SARVAJANIK UNIVERSITY

INCLUSIVE | INTEGRATED | INNOVATIVE

Faculty of Science

B. Sc. Environment Science

Semester - 4

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Faculty of Science

B. Sc. Environment Science

Faculty: Science	**Department:** Environmental Science
Program: B. Sc. Environmental Science	**Type of Subject:** Theory + Practical
Subject: Atmosphere, Climate and Disaster Risk Assessment	
Semester- 4	

Student Learning Outcomes (SLOs):

- The paper deals with dynamics of atmospheric processes, which include its composition, meteorological phenomena and atmospheric chemistry.
- The paper also highlights the anthropogenic intervention in 'anthropocene', which has led to global climate change.
- The paper also explores effects of global changes on human communities and initiatives taken at global and regional levels to combat them.

References and Textbooks: (With Author, Edition, Publishers, ISBN)

1. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
2. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
3. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
4. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
5. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
6. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
7. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future.Columbia University Press.
8. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. Climate Change and India. Universities Press, India.
9. Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2nd edition). Sage Publications

UNIT-1: Introduction of atmosphere and global energy balance (7 hours)

1.1 Evolution and development of Earth's atmosphere

1.2 Atmospheric structure and composition, significance of atmosphere in making the Earth, and Milankovitch cycles

1.3 Earth's energy balance and energy transfers in atmosphere

1.4 Earth's radiation budget, Green House Gases (GHGs), Greenhouse effect, Global Conveyor Belt

UNIT-2: Atmospheric circulation (8 hours)

2.1 Movement of air masses, Atmosphere and climate, Air and sea interaction, Southern oscillation, Western disturbances

2.2 *El Nino* and *La Nina,* Tropical cyclone, Indian monsoon and its development, Changing monsoon in Holocene in the Indian subcontinent

2.3 Impact of Indian monsoon on agriculture and Indus valley civilization

2.4 Effect of urbanization on micro climate, Asian brown clouds

UNIT-3: Meteorology and atmospheric stability (7 hours)

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3.1 Meteorological parameters (temperature, relative humidity, wind speed and direction, precipitation)
3.2 Types of Meteorological parameters and their effects on atmosphere
3.3 Atmospheric stability and mixing heights
3.4 Temperature inversion, plume behavior, Gaussian plume model

UNIT-4: Atmospheric chemistry (7 hours)

4.1 Chemistry of atmospheric particles and gases
4.2 Smog – types and processes, photochemical processes
4.3 Ions and radicals in atmosphere, Acid-base reactions in atmosphere, Atmospheric water
4.4 Role of hydroxyl and hydroperoxyl radicals in atmosphere

UNIT-5: Global warming and Climate change (7 hours)

5.1 Earth's climate through ages, trends of global warming and climate change, Drivers of global warming and the potential of different green-house gases (GHGs) causing the climate change
5.2 Atmospheric windows, Impact of climate change on atmosphere
5.3 Weather patterns, Sea level rise, Agricultural productivity and Biological responses range shift of species, CO_2 fertilization and agriculture
5.4 Impact on economy and spread of human diseases

UNIT-6: Ozone layer depletion (7 hours)

6.1 Ozone layer or Ozone shield, Importance of ozone layer
6.2 Ozone layer depletion and causes
6.3 Chapman cycle, Process of spring time ozone depletion over Antarctica
6.4 Ozone depleting substances (ODS), Effects of ozone depletion, Mitigation measures and international protocols

UNIT-7: Climate change and policy (7 hours)

7.1 Environmental policy debate, International agreements
7.2 Montreal protocol 1987, Kyoto protocol 1997
7.3 Convention on Climate Change
7.4 Carbon credit and carbon trading
7.5 Clean development mechanism

UNIT-8: Risk assessment tools (7 hours)

8.1 Principle and scope of assessment
8.2 History and purpose of IPCC scenarios
8.3 Long term risk assessment approach to climate science
8.4 Risk assessment to human, agriculture and water

Practicals:

1. Measurement of atmospheric humidity.
2. To determine wind velocity by cup type Anemometer..
3. To determine intensity of the solar radiation by Albedometer.
4. Draw and explain earth's radiation budget and energy balance of the earth's surface.

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B. Sc. Environment Science

Faculty: Science	**Department:** Environmental Science
Program: B. Sc. Environmental Science	**Type of Subject:** Theory + Practical
Subject: Environmental Biotechnology	
Semester- 4	

Student Learning Outcomes (SLOs):

- The major outcome to study the environmental biotechnology is to understand the current applications of biotechnology to environmental quality evaluation, monitoring and remediation of contaminated environments.
- Sustainable environmental biotechnology advances are helping to make manufacturing processes cleaner and more efficient by reducing toxic chemical pollution and greenhouse gas emissions.

References and Textbooks: (With Author, Edition, Publishers, ISBN)

1. Indu Shekhar Thakur (I K International Publishing) Environmental Biotechnology: Basic Concepts and Applications , 2nd Edition. ISBN: 9789380578477.
2. N. Arumugam and V. Kumaresan (Saras Publications) Environmental Biotechnology, 2nd Edition. ISBN: 9789384826031.
3. Pradipta Kumar Mohapatra (Dreamtech Press, New Delhi). Textbook of Environmental Biotechnology. ISBN: 9789389633054.
4. Viswanath Buddolla. (Narosa Publication). Environmental Biotechnology - Concepts and Applications. ISBN: 9788184875478.
5. A. K. Chaterjee (Prentice Hall India Learning) Introduction to Environmental Biotechnology. ISBN: 9788120342989.

UNIT-1: Introduction and Scope of Environmental Biotechnology (7 hours)

1.1 Definition, introduction and scope of environmental biotechnology
1.2 Need and issues of environmental biotechnology
1.3 Challenges of Environmental Biotechnology
1.4 Abatement of pollution and Environmental clean-up technologies

UNIT-2: Introduction and tools for genetic engineering (7 hours)

2.1 DNA modifying enzymes: Nuclease, Alkaline Phosphatase, DNA polymerase, Reverse Transcriptase, Polynucleotide Kinase, Methylase and DNA ligase
2.2 Methods of Gene cloning and Gene transformation
2.3 Linkers, adaptors, homopolymer tailing, Site directed mutagenesis
2.4 PCR: Process, Methodology and Types, Reverse Transcriptase PCR, Real Time PCR

UNIT-3: Different types of gene cloning vectors (7 hours)

3.1 Cloning vectors: Types and Properties, Essential components of gene cloning vectors, Selectable and screenable markers
3.2 Plasmids, Bacteriophages, M13 mp vectors, PUC19 and Bluescript vectors
3.3 Insertion and Replacement Vectors, TA cloning vectors, YACs and BACs

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3.4 Expression vectors, plant based vectors, Ti and Ri plasmids as vectors

UNIT-4: Gene library and Genome editing techniques (7 hours)

4.1 Isolation of mRNA and total RNA, reverse transcriptase and cDNA synthesis

4.2 Introduction to miRNA and siRNA

4.3 Gene knock in and Gene knock out

4.4 Genome Editing: CRISPER-CAS, TALENs, ZFNs

4.5Applications of genetic engineering techniques in environmental biotechnology

UNIT-5: Biomass and Bioenergy (7 hours)

5.1 Biomass as a source of energy: Composition and types of biomass

5.2 Biomass conversion: Thermo-chemical conversion, Bioconversion

5.3 Bioenergy – Petroleum plants, Bioethanol

5.4 Gaseous fuels – Biogas, Biohydrogen and Microbial Fuel cells

UNIT-6: Bioremediation technologies (7 hours)

6.1 Bioremediation: Introduction and Types

6.2 Bioaugmentation and Biofilteration

6.3 Bioremediation of hydrocarbons

6.4 Bioremediation of industrial wastes

6.5 Bioremediation of recalcitrant and xenobiotic compounds

UNIT-7: Phytoremediation and rhizoremediation technologies (7 hours)

7.1 Phytoremediation – Introduction, Types and Mechanisms

7.2 Advantages, Disadvantages and Applications of phytoremediation

7.3 Rhizoremediation – Introduction, Types and Mechanisms

7.4 Concept of Phytoextraction and rhizofilteration

UNIT-8: Applications of Environmental Biotechnology and sustainable technologies (7 hours)

8.1 Bioleaching: Types, Processes and Examples

8.2 Bioplastics, Bioscrubbers, Biopesticides and Biofertilizers

8.3Environmental Nanotechnology – Principles and Environmental applications

8.4 Biosensors: Types, Working and Applications

Practicals

1. Isolation of symbotic, nonsymbiotic and anaerobic nitrogen fixing bacteria from rhizosphere
2. Isolation of genomic DNA from bacterial, yeast and plant samples
3. Isolation of plasmid DNA
4. Study of biosorption of heavy metal by fungal biomass
5. Synthesis of AgNPs by using sodium citrate
6. Isolation and enrichment of Uric Acid Utilizing Bacteria
7. Study of seed viability and seed germination assay in presence of environmental pollutants.

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Faculty of Science

B. Sc. Environment Science

Faculty: Science	**Department:** Environmental Science
Program: B. Sc. Environmental Science	**Type of Subject:** Theory + Practical
Subject: Biofertilizer, Biopesticide and Mushroom cultivation	
Semester- 4	

Student Learning Outcomes (SLOs):

Upon successful completion of this course students will have learned

- Understanding of importance and practical aspects of production of biofertilizers.
- Role of biopesticides/bioinsecticides in the agriculture field.
- Nutritional value and commercial use of mushrooms for human consumption.
- Practical cultivation of mushrooms, management of diseases affecting mushrooms, mushroom harvesting and various avenues for using it into an entrepreneurship.

References and Textbooks: (With Author, Edition, Publishers, ISBN)

1. Bahl, N. (1984). Handbook on mushrooms, oxford &IBH publishing co. Pvt. Ltd. 2nd Addition. (https://archive.org/details/in.ernet.dli.2015.219901/page/n19/mode/2up)
2. Dubey R.C., (2012), A Textbook of Biotechnology, 4th Edition, S Chand and Company Ltd., 81-219-2608-4
3. Kadhila-Muandingi, N. P., Mubiana, F. S., & Halueendo, K. L. (2012). Mushroom Cultivation: a beginners guide. University of Namibia, Namibia.
4. Kainth, G. S. (1996). Export potential of Indian agriculture. Regency publication. ISBN-8186030212 (https://www.google.co.in/books/edition/Export_Potential_of_Indian_Agriculture/95TrPISDUXEC?hl=en&gbpv=1)
5. Kashangura C, (2004), Manual For Mushroom Cultivation
6. Okafor, N., & Okeke, B. C. (2017). Modern industrial microbiology and biotechnology. CRC Press. ISBN: 978-1-57808-434-0
7. Sandhu S., (2013) Biofertilizer Technology, Black print India Inc.,ISBN- 978-93-82036-22-7
8. Stamets, P., & Chilton, J. S. (1983). The mushroom cultivator. First Washington.
9. Thapa C. D., MUSHROOM CULTURE

Further Reading:

1. Brahma Mishra, (2012) "Fertilizer Technology and Management", IK International Publishing House Pvt. Ltd.
2. FAO, "Fertilizers and their use", (2015) 4th Edition, Scientific Publisher, New Delhi.
3. Meena, V. S., Mishra, P. K., Bisht, J. K., & Pattanayak, A. (Eds.). (2017). Agriculturally important microbes for sustainable agriculture: volume 2: applications in crop production and protection. Springer.
4. Paul, E. (Ed.). (2014). Soil microbiology, ecology and biochemistry. Academic press.
5. Suman, B. C., & Sharma, V. P. (2007). Mushroom cultivation in India. Daya Books. ISBN:9789351300212.

Unit-1: Biofertilizers: Microbial Inoculants (08 hours)

1.1 Bacterial and Cyanobacterial Inoculants

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1.2 Azolla and Mycorhizal fungi as Biofertilizer
1.3 Green Manuring
1.4 Frankia Induced Nodulation
1.5 Benefits of Biofertilizers and it's Commercial producers
1.6 Indian Status for Biofertilizers

Unit-2: Formulation of Biofertilizers (08 hours)

2.1 Mass production of Biofertilizers
2.2 Application of Biofertilizers
2.3 Economics of Biofertilizers
2.4 Cost and Availability of Biofertilizers

Unit-3: Biopesticide (08 hours)

3.1 Biological Control of Plant pathogen
3.2 Biological control of Insect pests
3.3 Biological control of weeds

Unit-4: Microbial Production of Insecticides (08 hours)

4.1 Biological Control of Insects
4.2 Production of biological insecticides
4.3 Bioassay of biological insecticides
4.4 Formulation and use of bioinsecticides
4.5 Safety Testing and Development of new Bioinsecticides

Unit-5: Introduction to Mushrooms (08 hours)

5.1 History of Mushroom Cultivation
5.2 Morphology of Mushrooms
5.3 Food Value of Mushrooms
5.4 Application of Mushrooms
5.5 Present status of the mushroom industry in India

Unit-6: Biology of Mushrooms (10 hours)

6.1 The Biology of Mushrooms
6.2 The Mushroom Life Cycle
6.3 Classification of Mushrooms
6.4 Genetic Improvement of Mushrooms

Unit-7: Cultivation Technology of mushrooms (06 hours)

7.1 Cultivation technique of button Mushrooms
7.2 Cultivation Technology Oyster Mushrooms
7.3 Cultivation Technology of Paddy Straw Mushroom
7.4 Cultivation Technology of Milky Mushroom

Unit-8: Post Cultivation Process (04 hours)

8.1 Packaging and quality control
8.2 Preservation and processing
8.3 Mushroom houses: Maintaining and monitoring House

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8.4 Production cycle
8.5 Export marketing of mushroom
8.6 Waste management and recycling

Practicals:

1. Isolation of symbiotic nitrogen fixing bacteria from root nodules of leguminous plant.
2. Isolation of non-symbiotic nitrogen fixing bacteria from soil
3. Isolation and purification of Azospirillum.
4. Isolation of Phosphate solubilizing microorganisms from rhizosphere.
5. Study of plant (Red rot of sugar cane) pathogenic fungi.

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Faculty of Science

B. Sc. Environment Science

Faculty: Science	**Department:** Environmental Science
Program: B. Sc. Environmental Science	**Type of Subject:** Theory + Practical
Subject: Nanoscience and Nanotechnology	
Semester- 4	

Student Learning Outcomes (SLOs):

After learning the course, students should be able :

- To understand the difference between bulk and nanoscale materials.
- To understand the basics of nanoscale science.
- To understand the synthesizing technique and difficulties to synthesize the nanomaterials so they can get interest in the search of new composition techniques of nanomaterials.
- To understand the various applications of nanoscience and nanotechnology.

References and Textbooks: (With Author, Edition, Publishers, ISBN)

1. Nanoscience and Nanotechnology Fundanentals to Frontiers, M.S. Ramachandra Rao, Shubra Singh2013, Wiley
2. Nanotechnology Principles and practicals, S.K. Kulkarni, 2017, Capital Publishing Company
3. Bio-nanotechnology: concepts and applications, Madhuri Sharon ,Maheshwar Sharon, 2013, CRC Press
4. Introduction to nanoscience and nanotechnology, Boca Raton, G.L. Hornyak, H.F. Tibbals, J. Dutta , J. Moore, CRC Press
5. A textbook of Nanoscience and Nanotechnology, B.S. Murty, 2012, Orient Blackswan Private Limited - New Delhi
6. Environmental Nanotechnology, M. H. Fulekar, Bhawana Pathak, 2018, CRC Press
7. A textbook of Nanoscience and Nanotechnology, T. Pradeep, 2012, Tata McGraw Hill Education Private Limited.

UNIT-1: Fundamentals of Nanoscience and Nanotechnology (3 hours)

1.1 Introduction to the world of Nanoscience

1.2 Nano and Nature: Nanoscopic colors, Bioluminescence, Tribiology

1.3 Introduction to hydrophilic and hydrophobic materials

1.4 Time line of Nanotechnology in different centuries

UNIT-2: Nano Scale Science (The big world of Nano scale) (4 hours)

2.1 Interconversion of Units

2.2 Introduction to surface area to volume ratio and aspect ratio

2.3 Difference between surface area to volume ratio of bulk materials and nano materials (sphere, rods, cubes)

2.4 Difference in aspect ratio of bulk wire and nanowire

2.5 Nanomaterial and wavelength of light

UNIT-3: Classification of Nano Structured Materials (4 hours)

3.1 Small things can make a big difference

3.2 Classification of nanostructured materials (3D, 2D, 1D, 0D)

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3.3 Relationship between dimension and shape of nanomaterials (Quantum dots, Quantum wires, carbon nanotubes, Fullerenes)

3.4 Effect of size on electronic and optical properties

UNIT-4: Fundamental of Atomic Structure and Bonding (3 hours)

4.1 Bohr's atomic structure

4.2 Bohr's atomic radii, comparative size of nanomaterials and atomic size, electronic configuration

4.3 Types of energy levels

4.4 Bonding and electronic structures of solids

UNIT-5: Concept of Solid State Physics and Crystal Structure (4 hours)

5.1 Introduction

5.2 Planes in the crystals and crystallographic directions

5.3 Types of crystal structures

5.4 Reciprocal lattice

UNIT-6: Synthesis Techniques (4 hours)

6.1 Introduction

6.2 Top-Down fabrication methods(concepts with examples only)

6.3 Bottom-Up fabrication methods(concepts with examples only)

6.4 Chemical, Biological and Self-assembly methods of synthesis

UNIT-7: Properties of Nano Materials (4 hours)

7.1 Introduction

7.2 Mechanical and Optical properties

7.3 Electrical and Magnetic properties

7.4 Structural and Thermal properties

UNIT-8: Applications and Future Perspective of Nanoscience and Nanotechnology (4 hours)

8.1 Introduction

8.2 Cosmetics & Domestic appliances

8.3 Nanobiotechnology and Medical fields

8.4 Environmental development

8.5 Food and Agriculture

Practicals:

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