

# Index

## A

Acanthodii, 8, 9, 18–19, 110  
Acellular bone, 10, 11, 92–94, 231  
Acroclin, 217–219  
Adameloid, 217  
Anal fin, 13–15, 278, 279, 281, 286–288, 300, 307  
Antarctic fish, 23, 142  
Aragonite, 134–136, 138–140, 145, 147, 148  
Arctic fish, 23, 142  
Armor-based constructs, 237  
Aspidin, 5, 92, 93, 226, 231

## B

Barbels, 9, 107, 108  
Bills, or beaks, 43–44  
Biocomposites, 50, 91–182, 215, 222, 231, 245, 353, 411, 418  
Biohalite, 165–166  
Biologically controlled mineralization (BCM), 155  
Biologically induced mineralization (BIM), 155  
Biomagnetite, 153–158  
Biomaterials, 3–49, 80, 104, 224, 263, 272, 321, 328, 334, 335, 351, 354, 371, 379, 390, 394, 405, 417, 418, 423  
Biomechanics, 15, 16, 29, 46, 48, 76–79, 97, 121, 127, 133, 153, 226, 244–252, 285, 308, 362, 417  
Biomedical applications, 69, 274, 335  
Biomedicine, 84, 271, 272, 327, 328, 363, 371, 415–419  
Biomimetic applications, 257–258, 431

Biomimetics, 15, 29, 50, 84, 104, 118, 237, 277, 291, 303, 308, 322, 410  
Biomineralization, 32, 74, 75, 96, 106, 110, 116, 133, 137, 143, 144, 148, 150, 152, 156, 172–179, 218, 249, 250, 322, 393  
Biopolymers, 50, 329, 347, 350, 354, 415  
Biorobotics, 302–308  
Biotechnology, 273  
Bones, 5, 70, 91, 213, 241, 265, 292, 323, 343, 392, 419, 429

## C

Calcification, 73–75, 84, 141, 143, 149, 150, 172, 173, 179, 215, 293, 322, 334, 335, 393  
Calcified structures, 135  
Calcite, 134, 139, 140, 143, 145, 148, 151  
Calcium hydroxyapatite crystals, 215  
Calculi, 172–179, 181  
Carcharhiniformes (Ground Sharks), 14, 81, 118  
Cartilage, 3, 7–9, 11, 15, 19, 69–84, 92, 95, 97, 105, 160, 170, 327, 331, 343, 352–354, 364–366, 417  
  gelatin, 352–354  
Cartilaginous endoskeleton, 9, 73  
  fishes, 9, 10, 77, 78, 82  
Caudal fin, 16, 277–286, 300  
Cetacean elastin, 368–371  
Chalcedony, 179–181  
Chondrichthyes, 8–11, 13, 73, 74, 84, 110, 116, 218, 303  
Claspers, 9

- Class  
 Acanthodii, 18–19  
 Amphibia, 4, 27–28  
 Chondrichthyes, 9–11, 13  
 Placodermi, 25–26  
 Class Aves (birds), 36–47  
 Class Cephalaspidomorpha (Petromyzontida), 7–8  
 Classification of marine vertebrates, 3–50  
 Class Myxini (Myxinoidea), 6–7  
 Class Osteichthyes (higher bony fishes), 19–21  
 Class Reptilia (reptiles), 28–36  
 Collagen, 5, 70, 92, 215, 244, 266, 283, 321, 345, 364, 382, 405, 415, 423  
 Collagenous composite material, 405  
 Composites, 213–231, 245, 294, 301, 330, 333, 347–349, 415  
 Coronoin, 217  
 Cosmine, 19, 25, 92, 117, 213, 220, 221, 223, 224  
 The Crocodylians (Order Crocodylia), 35  
 Ctenoid, 228–230
- D**  
 Dentine, 4–6, 9, 10, 17, 18, 24, 25, 93, 104–107, 110, 111, 114–118, 121, 124, 125, 129, 131–133, 215–224, 231, 323, 324  
 Dentine-based composite, 218–221  
 Dermal  
 bone, 8, 92, 94–95, 104, 107, 220, 241, 299  
 denticle, 9, 19, 106, 113, 230, 237  
 skeleton, 94, 114, 213, 220, 225, 226, 228, 241  
 Desmosine, 361, 365, 368  
 Dorsal fins, 12–15, 25, 278, 280, 286  
 Durodentine, 104, 106, 218, 219
- E**  
 Earstones, 135  
 Egg-capsule proteins, 403–411  
 Egg-case, 10  
 Egg shells, 143–153  
 Egg tooth, 44–45  
 Elasmidine (isopedine), 219, 228  
 Elastin-like proteins, 70, 364–366, 415  
 Elastoidin, 292–297  
 Elastomers, 3
- Enamel, 4, 10, 19, 24, 104–107, 110–112, 114, 115, 117, 121–124, 128, 132, 133, 213, 215–224, 231, 250, 391  
 Enameloid, 5, 6, 104, 106, 107, 110–112, 114, 115, 117, 121, 133, 213, 215–218, 220, 221, 223, 227, 231  
 Endochondral bone, 73, 92, 95–96, 104, 292  
 Enteroliths, 172, 177  
 Eyes, 13, 14, 17–19, 24, 25, 29, 33, 38–39, 75, 161, 334
- F**  
 Faecoliths, 172, 178  
 Films, 35, 151, 273, 302, 328, 331–334, 347–354, 378, 379, 382  
 Fin rays, 8, 107, 228, 229, 277, 279, 281, 282, 284–286, 291, 292, 296, 299, 302, 306, 307, 309  
 Fish  
 armor, 238  
 elastin, 366–368  
 fins, 277–309  
 scales, 213–231, 237–259, 265, 269, 271–274, 325–327, 330, 335, 347, 416  
 skin, 245, 252, 256, 263–274, 323–325, 345, 346, 348, 351, 352, 415  
 wings, 289–291  
 Fish-like devices, 300–308  
 Flexible eggshell, 144, 147  
 Flying fish, 19, 21, 22, 278, 289–291, 307, 308  
 Folded teeth, 104, 115–116
- G**  
 Ganoine, 19, 20, 219–221, 224, 228, 229, 249, 250  
 Gelatin based composite, 347, 348  
 Gelatin isolation, 355  
 Gels, 328, 329, 343, 345, 347, 349, 351, 353, 378  
 Gnathostomes, 4, 8–26, 71, 92, 94, 107, 364  
 Gular pouches, 45
- H**  
 Hagfishes or Hyperotreti, 6  
 Hagfish slime, 7, 379, 386–390, 417  
 Hard cartilage, 71, 84  
 Hemichordata, 69  
 Heterodontiformes (Bullhead sharks), 15  
 Hexanchiformes (Frisled and Cow sharks), 14  
 Hyaloine, 219, 220, 228, 230  
 Hypermineralized tooth plates, 104, 116–117

**I**

- Infraclass Chondrostei*, 22
- Infraclass Holosteii*, 22
- Infraclass Teleostei*, 22–23
- Intermediate filaments, 377, 378, 380, 383–386, 394, 417, 418
- Isodesmosine, 361

**K**

- Keratinization, 108, 380, 381
- Keratinized teeth, 108–109
- Keratin-like biological materials, 379, 417

**L**

- Lamniformes* (Mackerel sharks), 15
- Lamprey, 4, 7, 8, 70, 71, 73, 76, 81, 82, 108, 109, 134, 138, 306–307, 324, 364–366
- Lampreys or Hyperoartii, 7
- Lizards (Suborder Sauria), 32

**M**

- Magnetosensitive neurons, 162
- Magnetosome chain, 154–156
- Map-and-Compass model, 157
- Marine
  - biopolymers, 415
  - collagens, 321–335, 415
  - elastin, 361–371, 418
  - gelatins, 343–355
  - keratins, 377–394
  - Vertebrate, 3, 50, 69–84, 96, 104, 106, 115, 120, 132, 133, 143–181, 289, 382, 418, 419, 431
- Marine Mammals (Class Mammalia), 47–49
- Marine structural proteins, 415–419
- Materials, 3, 76, 97, 220, 237, 263, 277, 322, 344, 363, 378, 405, 415, 426
- Materials engineering, 277–309
- Medical aspect, 82–83
- Membranes, 34, 38, 72, 81, 83, 91, 94, 105, 108, 134–136, 140, 143, 144, 147–152, 155, 156, 164–166, 170, 171, 218, 221, 244, 273, 292, 293, 300, 302, 307, 309, 324, 328, 333, 348, 349, 364, 378, 387, 405, 416, 424–426
- Mesodontine, 9, 219, 226, 231
- Microstructures, 29, 112, 131, 133, 144, 152, 153, 227, 242, 247, 257, 258, 425
- Mineral-based composites, 213–231
- Mineralization process, 101, 155

**Mineralized**

- cartilage, 69–84
- tissues, 3, 91–181, 218, 219, 231, 249, 259
- Mucocartilage, 71
- Multiphase material, 103

**N**

- Narwhals, 48, 104, 122, 124–130
- Narwhal tusk, 126–130
- Nephroliths, 172, 176, 177
- Non-mineralized cartilage, 69

**O****Order**

- Anaspida, 5
- Batoidea, 15–16
- Beloniformes, 21–22
- Charadriiformes, 38
- Chimaeriformes, 17–18
- Cladoselachiformes, 12
- Coelolepida, 6
- Cyclostomata, 6–8
- Heterostraci, 5
- Osteostraci, 4
- Squamata, 32–36
- Testudines, 30–32
- Xenacanthiformes, 12–13
- Order Procellariiformes (Tube-nosed Birds), 37
- Order Selachii (typical sharks), 13–15
- Order Sphenisciformes (Penguins), 37
- Orectolobiformes (Carpet sharks), 15
- Orientation and navigation processes, 157, 158, 162
- Orthodontine, 110, 115, 121, 133, 218, 219, 226, 231
- Otoconia, 133–143
- Otoliths, 19, 133–143

**P**

- Pathological biomineralization, 172–179, 181
- Pectoral fins, 12, 13, 16, 21, 22, 24, 92, 278, 279, 284–286, 289, 291, 297, 302–306, 308
- Pelecaniformes order, 37
- Pelvic fins, 8, 9, 13, 22, 78, 278, 279, 281, 288–289, 291
- Perichondral bone, 9, 74, 92, 95
- Petrodentine, 104, 106, 117, 121, 133, 219
- Petromyzon marinus*, 365
- Pharyngeal denticles, 106, 110–112
- Plicidentine, 104, 106, 115, 133, 219

Polyphenol, 405, 409–411  
 Polypterus, 21, 215, 216, 244, 249, 281, 282, 299  
 Practical applications, 141–142, 271, 335, 344, 394, 416  
 Prelomin, 218  
 Prismatic calcified cartilage, 8  
*Pristiophoriformes* (Sawsharks), 13

## R

Regeneration, 79, 80, 220, 221, 228, 272, 297–299, 329, 330, 333, 334, 349, 415, 419  
 Respiratory turbinates, 39  
 Rigid eggshell, 144  
 Robotics, 50, 118, 273, 274, 277–309  
 Rostral teeth, 109–110  
 Rostrum, 10, 13, 22, 29, 43, 77, 97, 98, 101, 104, 109, 110

## S

Salt glands, 31, 33–36, 39, 40, 164–171, 426  
 Saw or saw-snout, 10  
 Scaffolds, 80, 81, 271, 274, 328–330, 362, 379, 415, 416, 418  
 Sea snakes (Hydrophiinae), 33  
 Selfcleaning, 257–258  
 Semidentine, 219  
 Shagreen, 269–271  
 Shark teeth, 118–122, 217  
 Silica-based minerals, 179–181  
 Skeletal  
   structures, 3, 15, 46  
   system, 94  
 Smart materials, 301–302, 363  
 Snakes (Suborder Serpentes, or Ophidia), 33  
 Soft cartilage, 71, 91  
 Soft eggshell, 144  
 Species richness and diversity of marine vertebrates, 3  
 Spin-brush complex, 10, 11  
 Sponges, 31, 179, 181, 321, 322, 328, 331, 334, 344, 379, 382

Squaliformes (Dogfish), 14  
 Squatiniformes (Angelsharks), 13  
 Sting, 11  
 Structural proteins, 3, 70, 80, 321, 362, 365, 378, 380, 410, 415–419  
*Subclass Elasmobranchii*, 11–12  
*Subclass Holocephali*, 17  
*Subclass Sarcopterygii* (lobe-finned fishes), 24–25  
 Superoleophobicity, 245, 256  
*Supraclass Agnatha* (Jawless fishes), 4  
*Supraclass Gnathostomata*, 9  
 Surface shape, 252–258, 286

## T

Teeth, 6, 78, 104, 213, 242, 380, 405  
 Tetrapoda, 26–49  
 Thelodont, 6, 226, 227  
 Tissue engineering, 79–82, 109, 263–274, 299, 300, 328, 330, 331, 354, 415–419  
 Tooth-like structures, 7, 91, 104–108, 225

## U

Uroliths, 172, 174, 176–179  
 Uropygial (preen) glands, 40

## V

Vasodentine, 219  
 Vaterite, 134, 140, 142, 143, 148, 150, 151  
 Vertebrate oral teeth, 114–132  
 Vestibular sensory apparatus, 133

## W

Walrus tusk, 48, 104, 130–132  
 Waterproof feathers, 40–41  
 Whale baleen, 390–394, 425, 426  
 Whale teeth, 104, 122–126  
 Wings  
   and diving, 42–43  
   and flight, 41–42