

Table of contents

1 Introduction	1
1.1 How do I use this book?	2
1.2 Biodiversity	4
1.3 Life	6
1.4 Species	8
2 Earth's History	11
2.1 Fundamentals of the geosciences	12
2.1.1 Construction and formation of the Earth	14
2.1.1.1 Composition of the Earth's layers	16
2.1.1.2 Plate tectonics	18
2.1.2 Rock-forming processes	20
2.1.2.1 Magmatism and igneous rocks	22
2.1.2.2 Weathering, erosion, sedimentation and sedimentary rocks	24
2.1.2.3 Carbonate balance and carbonates	26
2.1.3 Eons	28
2.2 The Precambrian	30
2.2.1 The Archean eon	32
2.2.1.1 Chemical evolution and origin of life	34
2.2.1.2 'RNA world hypothesis' and formation of cells during the Archean	36
2.2.1.3 The Archean carbon metabolism: fermentation	38
2.2.1.4 Evolution of the Archean photoautotrophy: energetics of the anoxygenic and oxygenic photosynthesis	40
2.2.1.5 Evolution of the Archean photoautotrophy: compartmentalisation	42
2.2.2 The Proterozoic eon	44
2.2.2.1 Biogenic and geochemical feedback loops of the Proterozoic oxygen evolution	46
2.2.2.2 Climatic effects of oxygen evolution: the Huronian glaciation (from 2.4 to 2.1 billion years)	48
2.2.2.3 Metabolic effects of oxygen evolution: cytotoxic effect	50
2.2.2.4 Metabolic consequences of oxygen evolution: aerobic respiration	52
2.2.2.5 Evolution of the eukaryotic cell in the Mesoproterozoic	54
2.2.2.6 Evolution of the eukaryotic algae in the Mesoproterozoic	56
2.2.2.7 The 'boring billion' years (1.85-0.85 billion years)	58
2.2.2.8 Evolution of complex multi-cellularity in the Neoproterozoic	60
2.2.2.9 Neoproterozoic glaciations (0.85–0.72 billion years)	62

2.3 The Phanerozoic eon	64
2.3.1 The Phanerozoic eon: an overview	66
2.3.1.1 Plate tectonics and climate evolution during the Phanerozoic.....	68
2.3.1.2 Lagerstätten.....	70
2.3.1.3 Fossilisation – the formation of fossils.....	72
2.3.1.4 Geochronology and stratigraphy	74
2.3.1.5 Termination and biostratigraphic definition of the Phanerozoic systems.....	76
2.3.2 Fossil biodiversity.....	78
2.3.2.1 Foraminifers	80
2.3.2.2 Reef-builders	82
2.3.2.3 Cephalopods.....	84
2.3.2.4 Benthic filter-feeders: brachiopods and bivalves	86
2.3.2.5 Trilobites	88
2.3.2.6 Echinoderms.....	90
2.3.2.7 Graptolites and Conodonts.....	92
2.3.2.8 Vertebrates.....	94
2.3.2.9 Land plants.....	96
2.3.3 The Palaeozoic era	98
2.3.3.1 The Ediacaran and Phanerozoic-Precambrian boundary.....	100
2.3.3.2 Evolution of skeletal elements	102
2.3.3.3 The Cambrian period.....	104
2.3.3.4 The Ordovician period.....	106
2.3.3.5 The Silurian period.....	108
2.3.3.6 Colonisation of terrestrial environments	110
2.3.3.7 The Devonian period	112
2.3.3.8 The Carboniferous period	114
2.3.3.9 The Permian period	116
2.3.3.10 Development of the cornus	118
2.3.3.11 Towards a smaller and shorter-lived haploid generation (gametophyte)	120
2.3.3.12 Towards an increasingly dominant diploid generation (sporophyte)	122
2.3.4 The Mesozoic era	124
2.3.4.1 The Triassic period	126
2.3.4.2 Reproductive adaptations to terrestrial life	128
2.3.4.3 The Jurassic period	130
2.3.4.4 Sauria	132
2.3.4.5 The Cretaceous period	134
2.3.4.6 Evolution of pollination.....	136
2.3.5 The Cenozoic era	138
2.3.5.1 The Palaeogene period	140
2.3.5.2 The Neogene period	142
2.3.5.3 Evolution of C ₄ photosynthesis.....	144
2.3.5.4 Physiological efficiency of C ₄ and CAM photosynthesis	146
2.3.5.5 The Quaternary period	148
2.3.5.6 The Cenozoic Ice Age.....	150

2.3.5.7 Hominisation	152
2.3.5.8 The future	154
3 Distribution of present-day biodiversity	157
3.1 Basics of the biogeographical distribution of taxa	158
3.1.1 Species descriptions	160
3.1.2 The species concept	162
3.1.3 Molecular diversity and OTUs	164
3.1.4 Biodiversity indices	166
3.1.5 Spatial distribution of biodiversity	168
3.1.6 Species concept limitations: viruses	170
3.1.7 Species concept limitations: lichen	172
3.2 Biodiversity distribution	174
3.2.1 Pattern and mechanisms	176
3.2.1.1 Biodiversity hotspots	178
3.2.1.2 Ecological niches	180
3.2.1.3 Speciation mechanisms	182
3.2.1.4 Island biogeography	184
3.2.1.5 Global biodiversity gradients	186
3.2.1.6 Biogeography of microorganisms	188
3.2.1.7 Alien and invasive species	190
3.2.1.8 Cenozoic mass extinction	192
3.2.2 Biogeographic regions	194
3.2.2.1 Global precipitation and temperature distribution	196
3.2.2.2 Global wind systems and climate zones	198
3.2.2.3 Tundra	200
3.2.2.4 Taiga	202
3.2.2.5 Temperate forests	204
3.2.2.6 Temperate grasslands	206
3.2.2.7 Montane and flooded grasslands	208
3.2.2.8 Mediterranean biome	210
3.2.2.9 Hot and temperate deserts	212
3.2.2.10 Subtropical and tropical grasslands	214
3.2.2.11 Subtropical and tropical arid (xerophytic) forests	216
3.2.2.12 Tropical rainforest	218
3.2.2.13 Lakes	220
3.2.2.14 Rivers	222
3.2.2.15 Oceans and seas	224

4 Megasystematics	227
4.1 Basics of Megasystematics	228
4.1.1 Historical and philosophical basis of megasystematics	230
4.1.1.1 Carl Linnaeus and the fundamentals of modern systematics	232
4.1.1.2 Basics of modern phylogeny: Darwin and Pasteur	234
4.1.1.3 What is a plant?	236
4.1.1.4 What is an animal?	238
4.1.1.5 What is a fungus?	240
4.1.1.6 Phylogenetic trees	242
4.1.1.7 Cladograms and phylograms	244
4.1.1.8 Molecular diversity of the eukaryotic supergroups	246
4.1.2 The three domains	248
4.1.2.1 Bacteria	250
4.1.2.2 Archaea	252
4.1.2.3 Eukarya	254
4.1.2.4 Eukarya: Cellular structures	256
4.2 Unikonta (= Amorphea)	258
4.2.1 Holozoa	260
4.2.1.1 Choanomonada	262
4.2.1.2 Porifera	264
4.2.1.3 Placozoa, Cnidaria, Ctenophora	266
4.2.1.4 Protostomia	268
4.2.1.5 Ecdysozoa	270
4.2.1.6 Spiralia	272
4.2.1.7 Deuterostomia	274
4.2.1.6 Gnathostomata	276
4.2.1.9 Amniota	278
4.2.2 Holomycota	280
4.2.2.1 Microsporidia and Chytridiomycota	282
4.2.2.2 Glomeromycota: arbuscular mycorrhizal fungi	284
4.2.2.3 Zygospor-forming fungi	286
4.2.2.4 Ascomycota	288
4.2.2.5 Basidiomycota	290
4.2.3 Amoebozoa	292
4.2.3.1 Conosa	294
4.3 Excavata	296
4.3.1 Metamonada	298
4.3.2 Discoba	300
4.3.2.1 Euglenozoa: Euglenida	302
4.3.2.2 Euglenozoa: Kinetoplastea	304

4.4 Archaeplastida	306
4.4.1 Glaucocystophyta	308
4.4.2 Rhodophyta	310
4.4.3 Viridiplantae	312
4.4.3.1 Streptophyta	314
4.4.3.2 Basale embryophytes: bryophytes	316
4.4.3.3 Rhyniophytina and Lycopodiophytina	318
4.4.3.4 Monilophyta (Ferns)	320
4.4.3.5 Gymnosperms	322
4.4.3.6 Magnoliopsida I: Overview	324
4.4.3.7 Basal Magnoliopsida and Monocotyledons	326
4.4.3.8 Eudicotyledons I: Rosids	328
4.4.3.9 Eudicotyledons II: Asterids	330
4.5 Rhizaria	332
4.5.1 Cercozoa	334
4.5.2 Retaria	336
4.5.2.1 Foraminifera	338
4.6 Alveolata and Stramenopiles	340
4.6.1 Alveolata	342
4.6.1.1 Ciliophora	344
4.6.1.2 Dinophyta	346
4.6.1.3 Apicomplexa	348
4.6.2 Stramenopiles	350
4.6.2.1 Peronosporomycetes (Oomycetes)	352
4.6.2.2 Phaeophyceae	354
4.6.2.3 Chrysophyceae	356
4.6.2.4 Bacillariophyceae	358
4.7 Hacrobia and eukaryotes of uncertain placement (incertae sedis)	360
4.7.1 Haptophyta	362
4.7.2 Cryptophyta	364
Glossary	367
References	379
Index	387

List of subject boxes

Cilium/Flagellum	259
Protection from predation	261
Predator-prey size relationships	263
Motile and sessile lifestyles	265
Symmetry and body structure	267
Segmentation	269
Freezing and thawing	271
Why can some fossils not be found?	273
Protection from UV radiation	275
The development of dinosaurs and angiosperms	277
Size and dimensions	279
Cell wall materials	281
Generational shift in parasites	283
Mycorrhiza	285
Organisational morphology and phylogeny	287
Multinucleate cells	289
Symbiosis / mutualism	291
Pseudopodia	293
Chemical communication and semiochemicals	295
Phagocytosis	297
Hydrogenosomes	299
Reducing of genome size in parasites	301
Perception of light	303
Position of the kinetoplast-kinetosome-flagellar pocket complex	305
Chlorophyll	307
Are higher-level organisms evolutionarily better-adapted?	309

Photo pigments and vertical ecological niches.....	311
Multicellularity	313
Shape as protection against predation.....	315
Cell wall and cuticula.....	317
Alternation of generations – meiosis	319
Vascular bundles	321
Origin, radiation, and dominance of taxa.....	323
Ancestry of the Magnoliopsida lineage.....	325
Carnivory in plants and fungi.....	327
Distribution mechanisms (wind and animal).....	329
Coevolution within pollination biology	331
Nucleomorph	333
<i>Paulinella</i> : a model for the emergence of plastids.....	335
Biogenic minerals	337
Biomineralisation	339
Organelles.....	341
Model organisms.....	343
Endosymbiotic algae.....	345
Bioluminescence	347
Compartmentalisation	349
Osmoregulation.....	351
The chemical basis for life	353
Buoyancy	355
Phototrophy, mixotrophy, heterotrophy	357
Locomotion by gliding	359
Eukaryotic biocenosis and the ‘microbial loop’	361
Algal blooms	363
Surface scales	365