

**MICROBES OF COASTAL ENVIRONMENTS**  
**COURSE SCHEDULE AND OUTLINE OF ACTIVITIES**

DAY 1

**Morning:**

Introductory lecture (45 minutes)

Bacterial taxonomy and an introduction to coastal and marine habitats with focus on the ecological role of bacteria

Lab activities

Introduction to the major body types of bacteria through microscopy of tooth plague bacteria

Distinguishing bacteria from microscopically small eukaryotes

Microscopy and measuring of microorganisms in hay infusions

Introduction to staining techniques –

Crystal violet (Gram) staining of prepared cultures of *E.coli* and *Bacillus subtilis*

Janus green staining of mitochondria (“fossil” bacteria) in *Paramecium*

Lecture (45 minutes)

Bacterial metabolism: bacterial photosynthesis, chemolithoautotrophy, fermentation, aerobic vs. anaerobic respiration, nutrient cycling in estuaries: marshes, seagrass beds, mud flats, human impact on nutrient cycling in estuaries, remediation of oil spills

Lab activities

Viewing and interpreting a prepared Winogradsky column

Microscopy of the contents of the Winogradsky column: cyanobacteria (e.g. *Oscillatoria*, *Spirulina*, *Chlorococcus*), sulfide oxidizer (e.g. *Beggiatoa*), purple sulfur bacteria (e.g. *Chromatium*), green sulfur bacteria (e.g. *Chlorobium*)

**Afternoon:**

Field trip

Tidal mud flats and salt marsh, South Slough and Charleston marina

Short lectures, collection of materials for lab observations and activities.

Focus: cyanobacteria, sulfate reducing bacteria, sulfide oxidizing bacteria, green sulfur bacteria, purple sulfur bacteria, animal-bacteria symbioses, seagrass-bacterial, marsh plant – bacterial interactions, effect of eutrophication

Lab activities

Introduction to enrichment techniques:

Each student will build a Winogradsky column; individual choices will be made as to selectively enrich particular groups of bacteria

Microscopy and viewing of the collected materials

DAY 2

**Morning:**

Field trip

Coos head bog and Bastendorff bog and surrounding forests

Short lectures, collection of materials for lab observations and activities.  
Focus at the bog: methanogenic bacteria (with demonstration of evidence for methane production), methanotrophic bacteria, methane transport tissues in bog plants and iron deficiencies caused by bacteria in aquatic plants (“bog disease”), magnetotactic bacteria, iron oxidizing/reducing bacteria, pitcher plant (*Darlingtonia*) symbionts (which are various fermenters), *Sphagnum*-*Nostoc* (cyanobacterium) symbiosis, mollusk-bacterial symbiosis (freshwater clam with spirochetes)

Focus in the forest – nitrogen fixation and actinorhizal symbionts (*Frankia*) of alder trees (*Alnus*) vs. mycorrhizal symbiosis, free living actinomycetes of soils, microbial decomposition of wood - rotten log bacteria and fungi, cellulose digestion in termite with the help of bacterial symbionts, galls and bacterial parasites in trees (e.g. *Agrobacterium* in Douglas fir), methanogenes associated with trees (“wet wood”), looking for *Myxobacterium* on bark of alders and other trees.

### **Afternoon:**

#### **Lecture (45 minutes)**

Methanogenesis, iron oxidation and reduction, fermentation, animal-bacterial and plant-bacterial symbioses

#### **Lab activities:**

Introduction to techniques for quantifying bacteria

Students will perform coliform counts with purchased coliform count plates using marine water samples collected on the way back from the field trip in more or less polluted places (eg. Cape Arago, South Slough, marina) plates will be incubated over night

Introduction to preparing clonal cyanobacteria cultures from outdoor mixed collections

Dissection of termites (*Zootermopsis*) to view great variety of bacterial symbionts  
Microscopy and behavioral manipulation of magnetotactic bacteria from prepared enrichment jar

Looking for cyanobacteria in sphagnum moss

Looking for symbiotic bacteria in freshwater clams (e.g. *Spirochaeta*)

Looking at neuston community (surface film taken from bog water) to maybe see rosette like arrays of stalked *Planctomycetes*

## DAY 3

### **Morning/afternoon**

#### **Field trip**

Eel creek dunes and beach

Short lectures, collection of materials for lab observations and activities

Focus: nitrogen fixation, plant-bacterial symbiosis (*Rhizobium* and legumes, cyanobacteria and mosses, *Frankia* and bay berries, seagrasses), fungal-bacterial

symbiosis (cyanolichens), dormancy and spores in bacteria, microbial decomposition of seaweeds, open ocean planktonic bacteria and marine snow, deep sea bacteria (vents, cold seeps, whale falls, deep sea fish symbionts, bioluminescence, manganese nodules, etc)

**Afternoon:**

Introduction to techniques for quantifying bacteria

Students will perform coliform counts on incubated coliform count plates and interpret the results (sample location vs. count)

Introduction to preparing clonal cultures from outdoor collections using mobile cyanobacteria on premade agar plates (continuation)

DAY 4

**Morning:**

Field trip

Rocky intertidal Cape Arago

Short lectures, collection of materials for lab observations and activities

Focus on: seaweed-bacterial symbiosis (e.g. *Roseobacter* in *Prionitis* and *Codium fragile* with *Calothrix*, *Anabaena*, *Phormidium*), marine cyanolichens (e.g. *Verrucaria*), Biofilms and their function in the intertidal food web, microhabitats and cyanobacteria distribution, animal-bacterial symbioses (mollusks (e.g. *Teredo* shipworm and *Teredinobacter*), “cyanophilic” sponges and “bacteriosponges”, protozoans and cyanobacteria, crustaceans)

**Afternoon:**

Lecture 45 minutes:

Cyanobacteria, microbial assemblages of hot springs, the origin of life, biofilms

**Lab activities**

Dissection of mussels to view bacteria, e.g. *Cristispira* contained in crystalline styles and very diverse mix of bacteria in digestive tract

Looking for evidence of bacteria in sponges and tunicates (marina fouling)

Microscopy of cyanobacteria of crusts scraped from intertidal rocks

Looking for *Calothrix*, *Anabaena*, *Phormidium* in *Codium fragile*

**Lab practical/Test**