and their application in statistical quality control

Knowledge and Skills

Demonstrate the ability to communicate in accepted terminology the statistical quality control rules and communicate about the use of simple rules, multirules and multi-stage quality control

Experience the use of statistical quality control for a range of instruments and processes within the laboratory

Show/demonstrate the ability to communicate using standard control rule notation and terminology

Describe and explain the need for different quality control rules based on instrument and method performance and quality goals

Identify situations where use of various quality control strategies are applicable within the laboratory

Critically appraise the use of statistical and non-statistical quality control within the laboratory

Participate in problem solving and quality improvements based on needs identified by statistical and non-statistical quality control

Competency: Frequency of statistical quality control testing

Knowledge and Skills

Describe and explain the frequency needed for quality control appropriate for various tests

Design and produce a quality plan that includes plans for frequency of quality control with a scientific, rather than arbitrary, basis

Describe and explain the need for an evidence-based scientific approach, rather than arbitrary approach, to determination of statistical quality control frequency

Competency: Repeat Patient Testing (RPT)

Knowledge and Skills

Describe and explain the principles behind Repeat Patient Testing and its applications for statistical quality control, operator competency assessment, evaluation of and use in bias comparisons and laboratory quality planning

Describe an explain how RPT can be used in statistical quality control, operator competency assessment, evaluation of bias and laboratory quality planning

Describe and explain the advantages and disadvantages of RPT compared to traditional commercially available quality control materials

Competency: Quality control validation

Knowledge and Skills

Demonstrate the ability to conduct quality control validation for a variety of laboratory tests in order to determine quality control rules appropriate to achieve a high probability of error detection and a low probability of false rejection needed for confidence in the production of laboratory results

Determine QC rules needed to achieve high probability of error detection and low probability of false rejection, based on observed instrument/method performance

Describe and explain different statistical and nonstatistical QC strategies based on the results of QC validation

Describe and explain the evidence-based approach involved in QC validation and its use in the determination of QC strategies for laboratory tests

Competency: Non-statistical quality control

Knowledge and Skills

Demonstrate applying non-statistical quality control appropriately for a variety of laboratory tests

Demonstrate when an increased emphasis on nonstatistical quality control is needed compared to statistical QC

Describe and explain the complementary nature of statistical and nonstatistical quality control in laboratory quality control and quality assurance

Describe and explain the fact that laboratory tests may differ in the need for and utility of statistical and nonstatistical quality control

Competency: Use of patient data for quality control

Knowledge and Skills

Describe and explain the application of patient data (average of normal, key quality indicators, moving averages, patient data review, plausibility checks and other techniques) in a variety of ways to help ensure that accurate and reliable results are produced by laboratory testing

Describe and explain how patient data evaluation is useful In quality control and quality

assurance processes

Subsection 4: QUALITY ASSURANCE/PROFICIENCY TESTING

Competency: External Quality Assessment (EQA) Programs

Knowledge and Skills

Describe and explain external quality assessment programs using peer group comparison or reference material/methods for test evaluations

Describe and explain the philosophical bases and concepts underpinning peer-comparison EQA and EQA using samples assayed by reference methods

Describe and explain the advantages and disadvantages of both approaches to EQA

Competency: Reports provided by external quality assessment providers

Knowledge and Skills

Evaluate external quality assessment reports based on the results and metrics provided

Able to determine whether performance is acceptable or not, whether further action needs to be taken and what actions should be taken to investigate suspected or confirmed unacceptable performance

Describe and explain the use of external quality assessment as an educational tool within the laboratory

Describe and explain external quality assessment as a method to help to ensure the production of accurate and reliable laboratory results

Competency: Proficiency Testing in veterinary laboratories

Knowledge and Skills

Describe and explain the veterinary tests which fall under regulatory control within the country/area in which training takes place, including 'reportable diseases', testing required for international transport and tests that are subject to regulatory proficiency testing on a regular basis

Describe and explain the bases for regulatory proficiency testing in veterinary laboratories versus voluntary participation in a commercial EQA Program

Show participation in ongoing proficiency testing events as appropriate for the type of laboratory and type of testing conducted

Show ability to write, review and/or improve Standard Operating Procedures and Policies that determine the steps to be taken should a 'reportable disease' be identified, and the correct procedures for notification of officials regarding this in the laboratory

Competency: Analysis and actions based on external quality assessment reports

Knowledge and Skills

Describe and explain the significance of reported external quality assessment parameters and their use in the identification of confirmed or potential problems, when actions should be taken, and what actions should be taken as a result of these evaluations

Show participation in ongoing external quality assessment report evaluations and corrective or preventive actions taken as a result of external quality assessment findings

Subsection 5: POPULATION-BASED AND SUBJECT-BASED REFERENCE INTERVALS AND APPLICATIONS OF BIOLOGIC VARIATION DATA

Competency: Population-based reference intervals

Knowledge and Skills

Able to discuss, explain and design a study for generation of one or more population-based reference intervals (actual experience in determining reference intervals is preferred, but may not be available at all training laboratories)

Describe and explain the statistical methods that should be applied for evaluation for outliers, reference result distribution and determination of the reference interval

Describe and explain the scale of the task of reference interval generation and the time and resources needed to commit to the proper generation of population-based reference intervals

Describe and explain the risks and limitations of using population-based reference intervals from the literature or generated by different instruments and methods

Competency: Biologic variation data

Knowledge and Skills

Evaluate papers on biologic variation in order to determine if a correct approach has been taken, guidelines followed, and the ramifications of any departures from the recommendations

Recognise situations in which biologic variation data can be used in the veterinary laboratory

Describe and explain the need for standardisation of biologic variation data collection and benefits of a standardised approach

Describe and explain the impact that variation in approaches can have on estimates of biologic variation

Able to apply biologic variation data for a variety of purposes within the veterinary laboratory

Competency: Subject-based reference intervals and index of individuality

Knowledge and Skills

Describe, explain and correctly interpret the index of individuality for various measures and species

Describe and explain the formulas and specifications used in evaluation of serial collections of patient data and in appropriate situations within the laboratory

Competency: Applications of biologic variation data

Knowledge and Skills

Describe and explain the formulae and specifications for biologic variation in evaluation of serial collections of patient data, results dispersion, critical number of specimens, quality specification and other uses in appropriate situations within the laboratory

Demonstrate calculation of reference change value, dispersion and laboratory quality specifications, and apply these within the laboratory

Describe and explain the need for inclusion of biologic variation data in a variety of situations within the veterinary laboratory and the limitations of the common lack of availability of this data

Subsection 6: ASSAY DEVELOPMENT AND INSTRUMENT/METHOD VALIDATION

Competency: Assay/method development

Knowledge and Skills

Demonstrate understanding of scientific papers and reports about assay development and instrument/method assessment, and recognize the correct approach to assay method development

Describe and explain the principles of assay method development

Demonstrate the ability to ask questions pertinent to development if a new assay method is to be adopted

Competency: Instrument/method validation

Knowledge and Skills

Design and implement a method validation plan appropriate for validation of a variety of instruments/methods

Describe and explain the role of instrument/method validation planning and implementation in the veterinary laboratory

Competency: Types of errors/variation associated with various studies conducted during instrument/method validation

Knowledge and Skills

Recognise the types of errors/variation associated with various studies conducted during instrument/ method validation and to determine and apply the statistical methods

to correctly analyse the data

Describe and explain the need for careful planning and analysis in instrument/method validation in order to identify error/variation associated with a candidate instrument/method

Describe and explain conclusions regarding the acceptability of the instrument/method based on the results of studies conducted

Competency: Determination of instrument/method performance suitability for the intended application

Knowledge and Skills

Review data from instrument/method studies, write a summary report and provide recommendations based on the intended application

Show participation in ongoing opportunities for instrument/method validation, performance evaluation and performance verification, as these arise within the laboratory

Subsection 7: POINT OF CARE TESTING

Competency: Point of Care Testing

Knowledge and Skills

Describe and explain the principles and methods used for a variety of point of care testing instruments and devices

Describe and explain the advantages and disadvantages of the use of hand-held or small benchtop devices, often for single or small numbers of tests, as used within the central laboratory, at a location within the same institution but remote from the central laboratory and in veterinary practice

Describe and explain the indications for testing using point-of-care instruments and devices compared to the use of larger instruments most commonly found within a reference laboratory (commercial, university, state/federal, or other)

Able to discuss the limitations of using point-of-care testing instruments and devices

Describe and explain the requirements and methods employed for quality assessment and quality control of point of care testing

Evaluate the correlation expected and achievable between point of care testing and a central laboratory (either within the same institution or at an outside location)

Competency: Training required for point of care testing

Knowledge and Skills

Describe and explain the importance of training and documentation for nurses, clinicians and lay persons involved in point of care testing in the clinic or in institutions/organisations outside of a central laboratory environment

Describe and explain the components of training and documentation needed for point of care testing used in clinics or in institutions/organisations outside of a central laboratory environment

Describe and explain the variety of situations for veterinary nurses, clinicians and lay persons that may be involved in point of care testing

Competency: Ongoing competency assessments for point of care testing

Knowledge and Skills

Discuss and explain, design and implement ongoing competency assessments for all personnel involved in point of care testing

Competency: Post-analytical issues associated with point of care testing

Knowledge and Skills

Discuss and explain the processes involved in data capture and reporting of point of care testing and in the patient record

Describe and explain the need for effect strategies to capture and record point of care testing data and its inclusion in the patient record

Competency: Accounting for costs and value of point of care testing

Knowledge and Skills

Demonstrate assisting an experienced clinical pathologist in analysing data regarding costs and value of point of care testing compared to centralised laboratory testing

Demonstrate assisting an experienced clinical pathologist in writing a summary report regarding conclusions about costs and value of point of care testing

Competency: Point of care testing instrument performance assessment

Knowledge and Skills

Describe and explain principles of performance assessment of point of care testing instruments

Advise clinicians about initial and annual performance assessments for point of care testing instruments and the importance of knowing standard deviation, coefficient of variation and bias compared to an index/reference instrument/method

Identify comparative instruments/methods appropriate for various point of care testing used within the central laboratory, at a location within an institution remote from the central laboratory and in practice

Competency: Troubleshoot problems with instrumentation, quality control, external quality assessment, instrument performance evaluation and interpretation results obtained by point of care testing

Knowledge and Skills

Demonstrate applying appropriate methods and designs for troubleshooting problems with point of care testing instrumentation and devices

Describe and explain applying appropriate methods and strategies for quality control of point of care testing

Describe and explain applying appropriate methods and strategies for external quality assessment for point of care testing

Describe and explain appropriate methods and strategies for instrument performance evaluation and interpretation of the results obtained

Demonstrate communicating appropriately about point of care testing with veterinary nurses, clinicians and laypersons conducting point of care testing for veterinary patients at a level appropriate for their understanding

Able to suggest appropriate sources and/or materials and/or other information for further education of veterinary nurses, clinicians and laypersons conducting point of care testing for veterinary patients