The Royal Australian and New Zealand College of Ophthalmologists

# Anatomy Curriculum Standard

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# Purpose

Anatomy encompasses gross anatomy, histology, imaging, radiological anatomy and development. A clear understanding of anatomy and histology underpins any rational approach to amelioration of disease by medical, and particularly surgical means.

The Anatomy Curriculum Standard gives both a complete, structured list of the anatomical knowledge required, and examples of how the assessment of a trainee's knowledge of anatomy may be framed in a clinical context.

These standards specify the knowledge of anatomy required for the safe practice of ophthalmology. It is expected that a specialist ophthalmologist has a well-founded and practical knowledge of the following five key elements:

AN1 the anatomy of the eyeball
AN2 the anatomy of the orbit and ocular adnexa
AN3 neuroanatomy
AN4 skull, scalp, face and neck anatomy
AN5 anatomical imaging.

The Vocational Training Program has been designed so that key ophthalmic anatomical knowledge is gained and assessed early in the program. This knowledge can then act as a sound foundation upon which ophthalmic clinical practice and surgery develop.

# Structure

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

Learning outcomes are statements of what trainees are expected to know, understand and do, while performance criteria specify the level of performance required to demonstrate achievement of the learning outcome.

# References

### Anatomy Core Reading


- Forrester, J.V., Dick, A.D., McMenamin, P.G., Roberts, F., & Pearlman, E. 2015, *The eye: basic sciences in practice*, 4th edn, Saunders/Elsevier, Edinburgh, New York, NY.
- Snell, R.S. & Lemp, M.A. 1998, *Clinical Anatomy of the Eye*, 2nd edn, Blackwell Science, Malden, MA.
- MacMinn, R.M.H., Hutchings, R.T., Logan, B.M., & Reynolds, P.A. 2004, *Color atlas of head and neck anatomy*, 3rd edn, Mosby, London.


### Additional Reading


- *Diagnostic imaging pathways* http://www.imagingpathways.health.wa.gov.au/


 

- Dutton, J.J. 2011, *Atlas of clinical and surgical orbital anatomy*, 2nd edn, Elsevier Saunders, Philidelphia, PA
  Chapter 6, 'The connective tissues system', is available on the College's Moodle learning management system.

- Jinkins, J.R. 2000, Atlas of neuroradiologic embryology, anatomy and variants, Lippincott, Williams and Wilkins, Philadelphia, PA.
  Chapter 4, "The Orbit", (pp. 427-455) is available on the College's Moodle learning management system.

**Other recommended anatomy texts and atlases**

- Bron, A.J., Tripathi, R.C., Tripathi, B.J., & Wolff, E. 2001, *Wolff's anatomy of the eye and orbit*, 8th edn, Arnold, London.

- Kiernan, J.A., Rajakumar, N., & Barr, M.L. 2014, *Barr's The human nervous system: an anatomical viewpoint*, Lippincott Williams & Wilkins, Philadelphia, PA.

- Netter, F.H. 2011, *Atlas of human anatomy*, 5th edn, Saunders/Elsevier, Philadelphia, PA.

- Rohen, J. W., Yokochi, C., & Lütjen-Drecoll, E. 2011, Color atlas of anatomy: a photographic *study of the human body*, 7th edn, Wolters Kluwer Health/Lippincott Williams & Wilkins, Philadelphia, PA.

- Sinnatamby, C.S. 2011, *Last's Anatomy: regional and applied*, Elsevier Health Sciences UK, London.

# Teaching and Learning

The College recommends the following activities to assist the trainee in achieving the learning outcomes described in the curriculum. The trainee is expected to:

- become familiar with the curriculum document and use it to guide his or her learning, as it directly informs the Anatomy examination;
- practice viewing anatomical specimens and imaging studies; and,
- consult resources, including past examination papers, on the RANZCO Moodle learning management system.

# Assessment Methods

The assessment consists of two equally-weighted parts:

1. Two-hour written examination, comprising twelve medium-length structured questions; and,
2. Objective structured practical examination (OSPE).

 

In the OSPE, candidates will be required to demonstrate how anatomical knowledge is applied in clinical practice by interpreting, connecting and extrapolating from information provided in:

- anatomical specimens or prosections
- cross-sectional anatomy specimens
- cross-sectional specimens of the head and neck, and neuroanatomy
- gross anatomy photographs and 3D prints of anatomy specimens
- photo-micrographs of histological or electron microscopic images
- radiographic and other imaging modalities (as describe in element 4 below)

Clinical scenarios will be utilised when appropriate.

 

# Learning outcomes and performance criteria

## AN1 THE EYEBALL

For each structure listed in table AN1, the trainee is expected to be able to describe the following:

- size
- shape
- position
- structure
- relations
- innervation
- blood supply
- histology
- embryology

The table also contains additional learning recommendations for each structure, highlighting clinical relevance and applied anatomy or functional relevance. This information is not intended to be exhaustive, but is provided to guide candidates in the application of their anatomical knowledge.

The trainee will be examined on both knowledge of anatomy and understanding of its relevance and application.

| STRUCTURE | UNDERSTANDING / APPLIED ANATOMY EXAMPLES |
|---|---|
| **1.1 Sclera** | 1.1.1 Explain the relevance of the relative deficiency of the sclera anteriorly where it blends with the cornea<br><br>1.1.2 Describe the arrangements/ pattern of the collagen bundles and differentiate these from arrangements in the cornea<br><br>1.1.3 Describe the openings for vortex veins and list the other nerves and vessels that pierce the sclera<br><br>1.1.4 Describe how the collagen of the EOM tendons blend with the scleral collagen<br><br>1.1.5 List the distances of the rectus tendons from the limbus<br><br>1.1.6 Be able to draw a diagram of the rectus tendon insertions into the sclera<br><br>1.1.7 Describe how the sclera blends with the cornea at the limbus (V-shape)<br><br>1.1.8 Explain how the sclera forms from neural crest mesenchyme along with the dura with which it is continuous |

 

| STRUCTURE | UNDERSTANDING / APPLIED ANATOMY EXAMPLES |
|---|---|
| **1.1 Sclera (continued)** | 1.1.9 Outline how the maturation of the sclera affects its ability to resist expansion with raised IOP<br><br>1.1.10 Explain how the thickness of the sclera can vary and why it would appear translucent/blue in thin sclera<br><br>1.1.11 Describe the collagen arrangement at the lamina cribrosa and how that may be associated with damage to ganglion cell axons when pressure is raised<br><br>1.1.12 Describe which cells are found in the sclera, and explain how the structure of the sclera affects its function e.g. not transparent like cornea but firm, noncompliant for EOM action<br><br>1.1.13 List which cells repair wounds created in surgery and explain the importance of the arrangement of the collagen bundles on this process |
| **1.2 Cornea** | 1.2.1 Describe how the anatomy or structure of the cornea contributes to its transparency<br><br>1.2.2 Describe the innervation of the cornea, including the pathway of the corneal reflex, using diagrams where appropriate<br><br>1.2.3 Compare and contrast the anatomy of the cornea and the sclera and explain how the differences relate to function<br><br>1.2.4 Outline the structure and function of the corneal layers and their role in the mechanism of wound healing<br><br>1.2.5 List the sources of corneal nutrition and oxygenation and outline their relevance in clinical pathology such as contact lens overuse<br><br>1.2.6 Explain how the corneal thickness and curvature, both anterior and posterior, impact on vision<br><br>1.2.7 Describe the relationship between the pre-corneal tear film and corneal epithelium |

 

| STRUCTURE | UNDERSTANDING / APPLIED ANATOMY EXAMPLES |
|---|---|
| **1.3 Limbus, anterior chamber and angle** | 1.3.1 Recognise that the limbus is the transition zone between the cornea to the sclera<br><br>1.3.2 Identify the corresponding layers of the cornea and the sclera, and describe the macroscopic and microscopic differences between the layers as they transition through the limbus<br><br>1.3.3 Define the anatomical and surgical limbus and explain its relevance in intraocular surgery<br><br>1.3.4 Describe the anatomic relationship between the trabecular meshwork and Schlemm's canal with emphasis on drainage of aqueous humor from the anterior chamber |
| **1.4 Uveal tract: iris** | 1.4.1 Give an account of the innervation of the iris and how pupil size is controlled<br><br>1.4.2 Describe the cellular components of the iris and the structure of the iris<br><br>1.4.3 The crystalline lens and zonules are closely related to the iris. Outline how interaction between these structures could result in elevation of IOP<br><br>1.4.4 Describe the embryological formation of the pupil and how this related to pupil abnormalities such as microcoria and persistent pupillary membranes |
| **1.5 Uveal tract: ciliary body** | 1.5.1 Describe the different structures within the ciliary body, distinguishing between the muscular and epithelial elements, the pars plana and pars plicata<br><br>1.5.2 Explain the mechanisms of accommodation and the interaction between the zonule and the ciliary body<br><br>1.5.3 Outline the innervation and blood supply of the ciliary body and the role of cholinergic neurotransmitters<br><br>1.5.4 Describe the anatomical basis of aqueous humor production<br><br>1.5.5 Define the blood-aqueous barrier and outline its clinical relevance<br><br>1.5.6 Describe the flow of aqueous humor through the posterior and anterior chambers, including the uveo-scleral pathway |

 

| STRUCTURE | UNDERSTANDING / APPLIED ANATOMY EXAMPLES |
|---|---|
| **1.5 Uveal tract: ciliary body (continued)** | 1.5.7 Outline the role the aqueous humor takes in nutrition and metabolic support of the lens and cornea |
| **1.6 Lens and zonular apparatus** | 1.6.1 Describe how the histological structure and anatomical attachments of the zonules relate to the function of the lens<br><br>1.6.2 Outline the embryology of the lens and explain how lenticular development could result in various types of congenital cataracts<br><br>1.6.3 Describe the nature of the hyaloid vasculature and its importance in lens and eye development |
| **1.7 Anterior and posterior chambers** | 1.7.1 Define the anatomical boundaries of the anterior and posterior chambers, and state in which chamber the crystalline lens sits |
| **1.8 Vitreous** | 1.8.1 Outline the importance of the posterior lens capsule and its relationship with the anterior hylaloid face, particularly in the setting of cataract surgery<br><br>1.8.2 Describe the attachments of the vitreous and their importance in the development of retinal detachment and in complicated cataract surgery<br><br>1.8.3 Explain the changes in the vitreous that occur with ageing that can lead to a posterior vitreous detachment |
| **1.9 Retina and retinal pigment epithelium (RPE)** | 1.9.1 Describe the ultra-structural features that make up the blood-retinal barrier and outline its clinical importance<br><br>1.9.2 Outline the anatomical or structural basis of the attachment of the neural retina to the RPE<br><br>1.9.3 Describe the dual blood supply of the retina and identify which components of the retina would be damaged by complete occlusion of the central retinal artery<br><br>1.9.4 Explain the anatomical aspects of retinal detachment |

 

| STRUCTURE | UNDERSTANDING / APPLIED ANATOMY EXAMPLES |
|---|---|
| **1.10 Uveal tract: choroid** | 1.10.1 Describe the laminae of Bruch's membrane<br><br>1.10.2 Describe the structure and function of the choriocapillaris<br><br>1.10.3 Describe the ultrastructure of the vascular endothelium of the choriocapillaris and relate it to its function<br><br>1.10.4 Understand the role of the choroid in the metabolic support of outer retinal function<br><br>1.10.5 Understand how blood flow in the choroid differs from that elsewhere in the body |
| **1.11 Optic nerve (ON)** | 1.11.1 Differentiate between the structure of the optic nerve at the optic nerve head and the intracerebral portion, including the cell structure and blood supply<br><br>1.11.2 Outline the reason for optic disc swelling with raised intracranial pressure. Include the likely effects on the ON head with chronic disc oedema<br><br>1.11.3 Describe the arrangement of the nerve fibres in relationship to the visual system and its relevance to visual field defects |

 

## AN2 ORBIT AND OCULAR ADNEXA

For each structure listed in table AN2, candidates are expected to be able to describe the following:

- size
- shape
- position
- structure
- relations
- innervation
- blood supply
- histology
- embryology

The table also contains additional learning recommendations for each structure, highlighting clinical relevance and applied anatomy and functional anatomy This information is not intended to be exhaustive, but is provided to guide candidates in the application of their anatomical knowledge.

Candidates will be tested on both knowledge of anatomy and understanding of its relevance and application.

| STRUCTURE | UNDERSTANDING / APPLIED ANATOMY EXAMPLES |
|---|---|
| **2.1 Bony orbit:**<br>• shape of walls of orbit<br>• bones<br>• foramina<br>• histology<br>• embryology | 2.1.1 Describe the neural and vascular structures that pass through the orbital foramina, and the superior and inferior orbital fissures. Be familiar with the distances between these structures and the orbital rim. Describe the likely clinical effects of a growing tumour occupying any of these spaces<br><br>2.1.2 Describe the bones that make up the orbital walls. Describe the anatomical structures that might be involved in trauma that leads to a fracture of the orbital floor<br><br>2.1.3 Should pressure rise in a paranasal sinus through tumour or infection, the contents may protrude into the orbital cavity. Describe the consequent altered position of the eye that might occur as a result of disease in each of the paranasal sinuses<br><br>2.1.4 Identify the anatomical site of orbital disease by observation of clinical signs / globe malposition, e.g. larcimal gland disease resulting in medial and inferior globe displacement |

 

| STRUCTURE | UNDERSTANDING / APPLIED ANATOMY EXAMPLES |
|---|---|
| **2.2 Orbital blood vessels:**<br>• ophthalmic artery<br>• central retinal artery<br>• lacrimal artery | 2.2.1 Describe the structures supplied by these vessels, and understand the likely clinical effect of occlusion |
| **2.3 Orbital contents, periorbita and fibroadipose tissue** | 2.3.1 Explain the anatomical basis of an infection on the face leading to cavernous sinus thrombosis<br><br>2.3.2 In pre-septal dissection to the orbital margin, what important structures should be considered |
| **2.4 Extra-ocular muscles and movements**<br>• rectus and oblique muscles and levator palpebrae superioris | 2.4.1 Describe the actions of the extra-ocular muscles<br><br>2.4.2 Describe the anatomical basis to Hering's law and Sherrington's law of reciprocal innervation<br><br>2.4.3 Describe the location of the tendons, and the structures and spaces that are traversed to reach them when performing surgery<br><br>2.4.4 Be able to draw a diagram of the apical region of the orbit, including the common tendinous ring, and origins of the extraocular muscles; and show their relations to the nerves and blood vessels entering the orbital cavity<br><br>2.4.5 Describe how to perform clinical testing of the actions of superior and inferior oblique muscles<br><br>2.4.6 Describe the primary, secondary and tertiary actions of each of the extraocular muscles<br><br>2.4.7 Describe the anatomy of the levator palpebrae superioris and Muller's muscle |

 

| STRUCTURE | UNDERSTANDING / APPLIED ANATOMY EXAMPLES |
|---|---|
| **2.5 Eyelids:**<br>• palpebral fissure<br>• muscles<br>• tendons<br>• aponeurosis / retractors<br>• skin<br>• tarsal plates<br>• conjunctiva / caruncle / plica semilumaris<br>• accessory lacrimal glands of the eyelids (within skin / conjunctiva / tarsal plate)<br>• lid margin<br>• orbital septum<br>• fascial planes | 2.5.1 Discuss the location of the vascular network of the eyelids<br><br>2.5.2 Discuss the layers of the eyelid and the tissue planes and the clinical significance for both surgery and disease<br><br>2.5.3 Consider the anatomy of the eyelids in terms of choosing the most appropriate surgical approach to access structures within the orbit<br><br>2.5.4 Recognise and understand the anatomical tissues that ensure normal eyelid position and function |
| **2.6 Lacrimal apparatus** | 2.6.1 Describe how acini function to produce tears and outline the role of myoepithelial cells<br><br>2.6.2 Explain the relationship of the lacrimal gland to the levator palpebrae superioris muscle/ aponeurosis<br><br>2.6.3 Describe the position of the lacrimal ductules and their relations and understand the implications for surgery in this area<br><br>2.6.4 Describe the lacrimal drainage pathway on both dacryocystogram and CT scans<br><br>2.6.5 Describe tear production: basal, reflex and psychic<br><br>2.6.6 Describe how innervation controls tear production<br><br>2.6.7 Describe the reflex arc and sites where this could be damaged |

 

| STRUCTURE | UNDERSTANDING / APPLIED ANATOMY EXAMPLES |
|---|---|
| **2.7 Periorbital structures**<br>• eyebrow<br>• nose<br>• paranasal tissue | 2.7.1 Identify anatomical structures in and around the orbit as they appear on CT images in coronal, sagittal and transverse planes<br><br>2.7.2 Correlate the cross section anatomy of anatomical specimens with CT and MRI scans<br><br>2.7.3 Understand the anatomy of the lateral wall of the nose and its relationship to the nasolacrimal system<br><br>2.7.4 Considering the innervation of both the eye, the periorbital structures and the nose, discuss possible sites of local anaesthetic infiltration to achieve maximum anaesthesia |

 

| **AN3 NEUROANATOMY** | |
|---|---|
| **STRUCTURE** | **UNDERSTANDING/ APPLIED ANATOMY EXAMPLES** |
| **3.1 Visual pathway and associated structures**<br>• optic nerve<br>• chiasm<br>• optic tract and lateral geniculate nucleus<br>• optic radiations<br>• primary and associated visual cortices<br>• superior colliculus and connections | 3.1.1 Facial trauma can lead to optic neuropathy: considering the anatomy of the optic nerve, describe how this may arise<br><br>3.1.2 Describe the visual field defects that arise from lesions along each part of the visual pathway<br><br>3.1.3 Conversely, identify the likely site of a lesion given a particular pattern of visual field loss<br><br>3.1.4 Outline the distribution of fibres in the chiasm and explain how that governs the field defects caused by various forms of chiasmal compression (e.g. pituitary disease, or suprasellar mass) |
| **3.2 Cranial nerves I – XII**<br>• understand the course of each nerve<br>• ascending and descending brainstem connections | 3.2.1 Describe the pupillary light reflex, and the pupil abnormalities caused by lesions at various points along that pathway<br><br>3.2.2 Understand the distribution of the retinal nerve fibres in the optic disc and how that governs the field defects characteristic of glaucoma<br><br>3.2.3 Describe the blink reflex pathway and understand its ocular surface protective function<br><br>3.2.4 Describe the clinical presentation of cranial nerve lesions<br><br>3.2.5 Describe the course of the facial nerve, and the depth and relationship of the facial nerve branches to the lateral canthus<br><br>3.2.6 Understand how lesions of the cavernous sinus affect the cranial nerves |
| **3.3 Brain stem, cerebellum, cervical spinal cord** | 3.3.1 Understand the location of lesions causing multiple cranial nerve palsies, for example:<br><br>− VI nerve palsy and contralateral hemiparesis<br><br>− VI nerve palsy, hearing loss and trigeminal facial pain<br><br>− VI nerve palsy, III nerve palsy and Horner syndrome |

 

| STRUCTURE | UNDERSTANDING/ APPLIED ANATOMY EXAMPLES |
|---|---|
| **3.4 Central and peripheral autonomic nervous system**<br><br>**Sympathetic nervous system**<br>• efferent nerve fibres (sympathetic outflow)<br>• sympathetic trunks<br>• superior cervical ganglion<br>• middle cervical ganglion<br>• inferior cervical ganglion<br><br>**Parasympathetic nervous system**<br>• efferent nerve fibres (cranio-sacral outflow)<br>• autonomic ganglia<br>• ciliary ganglion<br>• pterygopalatine ganglion<br>• submandibular ganglion | 3.4.1 Describe the functions of the autonomic nervous system<br><br>3.4.2 Draw a diagram of the ciliary ganglion, illustrating its relations with cranial nerve III and it branches<br><br>3.4.3 Describe the features of Horner syndrome and identify sites of disease that can result in these clinical features<br><br>3.4.4 Describe associated neurological features of Horner syndrome and how each may help localise the site of the lesion responsible<br><br>3.4.5 Explain the anatomical basis of the following effect: after a patient has had phenylephrine drops instilled in one eye, it is noted that the eyelid on the same side is elevated<br><br>3.4.6 Describe (and illustrate) the pathway of the direct and consensual light reflexes<br><br>3.4.7 Outline the anatomy of the relative afferent pupil defect (unequal direct and consensual pupil response) |

 

| **AN4 SKULL, SCALP, FACE AND NECK ANATOMY** | |
|---|---|
| **STRUCTURE** | **UNDERSTANDING/ APPLIED ANATOMY EXAMPLES** |
| **4.1 Bones** | 4.1.1 Identify the bones forming the cranium and face<br><br>4.1.2 Describe the sutures of the skull and the consequences of premature fusion of sutures<br><br>4.1.3 Describe the location of the fontanelles and the surrounding bones<br><br>4.1.4 Describe the external topographical anatomy of the skull. For example, what are the anatomical landmarks that define the temporal and infero-temporal fossae? or, describe the infra-temporal fossa and its relationship to the pterygopalatine fossa |
| **4.2 Foramina of skull** | 4.2.1 Identify the foramina of the skull and list the structures that pass through them |
| **4.3 Cranial fossae** | 4.3.1 Identify the bony landmarks of the anterior, middle and posterior cranial fossae |
| **4.4 Meninges and dural sinuses** | 4.4.1 Describe the structure of the dura mater, arachnoid mater and pia mater<br><br>4.4.2 Outline the structure, location and contents of the cavernous sinus<br><br>4.4.3 Describe the consequences of injury in and around the cavernous sinus<br><br>4.4.4 Describe the anatomy of the various dural sinuses and their relevance to the visual system |
| **4.5 Scalp** | 4.5.1 Describe the boundaries of the scalp<br><br>4.5.2 List the layers of the scalp<br><br>4.5.3 Describe the innervation, and note the layers where the sensory nerves and blood supply of the scalp lie, and their clinical relevance for injuries<br><br>4.5.4 Explain the relevance of the structure and location of these features when performing temporal artery biopsy |

 

| STRUCTURE | UNDERSTANDING/ APPLIED ANATOMY EXAMPLES |
|---|---|
| **4.6 Head and neck blood supply**<br>• common carotid<br>• internal carotid - course and branches<br>• external carotid | 4.6.1 Describe the points of anastomosis between the ICA and ECA especially around the orbital region<br><br>4.6.2 Describe the course of the superficial temporal artery and why this is of clinical relevance<br><br>4.6.3 Describe the blood supply of the brain and the contributions of the vertebral and intracavernous carotid arteries<br><br>4.6.4 Describe the blood supply of the visual pathways |

 

| **AN5 IMAGING** | |
|---|---|
| **LEARNING OUTCOMES** | **MODALITY** |
| **5.1 Interpret clinical images of ocular-related anatomy** | 5.1.1 Angiography (cerebral and orbital)<br>5.1.2 X Ray<br>5.1.3 CT<br>5.1.4 MRI/MRA/MRV<br>5.1.5 Ultrasound of eye and orbit (A scan, B scan, ultrasound biomicroscopy (UBM))<br>5.1.6 Dacryocystogram |
| **5.2 Interpret clinical images of the normal eye** | 5.2.1 Ocular photographs (extraocular and fundus)<br>5.2.2 Gonioscopy<br>5.2.3 Ocular coherence tomography (OCT) of the normal retina and of the anterior segment<br>5.2.4 Confocal microscopy of the cornea<br>5.2.5 Fluorescein angiography |

 

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