
Contents

Preface.....	xiii
Authors.....	xv
Chapter 1 General Overview	1
Definition.....	1
Classification	2
Occurrence and Distribution.....	2
Structure of Thallus—Cytomorphological Types.....	6
Unicells and Unicell Colonial Type.....	8
Filamentous Type	10
Siphonocladous Type.....	13
Siphonous Type.....	13
Parenchymatous and Pseudo-Parenchymatous Type.....	14
Palmelloid Type.....	15
Nutrition	16
Reproduction	17
Vegetative and Asexual Reproduction.....	17
Binary Fission or Cellular Bisection.....	17
Zoospore, Aplanospore, and Autospore	18
Autocolony Formation.....	18
Fragmentation.....	18
Resting Stages.....	18
Sexual Reproduction.....	20
Haplontic or Zygotic Life Cycle.....	20
Diplontic or Gametic Life Cycle.....	20
Diplohaplontic or Sporic Life Cycles.....	20
Summaries of the 11 Algal Phyla.....	22
Cyanobacteria.....	22
Glaucophyta.....	24
Rhodophyta	25
Chlorophyta	29
Charophyta	32
Haptophyta	33
Cryptophyta.....	35
Ochrophyta	35
Cercozoa—Chlorarachniophyceae.....	39
Myzozoa—Dinophyceae	39
Euglenozoa—Euglenophyceae	41
Endosymbiosis and Origin of Eukaryotic Photosynthesis	42
Suggested Reading	46
Chapter 2 Anatomy	49
Cytomorphology and Ultrastructure	49
Outside the Cell	49

Type 1—Simple Cell Membrane	49
Type 2—Cell Surface with Additional Extracellular Material	50
Type 3—Cell Surface with Additional Intracellular Material in Vesicles	60
Type 4—Cell Surface with Additional Extracellular and Intracellular Material.....	62
Flagella and Associated Structures	66
Flagellar Shape and Surface Features	68
Flagellar Scales.....	68
Flagellar Hairs	70
Flagellar Spines	72
Internal Features of the Flagellum	72
Axoneme.....	72
Paraxial Rod	73
Other Intraflagellar Accessory Structures	74
Transition Zone.....	75
Basal Bodies	79
Root System.....	82
How Algae Move.....	93
Swimming.....	93
Movements Other than Swimming.....	99
Buoyancy Control	100
How a Flagellum Is Built: The Intraflagellar Transport.....	102
How a Flagellar Motor Works	103
How a Paraxial Rod Works	104
The Photoreceptor Apparata.....	104
Types of Photoreceptive Systems	106
Type I.....	106
Type II	108
Type III.....	109
Photoreceptive Proteins	111
Fundamental Behavioral and Physiological Features.....	111
Sampling Strategies	112
Trajectory Control.....	113
Signal Transmission.....	114
An Example: Photoreceptor and Photoreception in <i>Euglena</i>	114
Chloroplasts	118
The Nucleus, Nuclear Division, and Cytokinesis	126
Ejective Organelles and Feeding Apparata	132
Suggested Reading	137
Chapter 3 Photosynthesis	141
Light	141
Photosynthesis	144
Light-Dependent Reactions	145
PSII and PSI: Structure, Function, and Organization	153
ATP Synthase	155
ETC Components	155
Electron Transport: The Z-Scheme	157
Proton Transport: Mechanism of Photosynthetic Phosphorylation.....	158

Contents

Pigment Distribution in PSII and PSI Super-Complexes of Algal Division	160
Light-Independent Reactions.....	160
RuBisCO.....	166
Calvin–Benson–Bassham Cycle.....	167
Carboxylation	167
Reduction.....	167
Regeneration.....	167
Photorespiration.....	168
The Energy Relationships in Photosynthesis: The Balance Sheet	168
Suggested Reading	170
Chapter 4 Working with Light	173
How Light Behaves	173
Scattering.....	173
Absorption	174
Interference.....	175
Reflection.....	175
Refraction	177
Dispersion.....	178
Diffraction.....	178
Field Instruments: Use and Application	181
Radiometry	181
Measurement Geometries: Solid Angles.....	181
Radiant Energy	182
Spectral Radiant Energy	182
Radiant Flux (Radiant Power).....	182
Spectral Radiant Flux (Spectral Radiant Power)	182
Radiant Flux Density (Irradiance and Radiant Exitance).....	182
Spectral Radiant Flux Density	183
Radiance.....	183
Spectral Radiance.....	184
Radiant Intensity	184
Spectral Radiant Intensity	185
Photometry	185
Luminous Flux (Luminous Power)	185
Luminous Intensity.....	185
Luminous Energy.....	188
Luminous Flux Density (Illuminance and Luminous Exitance)	188
Luminance.....	188
Lambertian Surfaces	188
Units Conversion	189
Radiant and Luminous Flux (Radiant and Luminous Power).....	189
Irradiance (Flux Density)	190
Radiance	190
Radiant Intensity.....	190
Luminous Intensity.....	190
Luminance.....	190
Geometries.....	190
PAR Detectors.....	191
The Photosynthesis–Irradiance Response Curve (P vs. E Curve)	193

Photoacclimation	196	
Suggested Reading	197	
Chapter 5	Biogeochemical Role of Algae.....	199
The Role of Algae in Biogeochemistry	199	
Limiting Nutrients	200	
Algae and the Phosphorus Cycle.....	202	
Algae and the Nitrogen Cycle	204	
Algae and the Silicon Cycle	209	
Algae and the Sulfur Cycle	212	
Algae and the Oxygen–Carbon Cycles	214	
Suggested Reading	218	
Chapter 6	Algal Culturing	221
Collection, Storage, and Preservation	221	
Culture Types	224	
Culture Parameters.....	226	
Temperature.....	227	
Light.....	227	
pH	227	
Salinity	227	
Mixing	228	
Culture Vessels.....	228	
Media Choice and Preparation	229	
Freshwater Media	230	
Marine Media	230	
Seawater Base.....	240	
Nutrients, Trace Metals, and Chelators	241	
Vitamins	243	
Soil Extract.....	244	
Buffers	244	
Sterilization of Culture Materials	245	
Culture Methods.....	252	
Batch Cultures	253	
Continuous Cultures	255	
Semicontinuous Cultures.....	256	
Commercial-Scale Cultures	257	
Outdoor Ponds.....	257	
Photobioreactors.....	259	
Culture of Sessile Microalgae	259	
Quantitative Determinations of Algal Density and Growth	260	
Growth Rate and Generation Time Determinations	264	
Suggested Reading	265	
Chapter 7	Algae Utilization	267
Introduction	267	
Sources and Uses of Algae.....	268	
Human Food	268	

Contents

Cyanobacteria	268
Rhodophyta.....	271
Ochrophyta (Phaeophyceae).....	274
Chlorophyta	279
Animal Feed.....	282
Extracts	286
Agar	287
Alginates.....	288
Carrageenan.....	289
Fertilizers.....	291
Cosmetics.....	293
Functional Foods and Nutraceuticals.....	294
Toxins	301
Selected Reading.....	305
Chapter 8 Oddities and Curiosities in the Algal World	309
In the Realm of Darkness.....	309
Algae–Animal Interaction: Riding a Sloth, Swinging on a Spider Web, Swimming in a Jelly	314
Some Like It Cold	320
Some Like It Hot	322
Some Like It Dry	324
Selected Reading.....	325
Index.....	327