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Goa University
Academic P. G. Departments
Entry No. 1057
Date : 08/09/20

Goa University
School of Earth, Ocean and
Atmospheric Sciences.

07/09/2020

NOTE

Placed in the file is Bos approved Syllabus of Marine Microbiology. As UG is proposed to offer this Syllabus for Semester-I Students, V.C may kindly approve the same.

07/09/2020

AR(PG)

7/9/20

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N| 2

May kindly approve on behalf of Academic Council in view of urgency.

9/9/20

JR-Acad - On leave

Approved. May kindly report to AC.

9/9/2020

JR(Acad)

11/9

HC

GOA UNIVERSITY
VICE-CHANCELLOR'S SECRETARIAT
Inward No.: 2013/2020
Date: 8/9/20 11/9/20

Goa University
Academic P. G. Departments
Entry No. 1168
Date: 11/09/20

Minutes of the sub-Board of Studies in Marine Microbiology held on 3rd September 2020 at 10:30 hrs. (online mode)

The sub-BoS in Marine Microbiology met on 3rd September 2020 at 10:30 hrs (online mode) to discuss restructuring and revision of the M.Sc. Marine Microbiology Programme.

Members present:

Prof. H.B. Menon	Chairperson
Dr. P. D'Costa	Member
Dr. N. Lotlikar	Member
Prof. S. Mutnuri	Member
Dr. M. J. B. Gonsalves	Member
Dr. M. Naik	Member
Prof. S. Garg	Member
Dr. V. S. Damare	Special Invitee
Dr. C. Berde	Special Invitee
Dr. N. Lotlikar	Special Invitee

Part A.

i. Recommendations regarding courses of study in the subject or group of subjects at the undergraduate level: Nil

ii. Recommendations regarding courses of study in the subject or group of subjects at the postgraduate level:

- Restructuring of the M.Sc. Marine Microbiology programme is recommended, keeping in view the shift of the M.Sc. Marine Microbiology programme from the Department of Microbiology to the School of Earth, Ocean and Atmospheric Sciences.
- The **Core Papers** are revised as follows. The paper 'MMC 204: Marine Microbiology' is deleted. The papers 'MMC 102: Microbial Genetics' and 'MMC 203: Molecular Biology' are combined into a single paper "MMC 205: Microbial Genetics and Gene Regulation'. Two new Core Papers 'MMC 103: Fundamentals of Oceanography' and 'MMC 207: Microbial Ecology' are introduced. The practicals for each of these papers will be conducted as separate 1 credit papers, instead of the combined 4 credit paper earlier.
- The following new **Optional Papers** (Theory and Practical) are introduced: **Theory Papers:** MMO 405: Marine Phytoplankton (02 credits), MMO 302: Marine Zooplankton Ecology and Microbial Interactions (03 credits), MMO 403: Coral Microbiology (03 credits), MMO 404: Bioinformatics Databases (02 credits).
- **Practical Papers:** MMO 312: Analytical Techniques in Phytoplankton Studies (01 credit), MMO 303: Marine Zooplankton – Practical (01 credit).
- All the Optional Practical papers are now placed in the 3rd Semester whereas the Theory Optional papers are placed in the 4th Semester. This is done to give students sufficient time to focus on their Dissertation work in the 4th Semester.
- The Field Trip Course was revised from 2 credits to 1 credit.
- Overall, the syllabus of the different papers was also revised (approximately 30%).

Part B

i. Scheme of Examinations at undergraduate level: Nil

ii. Panel of examiners for different examinations at the undergraduate level: Nil

iii. Scheme of Examinations at postgraduate level: Nil

iv. Panel of examiners for different examinations at post-graduate level: Nil

Part C.

i. Recommendations regarding preparation and publication of selection of reading material in the subject or group of subjects and the names of the persons recommended for appointment to make the selection: Nil

Part D

i. Recommendations regarding general academic requirements in the Departments of University or affiliated colleges: Nil

ii. Recommendations of the Academic Audit Committee and status thereof: Nil

Part E.

i. Recommendations of the text books for the course of study at undergraduate level: Nil

ii. Recommendations of the text books for the course of study at post graduate level: Nil

Part F.

Important points for consideration/approval of Academic Council

i. The important points/recommendations of BoS that require consideration/approval of Academic Council (points to be highlighted) as mentioned below

a) The restructuring of Marine Microbiology PG programme has been approved by the BoS

b) The revised syllabi have been approved after incorporating all modifications suggested by the BoS members.

ii. The declaration by the chairman that the minutes were readout by the Chairman at the meeting itself.

Date: 03/09/2020
Place: Taleigao Plateau

Harilal. B. Menon
Signature of the Chairman 03/09/2020

Part G. The Remarks of the Dean of the Faculty

i) The minutes are in order

ii) The minutes may be placed before the Academic Council with remarks if any.

iii)May be recommended for approval of Academic Council.

iv)Special remarks if any.

Date: 03/09/2020
Place: Taleigao Plateau

Signature of the Dean 03/09/2020

Goa University
P.O. Goa University, Taleigao Plateau, Goa 403 206, India

Syllabus of M.Sc. (Marine Microbiology) Programme

The School of Earth, Ocean and Atmospheric Sciences (SEOAS) offers a two-year full time M.Sc. Marine Microbiology programme, w.e.f. the academic year 2020-21. This Programme was initiated in June 2012, under the award of UGC sponsored 'Innovative Programme for teaching and research in interdisciplinary and emerging areas'.

The Programme is meant for students to pursue higher studies in Marine Microbiology. Being a University in coastal state of India, Goa University provides a strategic advantage in learning Microbiology of marine and coastal ecosystems. It serves to impart advanced training to students in the field of Marine Microbiology with focus on marine microbial diversity, bioprospecting and applications of marine microbes in the production of various biologically significant metabolites; and in bioremediation of polluted environments. Students undergo hands-on training with state-of-the art technologies and are trained so as to develop an aptitude for independent research. The Programme equips students for higher research leading to the Ph.D. Degree in India or in International Universities overseas, or for employment in Research Institutes, in teaching, and in Industry, the students finding speedy employment.

Prerequisites: B. Sc. Microbiology

Course Structure of M.Sc. Marine Microbiology

Core papers: 32 Credits

Optional Papers: 32 Credits

Code	Title of paper	L-T-P hrs/week	Credits
Semester I - Core Papers			
MMC 101	Microbial Biochemistry	3-0-0	3
MMC 102	Microbial Biochemistry – Practical	0-0-2	1
MMC 103	Fundamentals of Oceanography	3-0-0	3
MMC 104	Fundamentals of Oceanography – Practical	0-0-2	1
MMC105	Microbial Taxonomy and Systematics	3-0-0	3
MMC 106	Microbial Taxonomy and Systematics – Practical	0-0-2	1
MMC 107	Mathematics and Statistics in Biology	3-0-0	3
MMC108	Mathematics and Statistics in Biology -Practical	0-0-2	1
			Total = 16
Semester II - Core Papers			
MMC 201	Techniques and Instrumentation in Microbiology	3-0-0	3
MMC 202	Techniques and Instrumentation in Microbiology - Practical	0-0-2	1
MMC 203	Industrial Microbiology	3-0-0	3
MMC 204	Industrial Microbiology – Practical	0-0-2	1
MMC 205	Microbial Genetics and Gene Regulation	3-0-0	3
MMC 206	Microbial Genetics and Gene Regulation - Practical	0-0-2	1
MMC 207	Microbial Ecology	3-0-0	3
MMC 208	Microbial Ecology – Practical	0-0-2	1
			Total = 16
Semester III - Optional Papers			
MMO 301	Marine Virology	3-0-0	3
MMO 302	Marine Zooplankton Ecology and Microbial Interactions	3-0-0	3
MMO 303	Marine Zooplankton – Practical	0-0-2	1
MMO 304	Archaea	3-0-0	3
MMO 305	Archaea – Practical	0-0-2	1
MMO 306	Genetic Engineering	3-0-0	3
MMO 307	Genetic Engineering – Practical	0-0-2	1
MMO 308	Marine Mycology	3-0-0	3
MMO 309	Marine Mycology – Practical	0-0-2	1
MMO 310	Marine Pollution and Monitoring	3-0-0	3
MMO 311	Marine Pollution and Monitoring – Practical	0-0-2	1
MMO 312	Analytical Techniques in Phytoplankton Studies	0-0-2	1
MMO 313	Marine Extremophilic Microorganisms: Culturing and Characterization	0-0-2	1
MMO 314	Analysis of Microbial Pathogens in the Marine Environment	0-0-2	1

MMO 315	Microbial Remediation – Practical	0-0-2	1
MMO 316	Marine Microbial Screening for Secondary Metabolites	0-0-2	1
MMO 317	Microbiological Analysis in Fisheries	0-0-2	1
MMO 318	Microbial Oceanographic Methods	0-0-2	1
MMO 319	Field Trip/Study Tour – Practical	0-0-2	1
MMO 320	Training in an Institute/ Industry/ University	0-0-2	1
			Total = 16
Semester IV - Optional Papers			
MMO 401	Polar Microbiology	3-0-0	3
MMO 402	Deep Sea Microbiology	4-0-0	4
MMO 403	Coral Microbiology	3-0-0	3
MMO 404	Bioinformatics Databases	2-0-0	2
MMO 405	Marine Phytoplankton	2-0-0	2
MMO 406	Marine Extremophilic Microorganisms	3-0-0	3
MMO 407	Marine Microbial Prospecting and Technology	3-0-0	3
MMO 408	Marine Environment and Public Health	3-0-0	3
MMO 409	Marine Microbial Remediation	2-0-0	2
MMO 410	Ocean Observations and Techniques	3-0-0	3
MMO 411	Fishery Microbiology	3-0-0	3
MMD 412	Dissertation	0-0-8	8
			Total = 16

Programme: M.Sc. (Marine Microbiology)
Course Code: MMC 103
Title of the Course: FUNDAMENTALS OF OCEANOGRAPHY
Number of Credits: 3
Effective from Academic Year: 2020-21

Prerequisites:	Basic understanding of the marine environments.	
Objective:	Introduce the students to the dynamic nature of the marine environment.	
Content:		
1	**Introduction to Physical Oceanography**	**12 L**
1.1	Physical properties of the sea - temperature, salinity, pressure, density. Mixed layer depth. Ocean circulation- wind driven and thermohaline circulation. Eddies and gyres. Coriolis effect. Upwelling. Ekman transport. Currents. Water mass. Waves, tides and tsunamis. Sound in the ocean, energy from oceans.	
1.2	Atmospheric circulation, albedo, land-sea breeze, tropical cyclone, Indian monsoon, ITCZ, heat flux, ENSO - El Nino, La Nina, Southern Oscillation, Indian Ocean Dipole	
2	**Introduction to Chemical and Geological Oceanography**	**12 L**
2.1	Chemical properties of seawater. Elemental composition of seawater. Salinity and chlorinity. Residence time. Dissolved gases. Nutrients. Carbonate system. pH and alkalinity. Calcium carbonate precipitation and dissolution. Carbonate compensation depth and lysocline. Radioactivity.	
2.2	Geological time scale. Origin of the oceans. Ocean basins. Plate tectonics and seafloor spreading. Ocean floor morphology. Marine minerals and sediments types.	
3	**Introduction to Biological Oceanography**	**12 L**
	Habitat - estuaries, mangroves, salt marshes, rocky and intertidal, coral reefs, seagrass, coastal and open ocean, hydrothermal vents and cold seeps. Marine zonation. Pelagic and benthic communities. Marine photosynthesis. Phytoplankton and primary production. Gross and net productivity. New and regenerated productivity, f-ratio. Pigments. Redfield ratio. Measurement and control of secondary production. Benthic-pelagic coupling. Bioturbation. Bioluminescence. Exclusive economic zone.	
Pedagogy:	Lectures/tutorials/assignments/self-study	
References/ Readings	The Ocean: Their Physics, Chemistry and Biology, 1962 - Sverdrup, H.U., Johnson, M.W. and Flemming, R.H., Asia Publ. House, New Delhi.	
	Descriptive Physical Oceanography: An Introduction, 1989 - Pickard, G.B. and Emery, W.J., Pergamon press, U.K	

	Munn, C., Marine Microbiology: Ecology and Applications, Garland Science, Taylor and Francis, N.Y	
	Meller, C. B., Wheeler, P. A., Biological Oceanography, WileyBlackwell Publishers.	
	Oceanography (5th ed), 1990 Grant Gross, M., Englewood Cliffs, N.J. Prentice Hall.	
	Introductory Oceanography (5th ed), 1988 Thurman, H.V., Columbus Mercill Publ. Co, Ohio.	
Learning outcomes	Provides brief knowledge on how marine physics, chemistry, biology and geology are interrelated. Understanding of how different physicochemical processes govern life in the ocean.	

Programme: M.Sc. (Marine Microbiology)
Course Code: MMC 104
Title of the Course: FUNDAMENTALS OF OCEANOGRAPHY - Practical
Number of Credits: 1
Effective from Academic Year: 2020-21

Prerequisites:	Basic understanding of the unique properties of water.	
Objective:	To study physicochemical and biological parameters of seawater.	
Content:		**24 H**
1.	Estimation of seawater salinity by titration method.	
2.	Determination of dissolved O_2 of seawater using Winkler's method.	
3.	Determination of pH of seawater by potentiometric/spectrophotometric method.	
4.	Determination of nitrate, phosphate, silicate by spectrophotometric method.	
5.	Determination of chlorophylls and phaeo-pigments by spectrophotometric method.	
Pedology:	Laboratory experiments/ Field trips	
References/ Readings	Grasshoff, K., Ehrhardt, M. and Kremling, K., (1999). Methods of Seawater Analysis, Verlag Chem., Weinheim.	
	Ewing, G. W.; (1981) Instrumental Methods of Chemical Analysis. McGraw-Hill, New York.	
	Parsons, T. R., Maita, Y. and Lalli, C. M.; (1984). A Manual of Chemical and Biological Methods for Seawater Analysis, Pergamon Press, Oxford.	
	Strickland, J.D.H, and Parsons T.R., (1972). A practical handbook of seawater analysis, Fisheries Board of Canada bulletin.	
Learning outcomes	Students will know to carry out field surveys and analyse the physicochemical and biological parameters of the marine system.	

Programme: M.Sc. (Marine Microbiology)
Course Code: MMC 207
Title of the Course: MICROBIAL ECOLOGY
Number of Credits: 3
Effective from Academic Year: 2020-21

Prerequisites	Basic understanding of the marine environment and microorganisms.	
Objective:	Introduce the students to the marine environment, biodiversity and their interaction. Impart knowledge on the effect of climate change on microbial ecology.	
Content:		
1	**Marine environment, biodiversity and its interaction**	**12 L**
1.1	Marine microbial diversity. Ecosystem and food webs. Energy flow and cycling. Interaction between biotic and abiotic factors.	
1.2	Marine microbiome- Diversity, evolution and function, mutualism, commensalism, parasitism, microbial symbiosis, microbiomes from plankton, fish, coral, sponge, deep-sea invertebrate, and animals. Stress response and adaptation. Marine probiotics, prebiotics and its application.	
1.3	Biogeochemical cycles – carbon, nitrogen, phosphorus, sulphur, iron and manganese	
1.4	Oxygen minimum zones (OMZs), anaerobic microbial metabolism, OMZs in the world oceans, anthropogenic impact	
2	**Microbes and Carbon Cycling**	**12 L**
2.1	Marine carbon reservoirs, ocean carbon cycle, carbon pump-solubility, carbonate, biological, microbial, microbial loop, role of picoplankton.	
2.2	Production, transformations and fate of dissolved organic matter (DOM), Sources and composition of DOM, reactivity class of DOM, DOM release and microbial food webs, Extracellular enzymes, DOM release and global climate change, role of DOM in the ecosystem, chromophoric dissolved organic matter (CDOM), factors affecting CDOM and its role in the ecosystem. Carbon cycling in the anoxic environment and sediments.	
3	**Marine Ecosystem and Global Climate Change**	**12 L**
	Greenhouse gases. Warming potential. Changes in physical and biogeochemical properties: ocean acidification, global warming, deoxygenation. Causes, changing chemistry of the ocean. Physiological, population and community response in marine organisms. Impact on marine plankton, fishery, coral, humans. Changes in growth, distribution, energetics, food web, marine productivity, microbial loop, reproduction, survival, recruitment, prey-predator interaction. Thermal	

	limits and distribution of organisms. Climate change refugia and adaptation. Coastal and ocean species migration and change in the structure, Environmental and economic consequences. Multiple stressors and Synergistic effects.	
Pedagogy:	Lectures/tutorials/assignments/self-study	
References/ Readings	Mitchell, R. and Kirchman, D. L., Microbial Ecology of the Oceans, Wiley- Blackwell Publishers.	
	Nybakken, J. W. and Bertness, M. D., Marine Biology: an Ecological Approach, Benjamin Cummings, San Francisco.	
	Munn, C., Marine Microbiology: Ecology and Applications, Garland Science, Taylor and Francis, N.Y.	
	Elements of Marine ecology (4th ed) 1982 – Tait, R.V. and Dipper, F. Butterworth – Heinemann	
	Textbook of Marine Ecology, 1980 – Nair, N.B. &Thampy, D.M., Macmillan, 352 pp	
	Marine Biology, 1984, Thurman, H.V. and Webber, H.H., Harper Collins Publishers	
Learning outcomes	Students will understand the concept of the marine biodiversity and the factors governing them. Role of climate change in marine ecosystem.	

Programme: M.Sc. (Marine Microbiology)
Course Code: MMC 208
Title of the Course: MICROBIAL ECOLOGY - Practical
Number of Credits: 1
Effective from Academic Year: 2020-21

Prerequisites	Basic understanding of the unique features of marine environments and microorganisms.	
Objective	Enable the students to identify microbes and understand their role in the marine environment.	
Content		**24 H**
1.	Enumeration of plankton associated microbes.	
2.	Determination of particulate organic matter (carbon/ nitrogen/ phosphorus) from plankton/ seawater.	
3.	Determination of carbohydrates/proteins/lipids from plankton/ seawater/ sediments.	
4.	Estimation of CDOM from seawater by spectrophotometric method.	
5.	Determination of extracellular enzymes from plankton/ seawater/ sediments by MUF.	
6.	Determination of sulphide in seawater.	
Pedagogy:	Laboratory experiments/ Field trips	
References/ Readings	Parsons, T. R., Maita, Y. and Lalli, C. M.; (1984). A Manual of Chemical and Biological Methods for Seawater Analysis, Pergamon Press, Oxford.	
	Zoppini et al., (2005). Extracellular enzyme activity and dynamics of bacterial community in mucilaginous aggregates of the northern Adriatic Sea. Science of The Total Environment 353(1-3):270-86.	
	Strickland, J.D.H, and Parsons T.R., (1972). A practical handbook of seawater analysis, Fisheries Board of Canada bulletin. (2nd edition).	
	Padini et al., (2014). Contrasting phytoplankton community structure and associated light absorption characteristics of the western Bay of Bengal. Ocean Dynamics. 64:89–101.	
Learning outcomes	Understanding the role of microbes in the marine ecosystem and how to estimate it.	