

MARINE MICROBIAL BIOVERSITY (6 CFU) - 2016-17

Microorganisms

Bacteria not Whales!! Microorganisms – What are they? Properties of a cell; Microbiology: the science of Microorganisms; The discovery of microorganisms; Anton van Leeuwenhoek; Brief History of Microbiology; Prokaryotes: Bacteria and Archaea; Bacteria: medical and environmental relevance; The discovery of Archaea; LUCA and the tree of life; Bacteria and Archaea: Shared Similarities; Microbial Taxonomy: the basics; Prokaryotes: Size, Morphology and distribution; Size Variation Among Bacteria; Lower Limits of Cell Size; Prokaryotic cell structures; Abundance and Size; Distribution on Earth;

Microbial Eukaryotes; Eukaryotic cell structures; Abundance and Size; How did Eukaryotes form? Primary endosymbiosis; Secondary endosymbiosis; Protist Diversity; Ecological role: why should we care; Brief overview of protist diversity (Foraminiferans, Radiolarians, Ciliates, Green Algae, Dinoflagellates, Coccolithophores, Diatoms); Abundance and Size in the marine environment;

Viruses

What is a virus; Viral structure; An Ocean of Viruses; Virus: Structure and Morphology; Virus: Archaeal Virus; Abundance and Size; Abundance: case study from the Adriatic Sea; Virus Life Cycle; Viral Genomes; Viral diversity in the marine environment; Megavirus, and emerging group; Effect on biogeochemistry; Ecological Role: Viral Shunt; How virus influence climate; Killing the Winner Hypothesis; The Red Queen Hypothesis; CRISPR-Cas System; Virus role in controlling metabolism; Two “specials”: Viroids and Prions;

Primary Production

Primary production; Gross vs Net Primary production; Primary production in the oceans; Primary production Vs Respiration; Factor limiting primary production; Penetration of light; Photosynthetically active radiation; Nutrient and iron limitation of PP; Mixing and Upwelling zones; Iron limitation; Iron fertilization; Export efficiency; Primary production: not just biomass; DOM and POM; The microbial loop; Marine Snow; Limit of life and extremes;

Marine environments

The largest ecosystem on Earth; Slicing the pie: by light or by depth? Pelagic zone; Benthic realm; Photic and aphotic zone; The deep-sea; Brief history on the exploration of the deep-sea; Hydrothermal vents; Cold seeps; Other extreme environments (Polar regions, oxygen minimum zones, deep hypersaline anoxic basins, the subsurface biosphere); A case study: the Mediterranean sea – the one-stop shop for extreme environments; Life is based on RedOx reactions; CHNOPS elements; Carbon Cycle; Deep Carbon Cycle; Nitrogen Cycle; Sulfur Cycle;

Nutritional groups

Life is Electric; RedOx tower; Free Energy of Formation and Calculation; Catalysis; Proton Motive Force; Basic Metabolism; Microbial periodic table of elements; Phototrophy; Chemoorganotrophy; Chemolithotrophy; Boring Eukaryotes; The Phototrophic Way of Life; Patterns of Photosynthesis; Anoxygenic Photosynthesis; Oxygenic Photosynthesis; The Great Oxidation Event (GOE); Chlorophylls and Bacteriochlorophylls; Chemolithotrophy (Hydrogen Oxidation, Reduced Sulfur Compounds Oxidation, Nitrification and Anammox, Iron Oxidation, Methane Oxidation); Winogradsky and Chemolithoautotrophy; Aerobic and Anaerobic Respiration; Assimilative and Dissimilative Reductions (Oxidized Nitrogen Species Reduction, Sulfate Reduction, Sulfur Reduction); Methanogenesis and Acetogenesis; Fermentation; Down the thermodynamic ladder; Upper temperature limits for energy metabolism; Nitrogen Fixation; Heterotrophy; Autotrophy. Carbon fixation: Calvin cycle, alternative pathways and their role in the oceans; Earth Extant Electric Circuit; Co-evolution of geosphere and biosphere;

Genome organization in prokaryotes

Introduction to Genomics; Central Dogma in Molecular Biology; DNA Sequencing history; Prokaryotic Genomes; Genome Size. Gene Density; Properties of Plasmids; Prokaryotic genomes and the

species concept; Horizontal Gene Transfer. Horizontal Gene Transfer Impact; Gene Families, Duplications, and Deletions; Core Genome vs Pan Genome; Major Modes of Regulation; Global Control of Gene Expression; Examples of global control of gene expression: alternative sigma factors, quorum sensing; Omics tools in (Marine) Microbial Ecology; Definition and Possible applications; Sequencing technologies; Brief history of Metagenomic; The Omic Approach; Who is there: Taxonomic diversity; What they can do: Functional diversity; Omics: the Good, the Bad and the Ugly; Current Status of Microbial Genomes; Pure culture approaches integrated with omic techniques; Bacterial and archaeal diversity in marine environments Know your Beasts; The Tree Of Life: The Bacteria; Cyanobacteria; Firmicutes and Actinobacteria; the Bacteroidetes; Bacteria: the Proteobacteria in the marine environment; Thermophilic bacteria and other bacterial groups; The Tree Of Life: The Archaea; Euryarchaeota; Methanogens; Crenarchaeota; Thaumarchaeota; other archaeal groups; Tell me what you eat: Functional diversity as a concept; Ecological Redundancy; Diversity of primary producers; Diversity of Phototrophic Prokaryotes; Diversity in the nitrogen cycle; Diversity in the sulfur cycle; Other distinctive chemotrophic microbes; Unicellular algae (lecture 14 Guest Lecture)

Photosynthetic marine microorganisms: evolution (secondary endosymbiosis), systematic, cytology, genomes and ecology;

Microbial communities in the marine environments: Types of Community control: bottom-up, top-down and sideways; Temporal and Spatial Variation; Temporal Scales; Antibiotics, Bacteriocins, Chemical warfare; Biofilms; Biofilm Formation: Quorum Sensing; Biofilm and BioCorrosion;

New Frontiers of Marine Microbial Diversity: Microdiversity and spatio-temporal scales; Effect of climate change on marine microbes; Microbial communities: source or sink of CO₂; Contribution to biogeochemical cycling; Role of virus in controlling ecosystem functions; The subsurface microbiology; Lateral gene transfer and pattern of evolution; Functional redundancy and BEF relationships; In situ sampling and monitoring; Effect of Deep-Sea mining; Blue Technologies.