1 Introduction to the Algae

1.1 Defining the Algae

1.2 Algal Body Types
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1.3 Algal Reproductive Types
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1.4 A Survey of Algal Diversity

1.5 An Overview of Algal Photosynthesis
   - The General Processes of Photosynthesis
   - The Light-Acquisition Challenge
   - The Photoprotection Challenge
   - The Carbon-Fixation Challenge

1.6 Societal Issues Involving Algae

2 The Roles of Algae in Biogeochemistry

2.1 Cyanobacteria and the Origin of an Oxygen-Rich Atmosphere

2.2 Algae and the Carbon Cycle
   - Algae and Organic Carbon Sequestration
   - The Role of Algae in Carbonate Formation
   - Impact of Modern Carbon Dioxide Levels on Algal Photosynthesis
   - Carbon Concentration Mechanisms of Cyanobacteria
   - Carbon Concentration Mechanisms of Eukaryotic Algae
   - Algal Use of Organic Carbon

2.3 Mineral Limitation of Algal Growth

2.4 Algae and the Nitrogen Cycle

2.5 Iron Limitation of Algal Growth in the Oceans

2.6 Algae and the Sulfur Cycle

2.7 Algal Production of Halocarbon Compounds
   - Text Box 2.1 Remote Sensing of Phytoplankton

3 Algae in Biotic Associations

3.1 Algae in Food Webs
   - Algae as Sources of Dissolved Organic Material and Detritus
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Algal Defenses Against Herbivory
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3.2 Algae in Symbiotic Associations
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Algae as Parasites or Pathogens
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4 Technological Applications of Algae

4.1 Algae as Research Tools
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4.3 Algae as Sources of Food and Other Products
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4.4 Algae in Wastewater Treatment

4.5 Genetic Engineering of Algae

5 Algal Diversity and Relationships

5.1 Supergroups and Species Concepts

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Morphological species concept

Phylogenetic species concept

5.2 Algal Phylogeny

Algae and the Tree of Life Concept

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RAPDs

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Generating and Evaluating Phylogenetic Trees

5.3 The Application of Phylogeny

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6 Cyanobacteria

6.1 Structure, Motility, and Photosynthesis

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  - Cytoplasmic features

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6.2 Reproduction

6.3 Nitrogen Fixation

6.4 Cyanobacteria of Extreme Habitats

6.5 Evolution and Diversity
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  - Phylogeny and Diversity of Modern Cyanobacteria
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    - Filamentous cyanobacteria lacking spores, heterocytes, or akinetes
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7 Endosymbiosis and the Diversification of Eukaryotic Algae—With a Focus on Glaucophytes and Chlorarachniophytes

7.1 Origin of Eukaryotic Algae
  - Fossil Evidence for Early Events in the Diversification of Eukaryotic Algae
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7.2 Endosymbiosis in the Modern World
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    - Cyanobacterial endosymbionts
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    - Marine hosts having eukaryotic endosymbionts
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7.3 Primary Endosymbiosis, with a Focus on the Glaucophyta
   Issues Concerning Primary Endosymbiosis
   A Focus on the Glaucophyta
     Diversity of glaucophytes

7.4 Secondary Endosymbiosis with a Focus on Chlorarachniophytes
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   Apicomplexan Plastids
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7.5 Tertiary Endosymbiosis

8 Euglenoids

8.1 Euglenoid Relationships and Evolutionary History
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   Cellular Features That Distinguish Euglenoids
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8.2 Euglenoid Reproduction

8.3 Euglenoid Plastids and Light-Sensing Systems

8.4 Euglenoid Ecology

8.5 Euglenoid Diversity

9 Cryptomonads

9.1 Cryptomonad Relationships

9.2 Cryptomonad Mobility and Cellular Structure
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9.3 Cryptomonad Reproduction

9.4 Cryptomonad Ecology
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Temperature and Light as Factors in Cryptomonad Distribution
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9.5 Representative Diversity of Cryptomonads

10 Haptophytes
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10.2 Haptophyte Cellular Structure
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      Organic scales
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10.3 Cell Division
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10.4 Sexual Reproduction and Life Cycles
10.5 Haptophyte Ecology
   Haptophytes in Food Webs
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   Biogeochemical Impacts of Haptophytes
10.6 Haptophyte Fossil Record
10.7 Diversity of Living Haptophytes
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11 Dinoflagellates
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11.2 Dinoflagellate Cell Biology
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### 11.3 Sexual Reproduction and Cyst Formation

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### 11.4 Ecology

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### 11.5 Dinoflagellate Diversity

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**Gymnodiniales**
**Prorocentrales**
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**Suessiales**
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### 12 Photosynthetic Stramenopiles I—Diatoms, Pelagophytes, and Silicoflagellates

#### 12.1 Introduction to Photosynthetic Stramenopiles

**Relationships of Photosynthetic Stramenopiles**
**Cellular Features**

#### 12.2 Diatoms

**Diatom Evolutionary History**
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  Mitosis and cytokinesis
  
  Frustule development

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Diatom Motility and Mucilage Secretion

Diatom Spores and Resting Cells

Ecology and Nutrition
  
  Inorganic nutrients
  
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Diatom Collection, Identification, and Diversity
  
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12.3 Pelagophytes

12.4 Dictyochophytes
  
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13 Photosynthetic Stramenopiles II—Chrysophyceans, Synurophyceans, and Eustigmatophyceans

13.1 Chrysophyceans
  
  Chrysophycean Stomatocysts

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  Chrysophycean Diversity

13.2 Synurophyceans
  
  Synurophycean Cell Biology
    
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  Synurophycean Reproduction and Ecology

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13.3 Eustigmatophyceans
  
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14.2 Raphidophyceans
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14.3 Xanthophyceae
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14.4 Phaeophyceans (Brown Algae)
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   The cytoskeleton and cell division

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   Gametangia and parthenogenesis
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   Alariaceae.
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15 Red Algae

15.1 Evolutionary History of Red Algae
   Fossil Red Algae
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15.2 Red Algal Cell Biology
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   Plastids, Pigments, and Photosynthetic Storage
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15.3 Cell Division, Pit-Plug Formation, and Development
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15.4 Body Organization of Red Algae

15.5 Reproduction and Life Histories of Red Algae
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      Carpogonia and fertilization
   Postfertilization Development and Life History in Bangiophytes
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   Isomorphic and Heteromorphic Alternation of Florideophyte Generations

15.6 Red Algal Physiology and Ecology
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   Palmariales
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Corallinophycidae
   Corallinales
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16.1 Green Algal Relationships
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16.2 The Major Green Algal Lineages
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16.3 Cellular Features of Prasinophytes
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16.4 Prasinophyte Diversity

17 Green Algae II—Trebouxiophyceans

17.1 General Features of Trebouxiophyceae
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18 Green Algae III—Ulvophyceans

18.1 General Characteristics, Relationships, and Fossil History of Ulvophyceans
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18.2 Ulvophycean Diversity and Ecology
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19 Green Algae IV—Chlorophyceans

19.1 Chlorophycean Relationships

19.2 General Features of Chlorophyceans
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Chlorophycean Asexual Reproduction, Sexual Reproduction, and Life Cycle
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19.3 Chlorophycean Diversity

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Chlamydomonadales, aka Volvocales

Asexual reproduction of Chlamydomonas
Sexual reproduction in Chlamydomonas

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Colonial nonmotile relatives of Volvox

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Chaetophorales

20 Green Algae V—Streptophyte Algae (Charophyte Algae, Charophyceans)

20.1 General Features and Classification of Streptophyte Algae

Classification of Streptophyte Algae
Streptophyte Algal Orders and Their Evolutionary Significance

20.2 Streptophyte Algal Diversity

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Zygnematales + Desmidiales

Cell biology of Zygnematales
Cell walls and mucilage.
Mitosis and cytokinesis of zygnemataleans.

Reproduction in Zygnematales
Asexual reproduction.
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Ecology of Zygnematales
Diversity of Zygnematales
Overview of Desmidiales (placoderm desmids)
Cell wall structure, mucilage extrusion, and cell motility of Desmidiales
Mitosis and development of new semi-cells in Desmidiales
Reproduction in Desmidiales
Ecology of Desmidiales
Diversity of Desmidiales

Coleochaetales

Structure and development of Coleochaetales
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Asexual reproduction in Coleochaetales
21 Phytoplankton Ecology

21.1 Size and Scale in Phytoplankton Ecology
   Size in Phytoplankton Ecology
   Scale in Phytoplankton Ecology

21.2 The Physical Environment
   Water as a Fluid Medium
   Light and Heat
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21.3 The Chemical Environment
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   Nitrogen
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21.4 Growth Processes of Phytoplankton Populations
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   Question Box 21.1 Working with the Exponential and Logistic Equations
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   Question Box 21.2 Working with the Michaelis-Menten, Droop, and Monod Models of Nutrient Uptake and Growth

21.5 Loss Processes
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   Mortality and Washout
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22.4 The Influence of Physical Factors on Periphyton
22.5 The Influence of Biological Factors on Periphyton
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22.6 Temporal and Spatial Variation
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23 Terrestrial Algal Ecology

23.1 Soil Algae
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    Adaptations and distribution of biological crust organisms
      Adaptations to hot and dry conditions
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    Ecological functions of biological soil crusts
      Soil stabilization
      Soil enrichment
      Effects on vascular plants
    Disturbances and management
      Grazing
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  Soil Algae in Polar Ecosystems

23.2 Cryophilic Algae
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23.3 Subaerial Algae
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    Lithic algae in temperate and tropical ecosystems
Lithic algae in hot and temperate deserts
Lithic algae on human constructions

**Epiphytic Algae**
Epiphytic associations and nitrogen fixation

**Glossary**

**Literature Cited**