



## VIII Microbial Ecology 1-7

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[3 The Nitrogen Cycle](#), [4 Symbiotic Nitrogen-Fixing Bacteria](#),  
[5 Free-Living Nitrogen-Fixing Bacteria](#), [6 Nitrifying Bacteria](#), [7 Antibiosis](#)

### Ecology 1 The Carbon Cycle

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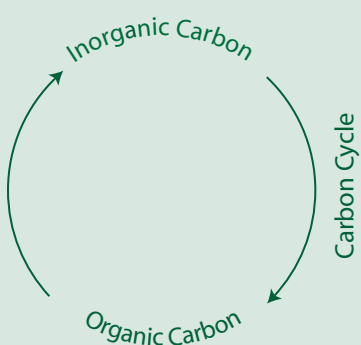
- Objectives/Key Words
- The Carbon Cycle
- Nutrition, Energy & Oxygen
- Autotrophs & Heterotrophs
  - Aerobic Phototrophs
  - Anaerobic Phototrophs
  - Lithotrophs
  - Heterotrophs
  - Respiration & Fermentation♦♦
  - Herbivores & Termites♦♦♦
- Mineralization
  - Mineralization
  - USS Constitution
  - Composting
  - Primary & Secondary Sewage Treatment
- Methanogens & Methylophs

- ❖ Food Preservation
- ❖ Galápagos Herbivores♦
- ❖ Grazing Elephants & Sheep♦♦
- ❖ Guanacos at Punta Tombo♦♦, Argentina
- ❖ Herculaneum♦, Italy
- ❖ Keep the Beaches Clean, La Paz, Mexico
- ❖ Kobe Beef & Greenhouse Gases, Tokyo
- ❖ Koala♦♦, Australia
- ❖ Landfill
- ❖ Lunch at a Tuscan Vineyard, Italy♦
- ❖ Manatee♦, Miami
- ❖ Matavi Bay Palm Tree microbes♦, Tahiti
- ❖ Methanogens & Paddy Fields
- ❖ Microbes in Food Production
- ❖ Microbes in Food Spoilage
- ❖ Miners Bay Dock Microbes♦, Active Pass, BC, Canada
- ❖ Notre Dame Cathedral Park, Paris
- ❖ Patagonia Peatlands♦, Argentina
- ❖ Port of Livorno microbes, Italy
- ❖ Red Kangaroo♦, Australia
- ❖ Recycling in La Paz, Mexico
- ❖ Red Tide, Blaine Harbor, WA, USA
- ❖ Salinas de Janubio salterns, Lanzarote
- ❖ Salish Orca: BC Ferries & Natural Gas
- ❖ Sewage Treatment
- ❖ Sitka National Historic Park♦, Alaska
- ❖ Termite Gut Protozoa♦
- ❖ Termites, Costa Rica
- ❖ Termite Mounds♦, Litchfield, Australia
- ❖ Tree-Climbing Goats♦, Morocco
- ❖ Two-Toed Sloth♦ Costa Rica
- ❖ USS Constitution, Boston
- ❖ Venice Wooden Pilings♦♦, Italy
- ❖ Vesuvius & Herculaneum♦, Italy
- ❖ Yeast Fermentation & Respiration: Brewing & Pizza Dough♦♦

- **Ecology Quick Quiz 1: The Carbon Cycle**
- **Ecology Question Bank 1.1-1.40**23♦

- 58 interactive pdf pages
- 245 illustrations, 37 images of microbes

- ❖ 51 scenic microbiology with 31 videos♦
  - ❖ Active Pass, Gulf Islands, Canada♦
  - ❖ African Herbivores♦
  - ❖ Alpacas, Akaroa, New Zealand
  - ❖ Anaerobic Methane Generator
  - ❖ Apollo Space Program, New Orleans
  - ❖ Argentinosaurus
  - ❖ Asian Herbivores♦♦♦
  - ❖ Auckland Dock Pylons, New Zealand
  - ❖ Black Tail Deer, Mayne Island♦, Canada
  - ❖ Canadian Beaver♦
  - ❖ Canadian Beavers in Argentina
  - ❖ Cook's Bay, Moorea♦
  - ❖ Collapsed Boat Dock, BC, Canada
  - ❖ Composting
  - ❖ English Harbour, Antigua



Carbon Cycle

### Ecology 2 The Winogradsky Column

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- Objectives/Key Words
- Mahoney Lake
  - **Sampling Mahoney Lake**✓
  - **Enrichment Culture**✓
  - *Amoebobacter purpureus*
- Winogradsky Columns
- **Constructing Columns**✓
- Oxygen & Sulfide Gradients
- Populations of Microbes
  - **Winogradsky Wet Mounts**\*\*\*✓
  - Aerobic Phototrophs
  - Sulfur Reducers
  - Anaerobic Phototrophs
    - Anaerobic Purple Phototrophs
    - Anaerobic Green Phototrophs

- **Ecology Quick Quiz 2A: Mahoney Lake**
- **Ecology Quick Quiz 2B: Winogradsky Column**
- **Ecology Quick Quiz 2C: Best Practice**
- **Ecology Question Bank 2.1'-2.6**♦♦

- 25 interactive pdf pages
- 37 illustrations, 22 images of microbes

- \* 1 techniques animation
- \* 2 techniques videos
- ✓ 5 best practice animations

- ❖ 3 scenic microbiology with 2 videos♦
  - ❖ The Great Geysir, Iceland♦
  - ❖ Mahoney Lake, British Columbia, Canada
  - ❖ Námafjall Geothermal Area, Iceland♦

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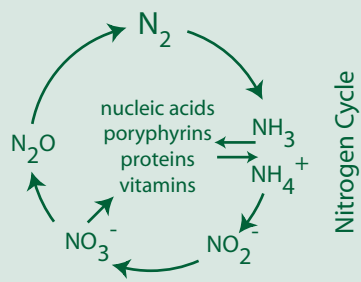
### Ecology 3 The Nitrogen Cycle

- Objectives/Key Words
- The Nitrogen Cycle
  - Organic Nitrogen
  - Nitrogen Fixation♦
  - Ammonification
  - Nitrification
  - Denitrification

- 14 interactive pdf pages
- 18 illustrations

- ✓ 1 best practice animation

- ❖ 4 scenic microbiology, 11 images, 1 video♦
  - ❖ ammonification & inorganic fertilizers
  - ❖ lupins & lupin pods
  - ❖ root nodules (clover/*Rhizobium*)♦
  - ❖ septic systems & the nitrogen cycle



Nitrogen Cycle

### Ecology 4 Symbiotic Nitrogen-Fixing Bacteria

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- Objectives/Key Words
- Root Nodules
- Symbiotic Relationships\*
- *Rhizobium* & *Frankia*
- **Root Nodule Squash**\*\*\*✓
- Bacteroids

- 12 interactive pdf pages
- 22 illustrations, 13 images of microbes

- \* 1 techniques animation
- \* 2 techniques videos
- ✓ 2 Best Practice animations

- ❖ 1 scenic microbiology, 6 images
  - ❖ Aer Lingus' Shamrock



Frankia/Alder Root Nodule

### Ecology 5 Free-Living Nitrogen-Fixing Bacteria

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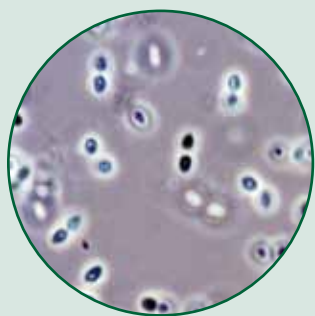
- Objectives/Key Words
- Free-Living Nitrogen-Fixers✓
- **Azotobacter/Azomonas Enrichment 1-2**\*✓
- **Azotobacter/Azomonas Streak Plates**\*\*\*✓
- **Azotobacter/Azomonas Wet Mount**\*\*\*✓
  - *Azotobacter* & *Azomonas* 1, 2', 3'✓
- **Clostridium pasterianum Enrichment**
  - *Clostridium pasterianum*✓
- Cyanobacteria Ecology
- **Cyanobacteria Enrichment**
  - Nitrogen-Fixing Cyanobacteria\*✓

- **Ecology Quick Quiz 5A: N<sub>2</sub>-Fixing Bacteria**
- **Ecology Quick Quiz 5B: Best Practice**
- **Ecology Question Bank 5.1'-5.3**

- 20 interactive pdf pages
- 36 illustrations, 31 images of microbes

- \* 3 techniques animations
- \* 3 techniques videos
- ✓ 9 Best Practice animations

- † 1 motility video
- † 1 *Nostoc* globular colony video



Azotobacter

### Ecology 6 Nitrifying Bacteria

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- Objectives/Key Words
- Nitrification
- Nitrifying Bacteria✓
- **Nitrifier Enrichment Culture 1-2**\*✓
- **Tests for NH<sub>4</sub><sup>+</sup>, NO<sub>2</sub><sup>-</sup>, NO<sub>3</sub><sup>-</sup>**
- Oxidation of NH<sub>4</sub> & NO<sub>2</sub>
- Inorganic Salts/Nobel Agar 1-2\*
- **Streak Plates for Nitrifiers 1\*\***-2'✓
- **Nitrifier Wet Mount**\*\*\*✓
- Nitrifiers Morphology & Motility\*\*✓

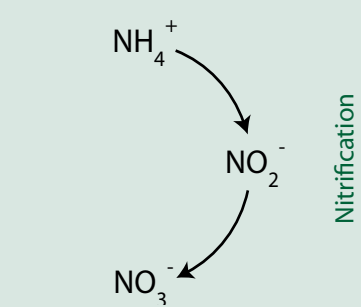
- 19 interactive pdf pages
- 17 illustrations, 6 images of nitrifiers

- \* 6 techniques animations
- \* 3 techniques videos
- ✓ 7 Best Practice animations

- † 2 motility videos

- ❖ 2 scenic microbiology with 2 videos♦
  - ❖ Nitrification in Aquaria♦
  - ❖ Nitrifiers & Monuments♦

- **Ecology Quick Quiz 6A: Nitrifiers**
- **Ecology Quick Quiz 6B: Best Practice**
- **Ecology Question Bank 6.1'-6.2**♦



Nitrification

### Ecology 7 Antibiosis

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- Objectives/Key Words
- Antibiosis
- Antibiotic-Producing Microbes 1'-2'✓
- **Crowded Agar Plate (Overview)**\*
- **Serial Dilutions of Soil**\*\*✓
- **Crowded Agar Pour Plate**\*\*✓
- Crowded Agar Plate✓
- **Seeded Agar Plate (Overview)**\*✓
- **Serial Dilution of Test Microbe**\*\*✓
- **Seeded Agar Pour Plate 1\*\***-2\*
- **Serial Dilutions of Soil**\*\*✓
- **Spread Plate of Soil Microbes 1\*\***-2\*\*✓
- Seeded Agar Plate✓
- **Spectrum of Activity 1\*\***-2\*\*✓
- Spectrum of Activity Plate✓

- **Ecology Quick Quiz 7A: Antibiosis**
- **Ecology Quick Quiz 7B: Best Practice**
- **Ecology Question Bank 7.1'-7.7**

- 29 interactive pdf pages
- 48 illustrations, 35 images of microbes

- \* 12 techniques animations
- \* 2 techniques videos
- ✓ 15 Best Practice animations

- ❖ 2 scenic microbiology, 6 images
  - ❖ Penicillin 50<sup>th</sup> Anniversary
  - ❖ Fleming Museum, London, England



Antibiosis