

Index

A

- Acetazolamide, 306
- Achromatopsia, 78
- Acrylate polymers, 472
- Acyclovir (ACV), 158
- Adie (tonic) pupil, 60
- Advanced glycation end products (AGEs), 292
- Ageing disorders, eye, 297–308
 - ageing process, 281–284
 - age-related disorders
 - cataract, 284–290
 - diabetes, cataract, 285
 - AMD (*see* Age-related macular degeneration (AMD))
 - anterior and posterior segments, 281
 - cataract, 309
 - choroid, 279–280
 - in cornea, 282–283
 - crystalline lens changes, 283
 - DR (*see* Diabetic retinopathy (DR))
 - eyelids and lacrimal system, 282
 - glaucoma (*see* Glaucoma)
 - healthcare resources and systems, 308
 - human, 278–279
 - in trabecular meshwork and uvea, 283
 - lens, 281
 - nations and communities, 309
 - NDDS, 309
 - process, 278, 280
 - retina, 280
 - retinal ageing, 284
 - sclera, 279
 - structure and functions, 279–281
 - vitreous ageing, 283–284
- Age-related macular degeneration (AMD),
 - 124, 284, 302, 408. *See also* Ageing disorders, eye
 - animal models, 302–304
 - BMI, 299
 - cataract surgery, 299
 - drug delivery approaches, 301
 - dry, 299
 - implants, 301
 - light exposure, 299
 - liposomes, 301
 - macula, 296
 - micro-/nanoparticles, 301
 - prevalence, 299
 - RPE, 296
 - smoking, 297–298
 - types and pathophysiology, 297
 - wet, 300
- Alanine aminotransferase (ALT), 514
- Albumin, 219
- Albumin nanoparticles, 474, 475
- Aldose reductase (AR) catalyzes, 285
- Alginate-based polymers, 220
- Alkyl p-amino-benzoates, 596
- Alpha-TPGS, 377
- Amacrine cells, 30, 48, 66
- Amblyopia, 77
- American Academy of Optometry (AAO), 295
- Amphiphilic prodrug leads, 238
- Amphotericin B liposomes, 478
- Angiogenesis, 467–468
- Angle-closure glaucoma (ACG), 304–305, 466
- Aniline derivatives, 596
- Annulus of Zinn, 50

- Anterior chamber, 23, 45
 Anterior ischemic optic neuropathy, 70
 Anterior uvea, 597
 Anterograde visual amnesia, 80
 Antiglaucoma agent, 152
 Antiglaucoma drug, 237, 399
 Anti-VEGF agents, 294
 Anton's syndrome, 77
 Aqueous formation, 25–26
 Aqueous humor (AH), 120, 152
 circulation, 26
 conventional pathway, 26
 drainage, 26–27
 formation, circulation and drainage, 25–27
 uveoscleral pathway, 27
 Aqueous layer, 38, 44–45
 Argyll Robertson pupil, 60
 AR inhibitors (ARIs), 292
 Arteriovenous nicking, 68
 Aspartate aminotransferase (AST), 514
 Azapentacene polysulfonate, 288
- B**
- BAB. *See* Blood-aqueous barrier (BAB)
 Baggy eyes, 282
 Balint syndrome, 79
 Barriers
 defensive, 594
 ocular membranes, 595–600
 ocular pharmacokinetics (*see* Ocular pharmacokinetics)
 Basement membrane, choriocapillaris, 22
 Benzalkonium chloride (BKC), 257, 473
 Benzododecinium bromide, 266
 Beta-blockers, 596
 Bevacizumab (Avastin®), 300, 301
 Bioadhesive ophthalmic drug inserts (BODI), 162, 163
 Bioadhesives
 acrylate polymers, 220
 albumin, 218, 219
 alginate, 220
 bioadhesive polycaprolactone microspheres, 221–222
 chitosan, 216, 217
 hyaluronan, 217, 218
 microemulsions, 223
 and mucoadhesives, 558–559
 particulate vesicular, 221
 PLGA, 222
 poly(ethylene oxide), 218
- Biochemical transporters, 54–55
 Biodegradable nanomaterials, 6
 Biodegradable polymers, 132, 133
 natural, 133
 synthetic, 133
 Biodegradation
 enzymatic, 134
 hydrolysis, 134
 oxidation, 134
 types of polymer, 135, 136
 Biodistribution, 2, 4
 Biologics, 448–450
 Biomaterial, 393, 394
 Biopharmaceutics, 115
 Blood-aqueous barrier (BAB), 233, 352, 410, 472, 488, 489, 599
 Blood-brain barrier (BBB), 491
 Blood-ocular barriers, 115
 BAB, 599
 BRB, 599–600
 cell growth, 490
 cell line, 490
 cell monolayers, 490
 cobblestone pigmentation, 490
 endothelial cells, 488, 491
 immortalized cell lines, 490
 lipophilicity, 489, 491
 ocular tissues, 488
 primary cell cultures, 489
 retinal diseases, 490
 tight barriers, 491
 tight junctions, 488
 Blood-retinal barrier (BRB), 29, 118, 148, 150, 233, 352, 410, 472, 484, 488, 489, 492, 599–600
 Blood urea nitrogen (BUN), 514
 Bottom-up fabrication method, 2
 Bowman's layer, 44
 Bowman's membrane, 11
 BRB. *See* Blood-retinal barrier (BRB)
 Brimonidine tartrate (BRT), 187, 237
 Brodmann area, 78, 79
 Bruch's membrane (BM), 22–23, 65, 296, 304
 Budesonide particles, 296
 Bulbar conjunctiva, 14
- C**
- Capsule drug ring (CDR), 429
 Carbon nanotubes (CNTs), 510, 511
 Carbonic anhydrase inhibitors (CAIs), 248
 Carbonic anhydrases (CAs), 294

- Carboxyethyl pyrrole (CEP), 302
Carboxymethylcellulose (CMC), 151
Catalin eyedrops, 288
Cataract, 287. *See also* Ageing disorders, eye
 BMI, 285
 cataractogenic process, 283
 classification, 284
 dense nuclear, 284
 diabetes, 285
 drug delivery approaches, 288–290
 electrolyte disturbances, 286
 lens of eye, 284
 liposomal systems, 289
 nanoparticles, 289–290
 oxidative damage, 286
 prevention and treatment, 286–288
 subcapsular, 285
 surgery, 287
 therapeutic drugs, 287–288
 tobacco and alcohol addiction, 285
 UVB radiation, 285
CD nanosuspensions, 504–505
Celecoxib microparticles, 295–296
Cellulose acetate phthalate (CAP), 562
Central retinal artery (CRA), 50
Central retinal vein (CRV), 50
Charcot-Wilbrand syndrome, 79
Chelating agents, 152
Chiasmal fibers, 72
Chitosan (CS), 93, 138, 140–141, 462
 antibacterial action, 216
 bioadhesive behavior, 216
 hydrogels, 217
 mucoadhesive property, 96
 nanoparticles, 473, 474
 structure, 140
Chlorhexidine acetate, 259
Chlorobutanol, 260
Choriocapillaris, 22
Choroid, 21, 279–280
Choroidal neovascularization (CNV), 157,
 158, 297, 329, 408, 477
Ciliary body, 20, 24, 58, 59, 232
Ciliary muscle contraction, 43
Ciliary processes, 41
Ciprofloxacin, 87
Circadian rhythm, aqueous flow, 26
CNTs. *See* Carbon nanotubes (CNTs)
Coacervation/ionic gelation method, 361–362
Collasomes, 272
Collector channels, 46
Colloidal carrier system
 advantages, 323–325
 application, 339
 budesonide microparticles, 338
 cubosomes, 337
 delivery methods and strategies, 323, 324
 disadvantages, 323–325
 factors, 323, 339–345
 micro- and nanoemulsions, 337
 niosomes, 336–337
 novel drug delivery technologies, 323
 nucleic acids, 338
 ocular drug delivery, 321
 piroxicam microemulsion, 337
 routes of administrations, 339–343
 schematic representation, 322
Color blindness, 64
Color vision, 64
Commercially available carboplatin (CAC),
 374
Compartment models, 121
Complexation, 244
Composites, 3
Compressive optic neuropathy (CON), 67
Confrontational visual field testing, 71
Congenital hypertrophy of retinal pigment
 epithelium (CHRPE), 63
Conjunctiva, 12–14, 597–598
 bulbar, 487
 cataract surgery, 487
 choroid, 21
 ciliary body, 20
 cyclosporin A, 487
 elastic layer, 22
 eyelids, 16–17
 hydrophilic drugs, 487
 inner collagen layer, 22
 iris, 20
 lacrimal drainage system, 18–19
 lacrimal gland and tears, 15–16
 ocular surface disorders, 487
 outer collagen layer, 22
 pharmacokinetics, 487
 sclera, 19
 scleral spur, 24
 tear fluid, 15
 Tenon's capsule, 14
 uveal tract, 20–23
Conjunctival epithelium, 213, 232
Conjunctival fornices, 14
Conjunctival/corneal squamous cell carcinoma
 (CCSC), 464
Conjunctival surface, 116
Contact lens users, 268–269
Contralateral homonymous hemianopsia, 75

- Cornea, 10–12, 39–40, 58, 596–597
 corneal stroma, 485
 Draize test, 486
 epithelial cell line, 486
 pharmacokinetic barriers, 484–485
 symptoms, 485
 tight junctions, 485
 viral infections, 486
 viral shedding, 485
- Corneal damages, 261, 264, 268
- Corneal diseases
 natural blinking phenomenon, 585
 normal tear drainage, 585
- Corneal endothelium, 12
- Corneal epithelial membrane, 151
- Corneal epithelium, 10–11, 113, 485–486
- Corneal opacification, 59
- Corneal stroma, 11–12
- Corneoscleral meshwork, 46
- Coulomb-controlled iontophoresis (CCI), 192
- Creatinine (CREA), 514
- CS-based nanosystems, 499
- Cubosomes, 337
- Cup to disc (C/D) ratio, 67
- Cyclodextrins (CDs), 85, 101, 133, 184–186
 description, 244
 eye drops, 249
 hydrogels, 248
 matrix, 240
 ocular mucoadhesives, 248
 pharmacokinetic and toxicological considerations, 246
 stable drug-CD complexes, 244
 structures, 245
- Cyclooxygenase-2-mediated ophthalmic disease, 377
- Cyclosporine A (CsA), 153, 158
- Cytomegalovirus (CMV), 408
 blindness, 477
 retinitis, 501
- D**
- Dendrimeric polyguanidylated translocators (DPTs), 100, 330
- Dendrimers, 3, 5, 85, 99–100, 186, 187, 505, 509–510
 anterior eye, 330–331
 click chemistry approach, 330
 divergent and convergent methods, 330
 ocular applications, 331–333
 posterior eye, 331
- Dermatochalasis, 282
- Descemet's membrane (DM), 12, 39, 44, 58
- Design of intraocular implants, 451
- Deuteranopia to protanopia ratio, 65
- Dexamethasone, 306
- Dexamethasone acetate (DA), 157
- Diabetic macular edema (DME), 294
- Diabetic retinopathy (DR). *See also* Ageing disorders, eye
 abnormal endothelium, 290
 budesonide particles, 296
 candesartan, 294
 celecoxib microparticles, 295–296
 development, 290
 dexamethasone polymeric implants, 295
 drug delivery approaches, 295–296
 fibrous tissue (gliosis), 292
 fluocinolone acetonide, 295
 growth factors, 294
 leukostasis, 293
 microaneurysms, 290
 microvascular disease, 290
 nonenzymatic protein glycation, 292–293
 non-proliferative stage, 290
 oxidative stress, 294
 pathologies, 296
 pathophysiologies, 294
 polyol pathway, 292
 protein kinase C activation, 293
 subclinical inflammation, 293
- Diacylglycerol (DAG), 293
- Dihydroazapentacene, 288
- Discomes, 237
- Disulfiram (DSF), 101
- Drug delivery
 via ophthalmic route, 149
 routes, eye, 34–35
 systems, 6, 150
 therapeutic molecule, 177
- Drusen, 65
- Dry eye syndrome, 282, 562
- Dynamic light scattering (DLS), 512
- E**
- EBR. *See* Exciton Bohr radius (EBR)
- Edinger-Westphal nuclei, 73
- Emulsification/solvent evaporation method, 359
- Enzymatic degradation, 134
- Epidermal growth factor (EGF), 294
- Episclera, 45
- Esterases, 55
- Ethylene vinyl acetate (EVA), 423

- Eudragit nanoparticles, 187
 acrylate polymers, 472
 flurbiprofen, 473
 ibuprofen-loaded, 473
 precipitation, 473
 QESD, 473
 in rabbit models, 473
- Eudragit® RS, 367
- Excipients, ODDS
 alginate, 562
 CAP, 562
 carbopol, 560
 carrageenans, 562
 CDs, 560
 EHEC, 561
 FDA-approved, 577–580
 gellan gum, 562
 HA, 562
 MC, 561
 HPMC, 561
 ophthalmic formulations, 563
 pharmaceutical functions, 563
 poloxamers, 560
 pseudolatexes, 561
 toxicology, 580
 xyloglucan, 561
- Exciton Bohr radius (EBR), 513
- Extracapsular cataract extraction (ECCE), 287
- Extrafoveal cone photoreceptor, 47
- Extraocular structures, 38
- Eye
 anatomy, 86, 472
 anterior, 472, 596, 600
 corneal barrier limits, 472
 drops
 glaucoma treatment, 249
 inflammation, 249
 drug delivery routes, 34–35
 intravitreal injections, 472
 lens, 281
 nanoparticles, 472
 posterior portion, 595
 vitreous body of rabbit, 604
- Eyeball, 57, 58
- Eyelids and lacrimal system, 282
- F**
- Familial adenomatous polyposis (FAP), 63
- FDA-approved excipients, 563–576
- FePt nanoparticles, 3
- Fibroblast growth factor (FGF), 294
- FITC-conjugated bovine serum albumin, 598
- FITC-conjugated dextrans, 598
- Fluid transfer into aqueous humor, 25–26
- Fluid transfer through gap junctions, 25
- Fluorescein isothiocyanate (FITC)-dextran, 597
- Folate-decorated polymeric nanoparticles, 301
- Food and Drug Administration (FDA), 324
- Forniceal conjunctiva, 14
- Fovea, 48
- Foveola, 48
- Free radicals, 5
- Fuch's dystrophy, 40
- Fungal keratitis, 465
- G**
- Gamma scintigraphy, 151
- Ganciclovir (GCV), 157, 159
- Ganglion cell layer (GCL), 30
- Ganglionic neurons, 66
- Gatifloxacin (GFX), 100
- GCPQ, 94
- Gelatin, 141
- Gellan gum, 151
- Gel-Larmes-Thea formulation, 560
- Gerstmann's syndrome, 79
- Glass transition temperature, 138
- Glaucoma, 61, 84, 91, 99. *See also* Ageing disorders, eye
 angle-closure, 304–305
 bilateral blindness, 304
 CAIs, 248
 CMV, 504
 contact lenses, delivery vehicles, 307
 drug delivery approaches, 306–308
 elderly, 307–308
 excitotoxicity, 305
 eye drops, 249
 injectable systems, 307
 IOP, 305
 liposomes, 306–307
 medications, 390
 nanospheres, 306–307
 neuroinflammation, 306
 neurotoxicity, 306
 normal-tension, 305
 pathophysiology, 305–306
 primary open-angle, 304
 sophisticated surgical implants, 307
 treatment, 305–306
 types of, 305

Glaucoma drug delivery
 contact lenses, 398
 hypotensive effect, 392
 IOP monitoring, 393
 nanomaterials, 394–399
 nanotechnology, 399
 patient adherence, 390–391
 side effects, 391
 site of action, 391
 Glaucomatous optic neuropathy (GON), 67
 GLUT-1 transporter, 54
 Gunn pupil, 60

H

HA–CS nanoparticles, 366
 Haller's layer, 21
 Hemidesmosomes, 39
 Hexose transporters (GLUT), 54
 High-performance liquid chromatography (HPLC), 122
 Homopolymer, 131
 Horner's syndrome, 59
 Horse radish peroxidase, 598, 599
 HSA nanoparticles, 474
 Human corneal epithelial (HCE) cell, 478
 Human eye, 278–279
 anatomical and physiological barriers, 245, 246
 conjunctiva, 213
 cornea, 213
 goblet cells, 214
 layers, 213
 Human retinal pigment epithelium (ARPE-19) cells, 475
 Human serum albumin (HSA), 373
 Hyaloid membrane, 62
 Hyaluronan-modified core-shell intravitreal liponanoparticles, 441–443
 Hyaluronan polymers, 217
 Hyaluronic acid (HA), 49
 Hybrid delivery systems, posterior segment eye disorders, 446–448
 Hydrocortisone 17-butyrate 21-propionate (HBP), 153
 Hydrogel-based formulations, 397
 Hydrogels, 96–97, 248
 Hydrolytic degradation, 134
 Hydrophilic drug molecules, 233
 Hydrophilic insulin, 599
 Hydrophobic molecules, 597
 Hydrophobicity of polymer, 137
 Hydroxybenzoates, 259
 Hydroxypropylcellulose (HPC), 161
 Hyperopia, 62

I

Idoxuridine, 153
 Immunoliposomes, 501
 Inclusion complexes, 244, 249
 Indomethacin, 157
 Inner and outer segments, photoreceptors, 30
 Inner nuclear layer (INL), 30
 Inner plexiform layer (IPL), 30
 Internal limiting membrane (ILM), retina, 30, 49
 Intraocular drug delivery technologies, 408–409
 capsule drug ring, intraocular implant, 429–430
 clinical stage of testing, 418
 diverse intravitreal delivery systems, 432
 drug delivery approaches to eye, 409–415
 episcleral implant, 423–429
 innovative frontiers, 450
 intraocular implant, 430–431
 microsystems, 433–446
 nanosystems, 433–446
 nonbiodegradable
 and biodegradable embodiments, 415–418
 scleral devices, 423
 ocular iontophoresis systems, 431–432
 oral administration, 413
 periocular and intravitreal administration, 413–415
 systemic administration, 411–412
 topical administration, 412–413
 transscleral delivery, macromolecules, 429
 vitreoretinal disorders treatment, 418–432
 Intraocular pressure (IOP), 99, 304
 Intravitreal drug administration, 117, 603–604
 Intravitreal implants, 604
 Intravitreal injections, 233, 604
 acyclovir and ganciclovir, 371
 bevacizumab antiangiogenic activity, 372
 cellular infiltrations/vascular inflammation, 371
 DOX vs. DOXM, 373
 K5-NP, 372
 neural retina, 370
 patient compliance, 371
 polyethylenimine, 372
 polymeric nanoparticles, 371
 requirement, 371
 RPE cells, 371, 372
 Intravitreal triamcinolone acetonide (IVTA), 293
 In vitro cell culture models
 blood-ocular barriers, 488–491
 conjunctiva, 487–488

- cornea, 484–486
 - endothelial cells, 484
 - ocular barriers, 484
- Ionic-buffered preservative, 265
- Iontophoresis, 92, 191, 234, 239, 541
 - CCI, 192
 - corneal infections, 191
 - corticosteroid-mediated effects, 193
 - delivering ophthalmic drugs, 193
 - dexamethasone phosphate, 193
 - drug delivery techniques, 193
 - drug molecules and nucleic acids, 190
 - gentamicin, 191
 - iranscorneal, 191
 - MP, 193
 - Pseudomonas*, 191
 - regulation, drug delivery, 191
 - transport of dyes and DNA, 192
 - transscleral, 191, 193
- Iris, 20, 61

- K**
- Keratocytes, 39
- Ketoconazole (KET), 101

- L**
- Lacrimal drainage system, 18–19
- Lacunae, 284
- Lamina cribrosa, 50
- Latanoprost (Xalatan), 55
- Latanoprost-loaded nanosheet (LLNS), 467
- Lateral geniculate nucleus (LGN), 49, 73, 74
- Lens, 27
 - capsule, 43
 - epithelium, 43
 - fibers, 44
- Limbus, 45
- Lipid-based nanovesicular systems, 233
- Lipophilic drug molecules, 238
- Lipophilic drugs, 392
- Lipophilic stromal layer, 235
- Liposomal bevacizumab, 301
- Liposomal hydrogel system, 98
- Liposome-based ocular delivery systems, 153
- Liposome–chitosan nanoparticle complexes (LCS-NP), 97
- Liposomes, 97–98, 153, 235–236, 395–396, 477, 478, 500–502, 509
 - anterior eye, 334
 - cyclosporine concentration, 335
 - hydrophilic and hydrophobic drug molecules, 334
 - posterior eye, 334–336
 - tears again liposomal spray, 336
 - verteporfin, 336
- Lutein, 48

- M**
- Macula, 48
- Marginal conjunctiva, 13
- Medulloblastoma, 70
- Meibomian (tarsal) gland, 39, 53
- Membrane-controlled reservoir inserts, 160
- Metalloproteinase-2 (MMP-2), 294
- Methacrylic acid-based polymeric materials, 161
- Methylcellulose (MC), 52
- Meyer's loop, 75
- Micelles, 322
- Microelectromechanical system (MEMS), 307
- Microemulsion
 - compositions, 194
 - cosurfactants, 194
 - dexamethasone eye drop, 195
 - drug-encapsulated, 195
 - hydrophilic or hydrophobic drug molecules, 195
 - mass production, 194
 - size, 194
 - surface, 194
 - surfactants, 194
 - synthesis, 194
 - ternary/pseudoternary, 194
- Microemulsion-based ocular bioadhesive formulations, 223
- Microemulsions, 154
- Microneedle-based drug delivery systems, 239
- Microneedles, 234, 239, 446–448
 - adaptable technology, 197
 - categories, 196
 - clinical/surgical setting, 196
 - conventional therapy, 196
 - deliver macromolecules, 195
 - disadvantages, 196
 - drug injections, 196
 - microfabricated, 196
 - minimally invasive hollow borosilicate, 196
 - pilocarpine-coated, 196
 - structures, 195
 - treatment, ocular diseases, 196

- Microneedle therapy, 591
- Microrobotics, 547
- Microspheres
- advantages, 198
 - anti-VEGF celecoxib-loaded, 198
 - biodegradability, 199
 - celecoxib-loaded PLGA, 198
 - colloids, solid polymers, 197
 - corticosteroid budesonide, 198
 - delivery system, 197
 - drug release, 197
 - encapsulation efficiency, 198
 - EPO release, 198
 - hydrophilic drugs, 197
 - oral administration, 198
 - PLGA and PLA, 197
 - reservoir system, 197
 - size, 197
- Microsystem technologies, targeted delivery, 438
- Minidiscs, 161
- Miosis, 59
- Moxifloxacin, 126
- MRP efflux transporters, 600
- Mucoadhesion, 395
- Mucoadhesives, 248, 558–559
- ophthalmic product, 262
 - polymers, 133, 137, 289
- Müller cells, 48
- Multidrug resistance protein (MRP), 597
- Multilamellar vesicles (MLV), 153, 235
- Multiple sclerosis (MS), 69
- Multiwalled carbon nanotubes (MWCNTs), 510, 511
- Mydriasis, 59
- Myopia, 62
- N**
- N*-Acetylcarnosine (NAC), 288
- Naltrexone hydrochloride (NTX), 237
- Nano-biomaterials, 5
- nanotoxicity, 516
 - ocular drug delivery system, 508
- Nanocapsules, 326
- Nanocarrier-drug complex, 89
- Nanocarriers, ocular tissues
- gene therapy, 545–547
 - intravitreal administration, 545
 - periocular administration, 545
 - topical, 544
- Nanoemulsions, 6
- Nanoemulsions, 395–396
- Nano-implants, 190
- Nanomaterials
- characteristics, 3
 - classification, 2–4
 - fabrication methods, 2
 - formulation, 2
 - ocular drug delivery system, 507
 - properties, 2
 - toxic effects in vivo, 506
- Nanomedicine, 393
- Nanomicelles, 478–479
- Nanoparticle-loaded contact lenses, 506
- Nanoparticles, 132, 156, 503–504
- anterior eye, 326–328
 - applications, 326, 327
 - cellular internalization, 4
 - characterization, 364
 - dialysis, 363
 - drying, 364
 - intravitreal disposition, 374–375
 - nanocapsules, 326
 - nanospheres, 326
 - ocular administration, 326, 327
 - opsonization, 326
 - periocular disposition, 375–376
 - polymers, 325
 - posterior eye, 328–329
 - purification, 362–363
 - sterilization, 363
 - systems, 5
- Nanoparticulate ocular drug delivery systems
- in animal models, 461–464
 - CCSC, 464
 - LLNS, 467
 - polylactides, 462
- Nanoporous, 398
- Nanoprecipitation method, 360–361, 477
- Nanospheres, 326, 396
- Nanostructured lipid carrier (NLC), 94
- Nanosuspensions, 155, 479
- Nanosystem
- design for management of posterior segment disorders, 434–438
 - ocular bioenvironment
 - anatomical structure, eyes, 535
 - invasive methods, 536
 - ocular implant, 548, 549
 - inflammatory ocular tissue targeting, 443–444
 - technologies, targeted delivery, 438–446
- Nanotechnology, 399
- description, 1
 - and ocular systems
 - anterior segment diseases, 498–499
 - eye, 496–498
 - posterior segment diseases, 499–500

- Nanotechnology-based formulations
 - cyclodextrin nanoparticle suspension, 504
 - dendrimers, 505
 - liposomes, 500–502
 - microemulsions, 503
 - nanoemulsions, 503
 - nanoparticle-loaded contact lenses, 506
 - nanoparticles (nanospheres, nanocapsules, and nanosuspensions), 503–504
 - niosomes, 502
 - Nanotherapeutics, 586
 - Nanotoxicity, 4–5
 - Nanotoxicity assessment
 - challenges and limitations, 524
 - in vitro assays
 - AlamarBlue redox system, 518
 - annexin V/propidium iodide staining, 517
 - apoptosis marker caspase-3, detection, 518
 - cell viability, 516
 - clonogenic cell survival assays, 519
 - comet assay, 519
 - DNA laddering, 519
 - [3H] thymidine, 518
 - intact lysosomes, detection, 517
 - LDH release upon necrosis, 516–517
 - MTT assay detecting mitochondrial activity, 516
 - stress response, 520–521
 - trypan blue assay, 520
 - TUNEL assay, 519, 520
 - in vivo assays, 521–524
 - inflammatory response, 521
 - Nanotube-based intravitreal implant, 440–441
 - Nanovesicle preparation, 240
 - Nanovesicular ophthalmic drug delivery systems, 239
 - Naringenin, 126
 - Nasolacrimal drainage, 52
 - Nasolacrimal duct, 84
 - Natural and synthetic polymers, alginate, 220
 - Natural biodegradable polymers, 133
 - Natural polymers
 - chitosan, 188
 - collagen, 188
 - condensation, 188
 - gelatin, 189
 - ocular drug delivery, 188
 - Nepafenac, 158
 - Nerve fiber layer (NFL), 30
 - New ophthalmic delivery systems (NODS), 164–165
 - Nicotinamide adenine dinucleotide phosphate (NADPH), 292
 - Niosomes, 98–99, 154, 236–238, 336–337, 502–503
 - Nonbiodegradable scleral devices, 423
 - Non-corneal routes, 597–599
 - Noninvasive delivery methods, 84
 - Nonionic surfactants, 237
 - Non-preserved unit-dose eye drops, 271
 - Non-steroid anti-inflammatory drugs (NSAID), 287, 473
 - Noonan syndrome, 71
 - Normal-pressure glaucoma (NPG), 306
 - Novel drug delivery systems (NDDS), 309
- O**
- o-carboxymethylated chitosan nanoparticles (OCM-CSNP), 366
 - Ocular anatomy, 9, 23
 - Ocular barriers, 178
 - aqueous Humor, 179–180
 - blood–aqueous, 181
 - blood–retinal barrier, 181
 - colloidal carriers, 539
 - conjunctival-Scleral, 180
 - corneal, 179
 - dendrimers, 542, 543
 - iontophoresis, 541
 - lens, 180
 - lipid carriers, 541, 542
 - polymer-based, 540, 541
 - precorneal, 178–179
 - vitreal, 180–181
 - Ocular drug delivery, 37, 83, 244
 - barriers types, 352, 353
 - biodegradable polymers, 354
 - blood–ocular barrier, 538
 - CDs (*see* Cyclodextrins (CDs))
 - challenges, 148–150
 - collagen corneal shields, 163, 164
 - colloidal carriers, 540
 - conjunctiva, 537
 - constraints and colloidal carriers, 353
 - cornea, 537
 - and eye anatomy, 544
 - eyedrop, 352
 - formulation approaches, 150–155
 - liposomes, 153
 - microemulsions, 154–155
 - niosomes, 154
 - penetration enhancers, 151–152
 - viscosity modifiers, 150–151
 - impediments, 352
 - intravitreal injections, 165–166
 - iontophoresis, 166–167

- Ocular drug delivery (*cont.*)
- nanomaterials in, 85, 90–91
 - nanoparticles, 353 (*see* Nanotechnology-based formulations)
 - nanotechnology-derived formulations, 155–158
 - nanoparticles/nanospheres, 156–157
 - nanosuspensions, 155–156
 - prodrugs, 157–158
 - ODDS, 164, 165
 - periocular administration, 167
 - pharmacodynamic and pharmacokinetic properties, 352
 - polymeric nanoparticles, 354
 - primary challenge, 84
 - sclera, 537
 - soluble drugs, 354
 - system, 153
 - insoluble inserts, 160–162
 - ocular implants, 159–164
 - soluble inserts, 162–164
 - tear film, 536
- Ocular drugs
- biopharmaceutics, 115
 - compartment model, 119
 - naringenin, 126
 - ophthalmic diseases, 116
 - pharmacokinetics and pharmacodynamics, 112, 118
 - precorneal removal, 113
 - subconjunctival administration, 117
 - treatment, 111
- Ocular gel, 250
- Ocular hypertension (OHT), 124
- Ocular iontophoresis, 166–167, 431–432, 589, 590
- Ocular membrane and barriers, ophthalmic, 595–600
- Ocular nanobiomaterials/nanoformulations, 509
- aluminum nanoparticles, 512
 - dendrimers, 509, 510
 - fullerene/CNTs, 510–512
 - gold nanoparticles, 513
 - liposomes, 509
 - nanotoxicity (*see* Nanotoxicity assessment)
 - QDs, 513–515
- Ocular nanoparticulate systems, 378
- Ocular penetration enhancer, 178–181, 195
- acetazolamide, 188
 - barriers, 178 (*see* Ocular barriers)
 - BRT nanoparticles, 187
 - CDs, 185
 - conditions, 178
 - dendrimers, 186, 187
 - Eudragit nanoparticles, 187
 - implants, 190
 - iontophoresis, 190–193
 - liposomal, 183
 - liposomes, 181–183
 - microemulsion (*see* Microemulsion)
 - microneedles (*see* Microneedles)
 - nanomaterials, 178
 - nanoparticle, 178
 - natural polymers, 188, 189
 - niosomes, 183, 184
 - synthetic polymers, 189, 190
 - transport of molecules, 178
 - vitreal injections, 178
- Ocular permeation enhancers
- microspheres (*see* Microspheres)
- Ocular pharmacokinetics, 112, 117, 125, 596–600
- anterior and posterior segment disorders, 595
 - defensive barriers, 594
 - ocular drug administration, 600–607
 - ophthalmic disorders, 595
 - optimal delivery, 594
 - in ophthalmic therapeutics
 - blood-ocular barriers, 599–600
 - cornea, 596–597
 - corneanon-corneal routes, 597–599
 - primary membrane barriers, 594
 - RPE, 595
 - systemic toxicity, 595
- Ocular pharmacotherapy, 37
- Ocular preservatives, 257, 259, 260, 266–270
- benzododecinium bromide, 266
 - characteristics, 255
 - chronic eye infections, 272
 - collasomes, 272
 - combination of, 262
 - concentration, 261
 - description and limitations
 - BKC, 257
 - chlorhexidine, 259
 - chlorobutanol, 260
 - hydroxybenzoates, 259
 - detergent, 256
 - filter devices, 271
 - formulation, 255
 - frequency, 261
 - hypo-osmotic solution, 272
 - ionic-buffering, 265
 - mucoadhesive ophthalmic product, 262

- non-preserved multidose drops, 271
- non-preserved unit-dose eye drops, 271
- oxidative, 256
- pharmaceutical industry, 255
- physicochemical deterioration and biodegradation, 254
- physiological state of cornea, 262
- polixetonium chloride, 265
- polyquaternium-1, 263
- qualities, 255
- risk, 273
- SOC, 264, 265
- sodium perborate, 264
- sorbic acid, 263
- toxicity (*see* Toxicity of ocular preservatives)
- treatment duration, 261
- types, 255, 256
- Ocular structures, 38
- Ocular transport
 - efflux, 538
 - influx, 538
 - nanotechnology-based drug delivery system, 539
 - vision threatening, 539
- OcuPhor™, 166
- Ocusert pilocarpine system, 160
- Ocuserts, 160
- Ointments, 234
- Oligonucleotides (ODN), 157
- Opacity, 59
- Ophthalmic agents, 53
- Ophthalmic drug delivery (ODD), 148, 216–223
 - advantages, 232
 - adverse ocular effects, 255
 - albumin nanoparticles, 474
 - applications, 5–6
 - bioadhesives (*see* Bioadhesives)
 - challenges, conventional, 85–87
 - chitosan nanoparticles, 473
 - contact lenses in, 87–88
 - Eudragit nanoparticles, 473
 - eye and barriers, 232–234
 - HSA nanoparticles, 474
 - medications, 254
 - nanomaterials, 89
 - nanovesicles, 232, 240
 - nanovesicular, 235–240
 - physical properties, 232
 - preparations, 254
 - preservatives, 255
 - PVA, 240
 - risk, 254
 - systems, 234
 - tear film and lachrymal drainage, 212, 214, 215
 - techniques, 239
 - topical applications, 254
 - toxicities, 472
 - treatment, eye conditions, 254
- Ophthalmic drug delivery systems (ODDS), 234
 - buffering agents, 559
 - colloids, 586
 - corneal
 - anatomy, 584
 - epithelium basal cells, 584
 - integrity, 584
 - dendrimers, 589
 - DM, 585
 - drug release rate, 559
 - eye, physiological and anatomical barriers, 555
 - in situ gelation, 558
 - lacrimal elimination, 556
 - liposomes, 587
 - microemulsions, 588
 - microneedles, 591
 - nanotherapeutics, 586
 - niosomes, 587
 - ocular iontophoresis, 589, 590
 - ointments, 586
 - penetration enhancers, 558
 - physicochemical properties, 557
 - preservatives, 559
 - reduced patient acceptability, 556
 - solubility enhancers, 557
 - solvents, 559
 - sonophoresis, 590
 - stability enhancers, 559
 - stromal keratocytes, 584
 - therapeutic concentrations, 585
 - topical solutions, 585
 - transporter proteins, 588
 - ultrasound-mediated delivery, 590
 - viscosity-enhancing agents, 558
- Ophthalmic formulation
 - nanomaterial-based, 89–92
 - nanomaterials in
 - CDs, 101
 - dendrimers, 99–100
 - hydrogels, 96–97
 - liposomes, 97–98
 - niosomes, 98–99
 - polymeric micelles, 92–95

- Ophthalmic preparations, 254, 256, 257, 262, 269
 Ophthalmic rod (OR), 165
 Optic chiasma, 71, 72
 Optic nerve, 32, 49–51
 intracanalicular region, 51
 intracranial region, 51
 intraocular region, 49
 intraorbital region, 50
 lamellar area, 50
 prelamellar area, 50
 superficial nerve fibers, 50
 Optic neuritis, 69
 Optical coherence tomography (OCT), 71
 Ora Serrata, 49
 Orbit, 32–34
 Orbital conjunctiva, 14
 Organic/lipid-based nanoparticle vectors, 479
 Organomercurials
 causing, 258
 gram-negative, 258
 gram-positive, 258
 phenylmercuric acetate, 258
 phenylmercuric nitrate, 257
 phenylmercuric salts, 258
 Pseudomonas aeruginosa, 258
 thimerosal, 258
 Osmotic pressure, 38, 44
 Outer nuclear layer (ONL), 30
 Outer plexiform layer (OPL), 30
 Oxidation polymers, 134
- P**
- Palpebral conjunctiva, 13–14
 Papilledema, 70
 Papillitis, 69
 Papillomacular bundle, 69
 Parafovea, 48
 Parasympathetic nervous system, 41
 Parkinson's disease, 60
 Particulate vesicular adhesives, 221
 PCL-based triblock polymer (PEG-PCL-PEG), 142
 Pegaptanib sodium (Macugen®), 300
 Peptide-histidine (PHT) transporters, 54
 Periodic acid-Schiff (PAS), 42
 Peripheral scotoma, 62
 Permeation enhancers, 151
 P-glycoprotein (P-gp), 597
 Pharmacokinetics, 5, 51–53
 Pharmacosomes, 154, 238
 Phenylboronic acid, 95
 Photodynamic therapy (PDT), 300
 Physiological State of Cornea, 262
 Pilocarpine, 306
 Pilocarpine nitrate drug delivery systems, 161
 Pimagedine, 293
 Pirenoxine (PRX), 288
 Platelet-derived growth factors (PDGFs), 294
 Pleomorphism, 283
 PLGA, 142
 Pluronic F127, 96
 Polixetonium chloride (Polyquaternium-42), 265
 Poloxamer, 221
 Poly-2-hydroxyethyl methacrylate (p-HEMA), 87, 155, 506
 Poly(amidoamine) (PAMAM), 100, 509
 Poly(dl-lactide-co-glycolide), 301
 Poly(ethylene glycol) (PEG), 476
 Poly(ethylene oxide), 218
 Poly(lactide) (PLA), 141–142
 Poly(lactide-co-glycolide) (PLGA)
 nanoparticles, 476, 477
 Polyhydrides, 189
 Polycaprolactone, chemical structure, 142
 Polycaprolactone (PCL), 463
 Polyethylene glycol (PEG), 93, 596
 Polyethylene glycol dimethacrylate (PEGDM), 423–428
 Polyethylene oxide (PEO), 93
 Polyglycolic acid (PGA), 504
 Polyglycolide (PGA), 141–142
 Polyisobutylcyanoacrylate/PBC polymers, 368
 Polylactic acid (PLA), 504
 Polylactic glycolic acid (PLGA)-based ocular
 bioadhesive systems, 222
 Polylactide (PLA), 189, 606
 Polylactide-co-glycolide (PLGA), 141–142
 Polylactide-co-glycolide biodegradable
 polymers, 606
 Polylactide nanoparticles, 462–463
 Polymer and dendrimer, 397
 Polymer biodegradations, 135, 136
 Polymer degradation, 135
 Polymeric materials and drug delivery, 131
 Polymeric micelles, 92–95
 Polymeric nanoparticles, 396–397
 anterior segment drug delivery
 albumin, 367
 brimonidine tartrate, 365
 chitosan, 365, 366
 disposition, 369–370
 gatifloxacin, 366
 HA-CS, 366
 ionic gelation method, 365
 natural and synthetic polymers, 365
 OCM-CSNP, 366

- PACA, 368
 - PCL, 368
 - pilocarpine and hydrocortisone, 367
 - Piloplex systems, 365
 - PLA, 368
 - PLGA, 367
 - polyisobutylcyanoacrylate/PBC polymers, 368
 - RS and RL, 367
 - sodium alginate, 366
 - topical delivery and subconjunctival injection, 365
 - dispersion, preformed polymers, 359–362
 - drug delivery system, 378
 - fabrication techniques, 355, 358
 - hydrogel system, 377
 - mechanisms, 377
 - mucoadhesive polymers, 377
 - multifunctional biodegradable nanoparticle, 377
 - PLGA nanospheres/microspheres, 377
 - polymerization method, 358–359
 - posterior segment drug delivery
 - intravitreal route, 370–373
 - periocular routes, 373–374
 - TPGS, 377
 - Polymeric triamcinolone-loaded microparticles and nanoparticles, 440
 - Polymerization method, 358–359
 - Polymers, 132, 355–357
 - in ophthalmic delivery
 - chitosan, 140–141
 - gelatin, 141
 - PCL, 142–143
 - PGA, 141–142
 - PLA, 141–142
 - PLGA, 141–142
 - PVP, 141
 - physicochemical properties
 - copolymer composition, 138
 - crystallinity, 139
 - glass transition temperature, 138
 - hydrophobicity/hydrophilicity, 137–138
 - molecular weight, 136–137
 - Polymyalgia rheumatica, 70
 - Polyquaternium-1, 263
 - Polysaccharide nanomaterials, 6
 - Polyvinyl alcohol (PVA), 52, 151
 - Polyvinylpyrrolidone (PVP), 141, 162, 189
 - Poly- ϵ -caprolactone (PCL), 142–143
 - Posterior junctional scotoma, 73
 - Posterior ocular tissues, 438
 - Posterior vitreous detachment (PVD), 284
 - Precorneal loss factors, 148
 - Precorneal tear film, 39
 - Presbyopia, 59, 63
 - Primary aphakia, 59
 - Primary open-angle glaucoma (POAG), 304, 466
 - Prodrugs, 55, 157, 158
 - Proliferative vitreoretinopathy (PVR), 408
 - Protein coroneae, 5
 - Protein kinase C (PKC), 293
 - Pseudolatex-based ocular formulations, 561
 - Pseudomonas keratitis*, 167
 - Pupils, 60
- Q**
- QDs. *See* Quantum dots (QDs)
 - Quantum dots (QDs), 513–515
 - Quasi-emulsion solvent diffusion (QESD), 361, 473
 - Quinax, 288
- R**
- Ranibizumab (Lucentis®), 124, 300
 - Rapid expansion of supercritical solution (RESS), 361
 - Reactive oxygen species (ROS), 282, 286, 293, 299, 302, 506, 510
 - Receptor for advanced glycation end products (RAGEs), 293
 - Relative afferent pupillary defect (RAPD), 60
 - Retina, 29–31, 280
 - components, 48
 - ILM, 49
 - retinal photoreceptor layer, 47–48
 - RPE, 47
 - Retina layers, 30
 - Retinal ageing, 284
 - Retinal capillary endothelial cells, 599
 - Retinal capillary endothelium, 491
 - Retinal ganglion cells (RGCs), 304, 305
 - Retinal pigment epithelial (RPE) cells, 23, 28, 47, 84, 156, 296, 297, 334, 484, 488, 489, 595
 - Retinitis pigmentosa (RP), 64, 548
 - Reverse Argyll Robertson pupil, 60
 - Reverse phase evaporation vesicles (REVs), 153
 - Reverse-phase high-performance liquid chromatography (RP HPLC), 477
 - RPE cells. *See* Retinal pigment epithelial (RPE) cells

S

- Salting out/emulsification–diffusion method, 360
- Sattler's layer, 21
- Schlemm canal, 46, 58, 283
- Schwalbe's line, 23
- Sclera, 19, 45, 58, 117, 279, 598–599
- Sclera–choroid–retinal pigment epithelium (SCRPE) membranes, 100
- Scleral spur, 24
- Scotoma, 67
- Secondary aphakia, 59
- Silver nanoparticles, 475
- Single-walled carbon nanotubes (SWCNTs), 510, 511
- Snellen chart, 71
- Snellen eye chart, 71
- Sodium alginate, 133
- Solid-lipid nanoparticles (SLN), 156
- Soluble ophthalmic drug inserts (SODI), 162–163
- Sonophoresis, 590
- Span (sorbitan)-based elastic vesicular drug delivery systems, 239
- Spanlastics, 239
- Spontaneous emulsification/solvent diffusion method, 360
- Stabilized oxychloro complex (SOC), 264–265
- Steroids, 596
- Stimulus-responsive ocular nanosystems, 444–446
- Stroma possesses, 596
- Supercritical anti-solvent (SAS), 361
- Supercritical fluid technology, 361
- Surfactants, 152
- SWCNTs. *See* Single-walled carbon nanotubes (SWCNTs)
- Swinging light test, 71
- Synthetic biodegradable polymer, 133
- Synthetic polymers
 - PCL, 190
 - PLA, 189
 - polyanhydrides, 189
 - PVP, 189

T

- Tarsal conjunctiva, 14
- Tay-Sachs disease, 68
- Tear film, 39, 53–54, 266–267
- Tear turnover, 84
- Tears Again Advanced Eyelid Spray®, 336

Tenon's capsule, 14

TER. *See* Transepithelial electrical resistance (TER)

- Terbinafine hydrochloride (THCl), 466
- Terminal complement complex (TCC), 302
- Thermoreversible gel, 141
- Thermo-sensitive gels, 240
- Timolol, 92, 190
- Tobramycin iontophoresis, 191
- Top-down fabrication approach, 2
- Toxicity of ocular preservatives
 - allergic symptoms, 267
 - conjunctival, 266
 - contact lens, 268–269
 - corneal damages, 268
 - human corneal, 270
 - newer, 269, 270
 - tear film disruption, 266, 267
- Trabecular meshwork, 23, 46, 283
- Transcorneal absorption, 115
- Transcorneal iontophoresis, 191
- Transepithelial electrical resistance (TER), 485
- Transforming growth factor-beta 2 (TGF- β 2), 294
- Transmission electron microscopy (TEM), 512
- Transscleral delivery of macromolecules, 429
- Transscleral drug delivery, 431–432
- Traumatic mydriasis, 59
- Triblock copolymer, 93, 94
- Tritanopia, 65

U

- Ultra resolution imaging (URI), 512
- Ultracentrifugation, 362
- Uveal trabecular meshwork, 46
- Uveal tract, 20–23, 40–43
 - Bruch's membrane, 42
 - choriocapillaris, 42, 43
 - choroid, 42
 - ciliary body, 41
 - ciliary epithelium and stroma, 41–42
 - dilator muscle, 41
 - iris, 40
 - sphincter muscle, 41
 - stroma, 40

V

- Vascular endothelial growth factor (VEGF), 290, 293, 475

VEGF trap-eye (aflibercept), 300
Vehicle additives, 394–395
Verteporfin (Visudyne®), 300, 336
Vesicular drug delivery systems, 240
Visual acuity, 71
Vitraser®[®], 190
Vitreomacular adhesion, 118
Vitreoretinal disorders, 411, 418–432
Vitreous, 49
 ageing, 283–284

 humor, 28
Vldl receptor–/–mice, 303

X

Xanthan gum, 151

Z

Zeaxanthin, 48