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- Coverage of pet animals, horses, birds and farm animals
- Practical tips for effective diagnosis
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- Step-by-step surgical procedures
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Frans C. Stades
Milton Wyman • Michael H. Boevé • Willy Neumann • Bernhard Spiess

Ophthalmology for the Veterinary Practitioner

Second, revised and expanded edition

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### Contents

#### 4 Ocular Emergencies
- Introduction ........................................ 31
- Luxation or propptosis of the globe ............ 31
- Chemical burns .................................... 34
- Blunt trauma ....................................... 34
- Orbital fractures ................................. 34
- Contusion of the globe ............................ 35
- Suffusion (hyposphagma) ......................... 35
- Traumatic corneal edema ......................... 35
- Hyphema ............................................ 35
- Trauma with deeper penetration ................. 36
- Lid lacerations and conjunctival sac wounds .................................................. 37
- Lacerations of the lid edge including the lacrimal canaliculus .................. 39
- Lacerations with loss of tissue .................. 39
- Conjunctival lacerations ......................... 39
- Corneal lacerations ............................... 40
- General rules of treatment ...................... 40
- Non-perforating corneal wounds ............... 40
- Perforating corneal defects ..................... 43

#### 5 Orbital and Periorbital Structures
- Introduction ........................................ 47
- Congenital abnormalities ....................... 48
- Trauma ............................................. 48
- Enophthalmos ...................................... 48
- Enophthalmos due to loss of support .......... 48
- Enophthalmos due to Horner's syndrome .... 49
- Exophthalmos ...................................... 49
- Exophthalmos due to swelling of the temporal muscles .................. 50
- Exophthalmos due to retrobulbar processes ........................................... 50
- Enucleation of the globe including the conjunctiva .................................. 53
- Evisceration of the globe ....................... 56
- Enucleation of the globe ....................... 56
- Exenteration of the orbit ....................... 56
- Orbitotomy ........................................ 56

#### 6 Lacrimal Apparatus
- Introduction ........................................ 59
- Keratoconjunctivitis sicca (KCS) ............... 61
- (Sialo)dacryoadenitis ............................ 64
- Tear stripe formation ............................. 65
- Micropunctum or stenosis of the lacrimal punctum ....................................... 65
- Atresia and secondary closure of the punctum ............................................. 66
- Dacryocystitis ..................................... 67
- Lacerations ........................................ 70
- Cysts and neoplasia ............................... 70

#### 7 Eyelids
- Introduction ........................................ 73
- Ankyloblepharon .................................... 74
- Aplasia palpebrae .................................. 74
- Dermoids / dysplasia of the lid ............... 76
- Distichiasis ........................................ 76
- Entropion .......................................... 78
- Entropion in sheep and horses .................. 86
- Ectropion and/or oversized palpebral fissure (macroblepharon) (Ect / OPF) .... 86
- Shortening of the lower palpebral conjunctiva ............................................ 87
- V-Y Method ......................................... 87
- Simple wedge resection ........................... 87
- Kuhn-Szymanowski method, Blaskovic's modification .................................... 87
- Kuhn-Szymanowski method ..................... 87
- Z-plasty / free transplants ....................... 88
- Total fissure shortening methods ............... 88
- Trichiasis ........................................... 89
- Nasal fold trichiasis ............................. 89
- Removal of nasal folds ......................... 89
- Medial canthoplasty .............................. 90
- Upper eyelid trichiasis .......................... 90
- Caruncle trichiasis and trichiasis in other locations ....................................... 91
- Blepharophimosis ................................ 94
- Oversized / overly palpebral fissure ........... 94
- Injuries ............................................. 94
- Ptosis .............................................. 94
- Lagophthalmos ..................................... 95
- Medial canthoplasty ............................... 95
- Lateral canthoplasty ............................... 95
- Blepharitis ........................................ 95
- Non-specific blepharitis ......................... 95
- Chronic blepharitis ............................... 95
- Specific blepharitis ............................... 96
- Chalazion / hordeolum ............................ 96
- Blepharitis adenomatosa (meibomianitis) .......... 96
- Juxtapalpebral defects / granulomatous changes ........................................... 96
- Eosinophilic granuloma ........................... 96
- Blepharitis in birds ............................... 99
- Blepharitis in horses .............................. 99
- Neoplasia of the eyelids ......................... 99
- Sarcoids in horses ................................ 103

#### 8 Conjunctiva and Nictitating Membrane
- Introduction ........................................ 105
- Non-pigmented margin of the nictitating membrane ....................................... 106
- Dermoid ............................................ 106
- Ectopic cilia ........................................ 106
### Contents

11.2.4.3 Hydrophthalmia or buphthalmos .......................... 162
11.3 **Clinical aspects of glaucoma** ................................. 162
11.3.1 Acute glaucoma ............................................. 162
11.3.2 Chronic glaucoma ........................................... 164
11.3.3 Therapeutic possibilities in glaucoma ..................... 165
11.4 **Secondary glaucoma** .......................................... 168
11.4.1 Secondary glaucoma associated with the lens or vitreous . 168
11.4.1.1 Dislocation of the lens .................................... 168
11.4.1.2 Lens proteins .............................................. 168
11.4.1.3 Cataract .................................................. 168
11.4.2 Secondary glaucoma associated with uveal changes .......... 168
11.4.2.1 Uveitis .................................................. 168
11.4.2.2 Iris atrophy / iridoschisis ................................ 168
11.4.3 Secondary glaucoma associated with trauma ................ 169
11.4.4 Secondary glaucoma associated with intraocular neoplasia . 169
11.4.5 Secondary glaucoma associated with medication ............... 169
11.4.6 Secondary glaucoma associated with ocular surgery .......... 169
11.4.6.1 Extracapsular lens extraction ................................ 169
11.4.6.2 Intracapsular lens extraction ................................ 169
11.5 **Phthisis bulbi** .................................................. 169
11.6 **Uvea** ............................................................. 171
11.6.1 Introduction .................................................. 171
11.6.2 Iris ............................................................. 171
11.6.2.1 Ciliary body .............................................. 172
11.6.2.2 Choroid .................................................. 173
11.6.2.2 Persistent (epp)uvalary membrane .......................... 173
11.6.3 Coloboma ..................................................... 174
11.6.4 Acoria/aniridia .............................................. 175
11.6.5 Heterochromia of the iris ................................... 175
11.6.6 Blue iris/white coat .......................................... 175
11.6.6.1 Oculocutaneous albinism and deafness ................. 175
11.6.6.2 Partial oculocutaneous albinism ......................... 175
11.7 **Acquired color differences in the iris** ..................... 175
11.7.1 Dysplastic abnormalities .................................... 176
11.7.2 Trauma ....................................................... 176
11.7.3 Leaking of vessels .......................................... 176
11.7.4 Coagulation disorders ...................................... 176
11.7.5 Uveitis ....................................................... 177
11.7.6 Neoplasms ................................................... 177
11.8 **Uveitis (anterier)** .............................................. 177
11.8.1 Traumatic uveitis ........................................... 179
11.8.2 Metabolic uveitis ........................................... 179
11.8.3 Infections .................................................... 179
11.8.3.1 Viral ...................................................... 179
11.8.3.2 Rickettsia ............................................... 180
11.8.3.3 Bacterial .................................................. 180
11.8.3.4 Mycotic .................................................. 180
11.8.3.5 Algae ...................................................... 180
11.9 **Secondary glaucoma** ........................................... 180
11.9.1 Traumatic uveitis ........................................... 180
11.9.2 Anterior uveitis in the rabbit ................................ 183
12.11 Iris atrophy ..................................................... 183
12.12 Dysautonomia or pupil dilatation syndrome (Key-Gaskell Syndrome) ................................. 184
12.13 Horner's syndrome ............................................... 184
12.14 Other pupillary abnormalities .................................. 184
12.15 Neoplasia ......................................................... 184
12.16 **Posterior Uvea** ................................................ 186

### 13 Lens and Vitreous

13.1 **Introduction** .................................................. 189
13.1.1 Ontogenesis .................................................. 189
13.1.2 Anatomy and physiology ..................................... 190
13.2 **Vitreous** .......................................................... 191
13.2.1 Secondary glaucoma associated with cataract ................ 192
13.2.2 Persistent hyaloid artery (PHA) .............................. 192
13.2.3 Persistent hyperplastic tunica vasculosa ...................... 193
13.3 **Developmental disorders of the lens** ........................ 193
13.3.1 Types of cataract ............................................ 196
13.3.2 Secondary cataract .......................................... 197
13.3.3 Therapeutic possibilities .................................... 197
13.3.4 Prevention of cataract ...................................... 201
13.4 **Lens luxation or ectopic lens** ................................ 201
13.5 **Vitreous floaters, asteroid hyalosis, and synchysis scintillans** ................................. 206
13.5.1 Vitreous floaters ............................................. 206
13.5.2 Asteroid hyalosis ............................................. 206
13.5.3 Synchysis scintillans ......................................... 206
13.6 **Hemorrhages and/or exudates in the vitreous** .................. 206
13.6.1 Blood .......................................................... 206
13.6.2 Hemorrhagic or other exudate in the vitreous .............. 207

### 14 Fundus and Optic Nerve

14.1 **Introduction** .................................................. 209
14.1.1 Ontogenesis .................................................. 209
14.1.2 Retina .......................................................... 211
14.1.3 Optic nerve or tract ......................................... 213
14.1.4 Vascular supply .............................................. 213
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.1.5</td>
<td>Choroid (vascular membranes)</td>
</tr>
<tr>
<td>14.2</td>
<td>Symptoms, pathologic changes, and reaction patterns of the fundus</td>
</tr>
<tr>
<td>14.3</td>
<td>Aplasia</td>
</tr>
<tr>
<td>14.4</td>
<td>Micropapilla and hypoplastic papilla</td>
</tr>
<tr>
<td>14.5</td>
<td>Coloboma</td>
</tr>
<tr>
<td>14.6</td>
<td>Retinal dysplasia (RD)</td>
</tr>
<tr>
<td>14.7</td>
<td>Collie eye anomaly (CEA)</td>
</tr>
<tr>
<td>14.8</td>
<td>Inherited enzyme deficiencies</td>
</tr>
<tr>
<td>14.9</td>
<td>Hereditary (progressive) retinal dysplasias/atrophy/ degeneration (PRA)</td>
</tr>
<tr>
<td>14.9.1</td>
<td>Hereditary progressive retinal degeneration/ progressive retinal atrophy</td>
</tr>
<tr>
<td>14.9.2</td>
<td>Hereditary (stationary) night blindness</td>
</tr>
<tr>
<td>14.9.3</td>
<td>Hereditary day blindness</td>
</tr>
<tr>
<td>14.9.4</td>
<td>Pigment epithelial dystrophy (PED)</td>
</tr>
<tr>
<td>14.10</td>
<td>Hemorrhages and other vascular abnormalities</td>
</tr>
<tr>
<td>14.10.1</td>
<td>Vascular occlusion</td>
</tr>
<tr>
<td>14.10.2</td>
<td>Hyperlipoproteinemia</td>
</tr>
<tr>
<td>14.11</td>
<td>Trauma</td>
</tr>
<tr>
<td>14.12</td>
<td>Intoxications</td>
</tr>
<tr>
<td>14.12.1</td>
<td>Iatrogenic intoxications</td>
</tr>
<tr>
<td>14.13</td>
<td>Abnormalities of nutritional origin</td>
</tr>
<tr>
<td>14.13.1</td>
<td>Vitamin A and vitamin E deficiencies</td>
</tr>
<tr>
<td>14.13.2</td>
<td>Thiamine (aneurine) or vitamin B1 deficiency</td>
</tr>
<tr>
<td>14.13.3</td>
<td>Taurine deficiency</td>
</tr>
<tr>
<td>14.14</td>
<td>Posterior uveitis/chorioretinitis/ retinitis</td>
</tr>
<tr>
<td>14.15</td>
<td>Retinal detachment</td>
</tr>
<tr>
<td>14.16</td>
<td>Hypertensive Retinopathy</td>
</tr>
<tr>
<td>14.17</td>
<td>Non-hereditary degenerative abnormalities</td>
</tr>
<tr>
<td>14.17.1</td>
<td>Feline central retinal degeneration (FCRD)</td>
</tr>
<tr>
<td>14.18</td>
<td>Papilledema</td>
</tr>
<tr>
<td>14.19</td>
<td>Papillitis, optic neuritis</td>
</tr>
<tr>
<td>14.20</td>
<td>Neoplasia</td>
</tr>
<tr>
<td>14.21</td>
<td>Amblyopia/amaurosis</td>
</tr>
<tr>
<td>14.21.1</td>
<td>Sudden acquired retinal degeneration (SARD)</td>
</tr>
<tr>
<td>14.22</td>
<td>Hypertensive Retinopathy</td>
</tr>
<tr>
<td>15</td>
<td>Breed Predispositions and Hereditary Eye Diseases</td>
</tr>
<tr>
<td>15.1</td>
<td>Introduction</td>
</tr>
<tr>
<td>15.2</td>
<td>Modes of inheritance</td>
</tr>
<tr>
<td>15.2.1</td>
<td>Simple inheritance</td>
</tr>
<tr>
<td>15.2.1.1</td>
<td>Autosomal dominant (not sex-linked)</td>
</tr>
<tr>
<td>15.2.1.2</td>
<td>Autosomal recessive (not sex-linked)</td>
</tr>
<tr>
<td>15.2.1.3</td>
<td>Sex-linked inheritance</td>
</tr>
<tr>
<td>15.2.1.4</td>
<td>Incomplete recessive or dominant, or incomplete penetrance</td>
</tr>
<tr>
<td>15.2.2</td>
<td>Multiple (polygenic) transmission</td>
</tr>
<tr>
<td>15.3</td>
<td>Is the abnormality inherited?</td>
</tr>
<tr>
<td>15.4</td>
<td>Breed predispositions and inherited eye abnormalities</td>
</tr>
<tr>
<td>16</td>
<td>Glossary of Terms Relating to the Eye</td>
</tr>
<tr>
<td>Index</td>
<td></td>
</tr>
</tbody>
</table>
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Abbreviations

a. artery
ACE angiotensin converting enzyme
ant. anterior
BAB blood-aqueous barrier
BCE before the Common Era
brev. brevis
BSS balanced salt solution
CE Common Era
CEA Collie eye anomaly
CH chorioidal hypoplasia
CRD chorioretinal dysplasia
CSNB congenital stationary night blindness
CT computed tomography
dv dorsoventral
ERG electroretinogram
ERU equine recurrent uveitis
ext. external
FCRD feline central retinal degeneration
FHV-1 feline herpes virus type 1
HA hyaloid artery
IOL intra-ocular lens
IOP intraocular pressure
KCS keratoconjunctivitis sicca
lat. lateral
LE lupus erythematosus

long. longus
m. muscle
med. medial
MRI magnetic resonance imaging
OD oculus dexter (right eye)
OS oculus sinister (left eye)
OU oculus uterque (both eyes)
PDT parotid duct transposition
PHA persistent hyaloid artery
PHTVL/PHPV persistent hyperplastic tunica vasculosa lentis/ persistent hyperplastic primary vitreous
PM pupillary membrane
PMMA polymethylmetacrylate
post. posterior
PRA progressive retinal atrophy
PU/PD polyuria/polydipsia
RD retinal dysplasia
RPE retinal pigment epithelium
SARD sudden acquired retinal degeneration
STT Schirmer tear test
TVL tunica vasculosa lentis
UDS Uveo-dermatologic syndrome
v. vein
VEP visual evoked potential
Origin of Plates and Figures

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10.30, 14.2: B. Spiess, Department for Small Animals, Ophthalmology Unit, Vetsuisse Faculty, University of Zurich, Switzerland.
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Remaining figures: F. C. Stades.
1 Introduction

The previous editions of this book have clearly proved their value. After the Dutch, German and English first editions in 1996, the second and third editions in German, Spanish, Portuguese, Italian and Japanese versions of the book have been published.

Over the past 10 years, continued progress has been made in the knowledge and medications associated with veterinary medicine, and in veterinary ophthalmology, in particular. Of direct interest to the practitioner are not only those drugs that are not available anymore, but also and more importantly, the new drugs and medications that have become available in the recent years. All together, these are good reasons for a thoroughly revised, new edition of this book.

We are very happy about the willingness of Prof. Dr. B. Spiess, Dip. ACVO/ECVO to join the team as coauthor. All the coauthors have each screened a part of the chapters and the editor has screened all and has tried to bring any differences in opinion, if necessary and possible, to a consensus.

The morphologic and physiologic features of the eye and the characteristics of ocular diseases are similar among domestic animals. Nevertheless, there are species differences in structure, in reactions of the eye, and in diagnostic procedures. There are also specific diseases and treatments in the different species.

Ophthalmologic diseases comprise a large proportion of the patients seen by the small animal practitioner. Eye problems are especially frequent in dog breeds with redundant nasal and forehead skin folds, misdirected hairs, or poorly apposed lids, and they cause discomfort to the animal. The large animal practitioner will see eye problems in horses similar to those in small animals, but usually less frequently, and some conditions are specific to the horse. In cattle, sheep, goats, swine, small mammals, and birds, eye diseases are also generally less frequent than in pet animals, but they may cause considerable problems when larger groups of animals are affected. Breed predisposition and hereditary ophthalmic disorders are frequent in all species, but are mainly recognized in the dog. A knowledge of breeds predisposed to eye anomalies and hereditary eye diseases is of major importance. In addition, the authors have tried to pay special attention to the recognition of eye abnormalities such as trichiasis, glaucoma, lens luxation, and progressive retinal atrophy, all of which are difficult to diagnose without specialized ophthalmic equipment.

Much has been published on the subject of veterinary ophthalmology and there are many excellent and detailed books on ophthalmology as well as beautiful atlases. The majority of ophthalmic disorders can be diagnosed using relatively simple equipment and without the need for additional or specialized procedures. However, there is little practical in-
Fig. 1:
Partly opened section of the eye and the nomenclature.
most helpful. We are also most grateful for the helpful criticism of Prof. Dr. J. Fink-Gremmels and Dr. C. Görig. The many hours spent by Dr. Bruce Belshaw in editing the original manuscript were vital for the book. His devotion to this task is gratefully acknowledged. We are also greatly indebted to Dr. Peter Beyon for his thorough, final correction of the manuscript.

The authors are especially grateful for the encouragement, understanding, and active help of their families during the preparation of this book.
2 Clinical and Differential Diagnostic Procedures

Emphasis should be placed at the start on both the patient’s history and those diagnostic procedures that are specific to the eye and adnexa when presented with an animal with an ocular problem. The general history and examination should be dealt with only briefly. If there are indications that another system is involved or that there is a systemic disease (e.g. sneezing, hemorrhage, loss of weight, neoplasia), then a general physical examination must also be performed.

It is important to follow a routine examination protocol as a checklist (Fig. 2.1) in order to provide a complete evaluation of the eye and adnexa. The recommended ophthalmic examination is described briefly; for further details of ophthalmic examination procedures, the reader is referred to specialized literature on the subject.1,2,3

2.1 Description of the patient

In addition to the age and sex of the patient, the species, breed and origin are of special importance. Many disorders of the eye have a predisposition in certain breeds or are inherited in specific breeds, and specific breed characteristics such as brachycephaly and/or redundant skin folding have to be considered.

2.2 Patient history

The following questions are important when taking the history:

- Was the onset of the problem acute or gradual, or was it present when the dog was obtained? Does it affect one or both eyes and if the latter, which eye is worse? Is the problem improving, static, or becoming worse?
- Have there been signs of general illness as well? Has the patient been vaccinated recently? Are there signs such as rubbing or scratching at the eyes, excessive blinking, blepharospasm, photophobia, or pain during barking, yawning, chewing or biting?
- Is there a discharge from the eye (watery, mucoid, purulent)? Does it result in periocular soiling and to what degree? Is the surface of the eye dry and encrusted?
- Is there deterioration of vision, disorientation, or a change in the patient’s behavior, and if there are such changes, are they more pronounced in bright or dim light?
- If the owner describes the eye as bulging, is it protruding from the orbit (exophthalmic) or is the globe itself enlarged (microphthalmos / buphthalmos)? Or, in contrast, is the eye too small (microphthalmos / phthisis bulbi) or lying too deep in the orbit (enophthalmos)?
- Are there changes in the color, position, or form of the globe?
- What are the normal living conditions of the animal: does it have to climb stairs, is it on a leash outdoors, is it restricted to its own terrain or free to roam, or has the animal a specific function (e.g. hunting, watchdog, jumping horse)?
- What is the composition of the family: are there children, are there other animals?
- What previous illnesses has the patient had, and what eye diseases? What information is available about illnesses of other animals in the same household or of parents or siblings of the patient?
- Are there any abnormalities in eating, volume of water drunk, urination, or defecation?
- Has the patient received eye washes or topical and/or systemic medication for the present ophthalmic problem?
Eye Examination Form

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<th>Clinician:</th>
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Weight: Vet informed (date); Tel. . . . . . . . . . . . . .

Problem:

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<tr>
<td>static</td>
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<tr>
<td>recurrence</td>
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<tr>
<td>general illness</td>
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Vision during:

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<tr>
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Discharge:

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<tr>
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<td></td>
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Abnormalities, siblings, parents, family:

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<th>defection:</th>
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Recent therapy and result:

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<td>culture yin</td>
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Eyelids:

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Fig. 2.1: Example of an eye examination protocol.
**Patient history**

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<thead>
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<td>○ Cytology</td>
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<td>○ Histology</td>
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<tr>
<td>○ Haematology</td>
<td>○ Haematology</td>
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</table>
2.3 Animal handling, equipment, and instruments

The examination should be performed in a room that can be dimmed and completely darkened, with a strong spotlight available above the patient. The examiner should be seated during the examination. Dogs and cats are held in a “Sphinx” position (Plate 2.1) at the edge of the examination table. All four feet of cats should be fixed to prevent injury. Materials for culturing like moist sterile swabs and cytobrushes are important aids in ophthalmologic diagnostics.

2.3.1 Restraint and sedation

Dogs should be muzzled if they are nervous, unreliable, or unfriendly. In dogs and cats, tranquilizers usually cause enophthalmos, inwards rotation of the globe, and protrusion of the nictitating membrane. For these reasons, they should only be used in low doses. In cats, a low dose of ketamine-xylazine results in excellent positioning of the globe for ophthalmic examination. For ocular irrigation, 0.9% NaCl solution in a soft plastic infusion bottle with a 2-mm cannula can be used. Proparacaine, lidocaine, or tetracaine, which can cause irritation during induction, can be used for topical anesthesia. Tropicamide can be used as a short-acting mydriatic. In puppies and kittens, and in adult animals or patients with apparent congenital intraocular abnormalities, 0.5–1% atropine can be used.

In horses a very low dose of detomidine (1–1.5 mg/100 kg) results in excellent positioning of the globe for ophthalmic examination. Blocking or infiltration anesthesia (supraorbital and/or auriculopalpebral) is also possible. However, general anesthesia is preferred for more extensive surgery, because of the lack of swelling and the better positioning for the surgeon.

2.3.2 Materials and instruments

The instruments that should be available include a penlight, a direct ophthalmoscope with a slit beam and a blue filter, Von Graefe or other suitable forceps, a curette, and a spatula. Disposable materials include the Schirmer tear test, fluorescein test strips (or single dose drops), rose bengal strips or single dose vials, and tubes containing transport medium for microbiological culturing. For ocular irrigation, 0.9% NaCl solution in a soft plastic infusion bottle with a 2-mm cannula can be used. Proparacaine, lidocaine, or tetracaine, which can cause irritation during induction, can be used for topical anesthesia. Tropicamide can be used as a short-acting mydriatic. In puppies and kittens, and in adult animals or patients with apparent congenital intraocular abnormalities, 0.5–1% atropine can be used.

2.4 Examination of the eye and its adnexa

General examination of the eye should start with a gross observation of the position and symmetry of the eyes and adnexa. In principle the specific examination begins with the adnexa and progresses inwards into the globe. However, the lacrimal tear film should be examined before it is influenced by other procedures, and thus before inspection of the lids. The globe as a whole can be examined either after the examination of the lids or after examination of the conjunctiva, but this important step should not be forgotten. The presence or absence of periocular swelling and the gross appearance of the cornea and conjunctiva should be determined. Observe the animal’s ability to move freely in a room with obstructions and its ability to follow moving objects such as cotton balls.

For purposes of recording findings, the points of reference are anterior or posterior, nasal/medial or temporal/lateral, dorsal/superior or ventral/inferior, and positions corresponding to the numbers on a clock.

2.4.1 Head, skull, and orbital area

The position of the head and its relationship to the body (e.g. tilted left or right) and the muscle tone are noted while the animal walks into the examination room, when it is at rest, and when it is placed on the examination table. The patient is stroked on the head not only as an introduction, but also for the inspection of its chewing muscles for pain, warmth, swelling or atrophy, and asymmetry. The mandibular lymph nodes are palpated. If abnormalities are found, all nodes are examined. The sinuses and the bony and soft tissue parts of the orbits are examined by percussion and are inspected for swelling, atrophy, abnormally hard or soft areas, pain, and asymmetry. If there are signs of a retrobulbar process, the mouth is opened to determine whether it can be fully opened and whether
opening causes pain. The soft tissue area behind the upper last
molars (Plate 2.2), forming the bottom of the orbit, is exam-
ined for abnormalities such as discoloration, abscesses, swell-
ing, etc. With the dog’s mouth closed, the same area can be
palpated via the corners of the mouth with the tips of ones
fingers. When pressure is applied, the globe will be displaced
1–2 mm or more anteriorly in the orbit. If there is a retrobul-
bar mass, this may be painful, the globe will move much more,
and/or the area will be found to be hard and indurated.

The medial canthus area is inspected for the presence of
tear-moistened hairs. In cats, these areas may contain particles
of pigment. Hairs surrounding the eye can irritate the conj-
junctiva and/or eyeball (trichiasis, especially in the Blood-
hound, Chow Chow, and short-nosed animals such as the
Pekingese and the “Peke-faced” Persian cat), and will show
wetness.

2.4.2 Tear film and tear production

The tear film and tear production are inspected before they
can be influenced by further examinations. The tear film is
examined at the junction of the cornea and the lid margin or
at the edge of the nictitating membrane (Plate 2.3). The cor-
nea and the image it reflects are inspected to see whether the
image is intact, not distorted, and has regular margins. If there
is doubt about the integrity of the tear film or there is a mu-
copurulent exudate, the Schirmer tear test (STT) is performed
(Plate 2.4). The test strip is grasped with a dry forceps and the
round sterile end is placed in the ventral conjunctival sac about
one-third of the distance from the lateral canthus. After 60 sec-
onds, the strip is removed and the length of strip that has be-
come moistened, from the notch, is measured in millimeters.
The reference values are 13–23 mm in dogs, 10–20 mm in
cats, 20–30 mm in horses, and 15–20 mm in rabbits (Table 2.1).
Values of 9 mm or less in dogs and 6 mm or less in cats indicate
keratoconjunctivitis sicca (KCS).5,6,7 If the value is between 10
and 13 mm in dogs or cats, rose bengal stain can be performed
after fluorescein staining has been completed.8 Rose bengal
staining reveals intact but devitalized epithelial cells in areas
where the tear film has broken down. However, this examina-
tion requires magnification, preferably a slit lamp (biomicro-
scope), which is not usually available in general practice. It
should be noted that rose bengal will stain devitalized epiteh-
ial cells that are infected with the rhinotracheitis virus (herpes
virus) in cats. The resulting stained areas with a dendritic ap-
ppearance are pathognomonic for this disease.

| Table 2.1: Reference values for tear production (Schirmer tear test [type 1]) |
|------------------|--------|--------|
|                  | µl     | SD     | Author           |
| Dog              | 20.2   | 3.0    | Hamor⁹           |
|                  | 18.8   | 2.6    | Saito¹⁰          |
| Cat              | 16.2   | 3.8    | McLaughlin¹¹     |
| Horse            | 22/26 (summer/winter) | 6.0   | Beech¹²         |
| Rabbit*          | 4.85   | 2.90   | Biricik¹³        |
|                  | 5.30   | 2.96   | Abrams¹⁴        |

* There are significant breed differences in rabbits (Abrams¹⁴)
2.4.3 Ocular discharge

Discharge, in spite of normal tear production, can have an infectious cause and thus, a sample should be collected for microbiologic culture. If the transport time is likely to exceed one hour, the specimen should be placed in transport medium and kept refrigerated to prevent drying and thus the death of the organisms. After collection of the sample, the conjunctival sac is irrigated with 0.9% NaCl solution.

2.4.4 Eyelids (palpebrae)

During examination of the lids, ectropion or entropion may be artificially corrected if the patient is restrained in a way that places traction on the skin behind the lids (Plate 2.5). The lid reflex and the apposition of the lid margins to the globe are inspected. The lid edges should be in contact with and follow the curvature of the cornea. The margins should be hairless in cats, while some eyelash hair is to be expected in dogs, horses, and cattle. The lid margins should also be pigmented, smooth, glossy, and intact. Plate 2.6 shows the lid margins in a horse with lashes on the upper lid as in humans. The lid margins should be inspected for discoloration, swellings, alopecia, and moisture. Scrapings are made of suspicious areas for examination for parasites (demodex, sarcoptes). Defects in the lid margins or absence of meibomian glands (Plate 2.7) may be due to aplasia palpebrae or injury to the lid. Wet lid margins or lid hairs indicate a disturbance of the normal lid function due to abnormalities, such as distichiasis, chalazion, or hordeolum, or direct contact between the hairs on the outer surface of the lid.
and the conjunctiva and/or cornea (entropion, trichiasis, exophthalmos). Wet, hairless, discolored areas may be due to chronic blepharospasm. Suspected entropion can be confirmed by the entropion test. For this purpose, a small skin fold, approximately 10–15 mm below the lower lid margin, is retracted slightly so that the lid margin turns inwards and the outer edge lies against the cornea (Plate 2.8). This should be corrected by a single blink, and its persistence indicates (habitual) entropion.

### 2.4.5 Conjunctiva

The conjunctiva is a thin, transparent membrane, through which the sclera and subconjunctival tissues should be clearly recognizable. The bulbar conjunctiva is usually very pale, especially in the cat. The palpebral conjunctiva is much redder in appearance because of the arborization of its vessels. Because of anastomoses between the uveal and bulbar conjunctival vascular systems, inflammation in the globe (uveitis) or increased intraocular pressure (IOP) will result in an engorgement of the conjunctival vessels at the limbus. These vessels are located more or less perpendicular to the limbus and they will be seen to move with the conjunctiva when it is moved. Chronic irritation by dust or bacteria causes a diffuse inflammatory redness, primarily in the lower conjunctival sac. The conjunctiva is examined for abnormalities such as discoloration, wetness, smoothness, or the presence of follicles (Plate 2.9). Follicles are small, glassy eruptions on the surface, especially on the inner surface of the nictitating membrane near its margin.

**Plate 2.8:**
Entropion test. A small skin fold, about 15 mm below the lid margin, is retracted so that the lid margin entropionizes. This should be immediately corrected by blinking and its persistence indicates entropion.

**Plate 2.9:**
Inspection of the lid edge and the palpebral conjunctiva of the upper lid. The lid margin is everted and the conjunctiva stretched with a Von Graefe’s forceps. A group of follicles centrally located in the conjunctiva is now shown (OS, dog).

**Plate 2.10:**
The “blinking” of the nictitating membrane (NM) of birds comes from the dorsomedial (OD). The NM in birds is almost transparent, blinks frequently and makes the precorneal tear film. In the anterior chamber in this eye is a worm, which is also visible through the NM, demonstrating its transparency.
Protrusion of the nictitating membrane may be the result of enophthalmos or a swelling at the base of the membrane. The combination of protrusion and exophthalmos indicates increased retrobulbar pressure, e.g. as a result of retrobulbar swelling. If there is swelling or discoloration of the conjunctiva, a swab, smear, or scraping should be taken for cytologic examination.

2.4.6 Globe (bulbus)

The symmetrical movement of the eyes, both horizontally and vertically, and the ability to fix both eyes on a distant point (as far as possible for the species) are evaluated. Abnormalities of gaze such as strabismus (Siamese; Plate 9.1) or rapid oscillations of the globe (nystagmus) should be assessed. The position of the globe in the orbit is examined for enophthalmos or exophthalmos. Enophthalmos may be a response to pain, but it can also be secondary to loss of retrobulbar pressure or support, neurological (e.g. loss of sympathetic tone, Horner’s syndrome), or loss of condition, or a lack of well-being (especially in the cat); thus symmetry is an important consideration. The retrobulbar pressure (or retropulsion) is evaluated by placing the tips of the two forefingers on the closed upper lids covering the globes, and gently pressing the globes backwards into the orbit (Plate 2.11). Space-occupying lesions within the orbit behind the eye will prevent its displacement into the orbit and/or make this painful.

Both globes should be of the same diameter (approximately 22–24 mm in the dog and cat) and in proportion to the orbit and the head of the patient. It is usually easy to recognize if one globe is too large (buphthalmos or macrophthalmia) or too small (microphthalmia or phthisical). The diagnosis of bilateral microphthalmia is more difficult. In cases of doubt, ultrasonography (or MRI) measurements have to be performed. A difference in color between the eyes, especially involving the cornea, may give the impression that the globes are of different sizes. An edematous, white, cloudy cornea will suggest enlargement of the globe. A microphthalmic eye may suggest enophthalmos or, vice versa, enophthalmos may suggest microphthalmos. When this is in doubt, measurement of the horizontal corneal diameter may be helpful (normally about 17 mm in the adult dog, 18 mm in the cat).

Measurement of IOP is still a major problem for the practitioner (Table 2.2). Manual tonometry is a crude method of determining very hard and very soft eyes (Plate 2.12). It is performed by placing the tips of the slightly curved forefingers over the closed lids on the globes, pressing them medially against the orbital wall.

Table 2.2: Intraocular pressure reference values

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<tr>
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<td>—</td>
<td>Wagner24</td>
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<td>Rat</td>
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<td>5.25</td>
<td>Mermoud25</td>
</tr>
<tr>
<td>Pigeon</td>
<td>13.4</td>
<td>1.4</td>
<td>Korbel26</td>
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</table>

Plate 2.11:
Palpation of the retrobulbar pressure. The tips of the forefingers are placed on the closed upper lids covering the globes, gently pressing the globes backwards into the orbit.

Plate 2.12:
Bilateral palpation of the ocular tension by placing the tips of the slightly curved forefingers over the closed lids on the globes, pressing them medially against the orbital wall.
ally against the orbital wall (not posteriorly toward the apex of the orbit; this is retropulsion and does not measure indentation of the globe). When the spherical curvature of the globes is felt, the globes are indented slightly so that the pressure is perceived. This perception of the pressure can be compared with that of a dog without ocular problems, or with that of the examiner. If manual tonometry is the only method available to the practitioner, and glaucoma is suspected, the patient should be referred immediately. Indentation (Schiötz) tonometry is influenced by the different radius of the cornea in different species and in different individuals, and of the globe during the progress of glaucoma. However, it can be performed with reasonable reliability when performed frequently and with carefully cleaned equipment. Then it is more applicable to the management of this devastating disease than gross observation. In addition, the Tonopen® (applanation tonometer) is available; this can be used very effectively with practice, but is expensive. Recently, a new rebound tonometer, TonoVet®, has become available. The apparatus is easy to handle and can be used without topical anesthesia. These tonometers are most accurate at the ranges of IOP of direct interest in glaucoma, but are less reliable with low or very high pressures.16,17,18,19

2.4.7 Sclera

The sclera is inspected for defects, discoloration, swelling, as well as injected and/or congested vessels. The scleral vessels run more or less parallel to the limbus and they are darker than the overlying conjunctival vessels.

2.4.8 Cornea

The normal cornea has an intact lacrimal tear film, is without defects, and is smooth, spherical, reflective, transparent, and highly sensitive. The corneal surface is inspected in a darkened room, preferably with a loupe (as in the direct ophthalmoscope: +20 to +40 and its slit beam; Fig. 2.2.). This inspection should be done by looking from all sides, and also with the light source coming from all sides. Corneal edema (island pattern, bluish-white, irregular) must be differentiated from scar tissue (dense, white, sclera-like tissue) and corneal lipidosis or dystrophy (glittering, white, resembling sugar, or glass fiber crystals). Pigmentation of the cornea resulting from chronic irritation is found especially in the dog as a reaction to chronic irritation. Corneal pigmentation is rare in the cat; however, a darkly pigmented deposit (corneal sequestration; Plate 2.7, 10.23) can occur in the central or pericentral cornea. If there are irregularities of the corneal surface, the cornea is stained by fluorescein dye to search for epithelial defects. Strips impregnated with the dye are held either in the ventral conjunctival sac or adjacent to the dorsal bulbar conjunctiva for 1–2 seconds. If the lacrimal passage to the nose is also being tested (passage time 30–60 seconds in the dog and cat), the strips are held in place longer, and the conjunctival sac and the cornea must be irrigated and the nose lowered. Defects in the cornea will be seen as intense yellow-green fluorescent irregularities. To potentiate the florescence, the blue filter of an ophthalmoscope or a Wood’s lamp may be used.

2.4.9 Anterior and posterior chambers

The anterior chamber is examined for transparency, flare, contour, and depth. The inferior inner surface of the cornea is checked for precipitates adhering to the endothelium, and the anterior chamber is examined for free precipitates (hypopyon), flare, clots, or blood (hypHEMA; signs of uveitis). Transparent, variably pigmented and sized spheres that are free-floating in the anterior chamber or fixed at the edge of the pupil are usually harmless iris or ciliary body cysts. Pigmented or discolored bulging areas on the iris surface may indicate neoplasms of the anterior uvea. A large, transparent or white disc in the anterior chamber may indicate a luxated lens. If the lens is luxated posteriorly, the anterior chamber will be deep, the iris hangs straight down and it will “flutter” after an eye movement (iridodonesis). If the lens is dislocated to one side, an aphakic, luminescent crescent may be seen between the contour of the lens and the pupil. The posterior chamber cannot normally be inspected. If a mass between the anterior surface of the lens and the back of the iris presses the iris forward, the lesion can be seen in the posterior chamber.
2.4.10 Pupil and iris

The normal iris is generally pigmented, but it may be blue in the Siamese (in the Siamese the anterior layers of the iris are unpigmented, the pigment of the pigmented epithelium on the posterior surface of the iris causes the blue aspect) or white, as in blue merle dogs. In miosis, the pupil of the cat has a vertical slit form, while that in horses, sheep, goats, and cattle is horizontally oval. In mydriasis, the pupils in all species are more or less round. The edge of the pupil bears iridic granules, varying from microscopically small ones in small animals to large ones in horses and ruminants (Plate 2.13). They are most prominent in the dorsal pupillary margin and are referred to as “corpora nigra”. The absence of these in horses indicates previous inflammatory disease.

The margin of the iris (pupil) is inspected for adhesions to the surface of the lens (posterior synechia) or adhesions to the cornea (anterior synechia). The pupil should react in 2–3 seconds when a pen-light is shone into the visual axis of the eye. The contralateral eye should also respond within a few seconds. Unilateral miosis can be a sign of uveitis or Horner’s syndrome (other signs of Horner’s syndrome are enophthalmos, ptosis, and protrusion of the nictitating membrane). Unilateral or bilateral mydriasis can be due to dysfunction of the afferent part of the reflex arc, the retina, the optic nerve, or the brain and the oculomotor nerve, but it can also be due to glaucoma. In nervous, frightened, or angry animals, the release of epinephrine may block the pupillary response.

2.4.11 Lens

During examination in the dark with the slit beam (Plate 13.3), special attention is paid to the transparency, diameter, and form of the lens. This examination should also be performed after inducing total mydriasis (15–20 minutes after one drop of 0.5% tropicamide; in young animals 20–45 minutes after 1% atropine).

In birds, a topical mydriatic does not induce mydriasis. Mydriasis can be induced by injecting d-tubocurarine into the anterior chamber, but because of the risks associated with this, it is almost exclusively used as a last resort. Alternatively, topical or intra-ocular tubocurarine, vecuronium, can be used.

If there are signs of luxation of the lens (clouds over the pupil edge, aphakic crescent, “disc” in the anterior chamber, or a deeper anterior chamber) or of glaucoma (mydriasis and complete diffuse corneal edema), the use of a mydriatic is contraindicated. The lens can be displaced anteriorly or posteriorly. If there is no associated cataract, the luxation may go unnoticed by the owner for some time. In the cat, secondary glaucoma usually occurs less acutely and rapidly than in the dog.

2.4.12 Vitreous

The vitreous is inspected by slit beam for white strings (persistent hyaloid artery from the center of the posterior pole of the lens), glittering (cholesterol) crystals, or larger clumps. Flares of exudate, blood, membranes, vessels, or tissue may be signs of posterior uveitis, retinal detachment, or intraocular neoplasia.

2.4.13 Fundus

In animals, the fundus can usually be examined quite satisfactorily with a direct ophthalmoscope. Dogs and cats must be positioned symmetrically on the table, like a sphinx. If the animal is uncooperative, the inexperienced clinician should consider sedation, unless the condition of the animal prevents this. If there are signs of defective vision, mydriasis should be induced after carrying out vision tests.
Vision is ideally tested, especially in the horse, when the animal is allowed to move around freely in an unfamiliar area containing obstacles. Testing vision in cats is not simple, because of their independent behavior; it is also difficult in puppies. Alternatives are:

- Observing the animal moving freely and almost falling from the examination table may be informative, but is more time-consuming.
- Observing how the eyes follow a small piece of cotton (distance about 20 cm).
- Optical placing reflex. Although less dependable, this test is useful in light-weight animals such as puppies, kittens, cats, and small dogs.
- The menace reaction, pointing at the eye with a finger, must be done without eliciting air currents, otherwise it is very unreliable.

The optic disc or papilla is located slightly ventral and nasal to the posterior pole of the fundus (Plate 2.14). The optic disc in dogs is more or less rounded and, in some animals, surrounded by a small edge of white glial tissue. The retinal arterioles are thinner and bright red; the venules thicker and dark red. In dogs, the venules may anastomose in the disc. In cats, the optic disc is small (about 1 mm) and pale pink. The retinal vessels disappear into the disc just inside the edge of the disc. In ruminants and pigs, there is a central vein within the confines of the disc. In horses, the small retinal vessels course to and from the disc like the rays of the sun, while in other species they follow a more or less inverted T-pattern. The area of the retina located temporal to the optic disc, referred to as the area centrals, has the highest concentration of cones but is not usually grossly visible. In humans, this area is referred to as the macula; it contains the fovea, a region which is composed entirely of cones.

A tapetum lucidum is found in most animals (tapetum; Gr.: carpet or covering structure; lucidum: L.: clear; tapetal fundus in Anglo-American literature) in approximately the upper half circle of the posterior part of the globe, which reflects the incoming light as orange-yellow to green-blue. The remaining surface of the posterior part of the globe is generally heavily pigmented because of the pigment in the interstices of the choroid and in the pigmented epithelium of the retina. This area is referred to as the tapetum nigrum (nigrum: L.: black) or non-tapetal fundus in Anglo-American literature. In very young animals, before the tapetal areas have matured, the whole fundus appears dark purple-blue. In white, blue merle, and albino animals, both parts of the tapetum may be partially or completely absent; in which case, ophthalmoscopy reveals the large choroidal vessels. These vessels have a more or less sun-ray pattern and in between these vessels, a sun-ray, striped pattern of white sclera may be distinguishable. The optic disc is usually located on, or just below, the junction of the tapetum lucidum and tapetum nigrum.

Distinct, local or total, hyperreflectivity of the retina may indicate neuroretinal loss of function, e.g. degeneration, whilst blood or cloudy, bullous, membranous, or elevated areas may indicate inflammation, and/or retinal detachment, or neoplasia.

The individual variation in the normal fundus pattern is enormous. For this reason, patients should be referred for ophthalmoscopy when interpretation of findings is uncertain.

2.4.14 Additional and specific examinations

Additional examinations that may be indicated include biopsy, binocular indirect ophthalmoscopy, slit-lamp biomicroscopy, tonometry, gonioscopy, electroretinography, visual evoked responses, fundus angiography, endothelial microscopy, ultrasonography, computed tomography (CT), magnetic resonance imaging (MRI), and other radiologic techniques. If the equipment or assessment is not available, the patient should be referred.
Index

A
Abscess
–, corneal 150 ff.
–, retrobulbar 50 ff.
Accommodation 171
Acetazolamide 23
Acetylcholine 23
Acetylcysteine 19, 22, 27
Acorea 175
Acylicol 25
Adenocarcinoma 184 ff.
Adenoma
–, eyelid 98–100
Adrenaline cf. epinephrine
Albinism
–, oculocutaneous 175
–, partial 175
Algae 180
Alpha-lysin 25
Amaurosis 218, 232
Amblyopia 218, 232
Anesthesi 27 ff.
Aneurine deficiency 227
Angiography 15
Aniridia 175
Ankyloblepharon 74
Anophthalmia 127
Antazoline 22
Antibiotics
–, specific 22, 24
–, standard 22, 24
Antiglaucoma agents 23
Antihistamines 22
Anti-hypertensive agents 27
Antimicrobial agents 24 ff.
Antimycotics 25
Antiphlogistics 25
Antiviral drugs 25
Aphakia 192
Aplasia palpebrae 10, 74 ff., 173
Applanation tonometer 13
Application, Therapeutics
Apiranal 23
Aqueous humor 157, 171
–, drainage
–, with implant 167
–, improved capacity 165 ff.
–, outflow 157 ff.
–, production 157
–, reduction 165
Area
–, centralis 15
–, seventeen 211
–, striata 211
Artery
–, hyaloid 189 ff.
–, persistent 192
–, retinal 209
Artificial
–, lens 200 ff.
–, tears 26, 63
Aterolol 27
Anophamic globe 10, 127, 170
Anopine 14, 22, 24, 26, 61
Autotransplantation
–, free conjunctival 146

B
Bacitracin 24
Bacteria 180
Basal cell carcinoma 100
BCG = Calmette–Guérin bacillus
100
Belladonna 61
Benoxinate hydrochloride 26
Beta blockers 23
Beta radiation 27
Betamethasone 25
Bimatropstes 23
Bipolar cells 210
Bird pox 98
Blepharitis 95 ff., 99
–, adenomatosa 96
–, blepharophimosis 94
Blepharoplasty 85, 101 ff.
–, rotation-flap correction 75
–, blepharoplasty 62
–, differential diagnosis 16
Blindness
–, differential diagnosis 17
Blood vessel
–, architecture 172
–, occlusion 225
–, walls 176
Blood-aqueous barrier 172
Blue eye 179
Botulism 61
Brachycephalic breeds 8
Breed disposition 237–246
Brimonidine 23
Brinzolamide 23
Brow sling 91
Bruch’s membrane 210
Buphthalmos 12, 128, 162
Butylycyanoacrylate 27

C
Canthoplasty
–, lateral 95
–, medial 90, 95
Canthotomy
–, lateral 94
Capsulorrhesis 193, 200
Carbonic anhydrase inhibitors 23
Carpoten 25
Caruncle trichiasis 91
Cataract 173, 193–201
–, alimentary 196
–, congenital 173, 196
–, diabetic 197
–, inherited 196
–, juvenile 196
–, radiation 196
–, secondary 197
–, senile 196
–, therapy 197–201
–, traumatic 196
CEA cf. Collie eye anomaly
Chalazion 96
Chemical burns 34
Chemical cauterizing agents 27
Cherry eye 110–112
Chloramphenicol 24
Chlorhexidine 24
Chlorotetracycline 24
Choriocapillaris 173, 211, 214
Chorioretinitis 214 ff., 226–228
Choroid 2, 173 ff., 214
Cilia
–, ectopic 106 ff.
Ciliary
–, body 2, 171 ff., 210
–, destruction 166 ff.
–, muscles 22
Ciprofloxacin 24
Clinical diagnosis 5–18
–, aids 5, 8 ff.
–, anamnesis 3
–, differential diagnosis 16 ff.
–, methods 5, 8 ff.
Epilation
–, electro- 76–78
–, cryo- 76
Epinephrine 22–24
Epiphora 113
–, differential diagnosis 16
Episcleritis cf. Scleritis
Epithelializing agents 26
Equine recurrent (chronic) uveitis (ERU) 182 ff.
ERG cf. Electroretinogram
Ethoxyzolamide 23
ERU cf. Equine recurrent (chronic) uveitis
Etodolac 61
Eversion of the nictitating membrane 108 ff.
–, correction 109
Exenation of the orbit 53, 56
Exophthalmos 47, 49–53, 125
–, differential diagnosis 16
Exudation flakes
–, preretinal 215
Eye
–, blind cf. Blindness
–, drops 19 ff.
–, duration of effect 20
–, muscles 2, 125
–, ointments 19 ff.
–, painful cf. Painful eye
–, pigmented cf. Pigmented eye
–, pressure
–, intraocular cf. Intraocular pressure
–, retrobulbar 12 ff.
–, red cf. Red eye
–, tear stained cf. Epiphora
Eyelid 2, 10 ff., 73–104
–, adenoma 98–100
–, carcinoma 100
–, clinical diagnosis 10 ff.
–, colobomas 10, 74 ff., 173
–, dysplasia 76
–, granuloma 96
–, lacerations 36, 37–39, 94
–, margin
–, granuloma 178
–, investigation 11
–, lacerations 37–39
–, upper
–, ectropinizing 10
–, wounds 38, 39
–, melanoma 99
–, neoplasia 99 ff.
–, third cf. Nictitating membrane

F
Face lifting 91
Famcyclovir 25
FCRD cf. Retinal degeneration, feline central
Feline dysautonomia 184
Fibrae latae 161
Filtration angle 2
–, abnormalities 161
Fip 179, 227
Fistula methods 168
FIV 179, 227
Fixation 5
–, false 10
Flitting flies cf. Vitreous floaters
Flumethasone 25
Flunixin 25
Fluorescein 26
Fluridine 23
Fluribiprofen 25
Flushing 19
Flushing bottle 19
Fly net 27
Follicle 11, 113
Folliculosis 11, 113
Fornix 73
Fracture
–, orbital 34 ff.
Framycetin 24
Frontal bone 47
Fundus 14 ff., 209–235
–, abnormal 214–235
–, changes 214–218
–, clinical diagnosis 14 ff.
–, ontogenesis 209
–, reaction patterns 214–218
–, reflection 209, 213, 217
–, symptoms 214–218
Funduscopy 14 ff.
Fungi 180
Fusidic acid 24

G
Gamma-interferon 25
Ganglion
–, cell layer 209 ff.
Gentamycin 21, 24
Gland
–, lacrimal 59
–, nictitating membrane 73, 105–112
–, hyperplasia 110–112
–, deep 64, 105
–, superficial 59, 105
–, parotid 64
–, zygomatic 47, 64
Glucoma 159–170
–, absolute 160
–, acute 161–164
–, chronic 162, 164
–, closed irido-corneal angle 161
–, clinical signs 162–164
–, duration 161 ff.
–, open irido-corneal angle 161
–, open pectinate ligament 161
–, primary cf. Primary glaucoma
–, primary morphologically abnormal pectinate ligament 161
–, secondary 160, 168–170
–, therapy 23, 165–168
–, cyclocryodestruction 167
–, fistula methods 168
–, surgical 167 ff.
Globe 125–128
–, clinical diagnosis 12 ff.
–, contusion 35
–, luxation 31–34
–, position 47 ff.
Glycerol 23
GM1 and GM2 gangliosidosis 154
Goniodygenesis 161
Goniodyplasia 161
Gonioscopy 15, 159 ff.
Gramicidin 24
Granuloma
–, cosinophilic 96, 118 ff., 137
–, eyelid 96 ff.

H
Hemorrhage
–, retinal 214 ff.
–, subconjunctival 113
–, subretinal
–, band-shaped 215
–, vitreous 206 ff.
Hemostasis 29
Hereditary eye diseases 237–246
Heterochromia of the iris 175
Homatropine 26
Hordeolum 96 ff.
Horner’s syndrome 49, 184
Hyaloid
–, artery cf. Artery, hyaloid
–, system 189 ff.
Hyaloidosis
–, asteroid 206
Hydorphthalmia 128, 162
Hyperlipoproteinemia 225
Hyphema 13, 35 ff., 176
Hypophysectomy 61
Hypoplasia
index

I
Idoxuridine 25
i-drops® 64
Immune reactions 180ff.
Indentation tonometry 13
Indomethacin 25
Infectious canine hepatitis 179
Infiltrates 114
Injection
–, conjunctival 19–21
–, intraocular 21 ff.
–, retrobulbar 21
–, subconjunctival 21
–, subpalpebral system 20
Injuries of Lacerations
Intoxications 225
Intraocular
–, pressure 12 ff., 157–170
–, antiglaucoma agents 23
–, reference values 12
–, volume
–, reduction 166 ff.
Inversion of the nictitating membrane 108
Iodine tincture 27
Iridic granules 14
Irido-corneal angle 158
–, malformation 161
Iridodonesis 13
Iris 2, 171 ff.
–, acquired color differences 175
–, atrophy 183
–, blue
–, /white coat 175
–, clinical diagnosis 14
–, cyst 13, 176
–, granulomatous swelling 185
–, infections 179 ff.
–, melanoma 184
Iritis
–, traumatic 179
Isosorbide 23

J
Juxtapalpebral changes 96

K
KCS of Keratoconjunctivitis sicca
Keratitis 134–150
–, deep
–, eosinophilic 136
–, herpetica 150
–, interstitial 136
–, pannosa 134–136
–, photosensitiv 135 ff.
–, punctate 149
–, superficial 134–136
–, ulcerative 137–147
–, vascular and pigmentary 135 ff.
Keratoconjunctivitis
–, infectious bovine/ovine 150
–, sicca (KCS) 61–64
–, ipsilateral 63
Ketoprofen 25
Ketorolac 25
Key-Gaskell syndrome 184

L
Lacerations
–, conjunctival 39 ff.
–, corneal 40–44
–, eyelid 37–39
–, margin 37–39
–, perforating 37
Lacrimal
–, apparatus 59–71
–, duct 59 ff.
–, catheterization 69 ff.
–, gland 2, 59
–, accessory 59
–, punctum 60 ff.
–, atresia 66
–, opening 67
–, secondary closure 66
–, stenosis 65
–, sac 61
Lagophthalmos 95
Lamina 161
Larvae
–, migrating 227
–, &alpha; &lt;symbol&gt;techniques 29
Latanoprost 23
Lateral geniculate bodies 211
Lavage system
–, subpalpebral 20–21
Leishmania 180
Lenses 2, 189–205
–, artificial 200
–, clinical diagnosis 14
–, extraction 198–200
–, extracapsular 199 ff.
–, intracapsular 169, 199, 205
–, hard 200
–, luxation 13, 163, 201–205
–, nucleus sclerosis 191
–, ontogenesis 189 ff.
–, perforation 41
–, soft 200
Lenticonus 192
Lentiglobus 192
Leptospira interrogans 180
Lidocaine 26
Ligament
–, palpebral
–, lateral 73
–, medial 73
–, pectinate 159
–, abnormalities 161
–, open 161
Limbus melanoma 155
Local anesthesia 8
Local anesthetics, 22, 26
Locoweed 61
Luckerization
–, globe 31–34
–, lens 13, 163, 201–205

M
Macroblepharon 86–89
Macrophthalmia 12, 128
Magnetic resonance imaging (MRI) 15
Magnification equipment 28
Mandibular lymph nodes 8
Mannitol 23
Medetomidine 8
Meglumine 25
Melobomania 10, 73 ff.
Melanoma
–, eyelid 99
–, iris 184
–, limbus 155
Meloxicam 25
Membrane
–, persistent (epi)pupillary 173–174
–, nictitating g. Nictitating membrane
–, pupillary (PM) 190
–, persistent (PPM) 130, 133, 173–174, 194
Metazolamide 23
Methylprednisolone 25
Miconazole 25
Microcornea 133
Microskeletche 218
Microphiakia 192
Microphthalmia 12, 127, 173, 194
Micropunctum 65
Miotics 23
Moll glands 73
MRI cf. Magnetic resonance imaging
Mucopolysaccharidosis 154
Mucus cells 73
Muscae volantes cf. Vitreous floaters
Muscle
−, ciliary 171
−, levator
−, angularis oculi medialis 73
−, palpebrae 73
−, malaris 73
−, orbicularis oculi 73
−, pupillary
−, dilator 171
−, sphincter 171
−, retractor anguli 73
Mydriatics 23–24
Nafazoline 29
Nasal folds
−, resection 89 ff.
−, trichiasis 89 ff.
Nasopharynx 61
Natamycin 25
Neomycin 24
Neoplasia
−, conjunctival 122
−, corneal 155
−, intraocular 207
−, orbital 51 ff.
−, retinal 231 ff.
−, retrobulbar 51 ff.
−, uveal 177, 181 ff., 184–186
Nerve
−, facial 64
−, optic 2, 209–235
Nictitating membrane 2, 105–112
−, flaps/oversuturing techniques
−, attached to dorsolateral conjunctiva 144
−, attached to upper lid 142–144
−, gland 2, 110–112
−, margin
−, non-pigmented 106
−, protrusion 12, 47
−, differential diagnosis 16
Night blindness 214
−, hereditary (stationary) 224
Non-tapetal area cf. Tapetum nigrum
Norfloxacin 24
Nystagmus 12, 126 ff.
Occlusion 161
Ocular
−, capsule 199 ff.
−, chambers 2, 157 ff., 171
−, changes 172
−, clinical diagnosis 13
−, drainage area 157 ff.
−, osmotic agents 22
−, therapeutic agents 22–27
Oculocutaneous syndrome 175
Oxofloxacin 24
Operating table
−, positioning of patient 28
Ophthalmoscopy 15
Optic
−, chiasm 211
−, nerve 14
−, neuritis 231
−, papilla cf. Papilla
Orbit cf. Periorbita
−, fracture 34
−, neoplasia 51 ff.
−, primary 52
Orbitotomy 56
Osmotic agents 23
Oxybuprocaine 26
Painful eye
−, differential diagnosis 16
Palpebra cf. Eyelid
Palpebral
−, aplasia 10, 74 ff., 173
−, fissure 73
−, length 10
Panus 131, 135–136
Panophthalmitis 128
Papilla 15, 210
−, coloboma 218 ff.
−, edema 230
−, hypoplastic 218
−, micro- 218
Papillitis 231
Parasites 180
Parasympatholytics 22 ff.
Parasympathomimetics 23
Pecten 211, 213
PED cf. Pigment epithelial dystrophy
Pedicle graft 75
Perforating injuries 37
Periorbita 45–57
PermaTweez® 76–77
Persistent hyaloid artery cf. Artery, hyaloid, persistent
Persistent hyperplastic primary vitreous
(PHPV) 193–194
Persistent hyperplastic tunica vasculosa lentis (PHTVL) 193–194
Phenazopyridine 61
Phenol 27
Phenylephrine 22, 24
Photophobia 172
Photoreceptors 210 ff.
−, degeneration 221–224
−, dysplasia 221–224
PHPV cf. Persistent hyperplastic primary vitreous
Phthisis bulbi 12, 127, 170
PHTVL cf. Persistent hyperplastic tunica vasculosa lentis
Pigment epithelium 210
−, dystrophy (PED) 224
Pigmented eye
−, differential diagnosis 17
Pilocarpine 23, 63
Pimecrolimus 27
Pinocytosis 159
Placing reflex
−, optical 15
PM cf. Membrane, pupillary
Poisoning cf. Intoxications
Polycoria 174
Polynyxin B 24
Posterior synchia 179
Povidone-iodine 24–26
PPM cf. Membrane, persistent pupillary
PRA cf. Retinal degeneration, hereditary (progressive)
Prednisolone 25
Preparation of the operative field 28
Pressure cf. Intraocular pressure
Primary glaucoma 159
−, acute 159
−, chronic 164
Process
−, ciliary 172
−, corneal 47
Proparacaine 26
Propriolactone 31–34
Propoxazol 180
Protrusion of the nictitating membrane 107
Pseudo-enophthalmos 125
Pseudo-exophthalmos 125
Pseudomonas 180
Pupil 2
−, abnormalities 184
−, clinical diagnosis 14
−, dilatation syndrome 184
Pupillary reaction 214
Radiation cataract 196
Radiotherapy 27
RD cf. Retina, dysplasia
Recurrent uveitis
  –, equine 182 ff.
Red eye
  –, differential diagnosis 16
Retina(l) 2, 209–211
  –, aplasia 218
  –, atrophy 219, 221–223, 226
  –, degeneration 15
  –, feline central (FCRD) 230
  –, hereditary (progressive (PRA) 221–224
  –, detachment 14 ff., 176, 207, 210, 228 ff.
  –, dysplasia (RD) 219
  –, geographic 219
  –, multifocal 219
  –, total 219
  –, folds 216
  –, hemorrhage 215
  –, inner layer 209 ff.
  –, neoplasia 231 ff.
  –, outer layer 210
  –, vessels 2, 214
Retinitis 227 ff.
Retinopathy
  –, hypertensive 229 ff.
Rickettsia 180
Rods 210
Rose bengal 26
Rotation-flap correction 75
Squamous cell carcinoma 100, 122, 155
Staphylococcus 141–142
Strabismus 12, 126
STT cf. Schirmer tear test
Subconjunctival hemorrhage 113
Sudden acquired retinal degeneration (SARD) 232
Suffusion 35
Sulfonamides 24, 61
Surgery 27–29
Suture materials 28
Symblepharon 114, 118–120
  –, correction 120
Synchysis scintillans 206

T
Tacking cf. Entropion, correction, tacking
Tacrolimus 27, 63
Tapetal area cf. Tapetum lucidum
Tapetum
  –, cellulosum 214
  –, fibrosum 214
  –, lucidum 2, 15, 173, 214
  –, nigrum 15, 173, 214
Tarsorrhaphy
  –, permanent 33
  –, temporary 32–33
Taurine deficiency 227
Tear
  –, film 59–61
  –, flow 59–61
  –, fluid
  –, blockage 61
  –, drainage 61
  –, production 9 ff.
  –, replacement therapy 26, 63
  –, stripe 9, 65
 Tears
  –, artificial 26, 63
Tension 159
Tetracaine 8, 26
Therapeutics 19–27
  –, application
  –, general rules 22
  –, injection cf. Injections
Therapy 19–30 cf. Therapeutics
  –, cryo– 29, 100
  –, laser 29
  –, radio– 27
  –, surgical 27–29
Thiamine deficiency 182
Timolol 23
Tissue plasminogen activator 27
Tobramycin 24

U
UDS cf. Uveo-dermatologic syndrome
Ulceration
  –, deep 140
  –, superficial 137–139
Ultrafiltration 157
Ultrasonography 16
Uvea 171–187
  –, functions 171
  –, neoplasia 177, 181 ff., 184–186
  –, posterior 186
  –, structure 171 ff.
Uveitis 177–179
  –, anterior 177–179, 182 ff.
  –, chronic relapsing 182 ff., 227
  –, idiopathic 181
  –, metabolic 179
  –, posterior 227 ff.
Uveo-dermatologic syndrome (UDS) 181

V
Van Waardenburg’s syndrome 174
Vasoconstrictors 22
Vein
  –, facial 64
  –, retinal 210
VEP cf. Visual evoked potentials
Vecuronium 14
Visual evoked potentials (VEP)  211
Vitamin
–, A  22, 26
–, deficiency  225
–, B1  26
–, deficiency  227
–, C  22, 26
–, E  22, 26
–, deficiency  225

Vitreous  14, 189–208
–, clinical diagnosis  14
–, floaters  206
–, hemorrhage  206–207
–, ontogenesis  189 ff.
–, persistent hyperplastic primary (PHPV)  193
–, synchysis scintillans  206
Vortex system  214

X
Xerophthalmia  22

Z
Zeis glands  73
Zinc sulfate  26
Zygomatic arch  47