The Royal Australian and New Zealand College of Ophthalmologists

Ophthalmic Pathology Curriculum Standard

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Purpose

The purpose of the ophthalmic pathology standard is to provide an overview of the essential knowledge and skills in pathology required of an ophthalmologist to perform their work effectively.

It is essential that the ophthalmologist:

- appreciates the role of pathology in understanding disease mechanisms and investigating and treating patients with ocular diseases
- has a good understanding of microbiology and virology, and how microorganisms can cause ophthalmic disease
- demonstrates adequate knowledge and understanding of genetics relevant to ophthalmology, recognises genetic diseases, their patterns of inheritance and how this information can be applied to clinical care
- understands the importance of a knowledge of genetics for diagnosis, prognosis and genetic counselling of patients and their families
- applies the correct procedures to laboratory investigations and interpretation of tests in terms of the underlying pathology, as well as an understanding of the sensitivity, specificity and limitations of certain investigations
- has sufficient knowledge of pathology to understand and follow a clinicopathological publication and/or presentation.

Structure

This standard comprises four educational elements and their associated learning outcomes and performance criteria.

1: General Ophthalmic Pathology

- Comprises six learning outcomes and their associated performance criteria
- The learning outcomes and performance criteria focus on the following, as relevant to the eye, orbit and adnexae:
  - tissue damage
  - acute and chronic inflammation
  - basic immunological disease processes
  - wound healing
  - vascular disorders
  - principles of neoplasia.

2: Microbiology

- Comprises five learning outcomes and their associated performance criteria
- The learning outcomes and performance criteria focus on:
  - the nature and role of normal microbial flora in the eye, adnexa and upper respiratory tract
  - the physical and physiological defences of the body against infection
  - techniques in ocular microbiological diagnosis
  - understanding the basics of microorganism culture and identification
  - interpreting the results of microbiological tests.

3: Genetics

- Comprises one main learning outcome and its associated performance criteria, which focus on the principles of molecular biology techniques used in the detection of genetic abnormalities.

4: Clinical Ophthalmic Pathology

- Comprises ten learning outcomes and their associated performance criteria, which focus on:
  - the basis of a disease with its clinical presentation
  - the incidence, aetiology, pathogenesis and genetics of a disease (where applicable)
  - the natural history of a disease
  - differential diagnosis
  - specimen preparation
  - laboratory procedures pertaining to ophthalmology specimens
  - the examination of ocular histologic sections
  - interpretation of laboratory reports
  - the pathological effects of treatment, including complications.
- Each learning outcome and performance criterion in section 4 applies to each of the curriculum areas.
- The curriculum areas for this section are drawn from the core reading. They focus on the key areas of the eyelid and lacrimal drainage system, conjunctiva, cornea, orbit and optic nerve, embryological development of the eye, glaucoma, inflammation, wound healing and trauma, retina – vascular diseases, degeneration and dystrophies, intraocular tumours, pathology of medical and surgical treatment, lens, ophthalmic manifestations of systemic diseases and laboratory investigations.
- Presumed clinical knowledge:
  - management of endophthalmitis
  - ocular surface impression cytology sampling
  - ocular surface biopsy and tissue handling, for infection, neoplasia, OCP/mucous membrane pemphigoid
  - corneal scrape
  - corneal biopsy
  - anterior chamber taps
  - diagnostic and therapeutic vitrectomy
  - temporal artery biopsy
  - intravitreal injection, risks and sequelae
  - resection of eyelid tumours and intraoperative margin control
  - frozen sections for intraoperative pathology assessment
  - effects of radiotherapy on ocular tissues

References

Core Readings

- Forrester, J.V., Dick, A.D., McMenamin, P.G. & Roberts, F. 2015, *The Eye: Basic Sciences in Practice*, 4th edn, W.B. Saunders, London [*ISBN: 978-0-7020-5554-6*] Chapter 3, Chapter 7, Chapter 8 and Chapter 9.

- Eagle, R. 2011, *Eye Pathology: An Atlas and Text,* Lippincott Williams & Wilkins, Illinois [*ISBN: 978-1608317882].*

- American Academy of Ophthalmology, Basic and Clinical Science Course (AAO BCSC),
  - Section 1: Update on General Medicine (*Infectious Disease*)
  - Section 2: Fundamentals and Principles of Ophthalmology (*Genetics*)
  - Section 4: Ophthalmic Pathology and Intraocular Tumors
  - Section 8: External Disease and Cornea (*Infectious Diseases of the External Eye and Cornea*)

- Relevant journal articles on ocular pathology from the RANZCO Clinical and Experimental Ophthalmology for the past twelve months

Additional Readings

- Levinson, W. 2006, *Review of Medical Microbiology and Immunology Examination and Board*, 9th edn, Lange Medical Publications [*ISBN: 978-0071460316*].

- Sehu, K.W. & Lee, W.R. 2005, *Ophthalmic Pathology: An Illustrated Guide for Clinicians*, Blackwell Publishing, Massachusetts [*ISBN: 978-0-470-79099-1*].

- Heegaard, S. & Grossniklaus, H. 2015, *Eye Pathology: An Illustrated Guide,* Springer Publishing, New York *[ISBN: 978-3662433812]*.

It is recommended that reading also be supplemented with appropriate articles from current and relevant peer-reviewed journals.

Teaching and Learning

The College recommends that trainees undertake the following teaching and learning activities to assist them in achieving the learning outcomes and performance criteria outlined in this curriculum standard:

- Familiarise yourself thoroughly with this standard. It outlines all the examinable material on which the questions in the Ophthalmic Pathology examination will be based.
- Thoroughly study the core readings as outlined in this curriculum standard, and where possible, consolidate your learning by familiarising yourself with the additional reading.
- Arrange to visit the practice of a histopathologist who reports on eye pathology. During this visit, focus in particular on developing skills to interpret ophthalmic pathology reports, and observing the dissection and processing of a globe. Preferably this will be the globe of a patient that you have seen during their enucleation procedure. In addition, arrange to be present during a frozen section performed on an ophthalmic specimen.
- Practise using a microscope to observe ophthalmic pathology slides. (Please note that the College uses digital images rather than a viva microscope examination to assess each trainee's ability to recognise pathologies of the eye. Nevertheless, the ability to use a microscope proficiently remains a core skill which a trainee is expected to learn).
- View the ophthalmic pathology images available on the College learning management system, Moodle, as a guide to the types of images that you may encounter in the Ophthalmic Pathology examination.

  It will be important for you to practise manipulating these slides to see the images at different magnifications and navigate from one slide to the next.

  Attend an ophthalmic pathology course organised by the College, and/or in your training network and/or other relevant organisations.

- Keep a log of ocular pathologies you encounter in clinics, surgery and/or on any visit to a histopathologist.
- Join a study group to help you prepare for the Ophthalmic Pathology examination. A useful task to do as part of a study group is to revise from previous examinations. Previous examination papers can be downloaded from Moodle.

Assessment

Ophthalmic Pathology Examination (3.5 hours)

- *Short Answer Questions (SAQs) – General Ophthalmic Pathology*
- *Multiple Choice Questions (MCQs) – Microbiology and Genetics*
- *Short Essay Questions (SEQs) including examination of ocular histologic sections – Clinical Ophthalmic Pathology*

The RANZCO Advanced Clinical Exam (RACE) may include elements of this curriculum standard.

Learning outcomes and performance criteria

SECTION 1: GENERAL OPHTHALMIC PATHOLOGY	
LEARNING OUTCOMES	**PERFORMANCE CRITERIA**
1.1 Know the mechanisms of tissue damage and degeneration relevant to the eye, orbit and adnexae	Explain the pathological processes of: • Cellular ageing • Hyaline change • Calcification • Metaplasia • Dysplasia • Apoptosis • Necrosis • Ischaemic cell injury
1.2 Know about acute and chronic inflammation relevant to the eye, orbit and adnexae	Describe: • Allergic types 1–5 • Cellular and vascular mechanisms of acute and chronic non granulomatous inflammation • Cellular mechanisms –of chronic granulomatous inflammations
1.3 Understand basic immunological disease processes relevant to the eye, orbit and adnexae	Describe: • Mechanisms of transplant rejection • The humoral and cellular mechanisms of the immune response
1.4 Understand wound healing relevant to the eye, orbit and adnexae	Describe: • How wound healing occurs • The process of scar formation
1.5 Understand vascular disorders relevant to the eye, orbit and adnexae	Describe: • Process of thrombosis • Process of new vessel formation • The pathogenesis of atherosclerosis
1.6 Understand the principles of neoplasia relevant to the eye, orbit and adnexae	Describe: • The characteristics of benign and malignant neoplasms • How tumours spread

SECTION 2: MICROBIOLOGY	
LEARNING OUTCOMES	**PERFORMANCE CRITERIA**
2.1 Describe and explain the nature and the role of the normal microbial flora in the eye, adnexa and upper respiratory tract	Describe: • The role of the resident flora in health and disease • Normal flora of the conjunctiva, eyelashes and eye lids • Normal flora of the mouth and upper respiratory tract
2.2 Describe the physical and physiological defences of the body against infection	• Describe the defence mechanism(s) of: – Lids – Blinking – Tears – Conjunctiva • Discuss innate immunity • Discuss acquired immunity
2.3 Describe the techniques in ocular microbiological diagnosis	Discuss each of the following: • Methods of specimen collection • Methods of specimen transport • Issues in specimen contamination • Issues in laboratory diagnostic criteria; normal flora or infection
2.4 Describe the basics of microorganism culture and identification	Discuss: • Microbiological stains and their interpretation • Basic culture media and uses • Effect of temperature and atmosphere requirements • Susceptibility testing; general principles and interpretation • Non-culture methods of identification of organisms including molecular techniques • Infectious disease serology
2.5 Interpret the results of microbiological tests	• Demonstrate the ability to interpret lab reports

SECTION 3: GENETICS	
LEARNING OUTCOMES	**PERFORMANCE CRITERIA**
3.1 Describe and apply the principles of molecular biology techniques used in the detection and diagnosis of genetic abnormalities	Discuss each of the following: • Obtaining DNA from patients • Polymerase chain reaction • DNA sequencing (Sanger and Next Generation) • DNA polymorphism analysis, SSCP, dHPLC • Gene linkage analysis, blood groups / enzymes, RFLPs, VNTRs, SNPs • LOD score • Genetic association studies SNPs • Genome Wide Association Studies (GWAS) • Cytogenetics: – Trisomy – Monosomy – Deletion – Inversion – Duplication – Translocation – Fluorescent in situ hybridisation (FISH) – Prenatal diagnosis • Clinical genetics including inheritance, diagnosis and genetic counselling

SECTION 4: CLINICAL OPHTHALMIC PATHOLOGY	
LEARNING OUTCOMES	**PERFORMANCE CRITERIA**
4.1 Correlate the basis of a disease with its clinical presentation	• Describe the macroscopic, histopathologic and (where appropriate) the ultrastructural morphology of a disease
4.2 Know (where applicable) the incidence, aetiology, pathogenesis and genetics of a given disease	• Compare and contrast accepted, recent theories of aetiology and pathogenesis • Describe the incidence of disease in varying populations encountered in clinical practice • Identify risk factors for the development of disease
4.3 Know the natural history of a disease	• Describe the natural history of a disease
4.4 Evaluate the different diseases included in the differential diagnosis	• Formulate an appropriate differential diagnosis of a disease presentation
4.5 Know the procedures for the preparation of specimens for the laboratory	• Describe the procedures for the preparation of specimens
4.6 Know laboratory procedures that pertain to ophthalmology specimens	• Describe the laboratory procedures • Communicate effectively with the pathologist
4.7 Examine ocular histologic sections	• Identify anatomical structures of normal tissue • Describe pathology including any prognostic features if relevant • Describe clinical manifestations of pathology • Formulate an appropriate differential diagnosis of a disease presentation • Determine appropriate tests, special stains or investigations required to establish diagnosis
4.8 Understand laboratory reports	• Interpret laboratory reports • Explain the aims, limitations, specificities and sensitivities of specified pathological investigations in a manner that can be understood
4.9 Know how treatment can alter the pathology of a disease	• Describe how treatment can alter the pathology of a disease
4.10 Know the pathological effects and complications of treatment	• Describe the pathological sequelae of treatment for a disease

Curriculum Areas

EYELID AND LACRIMAL DRAINAGE SYSTEM

Eyelid

- Infective
- Inflammatory
- Tumours
  - Benign
  - Pre-malignant
  - Malignant
- Soft tissue tumours
- Manifestations of systemic disease

Lacrimal drainage system

- Infections
- Tumours

Conjunctiva

- Non-specific chronic conjunctivitis
- Specific inflammatory conditions
  - Allergic eye disease
  - Autoimmune
  - Granulomatous conjunctivitis
  - Infective
- Degenerative
- Tumours
  - Benign
  - Pre-malignant
  - Malignant
  - Lymphoproliferative disease

CORNEA

Ulcerative keratitis

Degenerations

Dystrophies

Keractasia

Malformations

Trauma

Treatment related pathology

ORBIT & OPTIC NERVE

Orbital tissue pathology

- Inflammatory
- Tumours
  - Cysts
  - Neoplasias including hamartomas, teratomas and choristomas
  - Lymphoid tumours
- Lacrimal gland
  - Inflammatory diseases
  - Neoplasias
- Metastases

Optic Nerve Pathology
- Optic disc swelling / optic atrophy
- Primary optic nerve tumours
- Optic nerve hypoplasia

EMBRYOLOGICAL DEVELOPMENT OF THE EYE

Anterior segment anomalies

Posterior segment anomalies

Whole eye anomalies

The phakomatoses

The ocular effects of chromosomal abnormalities

Congenital infections

Drug embryopathy

GLAUCOMA

Congenital / infantile / juvenile

Open angle
- Primary
- Secondary

Angle closure
- Primary
- Secondary

Pathology of glaucoma treatment and complications

INFLAMMATION

Endophthalmitis / panophthalmitis
- Pyogenic Reactions
- Granulomatous Reactions

Chorioretinitis

Non-granulomatous uveitis

WOUND HEALING & TRAUMA

Healing and repair in ocular, orbital and periocular tissues

Modulation of wound healing

Trauma

The shrunken eye (atrophia / phthisis bulbi)

RETINA – VASCULAR DISEASES, DEGENERATIONS AND DYSTROPHIES

Vascular disease

Dystrophies

Degenerations
- Central
- Peripheral degenerations
- Pathology of retinal detachment and surgery

INTRAOCULAR TUMOURS

Iris

Ciliary body

Choroid

Retina

Panophthalmic neoplasia

PATHOLOGY OF MEDICAL AND SURGICAL TREATMENT

Ocular

Orbital

Adnexal

LENS

Cataract

Developmental anomalies

Phaco anaphylactic glaucoma

Phacolytic glaucoma

Pseudophakia

OPHTHALMIC MANIFESTATIONS OF SYSTEMIC DISEASES

Inflammatory: infectious and non-infectious

Neoplastic

Vascular

Immunodeficiency / immunosuppression

Metabolic

Genetic

LABORATORY INVESTIGATIONS

Routine formalin fixation, processing and slide presentation

Frozen section

Histochemical stains

- PAS (Periodic acid-Schiff)
- PASD (Periodic acid-Schiff Diastase)
- Congo red
- Alcian blue
- Masson trichrome
- Gram
- GMS (Gomori methenamine-silver nitrate)
- ZN (Ziehl-Neelson)
- EVG (elastin Van Gieson)
- Perls' Prussian blue

Principles of immunohistochemistry

A summary of antibodies frequently used in immunohistochemistry

- Anti-actin / myoglobin
- Desmin
- Carcinoembryonic antigen (CEA)
- CD1-79+
- Cytokeratin / CAM 5.2 / AE1 / AE3
- Epithelial membrane antigen (EMA)
- Factor VIII-related antigen
- Glial fibrillar acidic protein (GFAP)
- HMB45/melan-A
- S-100
- Vimentin

Cytology

EM (electron microscopy)

FISH (fluorescence in situ hybridization)

CISH (chromogenic in situ hybridization)

PCR (polymerase chain reaction)

Flow cytometry

Cytogenetics

Serology

Culture of microorganisms

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