Capacity Building in Oceanography
Through summer school courses

Why do I want to offer a capacity building course (CB-course) through my university?

Can it be embedded into the needs of my university (e.g. local graduate /postgraduate grogram)? Can it be counted for the partial fulfillment of a degree?

Do we want to offer it to our own students only or possibly also to students from other universities (outreach, prestige)?

Can we offer topics, knowledge, study sites, methods, etc. that are unique for the field of oceanography and attractive for students in the field?

Do we have the academic capacity (team of experts or access to them) to launch such an activity and can we count on the willingness of our colleagues to contribute?

In which form shall we offer the CB-course, as a block course at a suitable location outside the university (intense focusing) or as a regular curriculum course outside of the teaching semester?

Do we have the intention to develop the course into a sustainable CB-program?

Can we offer suitable course facilities to house and work with a group of students?

How do we evaluate and follow up on the success of our activities?

How can we assure funding for a number of years?

Example: ECODIM - Ecology and Diversity of Marine Microorganisms (Section: microbial Oceanography)

mmb

http://www.microeco.uzh.ch/chile/chile.html

ECODIM marine microbiology (mmb) graduate / postgraduate courses are part of the Austral Summer School at the University of Concepción, Chile. ECODIM was established in 2000 and is offered every second year

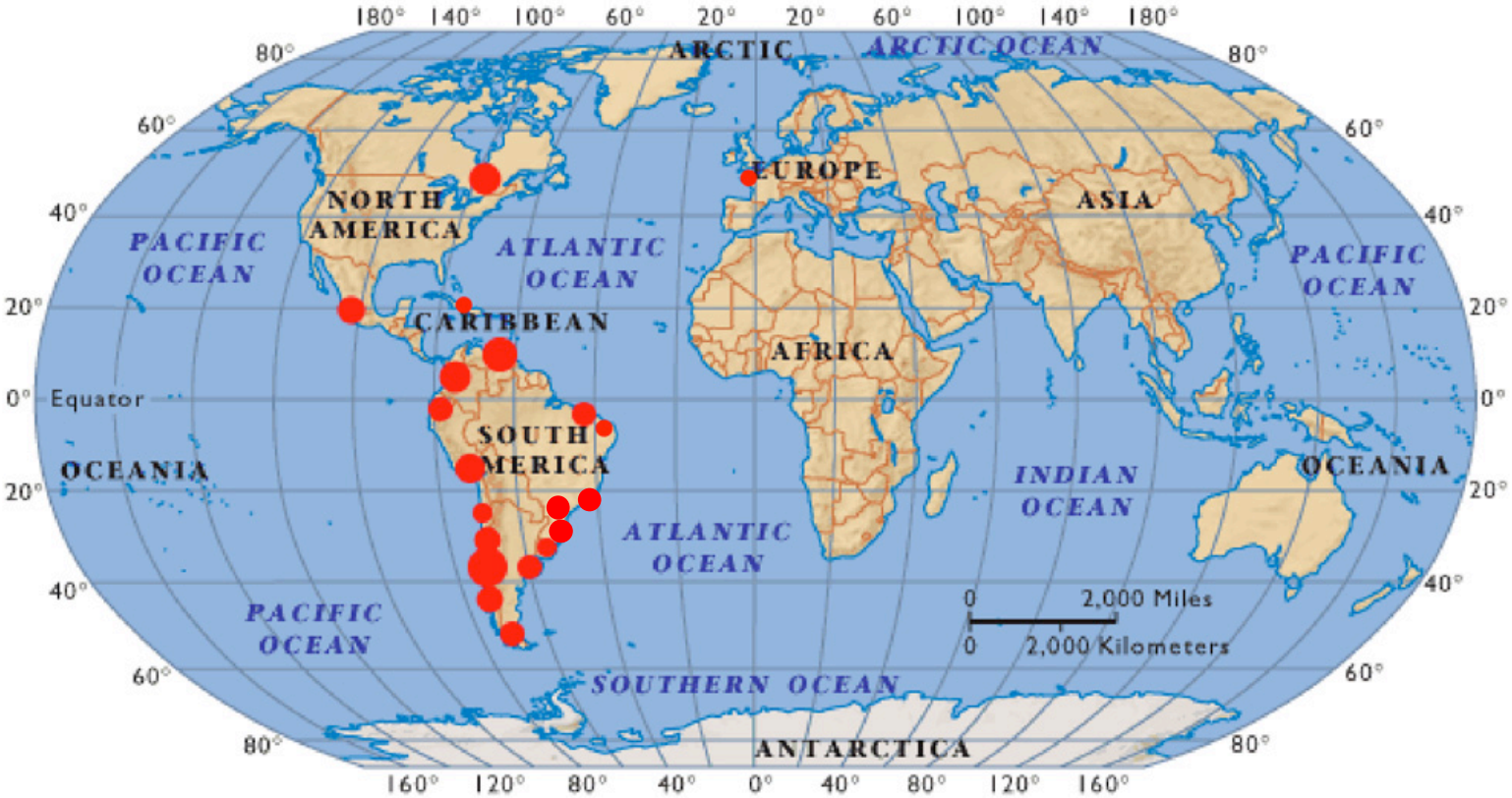
- A 3 week mind-opening training period
- Emphasis on capacity building through research-guided learning
- Attraction: Oxygen Minimum Zones in the upwelling region off the coasts of Chile and Peru
- Course features
  - Sampling trips (field experiences)
  - Lectures (syllabus that integrates various science fields)
  - Instructed experiments (methodology, instrumentation)
  - Computer supported exercises and data base searches (concepts, model design)
  - Group research projects (discoveries, hands-on instruction based on field observations)
  - Mini-symposia (outreach and front research, on Saturdays)
  - Student reporting (oral presentations, poster designs)

Goals and purpose of ECODIM courses

- To provide an overview of the many facets of the field of microbial oceanography by bringing together various themes of a number of environmental sciences
- To cross borders between physics, chemistry and biology applied to marine ecosystems
- To initiate contacts between scientific fields, which are not usually combined
- To learn about microbiology with a geochemical and environmental emphasis

Regional focus – international outlook and collaboration

Between 2000 and 2010 more than 90 students and 10 young investigators from 10 South- and North-American countries participated in ECODIM courses



At UdeC, ECODIM courses are part of an ongoing graduate / postgraduate program with an international outlook. The institution that offers them, foundations, government research agencies and instrument and supply companies support the courses.

Aims

Over a period of three weeks, we intend to convince the participants that “microbes rule the world”, make them aware of the impressive diversity in metabolic potentials and activities of microbes; and illustrate this by showing how microbes do their jobs optimally.

The goals are

- to train oceanographers, environmental scientists, microbiologists, engineers and educators at the postgraduate level,
- to apply basic priciples of microbial ecology to marine ecosystems,
- to learn how to properly diagnose and analyze environmental problems involving microbial components,
- to enable the participants to understand marine systems and to recommend prevention or remediation procedures if necessary and to supervise actual measures,
- to carry out research independently and contribute to sustainable capacity building.
- These goals are reached by transfering practical experience, conceptual know-how and theoretical knowledge in the fields of microbial ecology, environmental microbiology and geochemistry.

Contents

The courses provide an introduction to and an overview of the field of microbial ecology and the diversity of microbes in marine ecosystems.
It aims at bringing together various aspects of modern environmental, molecular and evolutionary microbiology and, in a few cases, clinical and health-oriented aspects of epidemiology.
The courses encourage a rapprochement between these various areas and treat them with an ecological outlook.

Themes covered in past courses comprise basic and applied aspects:

- Concepts in microbial ecology
- Ecosystem studies and models
- Microbiologically mediated geochemical cycles
- Diversity of microorganisms and their habitats
- Molecular and culture methods for the study of microbial genomics and physiology
- Responses of microorganisms and ecosystems on environmental alterations
- Global changes as drivers of ecosystem evolution
- Eco-clinical aspects of marine microbiology
- Methods for surveying and monitoring marine ecosystems
- Geochemical and symbiotic interactions between microbes, their hosts and the environment

Description

- At the course location, we emphasize the marine environment, but do not exclude other interesting microbial ecosystems available at various sites in the area.

- Some lectures illustrate the importance of microbes as living environmental agents and as partners in symbiotic and antibiotic interactions; others emphasize the roles microbes play in global geochemical cycles.

- A better understanding of microbes promises to provide an array of new products and processes as well as a better awareness of the microbial biosphere, which is the earth's life support system.

- Understanding microbial ecology will open new insights into the history of life on earth and possibly suggest new approaches to discovering life on other planets.

Course teaching philosophy

- Ideal learning opportunities: a combination of field experiences and laboratory experimentation
- Teaching across borders of scientific fields
- Building an appreciation and creating a profound understanding of the basic scientific principles of the “other” disciplines
- Illustrating background knowledge with field experiences and research results
- Small research projects with emphasis on discovery and research-driven teaching

Course structure

The course comprises:

- **Lectures** in the morning,
- **Laboratory work** in the afternoon,
- **Colloquia** and **modeling exercises** on the computer in the evening,
- **Discussions** and sessions on particular course subjects are offered during the course and
- **Research themes** are discussed during the **minisymposia** on Saturday mornings.

On **field trips** we point out

- physico-chemical characteristics of microbial habitats,
- collect microbes and try to enrich and isolate them in the laboratory.

The **laboratory work** is designed to educate students about current techniques and to encourage independent research.

It is divided into two parts

- In part 1, we train microbiological and molecular techniques and learn about concepts
- Part 2 is investigative, i.e. we would like to discover new microbes and understand their activities within complex communities. Here, the students carry out investigations in groups with faculty assistance and independently.
- A poster presentation is the envisioned research product.

Field investigations

- Research guided field experience as the starting point for every microbial oceanography course
- Collaboration with local researchers, with those from different countries and with a number of internationally leading experts
- Integrated investigations at selected sites
- Teaching the students how to do multidisciplinary microbial oceanography in the field and in the lab

Infrastructure for field investigations

- Sea-going boat with sediment coring and hydro cast
- Field-tested methodology and instrumentation
- Equipment needs to be taken to the field and / or be set up at a base station

Examples of laboratory exercises and course research projects

The students are encouraged to participate in short laboratory exercises, which will allow them to get hands-on experience in various techniques. The exercises are under the guidance of course staff members.

Examples:

- In situ measurements in marine habitats, e.g. defining the oxygen minimum zone (CTD)
- Analyzing the nutrient status of an ecosystem: gradients and transients
- Sample storage, microscopy and sample processing
- Detection of metabolic genes by PCR amplification
- Working with genomic data and databases
- Analyzing sequence data and constructing phylogenetic trees
- Microscopic analysis of planktonic and benthic microorganisms
- Designing diets for the enrichment and growth of Bacteria, Archaea and eukaryotic microbes
- Following community composition and growth employing flow cytometry
- Studying the structure of and activity in biofilms
- Enrichments as desired by students, e.g.
    - Isolation of metal resistant bacteria from industrial effluents
    - Degradation of halogenated aromatics
    - Analysis and physical enrichment for Thioploca and Beggiatoa
- Thermodynamic and kinetic modeling
- Solving microbiological problems

Seminar-type discussion topics

- Novel organisms and processes discovered in marine habitats
- Microbial regulation of ocean processes
- New looks at microbial productivity in the ocean
- Biotechnological applications from and for microbial oceanography
- Microbial involvement in geochemical cycling, present and past

Symposia

Current Aspects of Marine Microbial Ecology

One-day Symposia organized by the course but open to students and investigators from the host University offer opportunities to reach beyond the rather closed course environment and make potential applicants aware of the learning opportunity.

- Mini-symposium with invited international scientists and those from oceanographic and other appropriate faculties from the host country
- With topics from specialized fields, presenting recent discoveries and technological innovations
- To expose the course students to aspects not covered during the daily lectures
- With contents which are closely related to the course research projects
- To give insight into the importance of microbial oceanography for basic and applied research
- To offer additional opportunities to strengthen ties between the course host country and the international microbial oceanography course

What we have learned from past experiences and what works well

General concept

- The basic structure of the course is successful and it has improved with each course experience.

Minisymposia

- are a means of introducing the students to front research.

Research projects

- are activities during which the student gets practical experience and where he/she is learning by doing.
- molecular techniques were introduced into the course with the support of instrument manufacturers and reagent supply companies.

Colloquia

- the student is trained in how to search, evaluate and select the literature, which is most important for his/her research (self-learning).
- time spent on colloquia with student presentations improves scientific presentation and language skills.
- workshop-type discussions about new technical developments and limitations of certain techniques (e.g. DNA sequencing) help students to chose proper experimental approaches for their own research.
- familiarity with computer handling, which often still needs individual training, is a prerequisite for model building and access to databases.

Individual studies

- independent study time is integrated into the program for reading and preparing discussions about key papers.
- reading-assignments and exam papers are offered by the staff or freely chosen by the student. Advice assures that the time is spent on analyzing and presenting relevant publications.

Lectures

- include discussions and student activity,
- introduce basic microbiological concepts and knowledge and prepare the ground for focused research work,
- give context and overview before spiraling down into details.
- Lecture slides are made available on the course intranet for self-study and repetition

Field trips

- expose the student to difficulties when working under harsh conditions
- train decision-making at the spot
- emphasize the importance of detailed preparation and considering options

Grades and Certificates

Although the course offers grades for the students of the postgraduate program at UdeC, these need to be adapted and verified by outside students at their home institution. Course participants who successfully completed the course requirements receive a certificate (see example). The course contents are available on the Internet under

http://www.microeco.uzh.ch/chile/chile.html

Evaluations are based on four criteria

a) giving a 15-minute presentation on the work the student is presently involved in at his/her home institution (at the beginning of the course).
b) presenting the essence of a published scientific paper, selected by the student, in 25 minutes (discussion incl.) in English and being able to respond to questions related to it. The paper should be relevant to the course topics (microbiology, ecology, diversity in oceanography) and the particular scientific interest of the student (counts as individual exam at the end of the course).
c) the presentation of the course research results (counts as an individual and group effort)
d) the contribution to the final poster design (group effort)

Grade scale UdeC:

Points	Grade	Scale
100 - 88	A	excellent
87 - 68	B	good
67 - 58	C	sufficient
57 - 1	D	insufficient
0	F	failed
	I	incomplete
	X	withdrawn

First Name, Last Name

successfully completed the Postgraduate Course on

ECOLOGY & DIVERSITY OF MARINE MICROORGANISMS - ECODIM-VI

at the Estación de Biologia Marina at Dichato, **January, 00 - 00, 20- -**

The course provided an overview of microbial oceanography by illustrating basic concepts of the ecology of marine microorganisms and the roles they play in global geochemical cycles with examples from marine and other interesting microbial ecosystems. The lectures and the course research projects focused on the diversity of microbes in marine ecosystems, in particular on metagenomics, phylogenetic taxonomy, microscopy, flow cytometry, thermodynamic modeling and culturing techniques. The topic of the minisymposium and the selection of seminar papers illustrated the importance of microbes as living environmental agents and as partners in symbiotic interactions. Invited lecturers contributed aspects of environmental and health oriented microbiology.

The course was organized by the Department of Oceanography of the University of Concepción. Lecturers and course instructors came from the organizing institution, from other departments at Chilean Universities and from abroad.

Concepción, January 23, 2010

Kurt Hanselmann
Course Co-Director
ETH Zürich, Switzerland
Earth Sciences / Geomicrobiology

Osvaldo Ulloa
Course Co-Director
University of Concepción
Department of Oceanography

mmb

Course research results: posters and abstracts

The posters are made available to the students for presentation at national meetings

Examples of posters (http://www.microeco.uzh.ch/chile/chile.html)

ECODIM VI, 2010

- DETECTION AND ENRICHMENT OF BACTERIA OXIDIZING SULFUR COMPOUNDS FROM SEDIMENTS OFF CONCEPCIÓN, CHILE
- PRESENCE OF FUNCTIONAL GENES FOR SULFUR METABOLISM AND PROTEORHODOPSIN-DRIVEN ENERGY CONVERSION IN PLANKTONIC PROKARYOTES OF CONCEPCIÓN BAY, CHILE

ECODIM V, 2008

- ASSESSING THE DIVERSITY AND ABUNDANCE OF PICOEUKARYOTES IN THE UPWELLING SYSTEM OFF CONCEPCIÓN, CHILE.
- ANALYSIS OF BENTHIC MICROBIAL COMMUNITIES IN DEPTH PROFILES FROM THE SEDIMENT OF CONCEPCIÓN BAY

ECODIM IV, 2006

- CULTURE DEPENDENT AND INDEPENDENT MICROBIOLOGICAL ANALYSES OF TRANSIENTLY ANOXIC SEDIMENTS IN THE BAY OF CONCEPCIÓN, CHILE (~36,5 °S)
- COMMUNITY STRUCTURE OF PICOPLANKTON AND PROCESSES RELATED TO NITROGEN CYCLING IN THE OMZ OFF CENTRAL CHILE – COLIUMO BAY (~36,5 °S)
- MICROBIAL DIVERSITY IN BIOFILMS FROM THE INTERTIDAL ZONE IN COLIUMO BAY, CHILE

ECODIM III, 2003

- DISTRIBUTION OF BACTERIA IN SEDIMENTS FROM CONCEPCIÓN BAY, CHILE
- MICROBIAL DIVERSITY IN THE WATER COLUMN OF CONCEPCIÓN BAY, CHILE

ECODIM quality criteria

The course needs to be recognized by the international research community, and it has to have an excellent reputation

Instructors

- excellent instructors must feel attracted to support and contribute to the course
- all instructors will be chosen for their scientific as well as their didactic abilities
- all instructors need to receive excellent ratings from the course participants

Field trip

- the field trips are discovery and research-driven introductions to the course and remain a highly rated aspect of the course
- the field trips and the course can count on the guidance of a number of knowledgeable investigators

Research aspect

- well-prepared projects are carried out with expert methodology
- there is enough time permitted to work on research projects

ECODIM quality criteria, cont.

Infrastructure and accommodations at course site

- suitable local infrastructure and commitment by the staff
- room and board accommodations to keep student group together
- suitable field sites for studies
- the lab and the accommodations need to allow for focused scientific work and social interaction
- the chemical analytical, microbiological and molecular biochemical infrastructure is adequate for course work with 15-20 students
- rooms for lectures and seminars equipped with audiovisuals
- computers and computer network for online training and access to databases
- the symposia are highly attractive to students as well as to local and national scientists
- the course organization (logistics of the field trip, housing, lab use) receive the highest possible rating

Future directions of ECODIM courses

- establishing an international microbial oceanography research network
- maintaining it attractive for world-class investigators to be interested in participating and in offering lectures and / or supporting course groups on field investigations
- acquiring the support of established oceanographers from all over the world to introduce the course students to interesting sites in their countries
- basing the course on teams of international instructors with rotating participation
- integrating former course participants

Summary

WHAT THE COURSE ATTEMPTS TO OFFER

- An introduction to microbial diversity and ecology
- A discussion on some molecular techniques and on how they are related to cultivation-based approaches
- An examination of the strengths and limitations of approaches used to describe diversity, e.g.
  - Why molecular techniques do not replace cultivation but complement it
  - How cultivation attempts can be made successful
- Investigations of interesting microbial ecosystems on field trips
- An emphasis on the marine environment and other microbial ecosystems present in the area

WHAT THE COURSE SHOULD LEAD TO

- Make the student aware of the diversity in metabolic activities and of interactions between microbes and between microbes, animals and plants
- Give the student insights into the history of life on earth and on approaches to discovering life on other planets
- Make the student respect the microbial biosphere as the earth's life support system
- Make the student understand microbial diversity as a provider of an array of new products and processes
- Initiate new ways to discover infectious causes of diseases not previously recognized as microbial in origin
- Open up contacts between scientific fields which are not usually combined

WHAT WE INTEND TO TEACH

- How microbes behave in their natural environments
- The role of microbes in global geochemical cycles
- Some of the more unusual cultivation techniques as well as cultivation of interesting microorganisms
- Microbial diversity as a critical aspect of future environmental and medical research

- Microbial diversity as the basis for emergence of infectious diseases and increasing antibiotic resistance
- Experience in ”frontier” research

WHAT THE COURSE DOES NOT DO

- Cover all microorganisms
- Cover all techniques currently being used in diversity studies; we will focus on cultivation
- Offer exercises with known outcomes; we intend to investigate and discover

HOW THE COURSE IS ORGANIZED

- Lectures (morning), Lab exercises (afternoon), Workshops (evening), Group reports (end of course)
- Field trips (whenever appropriate)
- Minisymposia (Saturday morning)
- Research work in groups of 2 to 3 students on a specific project
- Student input is important

ECODIM course staff over the years

C Coordinator
I Instructor,
J Junior Instructor
L Lecturer,
S Symposium Speaker

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MARGARITA CARÚ	Universidad de Chile, Santiago CHILE	**S**
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