Eye Anatomy & Function

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External ocular appearance
Key Eye Functions

- Transmits and refracts light from the front to the back of the eye
  - *Transparent light path*
  - *Includes structures that bend light (refract)*
- Converts light energy into action potentials transmitted to brain
Layers and chambers of the eye

- Fibrous Tunic
- Vascular Tunic
- Nervous Tunic
- Anterior Chamber
- Posterior Chamber
- Vitreous Chamber
Defining ocular segments

**Anterior segment:**
Structures in front of vitreous:
Cornea, iris, ciliary body, and lens

**Posterior segment:**
Vitreous, retina, choroid, optic nerve
Tear film layers and functions

- **Oil layer:**
  - Meibomian glands
    - Prevents evaporation

- **Water layer:**
  - Lacrimal glands
    - Lubricates
    - Allows blinking
    - Washes away debris
    - Forms smooth surface

- **Mucin layer:**
  - Goblet cells of conjunctiva
    - Attaches tear film to eye
    - Spreads water evenly
Cornea functions

- **Transmits light, transparent**
  - Collagen and matrix
    - Aligned
    - Spacing
    - Relative dehydration is maintained by endothelial cells
  - No blood vessels

- **Refracts light +40-44 dioptres**
  - Curvature
  - Has different refractive index from air
Corneal anatomy

**Epithelium:**
Barrier to fluid loss and pathogen penetration

**Stroma:**
Collagen, ECM, keratocytes

**Endothelium:**
Maintains relative dehydration

**Dense innervation:**
Most sensitive organ in the body
Immune privilege
Rapid tearing reflex

**The cornea:**
Transmits light
Refracts lights
Protects ocular interior
Structure of the crystalline lens

- Iris
- Epithelium
- Equator
- Ciliary body
- Zonules
- Cortex
- Nucleus
- Capsule
- Lens fibres
Crystalline Lens: Structure and function

- Composed of α, β, and γ crystallins (water soluble proteins)
- Transmission of light
- Refraction of light. +17 dioptres
- Variable refraction of light - accommodation

Corneal 2/3rd and lens 1/3rd refracting power
Accommodation

**Far objects:**
- Ciliary muscle relaxed (↑ diameter)
- Zonules tight
- Lens flatter i.e. distance

**Near objects:**
- Ciliary muscle contracts (↓ diameter)
- Zonules relaxed
- Lens increases in convexity
  ‘accommodation’ i.e. near
Accommodation video

- [https://www.youtube.com/watch?v=p_xLO7yxgOk&list=WL&index=3&t=0s](https://www.youtube.com/watch?v=p_xLO7yxgOk&list=WL&index=3&t=0s)
- Search for accommodation reflex on youtube
Emmetropia, Myopia & Hypermetropia

Emmetropia: cornea/lens/eye length “normal”

- Myopic eye = long, hyperopic eye = short
Retinal Function

- **Photoreceptors**: conversion of light into action potentials
  - Cones. 6 million. High threshold to light. High acuity. Light adapted (photopic) vision. Colour vision- 3 types of cones: blue, green, red.
  - Rods. 120 million. Low threshold to light. Sensitive to movement. Dark adapted (scotopic) vision. No colour. Low resolution.
  - Synapse with bipolar cells → Retinal ganglion cells → Axons form the optic nerve. 1 million fibres.
Spectral sensitivity ranges (nm)

**S** (Blue 2%) 400-500nm

**M** (Green 32%) 450-630nm

**L** (Red 64%) 500-700nm
Vitreous
Inner limiting membrane
Nerve fibre layer
Ganglion cell layer
Inner plexiform layer
Inner nuclear layer
Outer plexiform layer
Receptor nuclear layer
External limiting membrane
Inner and outer segments of photoreceptors
RPE
Choroid

internal limiting membrane
Nerve fiber layer
Ganglion cell layer
Inner plexiform layer
Inner nuclear layer
Outer plexiform layer
Outer nuclear layer
External limiting membrane
Retinal pigment epithelium
<table>
<thead>
<tr>
<th>Layer</th>
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<tbody>
<tr>
<td>Vitreous</td>
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<td>Inner limiting membrane</td>
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**RETINAL MICRO-STRUCTURE**
Fovea is within the central macula
Human retina

fovea

optic nerve

Temporal

Nasal
Superior Retinal Detachment
Optic nerve head and adjacent retina

(Masson’s trichome)
Ciliary Body

- Attachment of zonules (suspensory ligament of lens)
- Accommodation. Ciliary body smooth muscle
- Secretion of aqueous humour: Ciliary epithelium
  - Provides nutrition for the (avascular) cornea and lens
  - Maintains intraocular pressure
Name these ocular structures
The Uveal Tract

The eye’s vascular and immunological pool

Iris
Variable size of pupil (iris diaphragm) with light level with nearness of fixation

Ciliary Body
Aqueous, accommodation, zonule

Choroid
Nutrition of retina and sclera

The most vascular tissue in the body
Eyelids and conjunctiva

1. Skin
2. Muscles
3. Tarsal plate - mechanical stability & Meibomian glands – oil layer of tear
4. Conjunctiva
   Attach eyeball to orbit & lids & permits rotation

Functions: Distribute tears, clear debris, cover eyes during sleep & prevent evaporation, protect from foreign bodies via the blink reflex
Eyelids and conjunctiva
Orbicularis oculi and eyelids

Orbicularis oculi muscle

50 in upper eyelid

25 in lower eyelid

Meibomian glands
Eye movements

- Elevation
- Intorsion/Internal rotation
- Abduction
- Adduction
- Depression
- Extorsion/External rotation
Extra-ocular muscles

- Annulus of Zinn
- Trochlea
Extra-ocular muscles

• Medial rectus. Adducts.
• Lateral rectus. Abducts.
• Superior rectus. Elevates.
• Inferior rectus. Depresses.
• Superior oblique. Intorts. depresses, abducts.
• Inferior oblique. Extorts. elevates, abducts.
**Innervation of extraocular muscles**

Lateral Rectus Muscle → “Abducts” → Innervated by Abducens nerve  
= Cranial nerve 6

Superior Oblique Muscle →  
Passes through the “trochlea” →  
Innervated by Trochlear nerve = Cranial nerve 4

The other 4 muscles →  
Produce “ocular movements” →  
Innervated by Oculomotor nerve = Cranial nerve 3
Extraocular muscles video

Search for ‘extraocular muscles eye anatomy’ on youtube
https://www.youtube.com/watch?v=f_rb6FMVHPk&t=7s
Tear production and drainage

- Lacrimal gland
- Meibomian glands
- Conjunctiva
- Upper cannaliculus
- Lower cannaliculus
- Lacrimal sac
- Lacrimal duct
Visual Pathway

Optic nerve
Optic chiasm
Optic tract
Lateral geniculate nucleus
Optic radiation
Primary visual cortex
Injuries to Visual Pathway

1° Visual cortex
**Visual Fields**

- **Left**
  - Temporal retina
  - Optic N.
  - Optic tract
  - Optic radiation
  - Visual cortex
  - Nasal retina

- **Right**
  - Temporal retina
  - Optic N.
  - Optic tract
  - Optic radiation
  - Visual cortex
  - Nasal retina

**Legend:**

- **A** Total blindness of right eye
- **B** Right nasal hemianopsia
- **C** Left homonymous hemianopsia
- **D** Bitemporal heteronymous hemianopsia
Cataract of the crystalline lens

**Age of onset**
- Congenital
- Age-related

**Location**
- Nuclear sclerotic
- Cortical
- Posterior
- Subcapsular

**Cause**
- Age-related
- Traumatic
- Diabetic
Phacoemulsification cataract surgery

Capsulorrhexis  Phacoemulsification  Injection of foldable IOL  IOL in capsular bag
Intra-ocular lens (multifocal and toric)
Long thought extinct living takahē were rediscovered in an expedition led by Invercargill based ophthalmologist & ENT physician Dr Geoffrey Orbell near Lake Te Anau in the Murchison Mountains, in 1948.
The End

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