BIOMEDICAL SCIENTIST TRAINING LOGBOOK

for

DIPLOMA OF EXPERT PRACTICE IN ULTRASTRUCTURAL PATHOLOGY

ISSUED TO:

Institute of Biomedical Science
12 Coldbath Square
London
EC1R 5HL

Tel: 020 7713 0214 ext 142
Email: examinations@ibms.org

CONTENTS

INTRODUCTION

All biomedical scientists undergoing training in preparation for sitting the IBMS Diploma of Expert Practice in Ultrastructural Pathology must use this logbook. It provides a training framework to enable biomedical scientists to acquire the minimum level of competence required to assess and comment on ultrastructural pathology.

Laboratories wishing to offer this training must be approved by the Institute for training. Where a laboratory belongs to a single organisation, with laboratories on multiple sites, or is a member of a network, if there is a single training policy and procedure in place that has been submitted for training status approval, the overarching approval is acceptable for the individual member laboratories. All laboratories wishing to participate in this training process must be United Kingdom Accreditation Service (UKAS) accredited. Training must be conducted in-house under the overall supervision and responsibility of a suitably qualified scientist. Additional appropriately qualified individuals may supervise training and where this happens this must be indicated in the training logbook.

The final assessment of competence is based upon the submission of an evidence-based portfolio and the subsequent written examination. The successful completion of these requirements will be recognised by the awarding of a Diploma of Expert Practice in Ultrastructural Pathology. This confers eligibility to undertake ultrastructural pathology assessment according to the modules in which practical training has been received as stated on the supplementary certificate.

Ultrastructural assessment and comments by a biomedical scientist holding a Diploma of Expert Practice remains the responsibility of the consultant pathologist and may only be undertaken with the agreement of the medical head of department and consultants wishing to support the initiative.

GUIDANCE TO CANDIDATES AND SUPERVISORS

Details about this qualification, such as eligibility criteria, aims and learning outcomes, the role and profile of the scientist supervisor, portfolio of evidence, final examination as well as sample questions and an indicative reading list are available in discipline specific guidance to candidates. These documents can be obtained from the Institute's website: www.ibms.org.

USE OF THE TRAINING LOGBOOK

Named scientific supervisor and other nominated supervisory individuals

The professional requirements of the named scientific supervisor are that the individual must be registered and fulfilling the criteria of an approved CPD scheme. The named individual may, at his/her discretion, delegate aspects of training to other individuals with appropriate and sufficient experience.

The decision to support the training of any eligible biomedical scientist to undertake assessment and comment on ultrastructural pathology lies with the individual's department, as does the decision as to the range and type of specimens that a biomedical scientist may handle. While the principle of training may be supported by the department, local restrictions on the scope of this training may prevent a biomedical scientist from completing all of the optional modules within the logbook.

The successful completion of the Institute training courses and final assessment of competence to undertake assessment of ultrastructural pathology does not confer an automatic right to undertake an expert role. The employment of biomedical scientists is at the discretion of a medical head of a department and consultants who support this initiative. Responsibility for specimens assessed by biomedical scientists, in accordance with departmental SOPs, remains with the consultant pathologist supervisor.

It is expected that the assessment of competence will be an ongoing process throughout the training period. Supervising scientists must be satisfied that an individual is competent to undertake the ultrastructural assessment of a particular specimen or tissue type before progressing to more complex assessments. The logbook allows for the recording of comments regarding progress and aptitude throughout the training period. It is incumbent upon any supervising scientists to ensure that training progress is documented at each stage of delivery.

Training modules

The logbook is divided into two sections comprising mandatory and optional training modules. Each aspect of training comprises the theoretical knowledge required to understand the processes that underpin the task and the practical skills and competencies to successfully execute the task. The biomedical scientist in training will be expected to acquire and demonstrate the knowledge that accompanies the practical skills.

The mandatory modules cover subjects common to all electron microscopy units, irrespective of workload type or specialism, and must be completed by all biomedical scientists undertaking training.

It is the choice of the biomedical scientist and scientific supervisor as to which optional modules are selected for training. This will be influenced by the nature of the laboratory workload. To fulfil the training requirements, it is acceptable for an arrangement to exist with another hospital for a period of secondment in order to obtain the required level of practical experience and competence. Practical training must cover at least one of the optional modules. The examination tests theoretical knowledge of assessment and comment on ultrastructural pathology in all areas but the certificate will reflect only the modules in which practical competence has been obtained. Success in the examination will depend upon a broad spectrum of knowledge acquired during training.

Standard operating procedures

All aspects of laboratory work must be covered by individual signed, indexed and dated SOPs. Before commencing training, it is mandatory that appropriate SOPs be in place to describe the departmental protocol for the ultrastructural assessment of tissues. The biomedical scientist must operate within the appropriate SOP at all times.

Audit

Audit must form an integral part of both the training process and ongoing practice. The requirement for preview and review of the specimen and any samples taken from it forms the basis of continuing audit of the biomedical scientist's competence and performance and must be clearly demonstrable within the portfolio of evidence presented for assessment. The extent to which audit is undertaken is at the discretion of the named scientist supervisor, taking into account the experience of the biomedical scientist.

Training methods

Training for ultrastructural pathology must follow the sequence of:

- observation of a suitably qualified scientist performing the ultrastructural assessment
- direct supervision by a suitably qualified scientist during ultrastructural assessment
- indirect supervision by a suitably qualified scientist who is available for advice and review
- slide/case review with a suitably qualified scientist

At all times within this training process there is an expectation of the trainee to be able to demonstrate self-directed learning. Within the training programme there is also a requirement to show knowledge and skills that include:

- audits of personal practice – A minimum of three different audits must be submitted (at least one must be of personal practice and another must be of clinical practice) with appropriate outcomes and reflection
- a demonstration of reflection on the learning outcomes relating to the pre-analytical, analytical and post-analytical components of the individuals practice, when appropriate

A continuing part of the process is the opportunity to discuss the trainee's development and progress. Progression from direct to indirect supervision will depend upon the locally agreed assessment of competence. This progression should be recorded and demonstrable within the portfolio of evidence collected by the trainee. The duration of practical training must be sufficient to ensure that competence has been achieved in all the mandatory modules and at least one of the optional modules.

RECORD OF TRAINING

Name		
Employment grade		
Institute membership number		
HCPC registration number		
Training Laboratory		
Address		
Telephone		
Email		
Named Scientific Supervisor		
Seconded Laboratory Name (if applicable)		
Duration of Training	**From:**	**To:**

RECORD OF TRAINING continued

Module	Named Scientific Supervisor	Dates of Training

MANDATORY MODULE 1 Clinical Governance	Date Started	Date Completed	Signature of scientific supervisor
Knows and understands: **<u>Health and Safety</u>** The safety responsibilities of the employee under the Health and Safety at Work Act 1974, COSHH, RIDDOR, Ionising Radiation Regulations and other current safety legislation The departmental safety policy The need to wear appropriate personal protective equipment and not to contaminate the work area Operation and use of ventilated work areas The universal precautions for handling specimens and the procedures in place to deal with high-risk specimens The hazards associated with • chemicals used in EM preparation including but not limited to, fixatives, resins and EM stains • physical hazards including but not limited to, glass knives, diamond knives and blades • electrical hazards of the TEM Methods of dealing with spillages The requirements for clinical and chemical waste disposal **<u>Errors and Incidents</u>** The risk to the patient of diagnostic errors			

How transposition errors can impact on patient treatment The principles of incident reporting, risk assessment and root cause analysis			

MANDATORY MODULE 1…continued **Clinical Governance**	**Date Started**	**Date Completed**	**Signature of scientific supervisor**
Knows and understands: **<u>Quality Management</u>** The principles of clinical audit including: • sample quality • audit of results, Turn Around Times (TAT's), trends, • with regards to ultrastructure interpretation: inter-centre, inter-operator variations The mechanisms and methods of demonstrating audit and analysis of own performance against an agreed set of criteria Quality control, internal and external quality assurance and quality assessment The contribution of electron microscopy in clinical management The current guidelines and regulations for dissection and retention of tissues including the appropriate Codes of Practice of the Human Tissue Authority The Good Practice Guidelines of the Patient Safety Agency The requirements for full SOP and risk assessment compliance The mechanisms and methods of demonstrating reflection on the learning outcomes within own practice			

MANDATORY MODULE 1…continued Clinical Governance	Date Started	Date Completed	Signature of scientific supervisor
Knows and understands: **<u>Specimen Identification</u>** The requirement to ensure that the specimen number on the request form and on the specimen container match correctly The requirement to check that the patient details on the request card/form and on the pot match correctly The importance of correctly recorded patient details How to deal with inadequately or incorrectly labelled specimens and incomplete requests When specimens need referral to a consultant pathologist or an experienced biomedical scientist			

Declaration

I declare that I have satisfactorily completed the clinical governance module for the Diploma of Expert Practice in Ultrastructural Pathology as required by the Institute of Biomedical Science.

Signed …… Date ……

I declare that …… has satisfactorily completed the clinical governance module for the Diploma of Expert Practice in Ultrastructural Pathology as required by the Institute of Biomedical Science.

Signed (scientific supervisor) …… Date ……

MANDATORY MODULE 2 General Principles of Election Microscopy Preparation Techniques	Date Started	Date Completed	Signature of scientific supervisor
Knows and understands: **<u>FIXATION</u>** The general principles of fixation of cells and tissues including factors affecting subsequent procedures Artefacts produced by fixation Understand the importance of fixation and processing to diagnosis How the biopsy/sampling procedure and subsequent handling (inc fixation) can affect ultrastructure of samples for electron microscopy Issues affecting sample quality - fixation, buffer type, biopsy to fixation time Sample taking, sample transport (UN3373). Communication with clinicians about same **<u>SAMPLE SELECTION/DISSECTION</u>** Medical terminology and the importance of clinical history in determining ultrathin block selection How to accurately describe the tissues being dissected or prepared for processing including recording the number of and location of where the blocks originate The importance of recording whether there is any tissue retained How to prevent carry over or contamination of specimens			

MANDATORY MODULE 2…continued General Principles of Election Microscopy Preparation Techniques	Date Started	Date Completed	Signature of scientific supervisor
Knows and understands: **<u>SAMPLE SELECTION/DISSECTION…. continued</u>** How to dissect tissue and where necessary maintain orientation of specimens to allow accurate assessment including; • skin biopsies • renal biopsies • muscle biopsies • nerve biopsies • Sampling the required area of a wax block, as marked on an H&E, for reprocessing into resin When specimens require to be wrapped or contained to prevent loss during processing **<u>PROCESSING AND EMBEDDING</u>** Understand different processing and embedding regimes for different purposes The effects on subsequent procedures with particular regard to the appearance of artefacts produced by poor processing Avoiding osmium in processing if the reason for doing EM is foreign body granuloma x-ray microanalysis Variations of embedding agents and their applications Understanding of maintaining orientation where necessary at the embedding stage The local procedures for accurate numbering of resin blocks			

MANDATORY MODULE 2…continued General Principles of Election Microscopy Preparation Techniques	Date Started	Date Completed	Signature of scientific supervisor
Knows and understands: **<u>SECTIONING AND STAINING</u>** The sectioning constraints due to the amount of tissue available Production of good quality glass knives for ultra-microtomy The use of an ultramicrotome and the principles of ultramicrotomy The correct use of a diamond knife and its maintenance Specific knowledge of section quality Production of semi-thin sections of appropriate thickness for light microscopy Appropriate staining of sections from resin embedded blocks Light microscopical techniques for the identification of areas of interest and the identification of normal/abnormal tissues Production of ultra-thin sections Selection of appropriate grids from the available range Staining ultra-thin sections to achieve good image quality when examined by electron microscopy, including alternative techniques such as immunocytochemical techniques. Artefacts produced by sectioning and staining techniques.			

Declaration

I declare that I have satisfactorily completed the general principles of EM dissection module for the Diploma of Expert Practice in Ultrastructural Pathology as required by the Institute of Biomedical Science.

Signed …… Date ……

I declare that …… has satisfactorily completed the general principles of EM dissection module for the Diploma of Expert Practice in Ultrastructural Pathology as required by the Institute of Biomedical Science.

Signed (scientific supervisor) …… Date ……

MANDATORY MODULE 3 Pathological Processes Relevant to Electron Microscopy	Date Started	Date Completed	Signature of scientific supervisor
Knows, understands and can give examples of: Acute inflammation Chronic inflammation Granulomatous inflammation Apoptosis Necrosis Tissue injury Immune responses Autoimmune disease Wound healing and repair Scarring Infections, acute and chronic including viral infections Thrombosis and coagulation Atherosclerosis Embolism Ischaemia and infarction Oedema Atrophy Hypoplasia Hyperplasia Metaplasia Neoplasia (benign and malignant)			

MANDATORY MODULE 3…continued Pathological Processes Relevant to Electron Microscopy	Date Started	Date Completed	Signature of scientific supervisor
Knows, understands and can give examples of: Premalignancy Malignancy Mechanisms of tumour spread, local and metastasis Tumour markers Common genetic conditions Common degenerative conditions The histological classification of tissues, e.g. epithelial, mesenchymal Functional anatomical structures or systems, their distribution and physiology, e.g. the endocrine system			

Declaration

I declare that I have satisfactorily completed the pathological procedures module for the Diploma of Expert Practice in Ultrastructural Pathology as required by the Institute of Biomedical Science.

Signed …… Date ……

I declare that …… has satisfactorily completed the pathological procedures module for the Diploma of Expert Practice in Ultrastructural Pathology as required by the Institute of Biomedical Science.

Signed (scientific supervisor) …… Date ……

MANDATORY MODULE 4 Electron Microscope Use	Date Started	Date Completed	Signature of scientific supervisor
Knows and understands: **TRANSMISSION ELECTRON MICROSCOPY AND ALTERNATIVE TECHNIQUES** The principles of and the operation and routine maintenance of electron microscopes to include: • trouble-shooting, • filament alignment and changes, • voltage and contrast set-ups • calibration systems • appropriate use of magnification and apertures • Astigmatism its correction, and its effect on interpretation of results. Principles of alternative techniques such as; • elemental analysis, • scanning electron microscopy • electron tomography • super resolution light microscopy • other alternative EM methodologies as appropriate to the modules studied. **DIGITAL IMAGING** Principles of digital image formation including • Background corrections • Calibration • Digital focussing • Annotation • Image analysis Legislation around the use and storage of digital images, including data protection and information governance			

Declaration

I declare that I have satisfactorily completed the electron microscopy techniques module for the Diploma of Expert Practice in Ultrastructural Pathology as required by the Institute of Biomedical Science.

Signed …… Date ……

I declare that …… has satisfactorily completed the electron microscopy techniques module for the Diploma of Expert Practice in Ultrastructural Pathology as required by the Institute of Biomedical Science.

Signed (supervisor) …… Date ……

MANDATORY MODULE 5 Ultrastructural Examination	Date Started	Date Completed	Signature of scientific supervisor
Knows and understands: **EXAMINATION OF SECTIONS** Know the importance of understanding the Patient and/or clinical history and how this informs the ultrastructural assessment Know the importance of understanding the Histopathological Findings i.e., LM, IF or IPx, Genetic testing and how this informs the ultrastructural assessment Cell organelles and extra cellular components in tissue sections Normal features of tissue samples commonly encountered within the candidate's laboratory Artefacts produced by fixation, processing, embedding and staining techniques Appropriate staining and operating parameters of the electron microscope to the quality of the image Effects of plane of sectioning on interpretation and image analysis The clinical implications of the results of ultrastructural assessment, especially in patient treatment and management. Recording features of interest seen on the electron microscope by production of digital images			

MANDATORY MODULE 5…continued Ultrastructural Examination	Date Started	Date Completed	Signature of scientific supervisor
Knows and understands: **DIAGNOSTIC ULTRASTRUCTURAL REVIEW** The limits and restrictions of electron microscopy in relationship to the study of organs and tissues The effect that artefact or plane of section can have on the appearance of the normal or diseased organs and tissues How to describe ultrastructural appearances using accepted medical and scientific terminology Performing a comprehensive ultrastructural review of the organ/tissue according to departmental standards Production of sufficient high-quality images of relevant features to allow assessment of the ultrastructural features of the sample Reporting – quantitative and qualitative results, preparation of reports with regards to tissue examined Presentation of results at MDT and other relevant meetings			

Declaration

I declare that I have satisfactorily completed the ultrastructural examination module for the Diploma of Expert Practice in Ultrastructural Pathology as required by the Institute of Biomedical Science.

Signed …… Date ……

I declare that …… has satisfactorily completed the ultrastructural examination module for the Diploma of Expert Practice in Ultrastructural Pathology as required by the Institute of Biomedical Science.

Signed (scientific supervisor) …… Date ……

OPTIONAL MODULE 1 **SKIN**	**Date Started**	**Date Completed**	**Signature of scientific supervisor**
Knows, understands and is competent in: Assessing how much tissue is reasonably required for diagnosis and the importance of saving surplus tissue. Embedding skin in the best orientation dependant on suspected diagnosis The terms used to describe normal and pathological skin appearances clinically The variations in skin types throughout the body The anatomical terms used to describe specific areas of skin throughout the body Identifying all normal epidermal, junctional and dermal components in toluidine blue stained semi-thin and ultrathin sections Identifying: Leukocytes and inflammatory cells. Platelets and fibrin. Mast cells. Macrophages and macrophage giant cells. Langerhans cells. The histopathological terms used to describe inflammatory skin reactions			
Has a basic knowledge of the relevant clinical dermatology, and is competent in the histopathology and ultrastructure relating to: Amyloid: cutaneous and systemic Foreign body granuloma ultrastructure and x-ray microanalysis interpretation. Hair disorders: SEM, phase contrast and TEM			

Inherited and acquired disorders of extracellular matrix including collagen, elastic and proteoglycan.			

OPTIONAL MODULE 1 continued **SKIN**	**Date Started**	**Date Completed**	**Signature of designated supervisor**
Has a basic knowledge of the relevant clinical dermatology, and is competent in the histopathology and ultrastructure relating to: Benign and malignant tumours found in the skin. In particular the ability to correctly identify organelles such as: • intercellular junctions of various types • melanosomes • neuroendocrine granules • cytoplasmic filaments • Birbeck granules • lipid • glycogen etc. How these components appear at various ages and in sun exposed parts. Normal scar formation in various stages. Familiarity with abnormal scars of various types Infectious agents found in and on the skin including various species of: Protozoa, Fungi, Bacteria and viruses Infectious agents found in and on the skin including various species of: • Protozoa			

• Fungi • Bacteria • Viruses			

OPTIONAL MODULE 1 continued **SKIN**	**Date Started**	**Date Completed**	**Signature of designated supervisor**
Has a basic knowledge of the relevant clinical dermatology, and is competent in the histopathology and ultrastructure relating to: Inherited and acquired disorders of epidermal maturation and keratinisation Inherited and acquired blistering conditions Inherited vasculopathies (CADASIL), haemoglobinopathies and porphyrias, lysosomal and glycogen related disorders Iatrogenic dermopathies and artefacts created by topical and injected local anaesthetics Disorders of pigmentation			

Declaration

I declare that I have satisfactorily completed the skin module for the Diploma of Expert Practice in Ultrastructural Pathology as required by the Institute of Biomedical Science.

Signed …… Date ……

I declare that …… has satisfactorily completed the skin module for the Diploma of Expert Practice in Ultrastructural Pathology as required by the Institute of Biomedical Science

Signed (scientific supervisor) …… Date ……

OPTIONAL MODULE 2 Primary Ciliary Dyskinesia	Date Started	Date Completed	Signature of designated supervisor
Knows, understands and is competent in the: Structure and function of: • the respiratory system and epithelial cells. • cilia (primary and motile) basal bodies and microvilli, including axonemal structure and intraflagellar transport. • other ciliated cells and systems – e.g. Sperm and fallopian tubes • other systems used for ciliary research – e.g. Chlamydomonas, mouse Features, causes, occurrence, manifestation of Primary Ciliary Dyskinesia (PCD) Significance of clinical history and clinical tests – including nasal nitric oxide measurement, PICADAR (PrImary CiliARy DyskinesiA Rule) scores and lung function assessment Other laboratory tests used for PCD diagnosis: • Ciliary beat frequency (CPF) • Ciliary beat pattern (CBP) • Air-liquid interface (ALI) culture • Immunofluorescence (IF) How TEM can contribute to diagnosis of PCD, including its sensitivity and specificity Genetic background to PCD including: • Genotype/phenotype relationships • PCD disease genes, their associated defects and ethnicities EM processing methods specific for PCD: • ALI cultures • Alginate • Agar			

• Agarose			

OPTIONAL MODULE 2 continued Primary Ciliary Dyskinesia	Date Started	Date Completed	Signature of designated supervisor
Knows, understands and is competent in the: Correct sample taking and is competent to communicate clearly with clinicians about same. Interpretation of LM – Identifying all normal components in toluidine blue stained semi-thin and ultrathin sections including adequacy, health, contamination and fixation quality. Interpretation of EM. Able to identify normal and pathological changes in goblet cells, inflammatory cells, basal cells, epithelium, microvilli, cilia 'blebbing' of epithelial surface; features of good and poor fixation, and ALI cultured tissue. Able to recognise contamination in sample – bacteria, virus, mucus, etc. and to advise on reduction or avoidance. Identify and quantify defects and partial ciliary defects according to international guideline. Classify outer arm defects (OAD), inner arm defects (IAD), outer and inner arm defects (OAD&IAD), etc. according to international guidelines into Class 1, 2 (Shoemark et al 2020). Causes, appearance and avoidance of secondary ciliary dyskinesia The impact on patients of diagnosis, management services follow up and support Understanding of the limitations of EM for PCD diagnosis			

OPTIONAL MODULE 2 Continued **Primary Ciliary Dyskinesia**	**Date Started**	**Date Completed**	**Signature of designated supervisor**
Diagnostic accuracy PCD with normal ultrastructure PCD with subtle changes e.g. • Hydin • RSPH defects • CCDC164 • CCDC65 (nexin) • CCNO • MCIDAS PCD database – input, interrogation and interpretation of data and trends When to request ALI or repeat brushing Unusual cases: • Long cilia • Intermittent central pairs • Reduced generation of multiple motile cilia (RGMMC) • Mis-localisation of basal bodies with few or no cilia • Ciliary aplasia Awareness of other ciliopathies: • Bardet Biedel syndrome, • Retinitis Pigmentosa • Meckel-Gruber			

• Polycystic Kidney Disease • Joubert's syndrome			

Declaration

I declare that I have satisfactorily completed the primary ciliary dyskinesia module for the Diploma of Expert Practice in Ultrastructural Pathology as required by the Institute of Biomedical Science.

Signed …… Date ……

I declare that …… has satisfactorily completed the primary ciliary dyskinesia module for the Diploma of Expert Practice in Ultrastructural Pathology as required by the Institute of Biomedical Science

Signed (scientific supervisor) …… Date ……

Optional Module 3 – Muscle and Nerve

Note for this module candidates are not expected to provide examples of every specimen type list ultrastructually. They should provide a good mix of the specimen types listed and should have theoretical knowledge of the specimen types they do not encounter within their own laboratory.

OPTIONAL MODULE 3 **Muscle and Nerve**	**Date Started**	**Date Completed**	**Signature of designated supervisor**
Understands muscle fibre types and their importance to function Histological structure of normal muscle Light Microscopy demonstration methods used in muscle biopsy evaluation			

Knows, understands and is competent in:
Ultrastructure of normal muscle
 	
• Muscle fibres
  ○ Sarcomere
  ○ Myofilaments
  ○ Mitochondria
  ○ Sarcoplasmic reticulum and T-tubule membrane
  ○ Glycogen and Lipid
  ○ Sarcolemma and basement membrane
  ○ Nuclei
• Sarcoplasm
  ○ Golgi
  ○ Microtubules and filaments
  ○ Free ribosomes
  ○ Lipofuscin and lysosomes
• Blood vessels
• Neuro-muscular junction			

Understanding the histological and ultrastructural features of different muscle types such as cardiac and smooth muscle			

OPTIONAL MODULE 3 continued **Muscle and Nerve**	**Date Started**	**Date Completed**	**Signature of scientific supervisor**

Terminology used when describing histological abnormalities seen in muscle diseases
• Internal nuclei
• Fibre splitting
• 'Moth-eaten' fibres
• Rimmed vacuole
• Hypertrophy
• Atrophy
• Degeneration
• Regeneration
• Fibre changes
  ○ Hypercontraction
  ○ Granular fibre /ragged red fibres
  ○ Basophilic fibres
  ○ Phagocytosis
  ○ Cores
  ○ Target fibres
• Fibrosis
• Inflammation
 	
Ultrastructural changes in seen in diseased muscle
○ Sarcolemma
  • Folding
  • Changes to basal lamina
  • Loss of plasma membrane
  • Abnormal caveolae			

OPTIONAL MODULE 3 continued **Muscle and Nerve**	**Date Started**	**Date Completed**	**Signature of scientific supervisor**
Ultrastructural changes in seen in diseased muscle…continued ○ Myofibrils and cytoskeleton • Loss of myofilaments and splitting of the myofilaments • Hypercontraction • Loss of I and A bands • Alterations to z lines • Ring fibres • Cores • Filamentous bodies • Concentric laminated whorls • Z-band Streaming • Rods • Cytoplasmic bodies • Accumulation of desmin ○ Nucleus • Location • Changes in shape and chromatin distribution • Inclusions ○ Mitochondria • Aggregates • Abnormal structure • Inclusions ○ Membrane system • Swollen sarcoplasmic reticulum			

• Replication of triads • Honeycomb structures • Tubular aggregates			

OPTIONAL MODULE 3 continued **Muscle and Nerve**	**Date Started**	**Date Completed**	**Signature of scientific supervisor**
Ultrastructural changes in seen in diseased muscle…continued ○ Deposits and particles • Excess glycogen and lipid • Lipofuscin • Lipopigment • Virus-like particles • Crystalline material ○ Miscellaneous • Actin accumulations • Zebra bodies • Fingerprint bodies • Curvilinear bodies • Reducing bodies • Autophagic vacuoles • Membranous/myelin-like whorls • Dense tubules • Mallory body-like inclusions • Tubuloreticular Inclusions (TRI's) • Inflammatory cells Understands Pathologies of muscle and how ultrastructural assessment can inform diagnosis • Neurogenic disorders e.g.; ○ Spinal muscular atrophy			

• Muscular dystrophies e.g.;
  ○ Duchenne and Becker
  ○ Limb girdle muscular dystrophy
  ○ Congenital muscular dystrophins
  ○ Emery-Dreifuss dystrophy Bethlem myopathy
  ○ Myotonic dystrophies			

OPTIONAL MODULE 3 continued **Muscle and Nerve**	**Date Started**	**Date Completed**	**Signature of scientific supervisor**

Ultrastructural changes in seen in diseased muscle…continued
• Congenital myopathies (examples given below)
  ○ Central core disease
  ○ Multi-mini core disease
  ○ Nemaline myopathy
  ○ Myotubular myopathy
• Myofibrillar myopathies e.g.
  ○ desminopathy
• Metabolic myopathies
  ○ Glycogenosis
  ○ Lipid storage disorders
  ○ Mitochondrial myopathies
  ○ Lysosomal storage disorders
• Inflammatory myopathies e.g.
  ○ Polymyositis and dermatomyositis
  ○ Inclusion body myositis
• Drug induced and toxic myopathies (Iatrogenic)
 	
Pre-examination Considerations of Nerve Biopsy
• Understand how thin resin sections/ultrastructural assessment fits in with other histological tests such as nerve teasing, immunocytochemistry etc.
• Histological structure of normal peripheral nerves			

OPTIONAL MODULE 3 continued **Muscle and Nerve**	**Date Started**	**Date Completed**	**Signature of scientific supervisor**
Ultrastructure of normal peripheral nerves • Axons • Myelin sheaths • Node of Ranvier • Schmidt-Lanterman clefts • Microtubules • Neurofilaments • Mitochondria • Collagen • Cell bodies and dendrites • Macrophages • Schwann cell – myelinated • Reich granules in Schwann cells • External lamina/collagen IV and laminin • Microfilaments/actin • Fibroblasts • Mast cells Understands the histological difference between various nerves Terminology used when describing histological abnormalities seen in nerve pathologies			

• Axonal degeneration • Axonal regeneration • Demyelination • Regeneration			

OPTIONAL MODULE 3 continued **Muscle and Nerve**	**Date Started**	**Date Completed**	**Signature of scientific supervisor**
Ultrastructural changes seen in nerve pathology • Axonal degeneration • Degeneration of myelin • Widely spaced myelin • Cytoplasmic inclusion bodies • Aggregates of glycogen • Basement membrane hyperplasia • Tubular reticular bodies in endothelial cells • Amyloid • Onion bulb formation • Bands of Bungner • Wallerian degeneration and regenerative clusters Ultrastructural changes seen due to handling trauma, autolysis, delay in fixation artefact etc ○ Myelin vacuolation ○ Myelin/axon separation • Mitochondrial swelling			

Understands the pathologies of nerves and how resin section and/or ultrastructural assessment can inform diagnosis ○ Neuropathy ○ Vasculitis ○ Chronic inflammatory demyelinating polyneuropathy (CIDP) ○ Sarcoidosis ○ Amyloidosis ○ Lymphomatosis ○ Leprosy ○ Acute demyelination			

Declaration

I declare that I have satisfactorily completed the muscle and nerve module for the Diploma of Expert Practice in Ultrastructural Pathology as required by the Institute of Biomedical Science.

Signed …… Date ……

I declare that …… has satisfactorily completed the muscle and nerve module for the Diploma of Expert Practice in Ultrastructural Pathology as required by the Institute of Biomedical Science

Signed (scientific supervisor) …… Date ……

Optional Module 4: Renal Biopsies

Note for this module candidates are not expected to provide examples of every specimen type list ultrastructually. They should provide a good mix of the specimen types listed and should have theoretical knowledge of the specimen types they do not encounter within their own laboratory.

OPTIONAL MODULE 4 **Renal Biopsies**	**Date Started**	**Date Completed**	**Signature of designated supervisor**
Knows, understands and is competent in the: Histological structure of normal kidney Ultrastructure of the normal kidney Glomerulus • Bowman's capsule • Parietal epithelial cells • Visceral epithelial cells (podocytes) • Glomerular basement membranes • Endothelial cells • Mesangial cells • Mesangial matrix Tubules • Proximal tubular epithelial cells • Distal tubular epithelial cells • Tubular basement membranes Components and structure of the renal interstitium ▪ Peritubular capillaries ▪ Fibroblasts ▪ Inflammatory cells ▪ Macrophage			

Understands how renal biopsies are taken and how subsequent handling can affect the ultrastructure of the biopsy.			

OPTIONAL MODULE 4 continued **Renal Biopsies**	**Date Started**	**Date Completed**	**Signature of designated supervisor**
Understands what techniques are carried out on renal tissue and what these demonstrate: how can these techniques inform the ultrastructural assessment: ▪ Specials stains ▪ Immunocytochemistry (Immunofluorescence and/ or Immunoperoxidase) Limitations of TEM (sample size, reprocessed material) Knows what constitutes a representative set of images Identifying components of renal biopsy in toluidine blue-stained semi-thin sections: ○ Renal capsule ○ Pelvicalyceal epithelium ○ Glomeruli – normal and pathological features ○ Distal and proximal tubules ▪ Tubular casts ○ Interstitium • Inflammatory cells • Peri-tubular capillaries • Large vessels Understand how to select areas of interest from toluidine blue-stained semi-thin sections and how to use this to trim a block for ultrathin sectioning Know and understand the relevance to ultrastructural examination of the clinical details provided			

OPTIONAL MODULE 4 Continued **Renal Biopsies**	**Date Started**	**Date Completed**	**Signature of designated supervisor**
Familiar with the main types of indication for taking a renal biopsy (nephrotic syndrome, nephritic syndrome, rapidly progressive renal failure, acute renal failure, chronic renal failure, isolated urinary abnormalities, transplant dysfunction) Familiar with common Laboratory tests carried out e.g. • eGFR and/or serum creatinine • Urinary protein to creatinine ratio • Urine dipstick results (haematuria/proteinuria) • Immunological serological results (e.g.: ANCA, anti-GBM, dsDNA, ANA,PLA2R, serum IgA levels, paraproteins, etc.) • Virological serology results (e.g. HepB, HepC, HIV etc.) Familiar with other important elements of clinical history e.g. • Medical history non-renal (e.g. diabetes…) • Drug history • Family history Knows and understands ultrastructural pathological features of renal biopsies Glomerular basement membranes • Alterations in thickness • Alterations in structure • Presence, size, specific location and sub-structure of immunoglobulin and complement deposits • Presence of reduplication / de-novo deposition of basement membrane Endothelium • Swelling • Tubulo-reticular inclusions			

• Cellular proliferation			

OPTIONAL MODULE 4 Continued **Renal Biopsies**	**Date Started**	**Date Completed**	**Signature of designated supervisor**
Knows and understands ultrastructural pathological features of renal biopsies Mesangium • Increase in matrix material • Cellular proliferation Presence, size, specific location and sub-structure of immunoglobulin and complement deposits Epithelial cell foot processes • Effacement of foot processes • Microvillous change Others • Sclerosis/hyalinosis • Presence of Inflammatory cells • Crystals • Excess storage products Tubular epithelial cells • Vacuolation • Presence of excess storage products, crystals, or other abnormal/excessive inclusions • Appearance of brush border • Immunoglobulin and complement deposits within tubular basement membrane Peri-tubular capillaries and intrstitium • Reduplication of basement membranes • Immunoglobulin and complement deposits • Fibrils such as amyloid			

OPTIONAL MODULE 4 Continued **Renal Biopsies**	**Date Started**	**Date Completed**	**Signature of designated supervisor**
Understands Pathologies of native renal biopsies and how ultrastructural assessment can inform diagnosis • Alport's syndrome • Amyloidosis, NOS/ AL/ Others • Anti-glomerular basement membrane disease • C1q nephropathy • C3 glomerulonephritis • C3 Dense Deposit Disease • Congenital nephrotic syndrome, Finnish type • Cryoglobulinaemic glomerulonephritis • Diabetic nephropathy • Fabry's disease • Focal segmental glomerulosclerosis: ○ (i.e., NOS/ tip variant/ collapsing type/ perihilar) • Fibrillary glomerulonephritis • Fibronectin glomerulopathy • Henoch-Schönlein purpura nephritis • HIV associated nephropathy • IgA nephropathy • Immune complex mediated glomerulonephritis, NOS • Immunotactoid glomerulonephritis • LCAT deficiency • Lipoprotein glomerulopathy • Lupus Nephritis, classes I –V • Membranoproliferative glomerulonephritis (immune complex) • Membranous glomerulonephritis • Minimal change disease • Monoclonal immunoglobulin deposition disease (MIDD); Light chain deposition disease /Heavy chain deposition disease/ mixed light chain/heavy			

chain/ proliferative GN with monoclonal IgG deposits disease • Nodular glomerulosclerosis, NOS			

OPTIONAL MODULE 4 Continued **Renal Biopsies**	**Date Started**	**Date Completed**	**Signature of scientific supervisor**
Understands Pathologies of renal transplant biopsies and how ultrastructural assessment can inform diagnosis • Post-infectious glomerulonephritis • Sickle cell glomerulopathy • Thin basement membrane nephropathy • Thrombotic microangiopathy • Uromodulin storage disorder • ADTKD–MUC1, HNF1B, REN • Karyomegalic nephropathy/tubulointerstitial nephritis • Light chain cast nephropathy • Light chain proximal tubulopathy Knows and understands BANFF criteria • Criteria and nomenclature • Ultrastructural changes listed in criteria • Double contours of glomerular basement membrane • Reduplication of peri-tubular capillaries Transplant glomerulopathy			
Knows, understands and is competent in: Preparing an informed and directed report of features seen: Preparation of reports/notes • Terminology • Features to describe • Qualitative results/findings e.g. • Basement membrane measurements			

Declaration

I declare that I have satisfactorily completed the renal biopsies module for the Diploma of Expert Practice in Ultrastructural Pathology as required by the Institute of Biomedical Science.

Signed …… Date ……

I declare that …… has satisfactorily completed the renal biopsies module for the Diploma of Expert Practice in Ultrastructural Pathology as required by the Institute of Biomedical Science

Signed ((scientific supervisor) …… Date ……