Name:

Enrolment No:

UPES

End Semester Examination, May 2025

Course: Environmental Microbiology and Biogeochemistry **Semester : IV**

Program: BSc Microbiology **Duration : 3 Hours**

Course Code: HSMB2034 **Max. Marks: 100**

Instructions: *All questions are compulsory. Support answers with labelled diagrams wherever necessary.*

S. No.	Section A Short answer questions/ MCQ/T&F (20Qx1.5M= 30 Marks)	Marks	COs
Q 1	**The Keeling Curve is a graphical representation of which of the following environmental parameters?** a) Global average temperature over time b) Atmospheric carbon dioxide concentration over time c) Ozone concentration in the stratosphere d) Sea level rise due to melting glaciers	1.5	CO1
Q 2	**The following combinations of Milankovitch cycle phases would most likely favor glaciation (ice age conditions) in the Northern Hemisphere:** a) Low eccentricity, high obliquity, and summer solstice at perihelion b) High eccentricity, low obliquity, and summer solstice at aphelion c) Low eccentricity, low obliquity, and summer solstice at perihelion d) High eccentricity, high obliquity, and summer solstice at perihelion	1.5	CO1
Q 3	**The primary function of the Biological Carbon Pump (BCP) in the global carbon cycle is:** a) It stores carbon in deep ocean sediments for millions of years. b) It transports carbon from the atmosphere to the surface ocean for phytoplankton growth. c) It transfers organic carbon from the ocean's surface to deeper layers through biological processes. d) It converts carbon dioxide into oxygen through photosynthesis.	1.5	CO1
Q 4	**The thermocline is most commonly defined as:** a) A region where the ocean temperature is uniform across all depths. b) A thin layer in the ocean where the temperature changes rapidly with depth. c) The deepest part of the ocean where cold water is found. d) A zone of maximum primary productivity in the ocean.	1.5	CO1

Q 5	**Mixed layer depth (MLD) can affect marine life in the Oceans as:** a) Shallow MLD leads to higher nutrient concentrations in the surface waters. b) A deep MLD allows more light penetration, increasing photosynthesis. c) A shallow MLD can limit nutrient mixing, potentially decreasing biological productivity. d) MLD has no effect on marine life.	**1.5**	**CO1**
Q 6	**DNRA influences nitrogen cycling in soils as:** a) It contributes to the release of nitrogen gas, completing the nitrogen cycle. b) It increases the availability of ammonium, which can be utilized by plants and microorganisms. c) It reduces the overall nitrogen content in ecosystems by converting ammonium to nitrate. d) It decreases nitrogen availability by converting ammonium to nitrogen gas.	**1.5**	**CO1**
Q 7	**A significant ecological and climatological concern related to microbial activity in permafrost is:** a) The release of methane due to microbial decomposition of organic matter. b) The introduction of harmful pathogens to human populations. c) The accumulation of toxic metals in the environment. d) The production of excessive nitrogen that harms plant life.	**1.5**	**CO1**
Q 8	**Extremophilic microbes thriving in circumneutral endorheic lakes are most likely to be:** a) Halophiles b) Alkalophiles c) Acidophiles d) Neutrophiles	**1.5**	**CO1**
Q 9	**The following factors most commonly triggers large-scale phytoplankton blooms in oceanic systems:** a) High salinity and calm waters b) Decreased sunlight and cooler temperatures c) Increased availability of nutrients such as nitrate and phosphate d) High oxygen concentration and deep thermocline	**1.5**	**CO1**
Q 10	**Phytoplankton group that is most often associated with harmful algal blooms (HABs) is:** a) Cyanobacteria b) Diatoms c) Dinoflagellates d) Coccolithophores	**1.5**	**CO1**
Q 11	**Iron fertilization experiments in the Southern Ocean showed that:** a) Iron limits phytoplankton growth in high-nutrient, low-chlorophyll (HNLC) zones b) Iron addition always results in toxic blooms c) Iron inhibits carbon fixation in marine microbes d) Iron plays no role in primary productivity	**1.5**	**CO1**

Q 12	**The relationship between coral polyps and zooxanthellae is best described as:** a) Parasitic b) Mutualistic c) Commensal d) Competitive	**1.5**	**CO2**
Q 13	**Coral bleaching occurs when:** a) Corals expel their calcium carbonate skeletons b) Zooxanthellae are expelled due to environmental stress c) Corals become infected with bacteria d) Corals increase their feeding on plankton	**1.5**	**CO2**
Q 14	**A major potential threat to thermohaline circulation due to climate change is:** a) Decrease in volcanic activity b) Increase in atmospheric nitrogen c) Freshwater input from melting ice disrupting salinity d) Depletion of ozone layer increasing UV radiation	**1.5**	**CO1**
Q 15	**The fast carbon cycle involves:** a) Movement of carbon through tectonic uplift b) Formation of fossil fuels c) Photosynthesis and respiration between the atmosphere and biosphere d) Burial of carbonate sediments in the deep ocean	**1.5**	**CO3**
Q 16	**The primary mechanism by which the ocean absorbs CO_2 from the atmosphere:** a) Diffusion and biological pump b) Biological pump c) Diffusion d) Downwelling of surface water	**1.5**	**CO3**
Q 17	**The following is negative feedback in the carbon-climate system:** a) Warmer temperatures increase permafrost thaw, releasing methane b) Increased CO_2 stimulates plant growth, enhancing carbon uptake c) Ocean warming reduces CO_2 solubility, releasing more CO_2 d) Forest fires release stored carbon during droughts	**1.5**	**CO3**
Q 18	**In anaerobic environments, sulfate-reducing bacteria (SRB) use sulfate as:** a) A carbon source b) A terminal electron donor c) A terminal electron acceptor d) An enzyme cofactor	**1.5**	**CO3**
Q 18	**Nitrogen transformation that directly contributes to the emission of potent greenhouse gas:** a) Nitrogen fixation b) Nitrification c) Denitrification d) Ammonification	**1.5**	**CO3**

Q 19	**Climate change can potentially intensify the nitrogen cycle in terrestrial ecosystems by:** a) By increasing N_2 gas solubility b) Through cooling-induced inhibition of microbes c) Via warming-enhanced microbial rates of nitrification and mineralization d) By reducing nitrogen deposition	**1.5**	**CO3**
Q 20	**Anoxic bottom waters of meromictic lakes are typically characterized by:** a) High oxygen and low nutrients b) Low salinity and low productivity c) High concentrations of reduced compounds like H_2S, CH_4 d) Rapid seasonal overturn	**1.5**	**CO3**
Section B (4Qx5M=20 Marks)			
Q 1	Describe various zonations of the Ocean with help of a labelled diagram.	**5**	**CO1**
Q 2	Explain symbiotic interactions between bacteria and Bobtail squids.	**5**	**CO2**
Q 3	Describe in details the process of Annamox and their significance for global N-cycling.	**5**	**CO3**
Q 4	Discuss impacts of Ocean acidification on marine food-web.	**5**	**CO2**
Section C (2Qx15M=30 Marks)			
Q 1	*"A chemical manufacturing plant is located near a river and has recently been reported to pollute the water body. An environmental monitoring team collects samples of wastewater being discharged from the plant and analyzes them. The results are as follows:* *BOD of the effluent: 25 mg/L* *COD of the effluent: 800 mg/L* *The river water downstream shows reduced levels of dissolved oxygen and a decline in aquatic biodiversity."* a) Mention the permissible limits of BOD and COD. b) Outline the principle of methods to analyse BOD and COD from water samples. c) Interpret the case of low BOD and high COD to indicate about the nature of pollution. d) Suggest choice of wastewater treatment strategies for scenarios where COD > BOD. e) Design an action plan for a municipality where river BOD levels are rising due to urbanization.	**15** (1+4+4+3+3)	**CO5**

Q 2	*"Aresenic (As) is a groundwater contaminant and a carcinogen. Microrganisms play a major role in the biotransformations of As adsorbed to sedimental minerals and in groundwater."* a) Mention the major oxy-anions of As. b) Explain important role of microrganisms in As mobilization from groundwater aquifer sediments with help of a schematic diagram. c) Enlist and describe key abiotic factors that may be involved in triggering As mobilization into ground-water and As contamination into agricultural fields. d) Discuss plausible solutions for microbially mediated bioremediation of As from groundwater and crop-lands.	**15** (1+5+ 5+4)	**CO4**
Section D **(2Qx10M=20 Marks)**			
Q 1	Sludge is often considered a byproduct — but can it be turned into a valuable resource. Explore the pros and cons of sludge management options.	**10**	**CO4**
Q 2	a) Discuss the formation of hydrothermal vents. b) Explain symbiotic microbial interactions of the hydrothermal vent community with help of a neat- labelled diagram.	**10** (5 + 5)	**CO2**