Anatomy and Histology of the Canine and Feline Eye

I. Overall Anatomy and Compartments of the Globe

a. **Anterior chamber**- bounded by cornea anteriorly and iris and anterior lens surface posteriorly; filled with aqueous

b. **Posterior chamber**- bounded anteriorly by iris, posteriorly by lens capsule and anterior vitreous face; filled with aqueous

c. **Vitreous**- attached at the pars plana, posterior lens capsule and inner limiting membrane of retina; almost completely acellular; composed of hyaluronic acid, small amounts of collagen and rare hyalocytes

d. **Posterior segment**- composed of retina and choroid

e. **Uvea**- composed of iris, ciliary body (anterior uvea) and choroid (posterior uvea)

f. **Fundus**- part of the retina and all associated structures that are visible with the ophthalmoscope; holangiotic retina in dogs and cats; has tapetal (superior) and nontapetal parts (inferior)

g. **Orbit- extraocular muscles**

   i. Dorsal rectus m.
   ii. Dorsal oblique m.
   iii. Lateral rectus m.
   iv. Medial rectus m.
   v. Ventral rectus m.
   vi. Ventral oblique m.
   vii. Retractor bulbi m.

h. Useful terms

   i. epibulbar- residing on the surface of the globe
   ii. episcleral- residing on the surface of the sclera
   iii. Tenon’s capsule- a fascial structure of the orbit that lies between episclera and loose conjunctival stroma
   iv. intraconal- the area within the retrobulbar space enveloped by fascia and extraocular muscles that contains the optic nerve
   v. retrobulbar space- the space located behind the globe
Normal canine orbit

Normal canine globe
II. Eyelid Anatomy

a. **Meibomian glands** - present in both eyelids; produce superficial oily layer of tear film

b. **Ciliary glands** - apocrine sweat glands that secrete into hair follicles or sebaceous glands or directly onto lid margin

c. **Cilia** - project from upper lid margin; not found on lower lid margin in dogs or cats

d. **Muscles**
   i. Orbicularis oculi - acts to close eyelids
   ii. Levator palpebrae superioris - the most important muscle that acts to retract the upper eyelid

e. **Palpebral and bulbar conjunctiva** - contain Goblet cells that produce the glycoprotein layer of the tear film
III. Nictitans Anatomy

   a. **Gland of the third eyelid** - mixed seromucous gland in the dog, serous in the cat; contributes significantly to the aqueous production of the tear film

   b. **Cartilage** - reinforces nictitating membrane

   c. **Lymphoid nodules** - number, size and location vary with age and antigenic stimulation; especially prominent on bulbar surface of third eyelid

   d. **Muscles** - dog has no specific muscle that draws the third eyelid across the globe such as is present in the cat; cat has 9 strands of smooth muscle fibers that extend into the third eyelid
IV. Corneal Anatomy

a. **Tear film** - superficial oily layer (Meibomian glands), central aqueous layer (gland of third eyelid), thin glycoprotein layer covering cornea (Goblet cells)

b. **Corneal epithelium** - stratified squamous; non-keratinized

c. **Basal lamina and superficial stroma** - collagenous acellular zone

d. **Corneal stroma** - lamellae composed of fine, evenly spaced collagen fibers

e. **Descemet’s membrane** - basement membrane of posterior epithelium

f. **Endothelium** - simple cuboidal epithelium
V. Iris Anatomy

a. **Anterior surface**- lined by discontinuous layer of stromal cells; no boundary between anterior chamber and iris

b. **Stroma**- contains fibroblasts, collagen, nerve fibers, smooth muscle, melanocytes and blood vessels; cats have a pigment called pheomelanin, a lighter colored pigment that consists of long and thin filaments compared to round granules contained in typical melanocytes

c. **Posterior epithelium and dilator muscle**- radially arranged smooth muscle fibers; posterior to sphincter muscle

d. **Sphincter muscle**- circumferentially arranged smooth muscle fibers

e. **Pupil**- round in the dog; slit-like in the cat
Normal feline iris. Note the lighter colored rod-shaped granules within the melanocytes “M.” These contain pheomelanin. The posterior epithelium contains two layers, “1” and “2.” The iris dilator muscle is labeled “U.” Note that the dilator muscle is continuous with the more anterior layer of the posterior epithelium.
VI. Structures of the Filtration Angle

   a. **Primary pectinate ligaments**- anchors the anterior base of the iris to the inner peripheral cornea

   b. **Secondary pectinate ligaments**

   c. **Corneoscleral trabecular meshwork**- consists of small trabeculae that in turn are separated by small intertrabecular spaces

   d. **Drainage vessels**- deep scleral vascular channels (angular aqueous plexus) drain to trabecular veins, then into the scleral venous plexus and the episcleral veins

   e. **Uveal trabecular meshwork**- comprises most of the inner iridocorneal angle in area; forms the ciliary cleft

   f. **Ciliary cleft**- bordered by secondary pectinate ligaments on one side, corneoscleral trabecular meshwork on the other side, anteriorly by the ciliary body and posteriorly by the uveal trabecular meshwork

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**Normal canine filtration angle.** “C” labels the corneoscleral trabecular meshwork. “I” labels the iris base. “F” labels the ciliary cleft. “A” labels the anterior chamber. “2” labels the secondary pectinate ligaments. “P” labels the angular aqueous plexus.
Normal feline iridocorneal angle. “I” labels the iris base. “P” labels the pars plicata of the ciliary body. “L” labels the ciliary cleft. “C” labels the corneoscleral trabecular meshwork. “U” labels the uveal trabecular meshwork. “G” labels the pectinate ligaments.
VII. Ciliary Body

a. **Pars plicata** - ruffled portion that produces aqueous

b. **Pars plana** - smooth portion that produces vitreous

c. **Ciliary epithelium** - has an outer pigmented and an inner non-pigmented portion; non-pigmented portion produces aqueous, hyaluronic acid, zonular ligaments and basement membrane

d. **Ciliary muscle and accommodation** - when muscle contracts with parasympathetic stimulation, tension is decreased on the zonular fibers supporting lens and lens becomes more spherical (shorter focal distance) because of the native elasticity of the lens capsule

e. **Zonular ligaments** - support lens; made from polymerized units of fibrillin and scant collagen
VIII. Lens

a. **Lens capsule**- basement membrane secreted by the cells of the lenticular epithelium
b. **Lens epithelium**- only on the anterior surface of the lens
c. **Lens fiber**- hexagonal in shape; interdigitate at the sutures
d. **Sutures**- “Y” shape on the anterior surface; inverted “Y” shape on the posterior surface
IX. Vitreous

X. Choroid

a. Tapetum - cellular in all carnivores; rodlets contain high levels of zinc-cysteine in the dog and zinc-riboflavin in the cat; cat tapetum is thicker than the dog tapetum; dog tapetum reflects light at a different wavelength and less efficiently than the cat

b. Choriocapillaris - the major blood supply for the outer retina, one of the most oxygen dependent tissues of the body

c. Bruch’s membrane - separates choroid and retina; composed of basement membrane of the pigmented epithelium of the retina, some intermediate connective and elastic tissue, and the basement membrane of the choriocapillaris

d. Choroidal vessels - run parallel to each other
XI. Retina

a. Retinal pigmented epithelium

b. Outer segment of rods and cones - cats have thicker rods than dogs

c. Inner segment of rods and cones - contains mitochondria and rough endoplasmic reticulum

d. Outer limiting membrane - tight junctions between Müller cells and photoreceptor cells
e. **Outer nuclear layer**- cell bodies of rods and cones; cone nuclei are larger and near the outer limiting membrane

f. **Outer plexiform layer**- synapses between photoreceptors and integrating neurons

g. **Inner nuclear layer**- cell bodies of integrating neurons, Müller cells, horizontal, bipolar and amacrine cells

h. **Inner plexiform layer**- synapses between integrating neurons and dendrites of optic tract neurons (ganglion cells)

i. **Ganglion cell layer**- cell bodies of optic tract neurons

j. **Nerve fiber layer**- afferent fibers to form optic nerve

k. **Inner limiting membrane**- basal lamina secreted by Müller cells; attached to vitreous

Normal canine retina. Labels correspond to letters in the outline under “Retina.”
XII. Retinal Blood Vessels

a. **Cat** - 3 major pairs of cilioretinal arteries and veins
   i. dorso-medial pair (curve laterally)
   ii. ventral-medial pair
   iii. ventral-lateral pair

b. **Dog**
   i. 20 cilioretinal arterioles radiate from optic disc and from 3-4 major veins
   ii. very short central retinal vein exists
   iii. retinal vessels tend to be more tortuous than in other animals

Normal feline retina. “T” labels the tapetum. “S” labels the choriocapillaris. Other letters correspond to the letters under the heading “Retina.”
Normal feline fundus. The retinal veins, “V,” are thicker than the retinal arteries, “A.”
XIII. Optic Nerve

a. **Optic disc**

b. **Lamina cribrosa** - area where nerve exits through sclera

c. **Myelinated and nonmyelinated axons** - ganglion cell layer has unmyelinated axons; axons become myelinated at optic disc

d. **Meninges**
   i. Dura mater - is continuous with cranial dura; merges anteriorly with outer 2/3 of sclera
   ii. Arachnoid- trabeculae are closely associated with dura; subarachnoid space is continuous with that of the brain
   iii. Arachnoid cap cells - cover the arachnoid to form the principle part of the arachnoid; support the dura from the subarachnoid space
   iv. Pia- closely applied to the surface of the optic nerve; sends septa into the optic nerve
   v. Pia trabeculae- originate in posterior lamina cribrosa region from the pia and surrounds the internal nerve fascicles

![Diagram of the optic nerve with labels: O - optic nerve, D - dura mater, P - pia, A - arachnoid, C - arachnoid cap cells, T - pia trabeculae.]

XIV. Sclera

a. **Thickness in the dog**
   i. Center of eyeground: similar to cat, only thinner
   ii. Entry point of optic nerve: 0.3-0.4 mm
   iii. Equator of globe: .12-.20 mm
   iv. Place of crossing in cornea: 0.6 mm

b. **Thickness in the cat**
   i. Center of eyeground: .09-.20 mm
   ii. Entry point of optic nerve: .13-.60 mm
   iii. Equator of globe: .09-.20 mm
   iv. Place of crossing in cornea: 1.1 mm in the form of a ring 5-7 mm wide

c. **Limbus**- corneoscleral junction; site of corneal stem cells

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"Normal feline optic nerve featuring the lamina cribrosa, “L.”

—Kristen Wrycha"