

# Contents

Introduction to the BCSC . . . . .	xv
<b>Objectives</b> . . . . .	<b>1</b>
<b>1 Introduction to Glaucoma: Terminology, Epidemiology, and Genetics</b> . . . . .	<b>3</b>
Highlights . . . . .	3
Definition . . . . .	3
Classification . . . . .	4
Open-Angle, Angle-Closure, Primary, and Secondary Glaucomas . . . . .	4
Epidemiology . . . . .	8
Primary Open-Angle Glaucoma . . . . .	8
Primary Angle-Closure Glaucoma . . . . .	10
Genetics . . . . .	10
Juvenile Open-Angle Glaucoma . . . . .	11
Familial Normal-Tension Glaucoma . . . . .	11
Primary Congenital Glaucoma . . . . .	12
Axenfeld-Rieger Syndrome . . . . .	12
Aniridia . . . . .	12
Genome-Wide Association Studies . . . . .	12
Pseudoexfoliation Syndrome . . . . .	13
Genetic Testing . . . . .	13
Environmental Factors . . . . .	13
<b>2 Intraocular Pressure and Aqueous Humor Dynamics</b> . . . . .	<b>15</b>
Highlights . . . . .	15
Aqueous Humor Production and Outflow . . . . .	15
Aqueous Humor Production . . . . .	15
Suppression of Aqueous Humor Formation . . . . .	18
Aqueous Humor Outflow . . . . .	18
Aqueous Humor Dynamics . . . . .	20
Measurement of Aqueous Humor Production . . . . .	21
Measurement of Outflow Facility . . . . .	22
Measurement of Episcleral Venous Pressure . . . . .	22
Measurement of Uveoscleral Outflow Rate . . . . .	23
Intraocular Pressure . . . . .	23
IOP Distribution and Relation to Glaucoma . . . . .	23
Variations in IOP . . . . .	24
Clinical Measurement of IOP . . . . .	26

<b>3 Clinical Evaluation: History . . . . .</b>	<b>35</b>
Highlights . . . . .	35
Importance of Patient History . . . . .	35
Relevant Factors . . . . .	35
Quality of Life . . . . .	37
<b>4 Clinical Evaluation and Imaging of the Anterior Segment . . . . .</b>	<b>39</b>
Highlights . . . . .	39
Refractive Error . . . . .	39
Ocular Adnexa . . . . .	39
Pupillary Function . . . . .	40
Slit-Lamp Biomicroscopy . . . . .	41
Conjunctiva . . . . .	41
Episclera and Sclera . . . . .	42
Cornea . . . . .	42
Anterior Chamber . . . . .	43
Iris . . . . .	43
Lens . . . . .	43
Vitreous and Fundus . . . . .	44
Gonioscopy . . . . .	44
Direct and Indirect Gonioscopy . . . . .	44
Gonioscopic Assessment and Documentation . . . . .	47
Anterior Segment Imaging . . . . .	53
Ultrasound Biomicroscopy . . . . .	53
Anterior Segment Optical Coherence Tomography . . . . .	54
Specular Microscopy . . . . .	57
<b>5 Clinical Evaluation and Imaging of the Posterior Segment: Optic Nerve, Retinal Nerve Fiber Layer, and Macula in Glaucoma . . . . .</b>	<b>59</b>
Highlights . . . . .	59
Optic Nerve Anatomy . . . . .	59
Blood Supply to the Optic Nerve . . . . .	61
Glaucomatous Optic Neuropathy . . . . .	64
Clinical Examination of the Optic Nerve Head . . . . .	66
Recording of Optic Nerve Findings . . . . .	73
Imaging of the Optic Nerve Head, Macula, and Retinal Nerve Fiber Layer . . . . .	73
Optical Coherence Tomography for Glaucoma Diagnosis . . . . .	74
Optical Coherence Tomography for Detecting Glaucoma Progression . . . . .	80
Imaging of the Lamina Cribrosa . . . . .	86
Optical Coherence Tomography Angiography . . . . .	88

<b>6 Perimetry . . . . .</b>	<b>91</b>
Highlights . . . . .	91
Introduction . . . . .	91
Basic Principles of Automated Perimetry . . . . .	92
Testing Strategies . . . . .	93
Patterns of Testing Points . . . . .	93
Factors Affecting Perimetry Results . . . . .	94
Patient . . . . .	94
Perimetrist . . . . .	94
Other Factors . . . . .	96
Interpretation of a Single Visual Field . . . . .	96
Test Quality . . . . .	96
Normality or Abnormality of the Visual Field . . . . .	97
Artifacts . . . . .	99
Patterns of Visual Field Loss in Glaucoma . . . . .	100
Interpretation of a Series of Visual Fields and Detection of Visual Field Progression . . . . .	103
Frequency of Testing . . . . .	108
Structure and Function Relationship . . . . .	109
Other Perimetric Tests . . . . .	109
<b>7 Primary Open-Angle Glaucoma . . . . .</b>	<b>113</b>
Highlights . . . . .	113
Primary Open-Angle Glaucoma . . . . .	113
Clinical Features . . . . .	113
Atypical Findings . . . . .	114
Risk Factors . . . . .	114
Association with Systemic Conditions . . . . .	117
Prognosis and Therapy . . . . .	118
The Glaucoma Suspect . . . . .	119
Ocular Hypertension . . . . .	120
Open-Angle Glaucoma Without Elevated IOP (Normal-Tension Glaucoma) . . . . .	121
Risk Factors and Clinical Features . . . . .	122
Differential Diagnosis . . . . .	123
Diagnostic Evaluation . . . . .	123
Prognosis and Therapy . . . . .	124
<b>8 Secondary Open-Angle Glaucoma . . . . .</b>	<b>131</b>
Highlights . . . . .	131
Secondary Open-Angle Glaucoma . . . . .	131
Pseudoexfoliation Syndrome . . . . .	131
Pigment Dispersion Syndrome . . . . .	134
Lens-Induced Glaucoma . . . . .	137
Intraocular Tumors . . . . .	139
Ocular Inflammation and Secondary Glaucoma . . . . .	139

Elevated Episcleral Venous Pressure . . . . .	142
Trauma and Surgery . . . . .	144
Schwartz Syndrome (Schwartz-Matsuo Syndrome). . . . .	149
Drugs and Glaucoma . . . . .	150
<b>9 Primary Angle Closure . . . . .</b>	<b>153</b>
Highlights . . . . .	153
Introduction . . . . .	153
Pathogenesis and Pathophysiology . . . . .	155
Pupillary Block . . . . .	155
Plateau Iris and Iris-Induced Angle Closure. . . . .	155
Role of Medications in Angle Closure . . . . .	156
Risk Factors . . . . .	157
Race and Ethnicity . . . . .	157
Ocular Biometrics. . . . .	158
Age . . . . .	158
Sex . . . . .	158
Family History and Genetics . . . . .	158
Refractive Error. . . . .	159
The Primary Angle-Closure Spectrum. . . . .	159
Primary Angle-Closure Suspect . . . . .	159
Primary Angle Closure . . . . .	163
Primary Angle-Closure Glaucoma. . . . .	163
Symptomatic Primary Angle Closure . . . . .	164
Plateau Iris . . . . .	167
Management . . . . .	167
<b>10 Secondary Angle Closure . . . . .</b>	<b>169</b>
Highlights . . . . .	169
Introduction . . . . .	169
Secondary Angle Closure With Pupillary Block . . . . .	169
Lens-Induced Angle Closure . . . . .	169
Secondary Angle Closure Without Pupillary Block . . . . .	174
Conditions Associated With a Pulling Mechanism . . . . .	174
Conditions Associated With a Pushing Mechanism . . . . .	181
Conditions Associated With Combined Pushing and Pulling or Other Mechanisms . . . . .	186
<b>11 Glaucoma in Children and Adolescents . . . . .</b>	<b>189</b>
Highlights . . . . .	189
Classification . . . . .	189
Genetics . . . . .	193
Primary Congenital Glaucoma . . . . .	193
Pediatric Glaucoma Without Anterior Segment Dysgenesis . . . . .	194
Pediatric Glaucoma With Anterior Segment Dysgenesis . . . . .	194
Primary Congenital Glaucoma . . . . .	194
Incidence . . . . .	194

Pathophysiology . . . . .	194
Clinical Features . . . . .	195
Differential Diagnosis . . . . .	196
Treatment and Prognosis . . . . .	196
Juvenile Open-Angle Glaucoma . . . . .	197
Secondary Glaucomas due to Nonacquired Conditions . . . . .	197
Axenfeld-Rieger Syndrome . . . . .	197
Peters Anomaly . . . . .	198
Aniridia . . . . .	200
Sturge-Weber Syndrome . . . . .	201
Neurofibromatosis . . . . .	201
Secondary Glaucomas due to Acquired Conditions . . . . .	202
Glaucoma Following Cataract Surgery . . . . .	203
Evaluating the Pediatric Glaucoma Patient . . . . .	203
History . . . . .	204
Visual Acuity . . . . .	205
External Examination . . . . .	205
Anterior Segment Examination . . . . .	205
Tonometry . . . . .	205
Pachymetry . . . . .	207
Gonioscopy . . . . .	208
Optic Nerve and Fundus Evaluation . . . . .	209
Visual Field Testing . . . . .	210
A-Scan Ultrasonography . . . . .	210
Other Testing . . . . .	212
Treatment Overview . . . . .	212
Surgical Management . . . . .	212
Medical Management . . . . .	216
Prognosis and Follow-Up . . . . .	218

## 12 Medical Management of Glaucoma and Ocular

Hypertension . . . . .	219
Highlights . . . . .	219
Introduction . . . . .	219
Prostaglandin Analogues . . . . .	221
Mechanism of Action . . . . .	221
Available Agents and Dosing Frequency . . . . .	226
Adverse Effects . . . . .	226
Adrenergic Drugs . . . . .	228
$\beta$ -Adrenergic Antagonists . . . . .	228
Adrenergic Agonists . . . . .	229
Carbonic Anhydrase Inhibitors . . . . .	231
Mechanism of Action . . . . .	231
Available Agents and Dosing Frequency . . . . .	231
Adverse Effects and Contraindications . . . . .	232
Parasympathomimetic Agents . . . . .	233
Mechanism of Action . . . . .	233

Adverse Effects . . . . .	234
Rho Kinase Inhibitors . . . . .	234
Mechanism of Action . . . . .	234
Available Agents and Dosing Frequency . . . . .	234
Adverse Effects . . . . .	235
Combined Medications . . . . .	236
Hyperosmotic Agents . . . . .	236
General Approach to Medical Treatment . . . . .	237
Long-Term Therapy . . . . .	237
Therapy for Acute Intraocular Pressure Elevation . . . . .	238
Administration of Ocular Medications . . . . .	239
Use of Glaucoma Medications During Pregnancy or by Breastfeeding Mothers . . . . .	239
Use of Glaucoma Medications in Elderly Patients . . . . .	240
Generic Medications . . . . .	241
Patient Adherence to a Medication Regimen . . . . .	241
2021 Update: Sustained-Release Bimatoprost Implant . . . . .	241
<b>13 Surgical Therapy for Glaucoma . . . . .</b>	<b>243</b>
Highlights . . . . .	243
Introduction . . . . .	243
Laser Trabeculoplasty . . . . .	244
Mechanism of Action . . . . .	244
Indications and Contraindications . . . . .	245
Technique . . . . .	246
Postoperative Care . . . . .	247
Complications . . . . .	248
Efficacy . . . . .	248
Cyclodestruction . . . . .	249
Mechanism of Action . . . . .	249
Indications and Contraindications . . . . .	249
Technique . . . . .	250
Postoperative Care . . . . .	251
Complications . . . . .	251
Efficacy . . . . .	251
Laser Peripheral Iridotomy . . . . .	252
Mechanism of Action . . . . .	252
Indications and Contraindications . . . . .	252
Technique . . . . .	253
Postoperative Care . . . . .	254
Complications . . . . .	254
Efficacy . . . . .	254
Peripheral Iridoplasty . . . . .	255
Mechanism of Action . . . . .	255
Indications and Contraindications . . . . .	255
Technique . . . . .	255
Postoperative Care . . . . .	255

Complications . . . . .	255
Efficacy . . . . .	256
Trabeculectomy . . . . .	256
Mechanism of Action . . . . .	256
Indications and Contraindications . . . . .	256
Technique . . . . .	257
Antifibrotic Agents in Trabeculectomy . . . . .	262
Postoperative Complications and Management . . . . .	264
EX-PRESS Shunt . . . . .	270
Plate-Based Tube Shunt Surgery . . . . .	271
Mechanism of Action . . . . .	271
Indications and Contraindications . . . . .	271
Technique . . . . .	271
Postoperative Management . . . . .	273
Cataract Surgery in the Glaucoma Patient . . . . .	277
Ocular Hypertension . . . . .	277
Primary Open-Angle Glaucoma . . . . .	277
Angle-Closure Glaucoma . . . . .	278
Cataract Surgery in Conjunction With Trabeculectomy or Tube Shunt Surgery . . . . .	278
Other Glaucoma Surgeries . . . . .	279
Minimally Invasive Glaucoma Surgeries . . . . .	279
Short Aqueous Stent to Subconjunctival Space . . . . .	284
Nonpenetrating Glaucoma Surgery . . . . .	285
Special Considerations in the Surgical Management of Elderly Patients . . . . .	286
Additional Materials and Resources . . . . .	287
Requesting Continuing Medical Education Credit . . . . .	289
Study Questions . . . . .	291
Answers . . . . .	297
Index . . . . .	303