Ph.D MICROBIOLOGY
(Autonomous)

CURRICULUM
(Revised with effect from 2017-2018 onwards)

DEPARTMENT OF MICROBIOLOGY
CENTRE FOR EXCELLENCE IN LIFE SCIENCES
BHARATHIDASAN UNIVERSITY
TIRUCHIRAPPALLI 620024, INDIA

Course Work for Ph.D. Scholars

All candidates, (Full-time or Part-time) shall undergo Course Work after provisional registration, as part of Ph.D. programme in the first year. The course work should be treated as pre-Ph.D. preparation. One of the courses to be prescribed for course work must be Research Methodology. However, for those candidates (Full time /Part time) with M.Phil. Qualification, the course on Research Methodology shall be exempted. The Research Scholars registered under the faculty of Arts, Science and humanity must undergo three courses of which one will be 'Research Methodology' (exempted for M.Phil. candidates), the second course will be in the core area of research and the third will be in the related areas to support the research work. In the case of Research Scholars registered under the faculty of Engineering and Technology Pharmacy, Medicine, Surgery, Veterinary Science, etc., they must undergo four courses of which one will be Research Methodology, two courses will be in the core areas of Research and the fourth course will be in the related areas required to support the research work. The Research Scholars must complete the course requirements normally within a period of 1½ years in order to pursue further with his / her Ph.D. research. The Registration shall be confirmed only after the completion of the course work. Failure to complete the course work within the stipulated period shall entail automatic cancellation of registration. The course will be evaluated for an internal assessment of 40% and a final examination 60%. Each course work must have 4 credits. The conduct of course work and question pattern may be followed according to the M.Phil. degree. Some of the course work may be of 'self-study' nature. These course works must be decided by the Doctoral Committee, in its first meeting to be held within three months from the date of provisional Registration based on the level of knowledge of the scholar in the area of research.

Depending upon the level of the scholar the Doctoral Committee can recommend for waiving one or more courses or add one or more courses over and above the minimum number of courses prescribed for the approval of the Vice-Chancellor.

i. The Research Advisors shall conduct the final examinations for the course work of their research students, evaluate the answer scripts and send the marks to the Controller of Examinations of the university along with a copy of the syllabus, the Question papers and the original answer scripts of the course work. The research students shall have to pay a fee of Rs.60/- towards the cost of the Statement of Marks and that the fee should be sent to the Controller of Examinations of the University by means of Demand Draft drawn in favour of "Bharathidasan University Tiruchirappalli".

ii. The Research Scholars who registered themselves for Ph.D. program on or after 01.04.2006 and still have not completed their course work papers shall do and complete them in accordance with the aforesaid new guidelines.

PROGRAM STRUCTURE

	Marks	Credit
Course I (Research Methodology)	100	4
Course II (Elective)	100	4
Course III(Elective)	100	4

GRADING OF THE COURSES

Marks	Grade point	Letter Grade
96 and above	10	S+
91-95	9.5	S
86-90	9.0	D++
81-85	8.5	D+
76-80	8.0	D
71-75	7.5	A++
66-70	7.0	A+
61-65	6.5	A
56-60	6.0	B
50-55	5.5	C
Below 50	0	F

FINAL RESULT

CGPA	Letter Grade	Classification of Final Result
9.51 and above	S+	First Class – Exemplary
9.01 – 9.50	S	
8.51 - 9.00	D++	First Class - Distinction
8.01 - 8.50	D+	
7.51 - 8.00	D	
7.01 - 7.50	A++	First Class
6.51 - 7.00	A+	
6.01 - 6.50	A	
5.51 - 6.00	B	Second Class
5.00 - 5.50	C	
Below 5.00	F	Fail

PROGRAM ME OUTCOME

- Research Granduands are well equipped with **Research** & **Development Competences** expressive of their **Creative Knowledge, Inventive Skill, Resolute Attitude** and **Innovative Pursuits** in their chosen fields.
- Research Granduands are **Seasoned** to the demanding Research Environment and explicitly **Spirited** enough to the occasion in their scientific/technological quests with exemplary qualities of productive contribution to **society, nation** and **world** in the arena of Science and Technology.
- Research Graduands are ready to espouse **Leadership Responsibilities** in their chosen fields of Science and Technology with **demonstrated perfection** and **benchmark contribution.**
- Research Graduants **Collate** information from a variety of sources and **Enrich** a coherent understanding of the subject concerned pertaining to **Novel** investigation on the problems in everyday life.

PROGRAMME SPECIFIC OUTCOMES

After completion of this programme the candidate will be able to

1. Apply the theory, methodologies and knowledge of microbiology to find solutions to molecular level mechanism in microorganisms.
2. Pursue research in interdisciplinary and multi faceted projects.
3. Understand the value of ethics in their discipline and its application in academics.
4. Demonstrate scientific quantitative skills, such as the ability to evaluate experimental design, read graphs, and understand and use information from scientific papers. Demonstrate skill in communication of scientific data in standard format.
5. Understanding of applications of microorganisms in the industry, health-care, environmental protection, food agriculture and research.
6. Understand the current trends in microbiology and critically appraising published work.
7. Have a positive interaction with people from various fields and can excel as a team leader/mentor in various projects.
8. Handle teaching sessions for graduate /undergraduate students and can access a performance of a student in a classroom.

Course 1: RESEARCH METHODOLOGY

Course Code: 18MICRM **Credits: 4**

Objectives

- To gain qualitative research and knowledge about microscope
- To explore basic concepts of instrumentations and their analysis
- Detailed study about Molecular biology techniques and bioinformatics

Syllabus

Unit I: Microscopy

Bright field, Dark field, Phase contrast, Fluorescent and Polarization microscopes - Electron microscopy – TEM & SEM – principle, structure and applications – specimen preparation for electron microscope. Ultra-thin sectioning of specimens using microtomes - Confocal microscope, Atomic force microscope (AFM).

Unit II: Analytical instrumentations

Atomic absorption spectrophotometer, NMR, Mass spectrometry, GC & MS, MALDI -TOF, Nano-LC, IR spectrum, X-ray crystallography. Measurement of radioactivity – GM counter & Scintillation counting methods. Application of Radioisotopes in biological sciences.

Unit III: Separation techniques

Centrifugation - preparative and analytical, ultra-centrifugation, density gradient centrifugation. GC & HPLC - Electrophoresis – Principle, types and applications – PAGE, SDS-PAGE, Agarose, Pulsed Field Gel Electrophoresis (PFGE), Two dimensional electrophoresis, DGGE, TGGE and T-RFLP.

Unit IV: rDNA techniques

Restriction mapping - RFLP, Cloning strategies. cDNA and genomic DNA library construction and screening of libraries. Southern, Northern, Western and Dot blotting & hybridization. Polymerase Chain Reaction – principles, types and applications, Single locus and multilocus DNA fingerprinting, PCR based DNA fingerprinting - RAPD, AFLP, STRR and LTRR analysis.

Unit V: Bioinformatics

Genbank sequence data bases – NCBI, EMBL and DDBJ – retrieving database entries. Sequence alignment and database searching – FASTA, BLAST - Phylogenetic analysis - Secondary and 3D structure prediction using DNA and protein sequences. Research Design and thesis writings- Lab design and man management- Interpretation and writing of research report-technique-significance-steps in report writing- layout of research report-types of reports-precautions-writing review articles-role of computer in research.

Unit- VI: Current Contours: (For Continuous Internal Assessment only)
Course during the semester concerned to be kept through handling the instrument. To be sourced from world over through multiple reliable informative sources- Workshop, YouTube, Internet and Webinars and so on.

References

1. Cynthia G and Per J. (2001). Developing Bioinformatics Computer Skills: Shroff Publishers & Distributors Pvt. Ltd (O'Reilly), Mumbai.
2. Higgins D and Willie T. (2000). Bioinformatics: Sequence, structure and databanks. Oxford University Press.
3. John GW. (2004). Bioinstrumentation .Student edition, John Wiley &sons, Ltd.
4. Keith W and John W. (2003). Practical Biochemistry Principles & techniques. 5 th
   edition, Cambridge University press.
5. Grumani N. (2006). Research methodology for biological sciences.1st Edition, MJP Publishers, A unit of Tamilnadu Book House.
6. Jogdand SN. (2004). Gene Biotechnology, Himalaya Publishing House, Mumbai.
7. Palanivelu P. (2001). Analytical biochemistry and separation Techniques - A Laboratory
   manual. 2 nd edition, Tulsi Book Centre, Madurai, Tamilnadu.
8. Karp G. (1999). Cell and Molecular Biology – Concepts and experiments. 2nd edn.
9. Kothari CR. (1990). Research methodology – Methods and Techniques, 2 nd Edition Wishwa prakasam, New Delhi.
10. Stavros K. (2005). More practical problem solving in HPLC, Wiley-VCH, Verlag. http://www.modares.ac.ir/uploads/Agr.Oth.Lib.17.pdf
11. https://edisciplinas.usp.br/pluginfile.php/2317618/mod_resource/content/1/BLOCO%20
    2_Research%20Methods%20The%20Basics.pdf.
12. Roig M. (2006). Avoiding plagiarism, self- plagiarism, and other questionable writing practices: A guide to ethical writing.

Course outcomes

Upon completion the students will be able:

- ✓ To understand basic microscope to modern microscope (TEM, SEM)
- ✓ To analyze the fundamentals of Analytical instruments
- ✓ To gain knowledge on the basics of Gas Chromatography– Mass Spectrometry and
- ✓ different liquid chromatographic techniques
- ✓ To analyze the fundamentals of PAGE, SDS-PAGE, Agarose, Pulsed Field Gel
- ✓ Electrophoresis
- ✓ To understand the molecular techniques (DNA fingerprinting - RAPD, AFLP, STRR)
- ✓ To gain knowledge on fundamental bioinformatics tools
- ✓ To use the techniques for the betterment of society
- ✓ To execute scientific method for every scientific cause

Course 2: MICROBIAL BIOENERGY AND ITS BIOTECHNOLOGICAL POTENTIALS

Course Code: 18MICR101 **Credits: 4**

Objectives

- To extract different biofuels like bioethanol, biobutanol, biodiesel etc.
- To synthesize biomedical relevant biopolymers.
- To bring the biological products in various neutraceutical and pharmaceutical applications

Syllabus

Unit I: Introduction and Scope

Introduction - Need for alternative fuel sources - History of biofuels - Global scenario of biofuel production - Microbial macromolecules as biofuel feedstocks - Bioalcohol - Biodiesel - Biohydrogen - Biomethane - Biokerosine - Biochar, Bio-oil, Syngas - Microbial fuel cells.

Unit II: Microbial Biofuels

Introduction – Importance - Merit and demerits - Possibilities and opportunities. Microbial feedstocks for biofuels - Microalgae - Cyanobacteria – Diatom - Bacteria - Fungi. Biomass production -Raceway ponds -Photobioreactors (thin film & tubular) - Fermenter. Bioconversion of feedstocks - Saccharification - ABE fermentation - Transesterfication - Pyrolysis - Fischer- Tropsch process. Microbial biorefinery.

Unit III: Bacterial Quorum sensing

Bacterial cell - cell communication system - Quorum sensing and its inhibition - types of auto inducers - QS inhibitor compounds and its role in expression of virulence genes among bacterial pathogens. Biofouling - Biofilms.

Unit IV: Cyanobacteria in human welfare

Cyanobacteria in human welfare: Production of fine chemicals, polysaccharides, bioactive molecules, pigments, lipids and polyunsaturated fatty acids, Biofertilizers and hydrogen.

Unit V: Instrumentation for screening Bioactive compounds

Morphological identification - Light microscope, Confocal laser scanning microscope and SEM. Screening of bioactive compounds from cyanobacteria - UV spectrophotometer - column chromatography - Thin layer chromatography - LCMS CJCMS - NMR Spectroscopy - FTIR.

Unit VI: Current Contours (For Continuous Internal Assessment only**)**

Review preparation related to the subject in end of the semester – Explanation of any one of the analytical instruments and its applications to other fellow students - Healthy group discussion related to subject.

References

1. Alexander NG and Hiroshi N (2007). Microbial Biotechnology Fundamentals of Applied Microbiology 2nd Edition, University of California, Berkeley.
2. Alexander NG and Hiroshi N (2008). Microbial Biotechnology: Fundamentals of Applied Microbiology, 2nd Edition by .Cambrideg University Press texbooks.
3. Deepak Y, Khare PK, Gupta RK, Paliwal GS (2013). Microbial Biotechnology and Ecology. Daya Publishing House.
4. https://www.elsevier.com/books/biotechnology-of-microbial.../978-0-12-803725-6
5. Nuzhat Ahmed, Fouad M. Qureshi, Obaid and Y. Khan. (2001) Industrial and Environmental Biotechnology, Publisher: Horizon Scientific Press Editors: England Horizon scientific press
6. Patra JK, Vishnuprasad, Chethala N, and Das G (2018). Microbial Biotehnology:Volume 1:Appication in Agriculture and Environmetal –Jayanta Kumar. Microbial Biotechnology: Energy and Environment By Rajesh Arora
7. Peter J (1995) World Journal of Microbiology and Biotechnology, Publisher: Microbiological Resources Centres (MIRCEN); UNESCO; International Union of Microbiological Societies (IUMS), Springer Verlag.
8. V K Mutha. (2010). Handbook of Bioenergy and biofuels. SBS Publishers
9. Vijai G and Susana RC (2017). New and Future Developments in Microbial Biotechnology and Bioengineering by Elsevier

Course Outcomes

After completion of the course would be able:

- ✓ To understand the methodology of production of different biological products.
- ✓ To study the downstream processing of different microbial products.
- ✓ To analyze the intracellular mechanism involved in the production of microbiological products.
- ✓ To explore the various fermentation reactions involved in varying microbes.
- ✓ To scrutinize the biomedical applications of biopolymers.
- ✓ To create awareness about the biological products applicable in various fields.
- ✓ To know the beneficial microbes available in the nature for human needs.

Course 2: MICROBIAL BIOENERGY AND NANOBIOTECHNOLOGY

Course Code: 18MICRI02 **Credits: 4**

Objectives

- To understand the scope and applications of Microbial biofuel and Nanobiotechnology.
- To explore the technical, economic and environmental optimization of the supply, processing and conversion into energy of solid biofuels
- To study the principles, limitations, challenges, improvements and applications of microbial nanotechnology.

Syllabus

Unit I: Introduction and Scope

Introduction - Need for alternative fuel sources - History of biofuels - Global scenario of biofuel production - Microbial macromolecules as biofuel feedstocks - Bioalcohol - Biodiesel Biohydrogen - Biomethane - Biokerosine - Biochar (Bio - oil, syngas) - Microbial fuel cells.

Unit II: Microbial Biofuels

Introduction - Importance - Merit and demerits - Possibilities and opportunities. Microbial feedstocks for biofuels - Microalgae Cyanobacteria - Diatom - Bacteria - Fungi. Biomass production - Raceway ponds - Photobioreactors (thin film & tubular) - Fermenters. Bioconversion of feedstocks - Saccharification - ABE fermentation - Transesterification - Pyrolysis - Fischer-Tropsch process. Microbial biorefinery.

Unit III: Metabolic engineering for biofuel production

Acet'Orbir CarEiolaSe (ACCase) - Butanol dehydrogenase *(AdhE2)* - Function and role in biofuel synthesis pathways. Metabolic engineering of microalgae for biofuel production - pBUT1 and pBUT2 plasmids for targeted gene expression. Insilico approaches - KEGG.

Unit IV: Nanobiotechnology and Nanofarming

Nanoparticles - Terminology - dosimetry importance and scope. Synthesis of nanomaterials - metallic and non -metallic - Chemical - Physical - Biological - Microalgae - Cyanobacteria - Bacteria- Fungi - Plant. Comparative nanomics - Nanofarming.

Unit V: Properties and application of Nanomaterials

Nanomaterials - Properties - Physical - Chemical - biological. Material Characterization, Application -.detection - diagnosis - treatment - catalysis - Bioimaging of Anti biofilm. Encapsulation and targeted delivery and catalysis - degradation - biofuel production.

Unit VI: Current Contours (For Continuous Internal Assessment only)

Quiz program related to the course during the middle of the semester. Group discussion on latest research, related to course for each unit. Oral presentation on above topic.

References

1. Christof M and Chad AM. (2004). Nanobiotechnology: Concepts, Applications and Perspectives. Wiley-VCH Verlag GmbH & Co. KGaA.
2. Hilary MLS (1995). Microbial Biofilms by Cambridge University Press
3. http://www.worldcat.org/title/microbial-biotechnology-energy-and-environment/oclc/818759659
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5359226/
5. Long R, Sanderson P and Rahman PKSM. (2006). the handbook of Microbial Bioresource.
6. Microbial Production of Nanoparticles by Nadiafarhana, Scribd Inc
7. Murali SA, Ahmad M, Islam K and Rajiv K. (2005). Microbial Nanoparticle Production. Wiley Publications.
8. Qiang L, Joshu C, Christiane H and Ao Xia. (2018). Bioreactors for Microbial Biomass and Energy Conversion (Green Energy and Technology)
9. Rai M and Posten C. (2013). Green Biosynthesis of Nanoparticles Mechanisms and Applications. Karlsruhe Institute of Technology.
10. Schlegel HG and Barnea J. (1977). Microbial energy conversion. Elsevier Ltd.
11. Soni SK. (2007). A Source of Energy for 21st Century Microbes. New India Publishing.

Course Outcomes

After completion of the course would be able:

- ✓ To understand and implement the benefits of Microbial biofuel and Nanobiotechnology.
- ✓ To know the merits, demerits, opportunities in the production of microbial biomass.
- ✓ To explore brief knowledge on biofuel production, extraction methods and genetically engineer the organisms for better production.
- ✓ To compare the properties, synthesis and applications of nanomaterials from algae, bacteria, fungi and plant.
- ✓ To perform different production methods (raceway pond, bioreactors, etc) of biomass and convert them into useful products such as biofuel.
- ✓ To synthesis nano materials and perform their applications in different field.
- ✓ To increase the production of biofuel by genetically engineering the targeted strains.
- ✓ To spread the basic knowledge of alternative biofuel in the society.

Course 2: ALGAL PIGMENTS AND ITS APPLICATIONS

Course Code: 18MICRI03 **Credits: 4**

Objectives

- To impart brief knowledge on classification, role and properties of algal pigments such as chlorophyll and carotenoids and to study the extraction procedures.
- To provide idea on exploitation of algal pigments in strain level.
- To expose the students to the applications of algal pigments and the patent processes.

Syllabus

Unit I:

Photosynthetic and accessory pigments: Chlorophyll, carotenoids and phycobilins- Distribution in thylakoid membranes -Role of pigments in algal metabolism- Properties: Physical and chemical- Classification of algae based on pigments and reserve food material: blue green algae, green algae, red algae, brown algae, golden algae

Unit II:

Carotenoids- General introduction- Types: Carotenes and Xanthophylls- major sources- plants, algae, fungi and actinomycetes - Carotenoid biosynthetic pathway- Carotenogenesis Secondary carotenoids- Factors influencing carotenogenesis- light, temperature, metal ions and salts, chemical induced carotenogenesis.

Unit III:

Various extraction methods: Physical methods- mechanical, osmotic pressure and sonication and Chemical methods: solvent, enzymatic and supercritical CO2 extraction- Separation of carotenoids- TLC, Column chromatography, HPLC structural characterization- FTIR, GC-MS, NMR

Unit IV:

Exploitation of algae for carotenoids: Dunaliella salina for B- carotene, *Haematococcus pluvials. Monoraphidium* sp for astaxanthin for commercial purpose. Down streaming process in carotenoid production. Advantages and disadvantages in commercialization of microalgal carotenoids. International and national scenario on microalgal carotenoid production

Unit V:

Application of carotenoids in various fields- Pharmaceuticals and Nutraceuticals- source of antioxidants, anticancer, anti-aging agents- aquaculture feeds- food colorant- intellectual property rights and steps in patenting a new product.

Unit VI: Current contours (For Continuous Internal Assessment only**)**

Extraction of phycoerythrin and phycocyanin pigments as pink and blue colouring agents in cakes, Carotene from algae as kesari powder (yellow), displaying biocolorants, toxicity testing of pigments.

References

1. Cambridge University Press.
2. Feng C, Algae and their biotechnological potential. Kluwer Academic Publishers
3. Hoek C, Mann DG and Jahns HM. (1995). Algae: an introductory,
4. http://assets.cambridge.org/97811070/00667/frontmatter/9781107000667_frontmatter.pdf
5. http://www.algaecompetition.com/PDF.cfm/GreenSolarGardens.pdf
6. Jeffrey SW. (1980).Primary productivity in the Sea, Springer US
7. Khattar S, Singh DP and Gurpreet KK. (2009). Algal Biology and Biotechnology International Pub.
8. RM Johri, Sneh L and Sandhya S. (2004). A Textbook of Algae, Dominant Pub
9. Rowan KS. (1989). Photosynthetic pigment of algae, Cambridge University Press.

Course Outcomes

Upon successful completion of this course the students would be able:

- ✓ To know the characteristics, properties and functional diversity of algal pigmentation and define the relationship based on them.
- ✓ To understand the different applications of pigments in various fields and their future prospectus.
- ✓ To understand the advantages and disadvantages on commercialization of algal pigments.
- ✓ To explore the patent and property rights.
- ✓ To perform different extraction procedures of algal pigments.
- ✓ To commercialize the products based on algal pigments in the strain level.
- ✓ To create awareness and to pass the information about the role of eco-friendly extraction of bio pigments from algae in the public.
- ✓ To assess the risks of production of bio pigments commercially.

Course 2: ALGOLOGY

Course Code: 18MICRI04 **Credits: 4**

Objectives

- To learn the identification, classification, cultural condition and ecology of major groups of algae.
- To study the useful and harmful economical importance of algae.
- To explore the algal sampling and culturing techniques.

Syllabus

Unit I: Introduction to Algae

Definition- Distribution of algae- Classification of Algae: Important features - Ultrastructure of prokaryotic and eukaryotic algal cells. Thallus organization among algae: Unicellular, colonial, filamentous, siphonous and parenchymatous thallus organizations with examples- pigment and food reserve material

Unit II: Vegetative reproduction in algae

Binary cell division, autocolony formation, fragmentation, Hormogones, hormocysts, planococcus, propagules, bulbils and adventitious branches. Asexual reproduction in algae: zoospores, aplanospores, hypnospsores, autospores, monospores, tetraspores, endospores and exospores. Sexual reproduction and life cycles in algae: Isogamous, anisogamous and oogamous sexual reproduction. Monophasic, biphasic and triphasic life histories. Life cycles in algae: Zygotic, gametic, sporic (biphasic). Sporic (triphasic) and somatic life cycles.

Unit III: Collection and preservation of algal samples

Isolation, purification and maintenance of cultures. Mass culturing methods: open and closed culture system- Various cell harvesting strategies: centrifugation- sedimentation- flocculation- floatation- filtration methods.

Unit IV: Economic importance of Algae

Food and feed- Pharmaceuticals and nutraceuticals- Phytohormone production: Auxins- Cytokinins – Gibberellins- Biofertilizers- Biofuel production : biodiesel- biohydrogen – bioethanol- biobutanol

Unit V: Environmental effects of algae

CO_2 mitigation and sequestration- hydrocarbon degradation- heavy metal biosorption - Harmful algal blooms- phycotoxins- toxic effect to aquatic organisms and its application in biomedical field.

Unit VI: Current Contours (For continuous internal assessment only)

Field trips to the coastal area to understand the sea farming of algae used to produce agar, conduct workshops to create awareness of industrial relevance of algae cultivation, hands on experience in the algal cultivation.

References

1. Hoek CVD, Mann DG and Hans MJ. (1995). Algae: An Introduction to Phycology, Cambridge University Press
2. http://herbarium.millersville.edu/class-web/botany2010/lab10-algae.pdf
3. http://www.jlakes.org/config/hpkx/news_category/2015-06-03/Phycology-CUP-2008.pdf
4. Josephine E. Tilden (1935),The algae and their life relations, University Of Minnesota Press
5. Krishnamurthy. V, Algal Biomass
6. Olivares, J.A. Algal Research: Biomass, Biofuels and Bio products, Elseiver.
7. Richmond A and Qiang Hu. (2003). Handbook of Microalgal Culture: Applied Phycology and Biotechnology, John Wiley & Sons Ltd.
8. Robert EL. (2008). Phycology, Cambridge University Press.
9. Solomon P. Wasser, International Journal on Algae, Begell House.
10. Vashistha BR, Singh VP and Sinha AK. (2011). Botany for Degree Students – ALGAE, S Chand & company-New Delhi.

Course Outcomes

Upon the completion of this course, the student would be able:

- ✓ To gain knowledge about the diversity of algae that are available and the benefits that can be obtained from their biomass.
- ✓ To gain the knowledge about the main applications and production methods for the different algae.
- ✓ To understand the useful and deterious effects of algae.
- ✓ To collect and preserve different algal samples.
- ✓ To differentiate different types of algae by means of their morphology, reproduction, metabolic characters.
- ✓ To utilize algae for economic development due to their beneficial activities.
- ✓ To assess the safe and risky impacts of algae in the environment
- ✓ To share the information about utilizing algae for bio remediation

Course 2: ENDOPHYTES

Course Code : 18MICR105 **Credits : 4**

Objectives

- To promote knowledge about microbial interactions and its types
- Learn about the mechanism of
- Study about metabolite production of plants

Syllabus

Unit I:

General introduction to microbes- Types of microbes- Prokaryotic and Eukaryotic microbes- Basic account of Bacteria, Cyanobacteria and Fungi.

Unit II:

Plant- Microbe interaction- Types of interactions (Commensalism, Neutralism, Proto cooperation, Co-operation, Mutualism, Symbiosis, Parasitism and Predation)- Evolution of plant microbe interactions- Chemical aspects of such interaction.

Unit III:

Endophytes- types of endophytes (Commensals, Symbionts, Parasites)- categories of endophytes (Bacteria, Cyanobacteria and Fungi)- Taxonomic aspects- Genomics and identification

Unit IV:

Colonization strategies of endophytes- Endophytes associated with plants- Leaf, root and stem endophytes- Localization of endophytes using specific staining methods- Distribution of endophytes within plants

Unit V:

Endophytes and their role in secondary metabolite production by plants- Methods and screening of endophytes- produced secondary metabolites- Role of endophytes in the production of taxol and related camptothecin- *In vitro* production of secondary metabolites in bioreactors.

Unit VI: Current contours (For continuous internal assessment only)

Collection of various microbial endophytes for culturing and storage. Seminars on the role of abiotic stress management of the endophytic groups. Study of Bioremediation capacity of endophytes using research articles.

References

1. Barbara S, Christine B. (2006). What are Endophytes? Soil Biology, Volume 9 Microbial Root Endophytes, B. Schulz, C. Boyle TN. Sieber (Eds.) Springer-Verlag Berlin Heidelberg.
2. Kalyanaraman R. Meenambiga SS. Arulmathi R. Current Research in Microbiology, Chapter 4:http://openaccessebooks.com/current-research-in-microbiology/endophytic-fungi-a-versatile-organism-for-modern-microbiological-research-and-industrial-applications.pdf

3. Kalyanaraman R. Meenambiga SS. Arulmathi R. Endophytic Fungi A Versatile Organism for Modern Microbiological Research and Industrial Applications.
4. Microbiology- https://www.cliffsnotes.com/study-guides/biology/microbiology
5. Prokaryotic and Eukaryotic cell: http://nptel .ac.in/courses /102103045/ download /mod2.pd f
6. Sanjana K, Tanwi S, and Manoj KD. (2016). "Omics" Tools for Better Understanding the Plant–Endophyte Interactions. Front Plant Sci. 7: 955.

Course Outcomes

Upon successful completion of this course the students would be able

- ✓ Will learn the microbial diversity and their life cycle and microbial isolation identification and classification.
- ✓ Helps in the detailed study about Prokaryotic and Eukaryotic microbes and classification.
- ✓ Knowledge about Plant-bacteria associations.
- ✓ Brief study about microbe interactions, role and their function
- ✓ Gain knowledge on *Colonization strategy* of the *endophytic* plant growth-promoting strains of and methods
- ✓ Able to understand Endophytes and their role in secondary metabolite production and their role.
- ✓ Study plants are infested with microbes Symptomless and plant disease.
- ✓ Gain brief knowledge about In vitro production of secondary metabolites in bioreactors.

Course 2: PHYTOCHEMICAL BIOTRANSFORMATIONS

Course Code: 18MICR106 **Credits: 4**

Objectives

- To extract the useful biopolymers present in the plants.
- To substitute the Phytochemicals instead of synthetics to an extent.
- To study the reaction pathways in the plants that can deliver the beneficial products.

Syllabus

Unit I:

Structure and functions of prokaryotic and eukaryotic cells and their organelles– Enzymes - Enzyme action - Biocatalysis - Mechanism of enzyme action - Enzyme Kinetics.

Unit II:

Basic biochemical reactions in plants – Basics of photosynthetic pathways (C3, C4 and CAM) - Synthesis of various carbohydrates and carbohydrate containing molecules– Role of photosynthetic pathway intermediates

Unit III:

Basics of respiration, nitrogen assimilation and protein synthesis, Lipid metabolism -An elementary GC count on the various. Types of secondary metabolites - Basic chemical cycles involved in secondary metabolism (Shikimic acid pathway, Meralonic acid pathway and Glycolate pathway).

Unit IV:

Basics of metabolic engineering - Hydrolysis and esterification reactions - Biocatalysis in non-conventional media - Oxidation reduction reactions - Carbon - Carbon bond forming reactions - selected case studies -Importance of bioinformatics and systems biology.

Unit V:

Basics of Biotransformation - Biotransformation of various secondary metabolites (Terpenoids, Alkaloids, Phenols, Flavanoids, Steroids, Lipoidal materials) - Role of endophytes in biotransformation - production of transgenic microbes for effecting biotransformation.

Unit VI: Current Contours (For continuous internal assessment only)

During the course of semester concerned awareness on antibiotic resistance program, to be sourced from world over through multiple reliable informative sources- Internet, Interaction, Social Media and so on.

References

1. Fanali S. (2017). *Liquid Chromatography: Fundamentals and Instrumentation*
2. Hostettmann K, Chen S, Marston A, and Stuppner H. (2014). *Encyclopedia of Analytical Chemistry.*

3. http://www.grsmu.by/files/file/university/cafedry/microbiologii-virysologii immynologii/files/essential_microbiology.pdf
4. John TA, Rachel M, John TR. (2013). Phytochemistry of Medicinal Plants.
5. Khadabadi SS, Baviskar BA and Deore SL. (2014). Pharmacognosy and Phytochemistry: A Comprehensive Approach (Pharmacognosy).
6. Merillon JM, Ramawat KG and Kishan GR. (2012). *Plant Defense: Biological Control.*
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Course Outcomes

Upon successful completion of this course the students will be able:

- ✓ To analyze about the benefits of internal biological reactions and products.
- ✓ To understand the enzymes and the biochemical pathways involved for biotransformation.
- ✓ To gain knowledge about exogenous compounds and its relevance.
- ✓ To analyze the biotransformation via plant tissue culturing.
- ✓ To understand the biochemical reactions occurring to leave the beneficial products.
- ✓ To classify about the benefits of biological Neutraceuticals.
- ✓ To reduce the usage of synthetics majorly in foods and drugs.

Course 2: MICROALGAL BIOFUELS

Course Code: 18MICR107 **Credits: 4**

Objectives

- To gain knowledge about microalgae and their life cycle
- To explore microalgae for biofuel through metabolic engineering and other strategies.
- Study structure, classification, properties and biological functions of microalgae feedstock

Syllabus

Unit I: Introduction and Scope

Introduction- need for alternative fuel source - History of Biofuels - Global Scenario of biofuel production- Microbial Macromolecules as Biofuel feedstock- Bioalcohol - Biodiesel- Biohydrogen - Biomethane - Biokerosine- Biochar (Bio-oil, Syngas) - Microbial fuel cells. Process design and Economics for the conversion of algal biomass to biofuels.Economic importance.

Unit II: Lipids

Structure, Classification, Properties and biological functions of saturated and unsaturated fatty acids.Structure and biological functions of Phospholipds, Sphingolipids, Glycolipids. Structure, classification and biological functions of amino acids - Classification, structure, peptide bond, properties and biological functions of proteins

Unit III: Metabolic engineering for Biofuel production

Acetyl CoA Carboxylase (ACCase) - Butanol dehydrogenase (AdhE2) - Function and role in biofuel synthesis pathways. Metabolic engineering of microalgae for biofuel production- PBUT1P and PBUT2 plasmids for targeted gene expression. Insilico approaches - KEGG.

Unit IV: Microalgal Biofuel

Introduction - Importance - Merits and demerits - Possibilities and opportunities. Microbial feedstocks for biofuels – Microalgae - Cyanobacterial - Diatom - Bacterial - Fungal. Bioconversion of feedstock - saccharification - ABE - Fermentation - Transesterification - Pyrolysis - Fischer - Tropsch process. Microbial biorefinery

Unit V: Methods of microalgae cultivation

Introduction - Methods of algae cultivation technology - Cost effective procedure- Biomass production - Raceway pond - Photo bioreactors (thin & tubular) - fermenter. Economic - advantage of cultivation - Merits and demerits of open cultivation system

Unit VI: Current Contours: (For Continuous Internal Assessment only)

Evaluate algal samples obtained from different sources and field trip - study of algal sample collection awareness of people about algae - Mobile laboratory - Development of germplasm maintenance techniques - Algal Raceway pond: Mass cultivation and maintenance. Hands on training in raceway pond harvesting- Seed culture preparation - to visit different places of small and large scale microalgae cultivation.

References

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10. Yadala S and Selen Cremaschi (2016). A dynamic optimization model for designing open channel Raceway ponds for batch production of algae biomass.
11. Zhang, Rodriguez S, and Keasling JD. (2011). Metabolic engineering of microbial pathways. Curr Opin Biotechnol. 2011 Dec;22(6):775-83

Course outcomes

Upon completion of the course the students will be able

- ✓ To understand history of biofuels and global scenario of biofuel production and their application
- ✓ To gain the economic value and importance of microalgae as feedstock
- ✓ To get a brief idea about functions of saturated and unsaturated fatty acids. Structure and functions of other biological function
- ✓ To explore the biological functions of amino acids- Classification, structure, peptide bond, properties and biological functions of proteins
- ✓ To evaluate the gene expression and conversion of microalgae feed stock
- ✓ To gain importance of biofuel production
- ✓ To attain idea about mass cultivation of microalgae indoor and outdoor cultivation
- ✓ To understand the economic advantage cultivation of microalgae in Raceway pond and Merits and demerits of open cultivation system

Course 2: MOLECULAR IMMUNOLOGY

Course Code: 18MICRII01 **Credits: 4**

Objectives

- A main focus concerns the understanding of immune system
- Discrimination and the importance of immunotechnique
- Comparing the models of immunological tolerance and highlighting the knowledge about current immunological developments

Syllabus

Unit I: Immune System

Organs1 and 8 cells involved in immune system and immune response. Lymphocytes, their subpopulation, their properties and functions, membrane bound receptors of lymph cells, helper T cells, T cells suppression, lymphocyte trafficking.

Unit II: Antigens and Immunoglobulins

Concept of haptens, determinants, conditions of antigenicity antigens and immunogenecity, Superantigen. Immunoglobulins: Structure and properties of immunoglobulin classes. Theories of Antibody formation, hybridoma technology for monoclonal antibodies and designer monoclonal antibodies. Multiple mylomas and structural basis of antibody diversity. Freund's adjuvants and its significance.

Unit III: Antigen- Antibody reaction

Antigen-Antibody reactionby precipitation, agglutination and complement fixation.
Non-specific immune mechanism-: Surface defences, tissue defenses, opsonisation, inflammatory reaction and hormone balance. Tissue metabolites with bactericidal properties (lysozyme, nuclein, histone protamine, basic peptides of tissues leukins, phagocytins, lecterins, haemocompounds)

Unit IV: Expressions and Regulation of Immune Response

Regulation of immune response: antigen processing and presentation, generation of humoral and cell mediated immune response, activation of B and T lymphocytes, cytokines and their role in Immune regulation, T cell regulation, MHC restriction,immunological tolerance. Cell mediated cytotoxicity: Mechanism of T cells and NK mediated lysis, antibody dependent cell mediated cytotoxicity, and macrophage mediated cytotoxicity. Complement system: Classical, alternate, lectin pathway of complement activation. Regulation of complement activation.

Unit V: Immunity and Immunoassays

Defense against bacteria, viruses, fungi and parasites. Immunodiagnostics and Immunotherapy in virology- Serological methods for detection and quantitation of viruses including Hepatitis, Influenza, HIV and others .Immuno-assays: SRID, ELISA, ELISA-PCR,

RIA, Western Blotting, lmmunofluroscens and their application. Immunedeficiencies and autoimmunity.

Unit VI: Current Contours (For Continuous Internal Assessment only):
Review and debate on latest discovery on immunology. Seminor on foreign body reaction to biomaterials. Quiz: Autoimmune diseases, Tumor immunology, immunological biosensors. Review on prospects and future of immunosensors.

References

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3. Charles A. Janeway, Paul Travers, Mark Walport and Mark J. schlomchick (2005). Immunobiology 6th edition. Garland Science Publishing.
4. Donal M. Weir and John Steward (1993). Immunology 7th edition. ELBS, London
5. http://mbbshelp.com/2017/03/31/lange-review-of-medical-microbiology-immunology-13th-edition/
6. http://www.immunology.utoronto.ca/online-learning
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12. Richard M. Hyde (1995). Immunology 3rd edition. National Medical series, Williams and Wilkins, Harward Publishing Company.
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Course Outcomes

After the completion of the course students will able to,

- ✓ Understanding of cells and organs of immune system
- ✓ The significance of cellular coordination in the generation of immune responses is explained
- ✓ Analysis how the immune system differentiate self and non self-immune mechanism
- ✓ Apply Mechanism of tissue in eliminating bacteria
- ✓ Understand immune class regulation and immune response
- ✓ Importance of immunotechniques were demonstrated
- ✓ Understanding of defense mechanism against various pathogens and immuno-assays.
- ✓ Execute the current development in immunosensors

Course 2: BIOLOGICAL MACROMOLECULES

Course Code: 18MICRII02 **Credits: 4**

Objectives

- To improve knowledge about organic molecules
- To enhance the skill to perform bio-molecular analysis
- To describe Biogenesis of macromolecules

Syllabus

Unit I: Carbohydrates

Classification.Structure and biological functions - mono, di, oligo, and polysaccharides. Glycoconjugates structural features of proteoglycans, bacterial cell wall peptidoglycans, teichoic acid, lipopolysaccharide. Biosynthesis- Gluconeogenesis

Unit II: Lipids

Classification and structure of fatty acids. Classification of lipids. Chemistry and biological function of fats, phospholipids. Lipoproteins. Salient features of bacterial lipids. Biosynthesis of Fatty acids, triglycerides, membrane phospholipids & lipopolysaccharides

Unit III: Amino acids and Peptides

Classification, Nomenclature and structure of standard amino acids.Structures and occurrence of nonstandard and non protein amino acids. Glutathione, enkephalins and endorphins. Chemical synthesis of peptides - Khorana's solution phase synthesis. Merrifield's solid phase synthesis.

Unit IV: Proteins

Classification and biological functions. Forces stabilizing protein structure. Primary, Secondary and tertiary structure, structure determination- Ramachandran plot. Purification of protein. Denaturation Melting temperature, effect of salts, chaotropic agents. Chaperons, thermodynamics of protein folding. Prediction of protein structures- Chou and Fashman scheme

Unit V: Nucleic acids

Structure & types of DNA & RNA - their topology and functions.Chromosome organization in microbes.Artificial nucleic acid - PNA.Structure of IRNA, rRNA and mRNA. Biosynthesis- Nucleotides, purines and pyrimidines

Unit VI: Current contours (For Continuous Internal Assessment only)

Discussion: How a Cell Knows When to Divide – Research applications of biochemical experiments – Diagnostic applications of biochemical analysis - Fluid dynamics. Artificial Cellular Compartments. Quiz: Macromolecules in cells. Debate: Current topics in biochemistry. Seminar: Protein secondary structure prediction –Journal: International Journal of Biological Macromolecules - Elsevier, Current Biochemistry.

References

1. Boyer R (2001) Modern Experimental Biochemistry, 3rd edition: Benjamin Cummings Publishing Company Inc.
2. Campbell MK (1999). Biochemisty, 3rd edition, Saunders college publishing/ Harcourt Brace College publishers. Freeman and Co.
3. Freidberg EC, Warker GC and Siede W (1995). DNA Repair and Mutagenesis, ASM Press.
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   New Delhi.
9. Plummer DT (1987) An introduction to Practical Biochemistry, 3 rd edition, Tata
10. Plummer DT (1987) An introduction to Practical Biochemistry, 3 rd edition, Tata

Course outcomes

By completing this course, Students will have the following skills

- ✓ Understand the chemical building blocks of life
- ✓ Apply the enzyme kinetics to research
- ✓ Understand the fundamental biochemical principles
- ✓ Understand the macromolecular structure prediction
- ✓ Analyze the biochemical strategies
- ✓ Execute the structure of all macromolecules
- ✓ Apply the molecule based theoretical information into research
- ✓ Analyze the biochemical reactions

Course 2: GENE TECHNOLOGY AND ANIMAL CELL CULTURE

Course Code: 18MICRII03 **Credits: 4**

Objectives

- To improve knowledge about gene technology
- To enhance the skill to the cloning
- To describe animal cell culture technique

Syllabus

Unit I: Microbial cloning systems

Host - Escherichia, Bacillus, yeast. Vectors - plasmids, cosmids, phagmid, expression vector, shuttle vector and artificial chromosomes. Enzymes - Types and Mechanisms of action endonucleases, exonucleases, ligases, methylase, alkayline phosphatase, kinases.

Unit II: Cloning and Analysis of recombinant DNA

Cloning strategies - pro and eukaryotic, Identification of clones - Specialized cloning systems, Expression systems, Fusion proteins, and Genome library construction - cDNA library. Whole genome analysis – methods - physical and chemical, DNA sequencing - automated sequence; chromosome walking.

Unit III: PCR – principle, reagents, reaction conditions

Procedural variations – RT PCR, Inverse PCR, Nested PCR, Multiplex PCR, Expression cassette PCR, Real time PCR. Applications – gene cloning, DNA sequencing, genome mapping, mutagenesis, pathogen diagnostics, environmental monitoring.

Unit IV: Equipment and general practice

The cell culture laboratory, autoclaves and hot air ovens, tissue culture hoods, incubators, centrifuges, microscopes.

Cell culture media: Sources, functions of the main ingredients of culture media, serum free media, choice of media formulation – requirement – liquid media preparation - from powder. Continuous cell line: Types of established cell lines – preparation – assessment of cell cultures – cell counting – suspension culture – adherent culture – subculturing of cells – setting up growth curve scaling up production: roller bottles, spinner cultures, microcarrier beads.

Unit V: Contamination

Types of contamination – curing – antimicrobial agents – fumigation.

Cryopreservation: Cryopreservatives – freezing mixture – freezing down cells – thawing procedure. Cell fusion: Aims and requirements - fusion partners - fusion technique - hybrid screening - expanding and cloning of hybrid. Transfection: Principle - DNA source - Transfection of DNA in to eukaryotic cells - electroporation - identification and use of transfected cell – applications.

Unit VI: Current contours (For Continuous Internal Assessment only)
Discussion: Gene chip technology - Epigenetic modification - Regeneration medicine - biopolymer scaffolds**. Quiz:** Tissue Engineering. **Seminar:** Cellular Therapy and Transplantation. **Debate:** Merits and demerits of gene technology in environmental aspects. **Journal:** Gene Technology, the Journal of Tissue Science & Engineering

References

1. Animal Cell culture and Technology by Michael Butler, Second Edition, BIOS Scientific Publishers, London and New York.
2. http://www.bch.cuhk.edu.hk/pdp2009/Home.files/PDP%20booklet%20%20(Teacher)%20v9.pdf
3. https://alison.com/course/genes-and-gene-technology
4. https://mxdoc.com/animal-cell-culture-and-technology-by-butler.html
5. https://swayam.gov.in/course/3713-cell-culture-technologies
6. Old, RW. Primrose, SB. (1994) Principles of Gene Manipulation. Blackwell Scientific Publications.
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8. Techniques for engineering genes (BIOTOL - Biotechnology by open learning) (1993), Published on behalf of Open University and University of Greenwich, Butterworth Heinemann Ltd, Oxford

Course outcomes

After the completion of the course students will able to,

- ✓ Apply the experiments used to manipulate DNA
- ✓ Understand microbial cloning systems
- ✓ Understand the equipment's used in cell culture laboratory
- ✓ Execute techniques used in cell culture laboratory
- ✓ Analyze the recombinant DNA
- ✓ Apply the theoretical information into research
- ✓ Understand of the polymerase chain reaction
- ✓ Analyze the genetic strategies

Course 2: MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Course Code: 18MICRII04 **Credits: 4**

Objectives

- To demonstrate a clear understanding of the facts and basic concepts of molecular biology
- To help the students gain the required knowledge to pursue academic career or work as an expert molecular biology and genetic engineering
- To enable the students to gain the ability to conduct research in the field of molecular biology

Syllabus

Unit I: Introduction

DNA modifying enzymes and their uses in Molecular Biology a) Restriction enzymes b) DNA Polymerase i) Klenow ii) DNA polymerase I iii) T4/T7 DNA Polymerase c) Reverse Transcriptase d) Terminal Transferases e) T4 Polynucleotide kinases & Alkaline phosphatase f) DNA dependent RNA polymerases. g) DNA ligases h) Nucleases: - Bal 31, S1 nucleases, DNase I, Mungbean nucleases, Ribonucleases, EXO III. Thermostable DNA polymerases used in PCR.

Unit II: Vectors

Plasmid vectors for use in E. coli and Gram positive bacteria. Bacteriophage - Lambda and M13 vectors, Cosmids, Phagemids. Artificial chromosomes (YACs, BACs).Specialized vectors & their uses.Expression vectors for Prokaryotes & Eukaryotes - Inducible vectors; vectors with tags (Histidine tags, signalling peptides for exportation), b) Gene fusion vectors.

Unit III: Cloning Methodologies

Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression

Unit IV: Gene Regulation and Expression in Microbes

Lactose, Arabinose and Tryptophan operons, Repressors and activator, Gene expression based on bacteriophage T7 RNA polymerase. Expression of foreign genes –fusion proteins.

Unit V: Techniques in genetic engineering

Hybridization technique, Southern, Northern-Western blotting techniques, Site directed mutagenesis, Restriction mapping, DNA profiling in forensic science, Chromosome walking, Chromosome jumping, DNA sequencing, PCR. Screening of recombinants - Antibiotic

resistance, lacZ complementation (Blue-white selection), fluorescent markers (e.g. GFP).

Unit VI: Current contours (For Continuous Internal Assessment only)
Discussion- Stem cell research; **Quiz**- Tools used for gene manipulation; **Debate**- Artificial antibody production Vs Naturally producing antibodies; **Seminar**- Aging is reversible; **Journal**- Tissue science and Engineering.

References

1. Ansubel FM, Brent A, Kingston AE and Moore DO (1988). Current protocols in Molecular Biology, Greene Publishing Associates, NY.
2. Berger SL and Kimmer AR (1987). Methods in Enzymology, Vol 152, Academic Press.
3. Fernandez JM and Hoeffler JP (1999). Gene expression systems. Academic Press.
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5. http://www.fao.org/docrep/014/i1905e/i1905e00.pdf
6. https://freebooksforall.xyz/molecular-biology-of-the-cell-6th-edition-ebook-free-download/
7. Primrose SB, Twyman RM and Old RW (2001). Principles of gene manipulation Sixth edition. Blackwell Publishers.
8. Sambrook J, Fritsch, EF and T Maniatis (1989). Molecular Cloning, A Laboratory Manual. Cold Spring Harbor Laboratory Press, New York, Second edition
9. Sandhya Mitra (2005). Genetic Engineering. Macmillan India Limited.
10. Watson (1992).Recombinant DNA. American Publishers. Second edition.

Course outcomes
After the completion of course students will able to,

- ✓ Understand the tools used in molecular biology
- ✓ Analysis different type of vectors and their uses (Lambda, M13, cosmids, phagemids, YACs, BACs and inducible vectors)
- ✓ Understand what are the ways to introduce foreign molecules to the host
- ✓ Execute how to construct genomic and cDNA libraries
- ✓ Understand the methods used to identify gene expression
- ✓ Execute the regulation and expression of genes in microorganisms (Lactose, Arabinose and Tryptophan)
- ✓ Understand methods used in genetic engineering
- ✓ Insight into the current methods in molecular biology

Course 2: INFECTION BIOLOGY

Course Code: 18MICRII05 **Credits: 4**

Objectives

- To know the molecular mechanism of microbial infections and methods of diagnosis of various diseases.
- To study about the etiology, diagnosis, control measures of clinically important pathogens.
- To get hands on training in techniques involved in immunology, genetics and genetic engineering.

Syllabus

Unit I: General infection biology

Historical perspective-discovery of microscopes, Louis Pasteur's contributions, Robert Koch's postulates, early discoveries of microbial toxins, toxicassays, vaccines, antibiotics and birth of molecular genetics and modern molecular pathogenesis studies, various pathogen types and modes of entry. Different theories of evolution of virulence.

Unit II: Host defense against pathogen

Host defense against pathogens – Innate immunity, Acquired immunity-mechanism of killing by humoral and cellular defence mechanisms, complements, inflammation process, cytokines, lymphokines, interferons, general disease symptoms, Immunodeficiency, Pathogenic adaptations to overcome the host defenses.

Unit III: Host – pathogen interaction

Virulence and virulence factors, colonizing virulence factors, virulence factors damaging the host tissues, virulence genes and regulation of the virulence genes.Transfer and evolution of virulence factors. Molecular genetics and gene regulation in virulence of pathogens like Leptospira, Vibrio Cholerae, E.coli, Shigella and Salmonella.

Unit IV: Modulation of immune response

Basic principles for vaccination.Socio-economic aspects on vaccinaton. Vaccines- types – whole-organism vaccines,recombinant vaccines, DNA vaccines, synthetic peptide, and multivalent subunit and anti-idiotype vaccines.

Unit V: Diagnostics & Assays

The main types of microscopy use at analysis of infectious diseases. Criteria & tests in identifying virulence factors, Comparisons between pathogenic and non-pathogenic bacterial isolates, Demonstration of virulence properties, Classical approaches based on serotyping. Molecular characterization of virulence factors – RAPD, RFLP, MLST PCR, RT-PCR, immunofluoresence, ELISA, FACS and Western blotting.

Unit VI: Current contours (For Continuous Internal Assessment only)
Group discussion: ICH-GCP Guidelines, GCP, GMP, GLP, Helsinki Declaration, Schedule Y, ICMR, DCGI, **e-journal:** List of Symbols and Abbreviations in Clinical Terminologies. **Literature:** Risk Management, Safety Data Generation, Safety Data Monitoring.

References

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8. Janeway CA Jr and Travers PT (1994). Immunology. Blackwell J Scientific Publishers.
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10. Roitt I (1994). Essentials of Immunology, 8th edition, Blackwell Scientific Publishers.
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Course Outcomes

By completing this course, Students will have the following skills

- ✓ Analysis the diagnostic and preventive methods for immunological and immunodeficiency disorders
- ✓ Understanding the better immunogen as new vaccines for diseases
- ✓ Apply the effect of socio-economic determinants on vaccination rates with self-paid
- ✓ Analysis the presence and quantity of genetically modified organisms (GMOs) in the environment
- ✓ Analyses of an antibody concentration and antigen concentration
- ✓ Understanding the separation and identification of proteins
- ✓ Execute the qualitative detection of gene expression through creation of cDNA transcripts from RNA
- ✓ Analyses of mixed genome samples and determination of taxonomic identity.

Course 2: MICROBIAL PHYSIOLOGY

Course Code: 18MICRII06 **Credits: 4**

Objectives

- Understand gene regulation on the single gene level and as global regulation
- Comprehend central metabolic pathways, energy production and nutrient transport in bacteria
- Theoretical background and understanding of microbial physiology that is necessary to conduct microbiological laboratory research

Syllabus

Unit I: Major Biomolecules

Carbohydrates - Classification, chemistry, properties and function - mono, di, oligo and polysaccharides. Conjugated polysaccharides- glycoprotein, muriens and lipopolysaccharides. Lipids - classification, chemistry, properties and function - free fatty acids, triglycerides, phospholipids, glycolipids & waxes. Conjugated lipids - lipoproteins.

Unit II: Amino acids and proteins

Classification, structure and function.Essential amino acids & amphoteric nature of amino acids.Reactions and functions of carboxy and amino groups and side chains. Peptide structure Ramachandran's plot. Structural levels of proteins - Primary, secondary, tertiary and quaternary, denaturation of proteins - Hydrolysis of proteins.

Unit III: Carbohydrate metabolism in microbes

Synthesis of Carbohydrate in photosynthetic, chemosynthetic and heterotrophic microbes. Fermentation of carbohydrates by microorganisms - Embden-Meyerhof-Parnas pathway, Entner-Doudoroff (ED) pathway, C2-C4 split Pathway Kreb's cycle, glyoxylate cycle, hexose monophosphate shunt (HMP), gluconeogenesis, synthesis of peptidoglcans and glycoproteins.

Unit IV: Metabolic pathways

The Electron Transport Chain (ETS), mechanism of oxidative phosphorylation.Inhibitors of ETS and oxidative phosporylation. Lipid metabolism in bacteria. Metabolism of triglycerides, biosynthesis & β -oxidation of fatty acids. Mineral metabolism - phosphorus, potassium, calcium and Trace elements – molybdenum, zinc, manganese, cobalt and copper.

Unit V: Metabolism

Metabolism of amino acids - Biosynthesis and catabolism of histidine, aromatic and branched chain amino acids by microbes. Biosynthesis and catabolism of purine and pyrimidine nucleotides, salvage pathways. Sources, Chemistry and biochemical functions of water soluble vitamins.

Unit VI: Current contours (For Continuous Internal Assessment only)
Quiz – carbohydrate, lipid, protein structures, **Group discussion** – Industrially important microorganisms, Disease management by better understanding of microbial physiology, **Seminar** – Current research topics of microbial physiology, **Debate** – Microorganisms - harmful or beneficial to human, **Literature** – Molecular tools for understanding of molecular physiology

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Course Outcomes

After completion of this course the student can able to

- ✓ Understand the physiology of the bacteria in molecular context.
- ✓ Understand the basic knowledge of biochemical concepts
- ✓ Understanding of the molecular machinery of living cells
- ✓ Analysis of the specificity of enzymes and the chemistry involved in enzyme action.
- ✓ Applied aspects of microbial physiology, such as enzymes, metabolism (catabolic and anabolic reactions), oxidation–reduction reactions, biochemical pathways, aerobic respiration, and fermentation
- ✓ Understand the basic concepts of metabolic pathways and gene regulation.
- ✓ Analysis of how microbes do catabolism to get energy and metabolism to build structure.
- ✓ To execute the knowledge and understanding of the principles that governs the structures of macromolecules and their participation in molecular recognition

Course 2: MICROBIAL GENETICS

Course Code: 18MICRII07 **Credits: 4**

Objectives

- To gain a sense of the role of genetics in defining biological phenomena through the study of systems where genetics uncovered new processes and/or mechanisms
- To explain the relationship between genetics, inheritance, genes and genomes
- Specific objectives of this course are to provide an understanding and discuss ramifications of inheritance related to genetic research

Syllabus

Unit I: Gene organisation

Organization of genes and chromosomes (Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes,heterochromatin, euchromatin, transposons). Mapping strategies - Genetic Linkage Maps and Physical Maps.

Unit II: Gene expression

Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).

Unit III: Plasmids

Plasmid biology, types of plasmids, detection of plasmids, purification of plasmid DNA, invitro plasmid transfer, plasmid replication, partitioning of plasmids at cell division and properties of bacterial plasmids.

Unit IV: Genetic transfer

Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.

Unit V: Mutagenesis

The law of DNA constancy and C - value paradox; DNA damage, mutation – types of mutation;physical and chemical mutagenesis; molecular basis of spontaneous and induced mutations, sitedirected mutagenesis. AMES test for mutagenesis; DNA repair. Recombination – homologous recombination, Holiday junction, gene targeting, gene-disruption, FL/FRT and Cre/Lox recombination, Rec A and other recombinases.

Unit VI: Current contours (For Continuous Internal Assessment only)

Quiz on – Enzyme engineering, Proteomics, genomics, metabolomics, **Group discussion** – Application of microbial genetics on medical field and agriculture, Recent trends on microbial genetics, **Literature** - Transposons: Discovery of transposition. Classes of bacterial transposons. Regulation of transposition activity.

References

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Course outcomes

After completion of this course the student can able to

- ✓ Understand the concept of recombinant DNA technology or genetic engineering
- ✓ Apply the proficiency in designing and conducting experiments involving genetic manipulation
- ✓ Execute PCR, nucleic acid hybridization and sequencing technologies for detection and diagnostics
- ✓ An understanding on application of genetic engineering techniques in basic and applied experimental biology
- ✓ Analysis of general principles of generating transgenic plants, animals and microbes
- ✓ Understand the DNA fingerprinting, and restriction fragment length polymorphism (RFLP) analysis and their applications
- ✓ Understand the tools of molecular genetics that are derived from microorganisms
- ✓ Analysis of the methods used to create recombinant DNA molecules
- ✓ Understand the depth knowledge about tools used for gene exploration

Course 2: INFECTIOUS DISEASES AND DIAGNOSIS

Course Code: 18MICRII08 **Credits: 4**

Objectives

- To learn about the various diseases caused by different microorganisms and its control
- To study about immunity, antigen antibody reactions
- To know the molecular mechanism of microbial infections and methods of diagnosis of various diseases.

Syllabus

Unit I: Introduction of Medical Microbiology

History, Koch & River's postulates, Role of Microbiology in Medicine, Classification of medically important microbes, Normal Microbial flora, Infection's Source, Mode of transmission, Prevention of medically important microbes.

Unit II: Infectious diseases

Bacterial diseases: Transmission, diagnosis, clinical symptoms and treatment for bacterial diseases; diphtheria, plague, tuberculosis, cholera, typhoid, peptic ulcer, Staphylococcal and Streptococcal diseases. Viral diseases: Etiology, prophylaxis, clinical symptoms and treatment for human viral diseases. Smallpox, Rabies, Viral hepatitis, Poliomyelitis, AIDS and secondary infections. Fungal and protozoan diseases: Cutaneous mycoses, systemic mycoses, opportunistic mycoses. Life cycle, diagnosis and treatment of following protozoan diseases – amoebiasis, Giardiasis, malaria, kala-azar.

Unit III: Elements of Immunity

Overview of the Immune system- Basic concepts in immunology (History), principles of innate and acquired immunity - Cells and organs of the immune system - Classes of antigens and their characteristics.

Unit IV: Antibody structure

Classification and characterization, structure, properties, agglutination, complement system, Hypersensitivity, immune tolerance, Humoral and cell mediated immune response: B-cell maturation, Activation and differentiation, Major Histocompatibility complex (MHC) - antigen processing and presentation T cell maturation, activation and differentiation.

Unit V: Laboratory Diagnosis

Laboratory diagnosis of bacterial diseases, Laboratory diagnosis of mycological and Parasitological diseases, Laboratory diagnosis of viral diseases, Antibiotic sensitivity test.Molecular diagnosis.

Unit VI: Current Contours (For Continuous Internal Assessment only)

Literature: Preclinical Trials, Phase of Clinical Trials (I,II,III,IV), **Group discussion:** PMS studies, **Model:** ADME -Pharmacokinetics, **Quiz:** Bio-Equivalence (BE) Bio- Availability (BA), **Seminor:** Half-life period, Wash out period,**e-journal :**Medical Terminologies, Randomization and types.

References

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7. Roitt I (1994). Essentials of Immunology, 8th edition, Blackwell Scientific Publishers.
8. www.biologydiscussion.com/bacteria/laboratory-diagnosis-of-bacterial-diseases/29731
9. www.clayton.edu/portals/23/docs/medicalterminology.pdf
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11. www.medibiztv.com/articles/microbial-flora

Course Outcomes

After completion of this course the student can able to

- ✓ Understanding the route of microbial flora in human body to know the nature of the microbes
- ✓ Understanding the pathophysiology of disease causing microorganisms to know the type of disease while diagnosis
- ✓ Execute the production and expression and maturation study of structural antibodies during infection
- ✓ Understanding the functions of immune systems in human bodies
- ✓ Analysis of allergic responses in human body through hypersensitivity reactions
- ✓ Analysis of bacterial sensitivity to an antibiotics
- ✓ Analysis of microbial disease diagnosis, treatment and prevention (bacterial, fungal, viral)
- ✓ Apply an isolation methods for the maintenance of pathogenic microorganisms from infected patients sample (biopsy, autopsy) in clinical laboratory

Course 2: BIOCHEMISTRY AND SIGNAL TRANSDUCTION

Course Code: 18MICRII09 **Credits: 4**

Objectives

- To know the basics about the cell and metabolism.
- To understand the process concerned in designing a drug
- To acquire knowledge about the drug molecules and their economic value.

Syllabus

Unit I: Regulation of transcription and translation in prokaryotes

Positive and negative control, repressor and inducer, concept of operon, lac-trp operons, attenuation, regulons, Regulation in eukaryotes - regulatory of strategies in eukaryotes, regulation of synthesis of primary transcripts, hormonal control, transcription factors, transcription factors as targets of signaling pathways, DNA binding motifs in pro- and eukaryotes Helix turn, helix, zinc fingers, leucine zippers/b zip, helix loop helix motifs. Regulation at the level of translation in eukaryotes.

Unit II: Signal transduction

Definitions, Signals, Ligands and receptors. Endocrine, Paracrine and Autocrine signaling. Sensory transduction Nerve impulse transmission, Nerve cells, synapses, resting membrane potential, action potential, voltage gated ion-channels, impulse transmission, neurotransmitters neurotransmitter receptors.

Unit III: Receptors and signaling pathways

Cell signaling, Cell surface receptors. G protein coupled receptors- structure, mechanism of signal transmission, regulatory GTPases, heterotrimeric G protein and effector molecules of G protein. Signalling molecules cAMP, cGMP, metabolic pathways for the formation of inositol triphosphate from phosphatidyl inositol diphosphate, calcium, DAG and NO as signaling molecules, ryanodine and other calcium receptors, Ser/Thr-specific protein kinases and phosphatases. Receptor tyrosine kinases, Signal transimmion via Ras proteins and MAP kinase pathways.

Unit IV: Signaling by nuclear receptors

Ligands, Structure and functions of nuclear receptors, Nuclear functions for hormones/metabolites - orphan receptors; cytoplasmic functions and crosstalk with signaling molecules, signaling pathway of the steroid hormone receptors. Cytokine receptors- structure and activation of cytokine receptors, Jak-Stat pathway, Janus kinases, Stat proteins.

Unit V: Regulation of the cell cycle

Overview of the cell cycle, cell cycle control mechanisms, Cyclin-dependent protein kinases (CDKs), regulation of cell cycle by proteolysis G1/S Phase, G2/M phase transition, cell cycle control of DNA replication, DNA damage check points.

Unit VI: Current Contours (For Continuous Internal Assessment only)
Model: TOP1 enzyme- **Debate:** BRCA1 and BRCA2 mutations- **Model:** Rustom-II – **Group discussion:** DNA damage in animals-Endosulfan – **Seminor:** Genetic code of honeybee-sensitivity to environmental change – **Quiz:** Discovery of DNA double helix.

References

1. Bruce Albert, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter 2007. Molecular Biology of the cell- 5th edition
2. David Freifelder (2003). Molecular biology-4th edition
3. Gerhard krauss (2004). Biochemistry of signal transduction and regulation- 3rd edition
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Course Outcomes

By completing this course, Students will have the following skills

- ✓ Understanding the various levels of transcription and transcription factors
- ✓ Analysis of DNA-binding proteins from structures of unknown function in structural biology
- ✓ Execute the production and regulation of various types of hormones
- ✓ Execute the new drugs discovery from structural and functional proteins
- ✓ Understanding the metabolism of cell cycles and their control mechanisms
- ✓ Analysis of chemical structure of the unknown proteins to discover drug molecules
- ✓ Analysis the functions and mechanisms of enzymes
- ✓ Understanding the replication cycles and repair mechanisms deoxyribonucleic acid

Course 2: MOLECULAR CLONING AND GENETICS

Course Code: 18MICRII10 **Credits: 4**

Objectives

- Molecular biology is the basic science that has as its goal an explanation of life processes at the subcellular and molecular level.
- Recent years have seen explosive advances in the study of DNA and molecular genetics, including gene cloning, sequencing and mapping.
- Developments in molecular biology have opened new areas of study and provided powerful techniques that are revolutionizing the pharmaceutical, health, and agricultural industries

Syllabus

Unit I: Introduction to Basics of genetic engineering

Gene as a unit of mutation and recombination.Mutagenesis, mutations and mutants – biochemical basis of mutations, spontaneous and induced mutations, isolation of mutants, mutagenesis, reversion, suppression, genetic analysis of mutants.Recombination methods – conjugation and transformation.

Unit II: DNA replication and repair

Identification of genetic material (Griffith, Avery and Hershey and Chase experiments). DNA replication - Meselson – Stahl experiment , Molecular mechanisms of DNA Replication – bidirectional and rolling circle replication. Differences in prokaryotic and eukaryotic replication. Plasmids – types, structure and replication. DNA repair – mechanism of excision repair, SOS repair and mismatch repair.

Unit III: Transcription and translation

Process of transcription – initiation, elongation – termination.Synthesis of mRNA in prokaryotes and eukaryotes.Synthesis of rRNA and tRNA.RNA processing – capping and polyadenylation.Genetic code, process of translation – initiation, elongation and termination. Signal sequences and protein transport.

Unit IV: Concept of Gene & Gene regulation

Organization of Gene in Prokaryotes and Eukaryotes - Introduction - Operon concept, lac and trp operons, promoters and repressors. Regulation of gene expression – Transcriptional control – promoters, terminators, attenuators and anti-terminators; Induction and repression; the lac operon – catabolite repression; Biosynthesis: trp operon – upstream activator sequences and enhancers, two component regulatory systems. Translational control – ribosome binding, codon usage, antisense RNA; post-transcriptional gene silencing – RNAi.

Unit V: Techniques of Genetic Engineering

PCR – principles, techniques and applications. Gene isolation, cloning and expression, DNA sequencing, oligonucleotide synthesis, Southern and Northern hybridization, FISH, RAPD, PCR-RFLP, STRR, LTRR. DNA fingerprinting and their applications for diagnosis of disease, site-directed mutagenesis, Gene silencing, Gene transfer technologies.

Unit VI: Current contours: (For Continuous Internal Assessment only)

Quiz on – Molecular tools, Restriction enzymes, types of plasmids, Antibiotic resistance genes, **Group discussion** – Transgenic animals and plants, Applications of current trends on genetic engineering approaches. **Debate** – genetic engineering is ethical?,Designing Life: Should Babies Be Genetically Engineered?, Should human cloning be legal?

References

1. Gardner, M. J. Simmons and D. P. Suntan, (2006) Principles Of Genetics, 8th Edition. John Wiley & Sons.
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3. https://publications.nigms.nih.gov/thenewgenetics/thenewgenetics.pdf
4. https://www.coursera.org/courses?query=molecular%20biology
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Course outcomes

After completion of this course the student can able to

- ✓ Understand the structure, formation and function of DNA, RNA and proteins
- ✓ Analyze the principles of gene regulation in prokaryotic and eukaryotic cells
- ✓ Analyze the consequences of different types of mutations and DNA-repair systems
- ✓ Understand the cell cycle, Mendelian genetics, family trees, recombination, restriction enzymes, molecular cloning, DNA-sequencing, and PCR
- ✓ Understand several modern molecular methods to elucidate molecular and genetic questions
- ✓ Analyse, evaluate and compile results from laboratory exercises
- ✓ Understand the DNA fingerprinting, and restriction fragment length polymorphism (RFLP) analysis and their applications
- ✓ Understand the tools of molecular genetics that are derived from microorganisms
- ✓ Apply the methods used to create recombinant DNA molecules
- ✓ Understand the basic differences between genomic and cDNA libraries

Course 2: APPLICATION OF NANO BIOTECHNOLOGY

Course Code: 18MICRIII01 **Credits: 4**

Objectives

- To study reasonable development of nanotechnology
- To study in detail about nano-materials, particles, nano-structures and fabrication
- To analyse the science of nanotechnology in a wide range of industrial and academic applications

Syllabus

Unit I:

History of nanobiotechnology; Terminologies of nanobiotechnolgy; Nanoparticals; Nanotubes; Nanowires; Silver nanoparticles. Cellular structures in all three dimensions to generate an accurate three-dimensional map of the interior of the cell; molecular structures in relation to the cellular architecture; cytoskeleton and the cell organelles; Protein functions at the cellular level

Unit II:

Surface characterization methodology; modification of biomaterials surfaces; quantitative assays of cell behavior in culture; biosensors and microarrays; bulk properties of implants; and acute and chronic response to implanted biomaterials; General topics include biosensors; drug delivery, and tissue engineering

.

Unit III:

Stimulation of antigens on macrophage using on-chip micro cultivation system; Virus particles used as a novel nanomaterial for tumor targeting; Microbial growth response to inorganic nanoparticles; Nanoparticle internalization and cytotoxicity; Nano curcumin (Polymeric nanoparticle-encapsulated curcumin) – a novel strategy for human cancer; Therapeutic application of gold nanoparticles.

Unit IV:

Advantages of scaffolds for bone tissue restoration; Protein nanopatterning advantages and disadvantages; Social and ethical implication of nanoscale sciences; Nanobiotechnology: Responsible action on Issues in ethics and society.

Unit V:

MRI, Imaging Surface Modified Nanoparticles MEMS/NEMS based on Nanomaterials Peptide/DNA Coupled Nanoparticles Lipid Nanoparticles for Drug Delivery Inorganic Nanoparticles For Drug Delivery Metal/Metal Oxide Nanoparticles (antibacterial/anti fungal/anti viral) Anisotropic and Magnetic Particles (Hyperthermia).

Unit VI: Current Contours (For Continuous Internal Assessment only)

Seminar was subjected to students related to their syllabus topics individually. Assignment was given based on e-journals and their advantages and disadvantages. Review work and review paper presentation was assigned on the recent discoveries. In order to enhance their research skills, a mini project was assigned related to their research work.

References

1. Chad A. Mirkin, Christof M. Niemeyer. (2007) Nanobiotechnology II: More Concepts and Applications, 1st edition Wiley-VCH Publisher.
2. Donald Martin. (2006). Nanobiotechnology of Biomimetic Membranes (Fundamental Biomedical Technologies) 1st edition, Springer Publication.
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4. http://www.understandingnano.com/nanotech-applications.html
5. https://www.osha.gov/dsg/nanotechnology/nanotech_applications.html
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9. Oded Shoseyov, Ilan Levy. (2007). NanoBiotechnology: BioInspired Devices and Materials of the Future by 1st edition Humana Press Publisher.
10. Sandra J Rosenthal, David W. Wright. (2005) NanoBiotechnology Protocols (Methods in Molecular Biology) Humana press publisher.
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Course Outcomes

After the completion of the course students would be able

- ✓ To know the basic science behind the properties of materials at the nanometre scale
- ✓ To explain the principles behind advanced experimental and computational techniques for studying nanomaterials
- ✓ To use nanotechnology, materials can effectively be made stronger, lighter, more durable, more reactive, more sieve-like, or better electrical conductors, among many other traits was studied
- ✓ To considerably improve, even revolutionize, many technology and industry sectors: information technology, homeland security, medicine, transportation, energy, food safety, and environmental science, and among many others.

- ✓ Researchers many techniques are taught such as, developing wires containing carbon nanotubes that will have much lower resistance than the high-tension wires currently used in the electric grid, thus reducing transmission power loss.
- ✓ To determine the particle's size, size distribution, molecular weight, density, surface area, porosity, hydrophilicity, surface charge density, purity, surface chemistry, and stability.
- ✓ The batch-to-batch reproducibility of material as provided by the sponsor/vendor will also be addressed during this stage.
- ✓ Gains knowledge about application in traditional energy sources and how its greatly enhancing alternative energy approaches to help meet the world's increasing energy demands.

Course 2: MICROBIAL GENOMICS

Course Code: 18MICRIII02 **Credits: 4**

Objectives

- To describe strategies involved in microbial genome sequencing
- To describe the strategies involved in functional genomics
- To provide examples of information that can be derived from genomics
- To expose the students to advanced concepts and principles of contemporary microbiological research through representative examples from recent literature.

Syllabus

Unit I:

Genome – size-complexity- structure and function of prokaryotic and eukaryotic genome. Physical mapping of genome-Sequencing whole genome- Restriction mapping – FISH – STS mapping - Hybridization assays - Physical mapping without cloning- Mapping by genetic techniques – DNA markers - RFLPs, SSLPs, SNPs – Linkage analysis – Cross breeding and pedigree analysis.

Unit II:

Basic DNA sequencing - Modifications of chain-termination method – cycle sequencing - Automated DNA sequencing- DNA sequencing by capillary electrophoresis - sequencing strategies - shotgun sequencing – Overlapping clone contigs - High throughput sequencing - EST sequencing and sequence skimming – Next Generation sequencing.

Unit III:

Overview of sequence analysis- Gene prediction- Tools for genome analysis. Detecting open-reading frames-using homology to find genes- software programs for finding genes-Identifying the function of a new gene- Analyses not based on homology-Genome annotation- Molecular phylogenetics.

Unit IV:

Comparative genomics of prokaryotes, organelles, Eukaryotes and other aspects. Representational difference Analysis of cDNA and Genome Comparisons-Gene Expression during Host-pathogen interactions- Genomics of Mycobacterium tuberculosis- Helicobacter pylori-Approaches to bacterial mRNA extraction and labeling for microarray Analysis.

Unit V:

DNA microarray – Construction and Design- Application of DNA microarray for comparative and evolutionary genomics. Gene silencing, RNAi, siRNA, shRNA - Proteome analysis – Protein-protein Interactions. Application of Microbial Genomics – genomic approaches for semi synthetic bacteria - Reverse Vaccinology: from genome to vaccine-Microbial genomics for Antibiotic Target Discovery.

Unit VI: Current Contours (For Continuous Internal Assessment only)

Seminar was subjected to students related to their syllabus topics individually. Assignment was given based on e-journals and their advantages and disadvantages. Review work and review paper presentation was assigned on the recent discoveries. In order to enhance their research skills, a mini project was assigned related to their research work.

References

1. Brendan Wren (Editor), Nick Dorrell (2002). Functional Microbial Genomics (Volume 33) (Methods in Microbiology), Academic Press, UK.
2. Brendan Wren, Nick Dorrell (2002). Functional Microbial Genomics (Volume 33) (Methods in Microbiology), Academic Press, UK.
3. Fraser C.M., Read T. and Nelson K.E. (2004). Microbial Genomes, Springer
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8. Sandy B. Primrose Richard M. Twyman. (2005) Principles of Genome Analysis and Genomics, Blackwell Publishing, USA.
9. Toft, C and Andersson, S. G. (2010). Evolutionary microbial genomics: insights into bacterial host adaptation. Nature Reviews Genetics, 11(7), 465.

Course Outcomes

After the completion of the course students would be able

- ✓ To understand the general methods utilized in the field of microbial genomics.
- ✓ To analyze and annotate a microbial genome fragment.
- ✓ To describe and use the methods for comparing microbial genomes.
- ✓ Use genomic databases and bioinformatic resources to explore microbial processes in the environment
- ✓ The diversity of microbial genes and genomes and the value of this diversity for the life-sustaining biogeochemical cycles, disease control, and biotechnology
- ✓ The complexity and functionality of microbial communities, the interactions among microbes and their environment; and the influence of the environment in shaping and driving the evolution of microorganisms and their communities were studied in detail
- ✓ Advancing microbiological research has always been linked tightly to technological innovations.
- ✓ Thus, the course will also offer an extensive discussion of the cutting-edge technologies and bioinformatic approaches that enable contemporary research.

Course 3: MICROBIAL METAGENOMICS

Course Code: 18MICRIII03 **Credits: 4**

Objectives

- To analysis of genetic content of microbial communities through metagenomics
- To understand the molecular methods, applicable for studying microbial communities
- To learn about the recent metagenomic tools, concerned with microbial phylogenetic
- genetic diversity
- To study metagenomic resources, bioinformatic tools and related softwares

Syllabus

Unit I:

Early Microbiology and Microscope- Pure culture – rRNA analysis and culturing – Metagenomics – Culture independent insight – Microbial diversity – Uncultivables – Extremophiles.

Unit II:

Population genetics and microheterogeneity- Symbiosis – Competition – Communication – role of small molecules – Quorum sensing and quorum quenching – virulence factors - Sequence based screening for small molecules – Antibiotics as signal molecules – Chemical ecology – Sargasso sea explorations.

Unit III:

Methods – Microarray – Functional gene arrays – Community genome arrays - Phylogenetic oligonucleotide arrays – Whole genome ORF arrays- Environmental Gene Tags – Environmental genomics – DGGE, TRFLP, M-TRFLP.

Unit IV:

Marine drug discovery platform – Sequence based analysis – Function driven analysis – Heterologous expression – Identifying active clones – Screens, Selections, Functional anchors – Search for potential producers – Polyketide synthases.

Unit V:

White biotechnology – Novelty – Diversity – Elusive metabolites - High throughput screening - Multiparameter footprint analysis – screening for industrial enzymes – Bioactive molecules – synthons – Putative gene products.

Unit VI: Current Contours (For Continuous Internal Assessment only)

Seminar was subjected to students related to their syllabus topics individually. Assignment was given based on e-journals and their advantages and disadvantages. Review work and review paper presentation was assigned on the recent discoveries. In order to enhance their research skills, a mini project was assigned related to their research work.

References

1. Alan T. Bull. (2004). Microbial Diversity and Bioprospecting. ASM press.Washington, D.C
2. Alexander Hillisch and Rolf Hilgenfeld. (2003). Modern Methods of Drug Discovery,Birkhauser, Switzerland
3. Brenden Wren and Nick Dorrell, (2002). Functional Microbial Genomics (Volume33) (Methods in Microbiology), Academic Press
4. Gilbert, J. A and Dupont, C. L. (2010). Microbial metagenomics: beyond the genome.
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7. https://www.nature.com/articles/ismej2010178
8. James N. Kyranos. (2004). High throughput Analysis for Early Drug Discovery.Elsevier Academic Press.

Course Outcomes

After the completion of the course students would be able

- ✓ Quality control, filtering and assembly to taxonomic classification
- ✓ Clustering, functional assignment, analyses of microbial community composition and comparative metagenomics.
- ✓ Construct your own metagenomic library
- ✓ Analyse and organise your data
- ✓ Interpret results, explore different databases, use different retrieval and analysis tools
- ✓ Submit metagenomics data to public repositories.
- ✓ Interpret results and compare them with other metagenomic datasets

Course 3: RHIZOREMEDIATION TECHNOLOGY

Course Code: 18MICRIII04 **Credits: 4**

Objectives

- To study process of microorganisms degrading soil contaminants in the rhizosphere
- To establish the rate of microbial population build up in the rhizosphere of selected plant species
- To identify which of the media combinations is most suitable for the effective breakdown of Hydrocarbon contaminated soil in the rhizosphere.
- To study the use of plants and their associated microorganisms to detoxify hydrocarbon pollutants for the treatment of contaminated soils

Syllabus

Unit I:

Definition and characteristic features of rhizosphere: Physical, chemical and biological process. Diverse powers of prokaryotes. Contribution of biogeochemical cycles to rhizosphere structure. Methods of rhizosphere research related with sustainable in modern agriculture. Applications to environmental biotechnologies tool in soil protection and remediation.

Unit II:

Diverse groups of rhizosphere soil microorganisms. Nature of interactions: plant-microbe interactions, microbe-microbe interactions. Molecular mechanisms involved in microbial interactions and sensing molecules. Uncultivable soil microorganisms' identification through molecular techniques. Genetically modified crops adaptation through rhizosphere engineering.

Unit III:

Microbial association: Symbiosis, associate symbiosis and free living – bacteria, actinomycetes, BGA and mycorrhizae. Screening and applications strategies of PGPR: soil nutrients fixers, solubilizers and mobilizers. Advantages of mycorrhizal helper bacteria. Outline of biopesticides, bioinsecticides, bioherbicides and its application to the agriculture and their impact in agroindustry.

Unit IV:

Source and types of xenobiotic compounds, microorganisms involved in degradation of chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, agrochemicals and surfactants.

Unit V:

Definition and concepts bioremediation. Isolation and screening bioremediation microbes. Bioremediation of organic compound contaminants and heavy metal. Bioremediation of

DDT, oil and coal. Role of super bug strains in xenobiotic degradation. Manipulation of bioremediation potentials of microbes with and without genetic engineering.

Unit VI: Current Contours (For Continuous Internal Assessment only)
Seminar was subjected to students related to their syllabus topics individually. Assignment was given based on e-journals and their advantages and disadvantages. Review work and review paper presentation was assigned on the recent discoveries. In order to enhance their research skills, a mini project was assigned related to their research work.

References

1. Forster. C. F. and D. A. J. Wase. (2000). Environmental Biotechnology.
2. James M., Lynch and Alan Wiseman. (1998). Environmental Biomonitoring: The Biotechnology Ecotoxicology Interface. Cambridge University Press,
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9. Subbha Rao, N.S. (2000). Soil Microbiology. IV edition. Oxford and IBH Publishing, Co. Pvt. Ltd.

Course Outcomes

After the completion of the course students would be able

- ✓ To obtain knowledge about concepts of root systems and the rhizosphere.
- ✓ To know about and understand fundamental physical, chemical and biological processes in the rhizosphere and their interaction.
- ✓ To appreciate the importance of rhizosphere processes in plant nutrition, pollutant uptake and ecotoxicology.
- ✓ To obtain insight into applications of the rhizosphere (rhizosphere management) in environmental technology and sustainable agriculture
- ✓ To learn to remediate the soil pollutants which are generally organic compounds that cannot enter the plant because of their high hydrophobicity.
- ✓ Generally, plants are not considered as the main mode of remediation in this procedure. Rather, the plant creates a niche for rhizosphere microorganisms to do the degradation.
- ✓ Rhizosphere microorganisms are served by the plant acting as a solar-powered pump that draws in water and the pollutant while producing substrates that benefit microbial survival and development. Root exudates and root turn over can serve as substrates for microorganisms that perform toxin degradation.
- ✓ To understand the sources, pathways and contaminants in the urban environment is

- ✓ essential for making informed management decisions.

Course 3: BIOREMEDIATION TECHNOLOGY

Course Code: 18MICRIII05 **Credits: 4**

Objectives

- To study the use of living organisms, primarily microorganisms, to degrade environmental contaminants into less toxic forms.
- Demonstrated the very few environments where microbes have not been able to survive, adapt, and indeed, thrive.
- To study the microbes acceptors to drive their metabolism. In addition to these redox (oxidation / reduction) reactions, myriad of other strategies enabling them to detoxify their environment.
- Bioremediation applies and selects suitable combination of microbial community activity, electron donor / acceptor / contaminant concentrations and other physical and practical parameters to remediate / recover a targeted pollutant.

Syllabus

Unit I:

Introduction, constraints and priorities of Bioremediation, Biostimulation of Naturally occurring microbial activities, Bioaugmentation, in situ, ex situ, intrinsic & engineered bioremediation

Unit II:

Solid phase bioremediation - land farming, prepared beds, soil piles, Phytoremediation. Composting, Bioventing & Biosparging; Liquid phase bioremediation - suspended bioreactors, fixed biofilm reactors.

Unit III:

Hazardous Waste Management biotechnology application to hazardous waste management - examples of biotechnological applications to hazardous waste management – cyanide detoxification - detoxification of oxalate, urea etc. - toxic organics -phenols.

Unit IV:

Concept of bioremediation (in-situ & ex-situ), Bioremediation of toxic metal ions biosorption and bioaccumulation principles. Concepts of phytoremediation. Microbial leaching of ore-direct and indirect mechanisms. Mining and metal. Use of microorganisms in augmentation of petroleum recovery. Biotechnology-with special reference to Copper and Iron.

Unit V:

Advances in phytoremediation and rhizoremediation. Heavy metal phytoremediation: microbial indicators of soil health for the assessment of remediation efficiency. Bioreporter technology for monitoring soil bioremediation. Molecular tools for monitoring and validating

bioremediation. Genetic engineering of bacteria and their potential for bioremediation. commercial use of GMOs in bioremediation and phytoremediation.

Unit VI: Current Contours (For Continuous Internal Assessment only)
Seminar was subjected to students related to their syllabus topics individually. Assignment was given based on e-journals and their advantages and disadvantages. Review work and review paper presentation was assigned on the recent discoveries. In order to enhance their research skills, a mini project was assigned related to their research work.

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Course Outcomes

After the completion of the course students would be able

- ✓ To understand the nature and importance of bioremediation.
- ✓ To describe bioremediation and when each strategy would be most applicable.
- ✓ To understand the influence of site characteristics
- ✓ To characterize such as hydraulic conductivity, soil type, microbial presence, and groundwater properties.
- ✓ To understand the influence of contaminant characteristics to bioremediation (e.g. chemical structure, toxicity, and solubility).
- ✓ To demonstrate the use of course concepts to solve problems in real world applications.
- ✓ Gain knowledge to remove the untreated toxic materials by using biological microbes to do the cleanup.
- ✓ To understand in better about water and soil treatment technique using naturally occurring organisms to attack hazardous materials and change them into less toxic substances.

Course 3: PROTEOMICS

Course Code: 18MICRIII06 **Credits: 4**

Objectives

- Proteomics is to identify all the proteins and to make proteome map which shows protein functioning.
- To study protein diversity depend on post transcriptional process
- To gain knowledge about protein function depending upon on its localization
- To identify proteins and experiment with other types of proteins in a critically methods which evaluate new research methods

Syllabus

Unit I:

Introduction to Proteome - proteome and technology - information and the proteome – Primary attributes for protein identification - protein species of origin - Protein N- and C-terminal sequence tags - cross species protein identification. Proteomics- Concept of proteomics- components of proteomics- proteomic analysis- importance of proteomics in biological functions- protein arrays- cross linking methods- affinity methods- yeast hybrid systems and protein arrays.

Unit II:

Proteomics Techniques-Protein level estimation- Edman protein microsequencing- protein cleavage- 2 D gel electrophoresis- metabolic labelling- detection of proteins on SDS gels; pattern analysis- Mass spectrometry- principles of MALDI-TOF- Tandem MS-MS- Peptide mass fingerprinting.

Unit III:

Protein protein interaction – types of protein protein interaction – biological effects of protein protein interactions – common methods to analyze protein protein interaction – immunoprecipitation and coimmunoprecipitation. Studying protein protein interactions by far western blotting – critical factors of far western blot analysis.

Unit IV:

Protein Profiling and database - Post Translational Modification; Glycoprotein Analysis; Phosphoprotein Analysis. Proteome databases – protein sequence database, SWISS-PROT, TrEMBL, specialized protein sequence databases, Metabolic databases, Some specific metabolic databases – application of proteomics in agriculture.

Unit V:

Challenges in Clinical Proteomics, Serum Proteomics, Urine Proteomics, Salivary Proteomics, Bioinformatics and Proteomics, Proteomics for Translational Research, Future of Proteomic Technologies for Clinical Applications.

Unit VI: Current Contours (For Continuous Internal Assessment only)

Seminar was subjected to students related to their syllabus topics individually. Assignment was given based on e-journals and their advantages and disadvantages. Review work and review paper presentation was assigned on the recent discoveries. In order to enhance their research skills, a mini project was assigned related to their research work.

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Course Outcomes

After the completion of the course students would be able

- ✓ Understand the importance of protein structure
- ✓ To understand the function of protein in a physiological context.
- ✓ Students will have an insight into methods available for the identification of unknown gene products in a high-through-put manner.
- ✓ Gains basic knowledge about theory and practice within bioinformatics
- ✓ The use of bioinformatics methods within research.
- ✓ To set up a proteomics investigation and able to use bioinformatics tools.
- ✓ Further they can able to critically choose between methods to solve proteomics and bioinformatics problems.

Course 3: ENVIRONMENTAL BIOTECHNOLOGY

Course Code: 18MICRIII07 **Credits: 4**

Objectives

- One of the main objectives of environmental biotechnology is the conservation of resources via the recycling of waste materials.
- The recoveries of more valuable products such as metals, oils, and vitamins are important aspects of this technology.
- Use of microorganisms in recovery of minerals of commercial interest is also an interesting area.
- Reclaiming organically polluted water, application of microbes to degrade recalcitrant compounds, use of animal waste as fertilizer, recycling of microbial protein as an animal feed
- Removal of heavy metals found in sewage sledges, are examples of this type of technology.

Syllabus

Unit I:

Definition, principles and scope of ecology, human ecology and human settlements, evolution, origin of life and specification, Ecosystem stability-cybernatics and ecosystem regulation, evolution of biosphere.

Unit II:

Ecosystem structure and functions, abiotic and biotic component, Energy flow, food chain, food web, Ecological Pyramids-types, biogeochemical cycles, ecological succession, Ecads and ecotypes.

Unit III:

Population ecology- density, natality, mortality, survivorship curves, age distribution, growth curves and models, r & k selection, population interactions- Mutualism, Parasitism, Predator-Prey relations, System Theory and Ecological Model.

Unit IV:

Earths major ecosystem - terrestial and aquatic ecosystem, soil microorganism and their functions, coastal management, criteria employed for disposal of pollutants in marine ecosystem, coastal water system and man-made reservoirs, biology and ecology of reservoirs.

Unit V:

Biotransformation, bioconversion, bioremediation, phytoremediation technology, fermentation technology, development of stress tolerant plants, Environmental problems & Environmental monitoring through microorganism, microbiology of water, air and soil, microbes as pathological agent in plant, animal and man.

Unit VI: Current Contours (For Continuous Internal Assessment only)

Seminar was subjected to students related to their syllabus topics individually. Assignment was given based on e-journals and their advantages and disadvantages. Review work and review paper presentation was assigned on the recent discoveries. In order to enhance their research skills, a mini project was assigned related to their research work.

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Course Outcomes

After the completion of the course students would be able

- ✓ Students should gain understanding of the role of microorganisms in their environment
- ✓ And how this knowledge can be used to solve environmental and industrial problems.
- ✓ Student utilizes the knowledge gained on the role and importance of microorganisms in the environment.
- ✓ And microorganisms are also used in the removal of heavy metals from aqueous effluents.
- ✓ Microorganisms has the ability to immobilize metal ions by both active and passive process was also studied.
- ✓ Students will be able to apply this knowledge in both real life and in a laboratory setting.
- ✓ In addition students will gain some basic environmental microbiology laboratory skills.
- ✓ Learns to promote sustainable and efficient use of natural resources like fungi, plants, algae, and bacteria in the industrial processes.

Course 3:.BIOPOLYMERS APPLICATION AND BIODEGRADATION

Course Code: 18MICRIII08 **Credits: 4**

Objectives

- To gain an understanding on the chemical structure of polymers and biopolymers, their classification and nomenclature.
- To acquire knowledge about the basic properties of polymers and biopolymers and how they relate to chemical and physical structure.
- To acquire acknowledge about the chemical processes involved in the production of synthetic polymers and the recovery of biopolymers.

Syllabus

Unit I:

Definition of Biopolymers and types of biopolymers, definition of bioplastics, Types of bioplastics, such as starch based, cellulose based plastics and some aliphatic polyesters (PLA, PHB), polyamides, Bio-Based Composites from Soybean Oil and Chicken Feathers, bio-derived polyethylene and genetically modified bioplastics. Environmental impact such as Bioplastics and biodegradation.

Unit II:

Biodegradable polymer classes, Natural biodegradable polymer, Synthetic biodegradable polymer and modified naturally biodegradable polymer. Non-biological and biological degradable polymer. Measuring of biodegradation of polymers- Enzyme assays, Plate test, Respiratory test, Natural environment, Field trial, Gas evolution test (CO_2 & CH_4). Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with estrogenic fillers (e.g. hydroxyapatite). Host tissue reactions.

Unit III:

Introduction of bioplastics and biocomposites, processing of bioplastics and biocomposites, applications of bioplastics and their composites- civil engineering, biomedical, automotives applications.

Unit IV:

Introduction of biomaterials, Material choice implications based on device design. General biomaterial evaluation procedures. Replacement of skeletal hard tissues. Polymer used as cosmetic implants, controlled drug delivery system artificial heart valves, bone replacement, artificial organs, dental applications.

Unit V:

Enhancement of biocompatibility by the use of Corona discharge and plasma processes. Surface coatings Silver/silver oxide silicone hydrogels UV curable systems PC coatings Heparin loaded systems

Unit VI: Current Contours (For Continuous Internal Assessment only)

Seminar was subjected to students related to their syllabus topics individually. Assignment was given based on e-journals and their advantages and disadvantages. Review work and review paper presentation was assigned on the recent discoveries. In order to enhance their research skills, a mini project was assigned related to their research work

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Course outcomes

After the completion of the course students would be able

- ✓ Understand the characterization of polymers based on the chemical structure
- ✓ Learns in detail about polymerization methods such as polycondensation, polyaddition and others. Polymerization techniques. Chemical modification and degradation.
- ✓ Resolution of a collection of exercises that allows students to become familiar with the structure and nomenclature of polymers as well as the basic techniques of chemical characterization
- ✓ Know and understand the chemical structure of polymers, how it is determined and how it relates to the behavior of polymers.
- ✓ Basic understanding of the procedure used for the synthesis of polymers
- ✓ How polymers are applied to industrial level and produced in large scale was studied in detail
- ✓ Knowing the degradation processes that affect the use of polymers and the exploitation and reuse.
- ✓ Gains knowledge about biopolymers and their essential role in nature and their uses to human beings.

Course 3: MICROBIAL BIOTECHNOLOGY

Course Code: 18MICRIII09 **Credits: 4**

Objectives

- In order to define fermentation and gain knowledge about the alcohol and lactic acid fermentation.
- Common foods and beverages produced during each fermentation process were to be understood.
- How microorganisms play an important role in the development and production of many
  vaccines, and provide examples of the importance of vaccines was to be studied
- Studying microbial genomes can be valuable to scientists.

Syllabus

Unit I:

Brief history of fermentation; Fermentation- general concepts, Applications of fermentation; Range of fermentation process- Microbial biomass, enzymes, metabolites, recombinant products, transformation process; Component parts of a fermentation process.

Unit II:

Types of fermentations- Aerobic and anaerobic fermentation, Submerged and solid state fermentation; Factors affecting submerged and solid state fermentation; Substrates used in SSF and its advantages; Culture media- types, components and formulations. Sterilization: Batch and continuous sterilization.

Unit III:

Process development, Optimization of a process, Classical and statistical methods of optimization, Immobilization: different matrices, whole cell and enzyme immobilization; Scale up of bioprocess General concept of a fermenter- Batch, fed-batch and continuous fermentation.

Unit IV:

Aeration and agitation- Effect of aeration and agitation on fermentation, Oxygen requirement and oxygen supply, Oxygen transfer kinetics; Determination of KLa value; Effect of agitation and microbial biomass on KLa value; Newtonian and non-Newtonian fluids; Foam and antifoams, their effect on oxygen transfer; Fermentation economics.

Unit V:

Isolation of industrially important microorganism from different sources using specific substrates; Design and Preparation of Media for Bioprocesses; Growth curve studies of bacteria/Yeasts in batch culture and calculation of maximum specific growth rate; To study the various methods of biomass measurement; Production of ethanol from sucrose by yeast;

Determination of yield coefficient and Monod's constant and metabolic quotient of E.coli culture on glucose.; To study the design of fermenter and its working; Production of citric acid using sucrose and molasses; Production of extracellular enzymes ; Ethanol production using immobilized yeast culture.

Unit VI: Current Contours (For Continuous Internal Assessment only)
Seminar was subjected to students related to their syllabus topics individually. Assignment was given based on e-journals and their advantages and disadvantages. Review work and review paper presentation was assigned on the recent discoveries. In order to enhance their research skills, a mini project was assigned related to their research work.

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Course Outcomes

After the completion of the course students would be able

- ✓ To demonstrate a familiarity with the wide diversity of microbes.Microbes and their potential for use in microbial biotechnology.
- ✓ To gain knowledge of microbial gene and genome structure and function, and how these can be manipulated.
- ✓ To demonstrate familiarity with methods to analyse and engineer genes for optimal expression.
- ✓ To demonstrate an understanding of the processes involved in small-scale and industrial scale bacterial fermentations.
- ✓ Able to demonstrate competence in finding, interpreting and analysing relevant data, such as genes, patents and publications.

- ✓ To gain knowledge about foods and beverages have traditionally been produced using microbes
- ✓ Gains knowledge about application of genetic engineering and advantages of biotechnological methods applied to agriculture

Course 3: MICROBIAL GENOMICS

Course Code: 18MICRIV01 **Credits: 4**

Objectives

- To know the advanced genome analysis techniques
- To validate the sequences with various annotation software
- Gain knowledge on functional genomics

Syllabus

Unit I: Genome Mapping

Genome – size-complexity- structure and function of prokaryotic and eukaryotic genome. Physical mapping of genome-Sequencing whole genome- Restriction mapping – FISH – STS mapping - Hybridization assays - Physical mapping without cloning- Mapping by genetic techniques – DNA markers - RFLPs, SSLPs, SNPs – Linkage analysis – Cross breeding and pedigree analysis.

Unit II: Sequencing methods and Strategies

Basic DNA sequencing - Modifications of chain-termination method – cycle sequencing - Automated DNA sequencing- DNA sequencing by capillary electrophoresis - sequencing strategies - shotgun sequencing – Overlapping clone contigs - High throughput sequencing - EST sequencing and sequence skimming – Next Generation sequencing.

Unit III: Genome Analysis

Overview of sequence analysis- Gene prediction- Tools for genome analysis. Detecting open-reading frames-using homology to find genes- software programs for finding genes-Identifying the function of a new gene- Analyses not based on homology-Genome annotation- Molecular phylogenetics.

Unit IV: Comparative Genomics

Comparative genomics of prokaryotes, organelles, Eukaryotes and other aspects. Representational difference Analysis of cDNA and Genome Comparisons-Gene Expression during Host-pathogen interactions- Genomics of *Mycobacterium tuberculosis*- *Helicobacter pylori*-Approaches to bacterial mRNA extraction and labeling for microarray Analysis.

Unit V: Functional Genomics

DNA microarray – Construction and Design- Application of DNA microarray for comparative and evolutionary genomics. Gene silencing, RNAi, siRNA, shRNA - Proteome analysis – Protein-protein Interactions. Application of Microbial Genomics – genomic approaches for semi synthetic bacteria - Reverse Vaccinology: from genome to vaccine-Microbial genomics for Antibiotic Target Discovery.

Unit VI: Current Contours (for continuous internal assessment only)
Discussion onGenome based identification of microbes in human ocular body fluid-proximity dependent hybridization- Literature Seminar on nanopore sequencing technology-sequencing human genome with pocket sized nanopore device- single molecule real time sequencing (SMRT)- Latest quiz on the ocean gene atlas- group I intron are in archea-CRISPR.

References

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Course Outcomes

After completion of the course the student can be able to,

- ✓ Analyze the raw sequence data, cleaning and assembly of sequences
- ✓ Know about Gene-by-gene annotation
- ✓ Gain knowledge in genome wide associated study
- ✓ Understanding the filtering and assembly to taxonomic classification,clustering, and functional assignment
- ✓ Analyses of microbial community composition and comparative metagenomics
- ✓ Know the basic principles of genome organization and evolution in microbes
- ✓ know how gene functions are predictedusing systems biology techniques
- ✓ Ability to obtain and analyse information using bioinformatics principles and tools

Course 3: COMPUTATIONAL BIOLOGY AND BIOINFORMATICS

Course Code: 18MICRIV02 **Credits: 4**

Objectives

- To be experienced in bioinforamtics programs
- To study the basics of insilico analysis
- To be familiar in biological databases.

Syllabus

Unit I: Introduction to Computational Biology and Sequence Analysis

Molecular sequences, Genome sequencing: pipeline and data, Next generation sequencing data, Biological databases: Protein and Nucleotide databases, Sequence Alignment, Dynamic Programming for computing edit distance and string similarity, Local and Global Alignment, FASTA algorithm, Functional Annotation, Progressive and Iterative Methods for Multiple sequence alignment.

Unit II: Phylogenetics

Introduction to Phylogenetics, Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees, Parsimonous trees, Additive trees, Bootstrapping.

Unit III: Protein Structure, Modelling and Simulations

Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modeling, Structural Genomics, Molecular Docking principles and applications, Molecular dynamics simulations.

Unit IV: Introduction to primary Databases

Types of Biological data- Genomic DNA, cDNA, rDNA, ESTs, GSSs; Primary Databases Protein Sequence Databases- UniProtKB, UniProt, TrEMBL, Swiss-Prot, UniProt Archive-UniParc, UniProt Reference Clusters-UniRef, UniProt Metagenomic and Environmental SequencesUniMES. Literature Databases- PubMed, PLos, BioMed Central.

Unit V: Bioinformatics for Genomics

GenBank – NCBI, EMBL & DDBJ – retrieving sequences. Tools used for phylogenetic analysis, FASTA, BLAST, Phylip. RNA structure prediction, Restriction enzyme patterns. Designing primers & probes. Submission of rDNA sequences – Bankit & Sequencing guidelines.

Unit VI: Current Counters (For continuous internal assessment only)

Literature Seminar on BaMM server- HSYMDOCK: a docking web-SMARTIV: gRINN-ComplexContact, Discussion onSWISS-MODEL: homology modelling of protein structures and complexes- Create a model on protein interaction and binding -Updated quiz onGADGET: phylogenetic trait scores worldwide.

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Course Outcomes

After completion of the course the student can be able to,

- ✓ Use genomic databases and bioinformatic resources to identify the microbes
- ✓ Can understand the similarity and differences of two individual genus by specific program.
- ✓ Understand the general methods of phylogentics tree construction
- ✓ Know the advances in bioinformatics and computational biology.
- ✓ Understanding of biological databases and retrieval of sequences from databases.
- ✓ Develop an understanding of algorithms protein modelling
- ✓ Develop computational skills relevant to solving problems in bioinformatics
- ✓ Develop docking skills and its application in various interaction studies.

Course 3: BIOLOGY OF PROBIOTICS

Course Code: 18MICRIV03 **Credits: 4**

Objectives

- To get knowledge on beneficial role of probiotics
- To know the application of probiotics
- To be familiar in characterization of Probiotics

Syllabus

Unit I: Gastrointestinal Ecosystem

Introduction - Gastrointestinal tract architecture - Intestinal microbiota - Functions of endogenous microflora on the intestine - GI microbiota and regulation of the immune system - Factors affecting the gut microbial balance - Gastrointestinal diseases - Treatment and prevention of gastrointestinal disease: Antibiotics, Probiotics, Prebiotics, Synbiotics.

Unit II: Probiotics

Definition - History of probiotics - Features of probiotics - Types of probiotics: Human probiotics, Animal probiotics - Forms of probiotics - Selection criteria of ideal probiotics - Probiotic territorial colonization – Physiological effects and mechanism of action of probiotics - Side effects and safety profile of probiotics - Limitations of probiotics - Dosage.

Unit III: Probiotic microbes and foods

Probiotic *strains* - *Lactic acid bacteria (LAB): Lactobacillus, Leuconostoc, Pediococcus, Lactococcus* and *Streptococcus* - *Bifidobacteria* - *Saccharomyces* - *Escherichia coli* - *Bacillus* - *Enterococcus* - Commercial probiotic strains - Genetically modified probiotics (GMP) Probiotic recipies: Fermented and unfermented milk - Yogurt - Cheese - Sauerkraut - Garlic - Miso - Tempeh - Soy beverages.

Unit IV: Probiotic Selection Techniques

In vitro assessment of probiotic microbes : Acid resistance - Bile salt resistance - Resistance to H_2O_2 - Pepsin resistance - Pancreatin resistance - Antibiotic resistance – Antimicrobial activity assay - Inhibitory activity assay - Phosphoketolase assay - Phenol tolerance - NaCl tolerance - Hydrophobicity of microbes - Mucin adhesion assay.

Unit V: Applications of probiotics

Probiotics in clinical practice as therapeutics against enteric disorders - Infectious diarrhea - Lactose intolerance – Hypertension - Irritable bowel syndrome (IBS) - Allergy - Atopic dermatitis - Bacterial vaginosis - Cholesterol assimilation - Inflammatory bowel diseases - *Helicobacter pylori* infection - Anticancer effects - Tooth decay and periodontal disease - Probiotics as drug delivery system - Future prospects of probiotics - Other benefits.

Unit VI: Current Counters (for continuous internal assessment only)

Updated quiz on Factors Affecting Gastrointestinal Microbiome Development in Neonates, methods for phylogenetic analysis of microbiome data- Discussion on Benefaction of probiotics for human health: A review- Effects of Probiotics, Prebiotics, and Synbiotics on Human Health- Updated quiz on prebiotics and probiotics: creating a healthier you, probiotics as potential antioxidants.

References

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Course Outcomes

After completion of the course the student can be able to,

- ✓ Understanding the basics and analyzing different sources of probiotics
- ✓ Mechanism of action of probiotics
- ✓ Studying of probiotic regulation on GI tract
- ✓ Basic selection criteria of an effective probiotic
- ✓ Understanding and applying the guidelines regarding safety according to DBT
- ✓ Studying about the basic knowledge on prebiotics and synbiotics

- ✓ Optimization studies for the maximum probiotic activity
- ✓ Studying the biological applications of Probiotics

Course 3: TECHNIQUES IN MOLECULAR BIOLOGY

Course Code: 18MICRIV04 **Credits: 4**

Objectives

- To study the molecular techniques for characterization of microbes
- To study the purification procedures for validation of expressed products
- To find out the necessary bioinformatics program for characterization of microbes.

Syllabus

Unit I: Molecular Taxonomy

Introduction- Importance of 16S rRNA in taxonomy & phylogeny, 16S rDNA amplification. Southern, Northern, Western and Dot blotting, Principles and techniques of Southern and Northern hybridization. Principles and applications of PCR, RT-PCR, and qPCR. DNA Microarays/Chips. Cloning strategies.

Unit II: Separation Techniques

SDS - PAGE. Electrophoresis – Principle, types and applications – PAGE (proteins), Agarose (Nucleic acids), Pulse field Gel Electrophoresis (PFGE), Two dimensional electrophoresis (IEF), Density Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE) and TRFLP (*Terminal Restriction Fragment Length Polymorphism*).

Unit III: rDNA Techniques

Restriction Mapping –Restriction fragment length polymorphism (RFLP), Single locus and multi locus DNA finger printing, PCR based DNA finger printing –Random Amplified Polymorphic DNA (RAPD), Amplified fragment length polymorphism (AFLP), Short tandem repeat (STR) and LTR analysis. DNA sequencing – manual and automated methods.

Unit IV: Sequencing Methods and Strategies

Basic DNA sequencing - Modifications of chain-terminator sequences- Automated DNA sequencing- DNA sequencing by capillary array electrophoresis- shotgun sequencing - High throughput sequencing- sequencing strategies-Alternative DNA sequencing – EST sequencing.

Unit V: Bioinformatics for Genomics

GenBank – NCBI, EMBL & DDBJ – retrieving sequences. Tools used for phylogenetic analysis, FASTA, BLAST, Phylip. RNA structure prediction, Restriction enzyme patterns. Designing primers & probes. Submission of rDNA sequences – Bankit & Sequin guidelines.

Unit VI: Current Counters (for continuous internal assessment only)

Discussion on Cross talk between proteins affects gene expression- Taxonomic discoveries based on DNA barcoding and morphology- Literature Seminar on DNA- surveillance, applied molecular taxonomy for species conservation and discovery- Up to date quiz on spectrometer in smartphones- Create a model on modern DNA sequencing methods.

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Course Outcomes

After completion of the course the student can be able to,

- ✓ Studying about the basics concepts in molecular biology
- ✓ Isolation of DNA and incorporation of PCR technique
- ✓ Understanding the basic of molecular biology techniques like SDS- PAGE,RT-PCR etc.
- ✓ Sequencing of the amplified DNA
- ✓ Genbank Submission of Sequences in NCBI, DDBJ
- ✓ Understanding about the Bankit and their uses
- ✓ Gaining knowledge on restriction site analysis
- ✓ Application of RAPD techniques in the probiotic studies

Course 3: ALGOLOGY

Course Code: 18MICRIV05 **Credits: 4**

Objectives

- To get basic and essential knowledge on algae
- Cultivation and maintenance of algae
- Gain knowledge on algal commercial applications.

Syllabus

Unit I: Introduction to Algae

Introduction to algae: Definition- Distribution of algae- Classification of algae: Important features – Ultrastructure of prokaryotic and eukaryotic algal cells. Thallus organization among algae: Unicellular, colonial, filamentous, siphonous and parenchymatous thallus organizations with examples- pigments and food reserve material.

Unit II: Reproduction in Algae

Vegetative reproduction in algae: Binary cell division, autocolony formation, fragmentation, Hormogones, hormocysts, planococcus, propagules, bulbils and adventitious branches. Asexual reproduction in algae: zoospores, aplanospores, hypnospores, autospores, monospores, tetraspores, endospores and exospores. Sexual reproduction and life cycle in algae: isogamous, anisogamous, and oogamous sexual reproduction. Monophasic, biphasic, and triphasic life histories. Life cycles in algae: Zygotic, gametic, sporic (biphasic). Sporic (triphasic) and somatic life cycles.

Unit III: Cyanobacterial Cultivation

Collection and preservation of algal samples.Isolation, purification and maintenance of cultures. Mass culturing methods: open and closed culture system – Various cell harvesting strategies: centrifugation – sedimentation- flocculation- flotation – filtration methods.

Unit IV: Cyanobacterial Metabolites

Economic importance of algae: Food and Feed – Pharmaceuticals and neutraceuticals – Phytohormone production: Auxins – Cytokinins – Gibberellins – Biofertilizers – Biofuel production: biodiesl – biohydrogen- bioethanol- biobutanol.

Unit V: Cyanobacterial Applications

Environmental importance of algae: CO2 mitigation and sequestration- hydrocarbon degradation – heavy metal biosorption – harmful algal blooms – phycotoxins – toxic effect to aquatc organisms and its application in biomedical field.

Unit VI: Current Contours (for continuous internal assessment only)

Conclave talk on Cell wall structure of coccoid green algae, Shaping colour changes in a biofilm-forming cyanobacterium by modifying the culture conditions- Discussion on quantifying biomolecules in *Spirulina platensis* via Fourier transform infrared Attenuated total reflectance spectroscopy- Updated quiz onIn situ photosynthetic yields of cave photoautotrophic biofilms using two different Pulse Amplitude Modulated fluorometers- Development of caynobacteria for nano- marine drugs- Model on Photobioreactor Cultivation Strategies for Microalgae and Cyanobacteria.

References

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Course Outcomes

After completion of the course the student can be able to,

- ✓ Gain knowledge and skills to identify cyanobacteria
- ✓ Become familiar with sampling, isolation, culturing in the laboratory and techniques.
- ✓ Know about algal survival at varied environment in respect to adaptation.
- ✓ Diversity and traditional classification of algae will be studied.
- ✓ Gain Knowledge about the main applications of algal products
- ✓ Awareness and knowledge about the benefits that can be obtained from algal biomass.
- ✓ Know the facts and ideas on the subject of algal production at large scale.
- ✓ Study the physiological aspects of algae and its symbiotic relationship

Course 3: CYANOBACTERIAL DIVERSITY AND BIOTECHNOLOGY

Course Code: 18MICRIV06 **Credits: 4**

Objectives

- To be familiar in cyanobacterial Taxonomy and Identification.
- Aim to know the cyanobacterial mechanism in secondary metabolite production.
- To expand knowledge in cyanobacterial applications.

Syllabus

Unit I: Molecular evolution and Taxonomy of Cyanobacteria

Introduction, Guidelines to the taxonomy of cyanobacteria, Botanical and Bacteriologist classifications. Habitat diversity – soil, freshwater, marine, arid and temperate regions, and symbiosis. Chemotaxonomic and macromoloecular classifications – use of isozymes, proteins and polyamines, ITS, 16SrRNA and other marker genes.

Unit II: Cyanobacterial Pigments

Introduction to phycobilisomes and phycobiliproteins. Linker polypeptide and skeleton of PBS. Organization of genes encoding the phycobiliproteins. Chlorophylls and phycobillins biosynthetic pathway. Extraction and purification methods. Application of cyanobacterial pigments. Scytonemin and UV protecting pigments.

Unit III: Genetic analysis of cyanobacteria

Introduction to genemanipulative techniques for cyanobacteria. Mechanism of gene transfer, mutagenesis, reporter systems, and mapping in cyanobacteria. Expression of foreign genes in cyanobacteria;pratical problems and possible solutions for developing a genetic system.

Unit IV: Cyanobacterial Stress physiology

Responses of cyanobacteria to various environmental stresses; chromatic adaption, nutrient deficiency, salt tolerance, heat shock response and molecular chaperons. Genes encoding the adaptive responses in cyanobacteria. Role of ROS enzymes systems and various other enzymes in stress tolerance.

Unit V: Biotechnological potentials

Bioactive compounds produced by cyanobacteria: anti-viral, anti- cancer enzyme inhibitors, hepato, neurotoxins. Synthetic and molecular mechanisms of ribosomal and non-ribosomal peptides; peptide-polketide hybrid molecules. Bio hydrogen and bio diesel production strategies and characterization and over expression of their genes. Application of cyanobacteria in various fields.

Unit VI: Current Counters (for continuous internal assessment only)

Modernized quiz onRecent developments in cyanobacterial research with special reference to aquatic habitats, molecular ecology and phylogenetic taxonomy- A curated database of cyanobacterial strains relevant for modern taxonomy and phylogenetic studies- Literature Seminar on Diazotrophic *Trichodesmium* influence on ocean color and pigment composition - sunscreen from microbes- Discussion oncontrols on oxygen production in cyanobacterial mats.

References

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Course Outcomes

After completion of the course the student can be able to

- ✓ Acclaimed to identify cyanobacteria at genus and species level
- ✓ Cyanobacterial classifications and validate the genus through molecular methods will be developed
- ✓ Cyanobacterial pigments related to application oriented methods will be expanded
- ✓ Cyanobacterial extraction methods will be optimized
- ✓ Ability to develop a standardized methods in cyanobacterial expression and mapping
- ✓ Will know the cyanobacterial physiology against various stress
- ✓ Will understand the influence of cyanobacterial toxins in environment

  Cyanobacteria related to energy and environment will be flourished

Course 3: MICROBIAL METABOLISM

Course Code: 18MICRIV07 **Credits: 4**

Objectives

- To study the important metabolic pathways of microbes
- To study the bacterial transport across the membrane
- To study the protein machinery and enzyme technology of microbes

Syllabus

Unit I: Anabolic pathways

Anabolic reactions - Acetyl coA pathway, Calvin cycle - C3, C4, CAM- HMG CoA reductase pathway. Overview of photosynthesis: Light reaction- non-oxygenic and oxygenic photosynthesis.

Unit II: Catabolic pathways

Catabolic reactions - Glyoxylate cycle- Oxidative Phosphorylation. Carbohydrate catabolism- Glycolysis- Pentose Phosphate Pathway- Entner-Doudoroff pathway- Krebs cycle- Electron transport system - Beta oxidation.

Unit III: Bacterial membrane transport

Introduction to membrane structure & function. Diffusion in membranes, movement of ions and molecules across membrane, osmosis, ion-channels, active transport, ion pumps, group translocation, mechanism of sorting and regulation of intracellular transport, electrical properties of membrane. Mechanism of protein export across the bacterial outer membrane.

Unit IV: Protein biosynthesis & processing

Cellular machinery of protein synthesis. Steps in translation - formation of initiation complex - initiation factors & their regulation, elongation factors, termination. Genetic code, aminoacylation of tRNA, tRNA identity, aminoacyl tRNA synthetase. Translational proof reading, translational inhibitors, post- translational modification of proteins. Protein turnover.

Unit V: Microbial enzymes

Introduction to enzymes and enzyme kinetics. Enzyme regulation, mechanism of enzyme catalysis- isozymes. Enzyme and chemical reaction, chemical nature of co-enzymes, enzyme specificity and efficiency. Factors influencing enzyme activity, energy production, oxidation-reduction reaction. Applications of serine protease, ribonuclease, lactate dehydrogenase, hydrogenase & nitrogenase enzymes.

Unit VI: Current Counters (for continuous internal assessment only)

Seminar on How a cell knows when to divide, atomic force microscopy in measuring protein assembly- snap lock mechanism in bacterial roboswitch- metabolic interactions in microbial community- Discussion on using metabolic networks to resolve ecological properties of microbiomes- Open chat on bacterial membrane vesicles transport their DNA cargo into host cells.

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Course Outcomes

After completion of the course the student can be able to,

- ✓ Study the anabolic pathways for synthesis of molecules and energy storage.
- ✓ Study the breakdown of biological molecules for release of energy.
- ✓ Know the basic principles of microbial metabolism for engineering.
- ✓ Understand how transport occurred between the bacterial membranes.
- ✓ Know the differences between prokaryotic and eukaryotic protein synthesis.
- ✓ Know the importance of enzyme for each biological system
- ✓ Understand the importance of coupled channels, cotransport, and counter transport.

Course 3: PHOTOBIOLOGY AND BIOENERGETICS OF CYANOBACTERIA

Course Code: 18MICRIV08 **Credits: 4**

Objectives

- Introduction to cyanobacterial fuel production
- To study the photosystem of cyanobacteria for increased bioenergy production
- To study the cyanobacterial genes involved in fuel production

Syllabus

Unit I: Renewable energy

Introduction to solar fuels & renewable energy from cyanobacteria. Methods to produce solar fuel: indirect, direct and semi-direct process. Principle reactions for artificial photosynthesis. Cyanobacteria as a source of renewable energy – Hydrogen, Ethanol, Photanol, Diesel, Methane, electricity & fuel cells.

Unit II: Cyanobacterial photosynthesis

Introduction to structure and functions of chloroplast, thylakoid membranes. Overview of photosynthesis - Photosystem I & II. Components involved in photosynthesis & respiration. Light harvesting pigments, mechanism of electron transport, proton motive force, ATP synthesis, Photophosphorylation. Regulation of photosynthesis & respiration.

Unit III: Cyanobacterial N_2 fixation mechanism

Introduction to N_2 fixation, nitrogenase, heterocyst formation & differentiation. Molecular aspects of cyanobacterial nitrogen fixation: Genes involved in the regulation of nitrogen fixation, functions of *nif* genes. Genetic aspects of nitrate, nitrite and ammonia assimilation. Gene network of hydrogen metabolism in nitrogen-fixing heterocystous cyanobacteria.

Unit IV: Cyanobacterial H_2 metabolism

Introduction to hydrogenases, classification, structure & properties. Genetic analysis of hydrogenase complexes - uptake & bidirectional hydrogenase. Mutational approaches, Metabolic engineering pathway for energy production. Maturation and regulation of hydrogenase. Strategies for improving biological H_2 production. Biotechnological applications of hydrogenases.

Unit V: Synthetic biology in cyanobacteria

Introduction to tools for synthetic biology in cyanobacteria. Development of biobricks – promoters, transcriptional terminators, ribosome binding sites, negative regulation of gene expression, plasmid construction, codon usage, transformation of cyanobacteria. Challenges and opportunities of synthetic biology to improve H_2 production. Applications of engineered cyanobacteria.

Unit VI: Current Counters (for continuous internal assessment only)

Open argument on New Nano reactor to produce hydrogen biofuel- cyanobacteria based biofuel: an innovative platform for clean energy production- Literature Seminar on NREL creates new pathways for producing biofuels and acids from cyanobacteria- Discussion on optimizing phycobilisome of cyanobacteria for biofuel production.

References

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4. https://blog.ucsusa.org/science-blogger/cyanobacteria-based-biofuel-an-innovative-platform-for-clean-energy-production
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Course Outcomes

After completion of the course the student can be able to

- ✓ Study the interaction of photosynthesis, respiration and nitrogen fixation in cyanobacteria
- ✓ Challenges and opportunities of synthetic biology to improve H2 production
- ✓ Knowledge about metabolic engineering pathway for enhanced energy production in cyanobacteria
- ✓ Genetic analysis of hydrogenase complexes - uptake and bidirectional hydrogenase
- ✓ Study the genes involved in the regulation of nitrogen fixation, functions of nif genes.
- ✓ Understanding the gene network of hydrogen metabolism in nitrogen-fixing heterocystous cyanobacteria
- ✓ Biotechnological applications of engineered cyanobacteria.
- ✓ Knowledge about mutational approaches for enhanced H2 production in cyanobacteria

Course 3: CYANOBACTERIAL DIVERSITY AND BIOTECHNOLOGICAL POTENTIALS

Course Code: 18MICRIV09 **Credits: 4**

Objectives

- To be familiar in cyanobacterial Taxonomy and Identification at advanced molecular techniques.
- Aim to know the cyanobacterial mechanism in secondary metabolite production.
- To expand knowledge in cyanobacterial applications.

Syllabus

Unit I: Molecular evolution and Taxonomy of cyanobacteria

Introduction, Guidelines to Taxonomy of cyanobacteria, Botanical and Bacteriological classifications.Habitat diversity – soil, freshwater, marine, arid, temperate region, and symbiosis. PCR based fingerprinting – RAPD, STRR& LTRR, Rep- PCR, ERIC,BOX, AFLP.

Unit II: Genetic analysis of cyanobacteria

Introduction to gene manipulative techniques for cyanobacteria.Mechanism for gene transfer, mutagenesis, reporter systems, and mapping in cyanobacteria.Expression of foreign genes in cyanobacteria; practical problems and possible solutions for developing a genetic system.

Unit III: Cyanobacterial stress physiology

Responses of cyanobacteria to various environmental stress;chromatic adaption,nutrient deficiency, salt tolerance, heat shock response and molecular chaperones .Genes encoding the adaptive response in cyanobacteria.Role of ROS enzymes systems andvarious other enzymes in stress tolerance.Phycobiliproteins and its applications.

Unit IV: Biotechnological potentials

Bioactive compounds produced by cyanobacteria: anti-viral, anticancer, enzyme inhibitors, antihyperlipidemic, hepato and neurotoxins.Synthetic and molecular mechanisms of ribosomal and non-ribosomal peptides; peptide-polyketide hybrid molecules.Bio-hydrogen, bio diesel production strategies, characterization and overexpression of their genes.Application of cyanobacteria in various fields.

Unit V: Bioinformatics for genomics

Genome sequence comparison, alignment and data base searching. Gen bank- NCBI, EMBL&DDBJ – retrieving sequences. Tools used for phylogenetic analysis – Ribosomal database Project, FASTA, BLAST, Phylip. RNA structure prediction, restricting enzyme patterns.Designing primer &probes.DNA barcoding. Submission of rDNA sequences – Bankit& sequin guidelines.

Unit VI: Current Counters (for continuous internal assessment only)

Argument on Cyanobacterial Farming for Environment: Innovations and PerspectivesAssingment on Diazotrophic *Trichodesmium* influence on ocean color and pigment composition in the South West tropical Pacific, Updated quiz onStructural Diversity, Biological Properties and Applications of Natural Products from Cyanobacteria. Literature seminar on Nitrogen metabolism in cyanobacteria: metabolic and molecular control, growth consequences and biotechnological applications.

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Course Outcomes

After completion of the course the student can be able to

- ✓ Acclaimed to identify cyanobacteria at genus and species level
- ✓ Cyanobacterial classifications and validate the genus through molecular methods will be developed
- ✓ Cyanobacterial pigments related to application oriented methods will be expanded
- ✓ Cyanobacterial extraction methods will be optimized
- ✓ Ability to develop a standardized methods in cyanobacterial expression and mapping
- ✓ Will know the cyanobacterial physiology against various stress

- ✓ Will understand the influence of cyanobacterial key molecules like NRPS and PKSfor metabolite production will be studied.
- ✓ Cyanobacteria related to bioinformatics for sequencing and other biological websites will be studied.

Course 3: LIPIDS AND CELL BIOLOGY

Course Code: 18MICRIV10 **Credits: 4**

Objectives

- To be familiar in fatty liver diseases
- To know the signaling pathways and cell cycle
- To get basic knowledge in proteomics and cancer biology.

Syllabus

Unit I: Lipids and Fatty liver disorders

Lipids: Structure, classification, properties and biological functions of fatty acids. Steroids– functions of cholesterol, bile acids and sex hormones.Lipogenesis.Biosynthesis, regulationsof fattyacid, cholesterol and its clinical significance.Hyperlipidemia, hyperlipoproteinemia,Fatty liver, Gauchers disease, Tay-Sachs and Niemann-Pick disease, ketone bodies, Abetalipoproteinemia , Lipotrophic factors and its clinical investigation. Normal and abnormal functions of liver.Diseases of the liver- Dyslipidameia,hepatitis cholestasis, cirrhosis.Hepatobiliary diseases: formation of bilirubin, urobilinogen bile acids, types of jaundice and its clinical investigation, liver function tests and related diagnosis. Ethanol Metabolism – Hepatic cell injury.Oxidation of lipids.Role of carnitine cycle in the regulation of β -oxidation.Ketogenesis and its control.Lipoprotein metabolism - exogenous and endogenous pathways.

Unit II: Receptors and Signaling Pathways

Cellsignalling, cell surface receptors. G Protein coupled receptors and its regulation. Signalling molecules-cAMP, cGMP, metabolic pathways for the formation of inositol triphosphate from phosphatidyl inositol diphosphate, Ca^{2+}, DAG and NO as signalling molecules, ryanodine and other Ca^{2+} receptors, phosphoregulation of inositol and calcium channel activation. Ser/Thr-specific protein kinases and phosphatases.Receptor tyrosine kinases- Ras&Raf proteins,MAP kinase pathways. Jak-Stat pathway.

Unit III: Cellular anatomy and Physiology

Overview of the cell cycle, cell cycle control mechanisms, CDKs, regulation of cell cycle by proteolysis, G_1/S Phase transition, G_2/M Phase transition, cell cycle control of DNA replication, DNA damage check points. Development of cell lines, morphological characterisation, cultivation, differentiation, transfection, expression of recombinant protein in celllines, cryopreservation. Apoptosis, Necrosis.

Unit IV: Cancer Biology

Cancer, types of cancer, cancer initiation, promotion & progression, metastasis development, carcinogenesis, dysregulation of cancer, associated genes, chromosomal changes, gene amplification, epigenetic changes, molecular profiles of cancer cells. Errors of signal proteins and tumourigenesis.Oncogenes, proto-oncogenes and tumorsuppressor genes.p53signalling pathway and tumour suppression, APC and Wnt/ β Catenin Signalling.

Unit V: Proteomics

Proteomic tools-structural proteomics, quantitative 2D(DIGE), multidimensional chromatography.spectroflourimetry. principle and application of mass spectra, NMR, ESR, GC-MS , LC-MS, MALDI-TOF, X-ray diffraction. Biochips (DNA chips, Protein chips and

Sensor chips).Proteomics for understanding diseases at molecular level-new targets for anti-cancer drugs. Protein profiling, prediction by homology modeling, online analyzingtools.

Unit VI: Current Counters (for continuous internal assessment only)
Updated quiz on NAFLD: insights from sphingolipidomics- Dieting bacteria cure fatty liver diseases- G protein coupled receptor kinases past, present and future-Literature Seminar on role A kinase anchoring protein in cancer development- autophagy, inflammation and immunity in cancer treatment- Discussion onnotch signalling pathways and their importance in treatment of cancer- cancer CRISPR screens *invivo*.

References

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6. Reggi E and Diviani D (2017). The role of A-kinase anchoring proteins in cancer development, Cellular signalling, 40, pp143-155.
7. Zhong Z, Sanchez-Lopez E and Karin M (2016).Autophagy, inflammation, and immunity: a troika governing cancer and its treatment, Cell, 166(2), pp288-298.

Course Outcomes

After completion of the course the student can be able to,

- ✓ Understand the cell cycle, angiogenesis and apoptosis.
- ✓ Understand how immunotherapy is, and can be, used to treat human illness
- ✓ Understand how genetics involved in progression of cancer
- ✓ Analyze quantitative proteomic data by various software tools
- ✓ Understand the basic principles of signal transduction mechanisms.
- ✓ Understand how signaling pathways are interlinked.
- ✓ Understand the mechanisms behind receptor and ligand interaction.
- ✓ Analysis of compounds using various analytical tools

Course 3: CYANOBACTERIA AND PLANT PHYSIOLOGY

Course Code: 18MICRIV11 **Credits: 4**

Objectives

- To become familiar in physiology of plant and cyanobacteria
- In order to link the cyanobacterial mechanism with plant growth
- To study the cyanobacterial application in plant biotechnology.

Syllabus

Unit I: Photosynthesis

Light and pigments; Light dependent reactions of Photosynthesis; CO_2 fixation- C3, C4 , Crassulacean Acid Metabolism (CAM) pathways, Regulation of C4 photosynthesis and CAM; Photorespiration, Factors affecting the rate of photosynthesis. Cyanobacterial CCM in photosynthesis of C3 plants.

Unit II: Respiration

Organization of mitochondrial electron transport system in plants, cyanide resistant pathway and alternative oxidase, its role in regulation of mitochondrial electron transport.Transport of metabolites across mitochondrial membrane. Regulation of pentose phosphate pathway and its significance.Gluconeogenesis. Anaerobic respiration

Unit III: Plant biotechnology

Plant Tissue Culture-Historical perspective; Totipotency; Organogenesis, somatic embryogenesis, their regulation and application; Micropropagation; Somaclonal variation; Androgenesis and its applications in genetics and plant breeding; Germplasm conservation and cryopreservation. Protoplast Culture and Somatic Hybridization-Protoplast isolation, culture and usage.

Unit IV: Plant growth regulators

Auxin, cytokinins, Gibberellins, Abscisic acid- Biosynthesis, storage, breakdown and transport; physiological effects and mechanism of action.Biosynthesis of IAA in cyanobacteria; Indole-3-acetic acid in microorganism-plant signaling.Genome-wide screening for key genes in IAA biosynthesis.*IPDC* homologues in cyanobacteria.

Unit V: Cyanobacterial biofertilizers

Association of cyanobacteria with crop plants, cyanobacterial communities in rice fields, free living cyanobacteria and symbiotic cyanobacteria as a source of N, cyanobacteria - biofertilizer for rice.Rhizosphere dynamics of cyanobacterial regime, phytohormones quantification.

Unit VI: Current Counters (for continuous internal assessment only)

Literature Seminar on New take on early evolution of photosynthesis, CRISPR/Cas9-mediated gene targeting in Arabidopsis using sequential transformation- Enhancement of plant growth and yields in Chickpea (Cicer arietinum L.) through novel cyanobacterial and biofilmed inoculants- Discussion on Control of cytokinin and auxin homeostasis in cyanobacteria and algae- Phytohormones in microalgae: a new opportunity for microalgal biotechnology-Updated quiz on Diversity and functional traits of culturable microbiome members, including cyanobacteria in the rice phyllosphere.

References

1. Antonia H and Enrique F (2008). The cyanobacteria: Molecular biology, Genomics and Evolution, Ciaster Academic press, Spain.
2. Bhojwani SS and RazdanMK. Plant Tissue culture: Theory and Practice, Elsevier Science, Amsterdam.
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Course Outcomes

After completion of the course the student can be able to,

- ✓ Provides a theoretical basis for understanding cell and molecular biology of plants.
- ✓ Understanding the structure, function and regulation of photosynthesis in plants.
- ✓ Acquire working knowledge of laboratory techniques in plant biotechnology.
- ✓ Describe the function of plant hormones and their molecular mechanisms
- ✓ Understanding the theoretical background knowledge in plant sciences.
- ✓ Familiarize with the theoretical basis on practical application of plant growth regulators
- ✓ Understanding the interaction of cyanobacteria and plants
- ✓ Familiar in application of cyanobacteria as biofertilizer

Course 3: GENE REGULATION AND METABOLOMICS

Course Code: 18MICRIV12 **Credits: 4**

Objectives

- To know the genome organization in prokaryotes and eukaryotes
- To know genome regulation in microbial genomes
- To be familiar in metabolism of macromolecules

Syllabus

Unit I: Genome Organization and its Replication

Conjugation, transduction and transformation; Gene mapping in bacteria; Bacterial and cyanobacterial genomes; Replication of bacterial and eukaryotic genomes; Diversity of DNA polymerases; Replication of plasmids; plasmid copy number.

Unit II: Regulation of Transcription in Prokaryotes

Discovery of RNA and its synthesis; Operon concept; Promoters and terminators; Positive and negative control of transcription; Repression and activation; RNA polymerases, Accessory factors; Sigma factors; Control of termination, Synthetic promoters. Genetic Code and Translation- tRNAs; ribosomes; Initiation and termination of translation; Translational and post translational controls; Attenuation.

Unit III: Regulation of Eukaryotic genome

RNA polymerases and general transcription factors; Heterogeneous nuclear RNA; Cap structure and function; Polyadenylation; Transcription factors, DNAbinding and activation domains, co-activators; Chromatin remodeling and gene activation. Split Gene Concept and RNA Processing - Introns and exons - size, distribution and evolution; RNA splicing; Catalytic RNA; Alternative splicing; RNA stability.

Unit IV: Bio energetics

Carbon Assimilation - Light absorption and energy conversion; Calvin Cycle; Hatch-Slack pathway; Reductive pentose phosphate pathway; Carbon dioxide uptake and assimilation; Photorespiration; Glycolate metabolism. Biological Oxidation and Release of Energy-Glycolytic pathway; Kreb's cycle; Oxidative phosphorylation , Pentose phosphate shunt pathway.

Unit V: Metabolism of Macromolecules

Biosynthesis and inter-conversion of carbohydrates and lipids; Metabolism of nucleotides, amino acids and vitamins. Nitrogen, Sulphur and Phosphorus Metabolism - Nitrate reduction; Pathways of ammonia assimilation; Reductive amination; Trans-amination; Regulation of nitrogen assimilation; Uptake, transport and assimilation of sulphate and phosphate.

Unit VI: Current Counters (for continuous internal assessment only)

Discussion on From structure to mechanism understanding initiation of DNA replication - Assignment on DNA replication origin where do we begin?- Literature Seminar on Systematic approach for dissecting the molecular mechanisms of transcriptional regulation in bacteria- Updated quiz on RNA-mediated gene regulation is less evolvable than transcriptional regulation.

References

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Course Outcomes

After completion of the course the student can be able to,

- ✓ Can compare gene regulation in pro-and eukaryotic organisms
- ✓ Understand the principles of metabolomics.
- ✓ Understand metabolism and the interaction of the metabolome with the genome
- ✓ Describe the principles of metabolism
- ✓ Apply knowledge and research applications in genomics
- ✓ Familiar with theoretical aspects and principles in metabolomics
- ✓ Understand the metabolomic and proteomic-based research
- ✓ Evaluate and discuss original research articles in the area of gene regulation

Course 3: BIOLOGY OF PROBIOTICS

Course Code: 18MICRV01 **Credits: 4**

Objectives

- The main objective of this course is to concentrate on gastrointestinal tract and their architecture, Functions of endogenous microflora and regulation of the immune system.
- To know the role of antibiotics, probiotics, prebiotics, and Synbiotics
- To acquire a basic understanding on physiological effects and mechanism of action of probiotics and probiotic selection techniques
- To learn about the Genetic tools used for the identification of adaptation and probiotic factors.

Syllabus

Unit I: Gastrointestinal Ecosystem of Chicken

Introduction - Gastrointestinal tract architecture - Intestinal microbiota - Functions of endogenous microflora - GI microbiota and regulation of the immune system - Factors affecting the gut microbial balance - Role of enteric pathogens in gastrointestinal diseases - Treatment and prevention of gastrointestinal disease: Antibiotics, Probiotics, Prebiotics, Synbiotics.

Unit II: Probiotics

Definition - History of probiotics - Features of probiotics - Types of probiotics: Human probiotics, Animal probiotics - Forms of probiotics - Probiotic territorial colonization - Physiological effects and mechanism of action of probiotics - Side effects and safety profile of probiotics - Limitations of probiotics - Dosage.

Unit III: Probiotic microbes

Probiotic strains - Lactic acid bacteria (LAB): Lactobacillus, Leuconostoc, Pediococcus, Lactococcus - Actinobacteria: Bifidobacteria - Streptomyces - Oerskovia - Fungi: Saccharomyces, Candida, Aspergillus - Others: Escherichia coli - Bacillus - Enterococcus - Commercial probiotic strains - Genetically modified probiotics (GMP).

Unit IV: Probiotic selection techniques

In vitro assessment of probiotic microbes: Survivability- Acid resistance, Bile salt resistance, Pepsin resistance, Pancreatin resistance, Colonization properties- Aggregation, Hydrophobicity, Adhesion with intestinal epithelial cell lines, Mucin adhesion assay, Biofilm forming ability, Safety- Hemolytic activity - Antibiotic resistance, Functional properties - Antimicrobial activity, Bile salt hydrolase activity, Production of digestive enzymes, In vivo assessment of probiotic microbes in chicken model.

Unit V: Mechanisms of Probiotic microbes

Adaptation factors: Stress resistance - Cell envelope integrity, DNA & protein repair, Transport and hydrolysis of bile (bsh gene); Adhesion factors - S layer and mucus binding proteins (mub gene), LTA, EPS, PG; Health promoting factors - Microbe Microbe interaction, Production of antimicrobial compounds, Competitive exclusion; Genetic tools used for the identification of adaptation and probiotic factors.

Unit VI: Current Contours (For Continuous Internal Assessment only)

Daily news and research paper on Probiotics, Prebiotics and probiotics food preparations. Quiz on- Features of probiotics - Types of probiotics: Human probiotics, Animal probiotics - Forms of probiotics. Debate on-advantage and disadvantage of probiotics for human and animal.

References

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Course Outcomes

After completion of this course the student can able to

- ✓ Understand the basic knowledge of gastrointestinal ecosystem
- ✓ Learn the gastrointestinal microbiota and regulation of the immune system
- ✓ Explain the definition and types of probiotics
- ✓ Characterize the limitation and dosage of probiotics
- ✓ List out the commercial probiotic strains

- ✓ Knowledge about the genetically modified probiotics
- ✓ Able to do the in vitro assessment of probiotic microbes
- ✓ Exploring the genetic tools used for the identification of adaptation and probiotic factors

Course 3: NANO BIOTECHNOLOGY

Course Code: 18MICRV02 **Credits: 4**

Objectives

- To study the synthesis of nanostructured materials - physical, chemical and biological methods
- To acquire the knowledge about synthesis process, application and role of plants in nanoparticle synthesis
- To understand the nanoprobes for analytical applications- medical diagnostics and biotechnology
- To analysis the nanomechanics and tissue pathology and drug delivery.

Syllabus

Unit I: Nanotechnology Introduction- Metal Nanoparticles - Synthesis of Nanostructured Materials - Physical Methods, Chemical Methods and Biological methods - Synthesis of Metals, Intermetallics, and Semiconductors - Size Control - Crystalline Phase Control - Size Quantization Effects - Nanocomposites preparation - Nanocomposites Containing Elemental Nanoparticulates - Nanocomposites Containing Nanoparticulate Substances - Metal Oxide Nanocomposites

Unit II: Biosynthesis of nanoparticle -using of bacteria, Actinobacteria and fungi, Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Mechanism of formation; Viruses as components for the formation of nanostructured materials; Synthesis process and application, Role of plants in nanoparticle synthesis- Silver Nanoparticles- Top-Down vs. Bottom-Up - Crystal Structures - Synthesis of Silver Nanoparticles - Tools for developing an optical model - Detection of Silver Nanoparticles - The Bactericidal Effect of Silver Nanoparticles - application of silver nanoparticles - Health effects of Silver Nanoparticles

Unit III: Characterization of Metal Nanoparticles. Spectrophotometry- UV- Visible spectrophotometry, Energy Dispersive Spectrophotometry, Atomic Absorption Spectrometry; Microscopic studies- SEM, TEM, AFM, STEM, Confocal Microscopy, Analytical Electron Microscopy- XRD- FT-IR- Zeta potential analyzer- Particle size analyzer.

Unit IV: Biomedical Applications- Drugs - Drug Delivery - Photodynamic Therapy - Molecular Motors - Neuro-Electronic Interfaces - Protein Engineering - Shedding New Light on Cells: Nanoluminescent Tags- Optics and Electronics - Light Energy - Light Production - Light Transmission - Interaction between bimolecules and naoparticle surface - Application of nano in biology - Nanoprobes for Analytical Applications- Medical diagnostics and Biotechnology, Current status of nano Biotechnology, Future perspectives of Nanobiology.

Unit V : Biocomputational Approach - Nanomechanics and Tissue Pathology- Assembly and Characterization of Biomolecule–Gold Nanoparticle Conjugates and Their Use in Intracellular Imaging - Whole-Blood Immunoassay Facilitated by Gold Nanoshell–Conjugate Antibodies - Assays for Selection of Single-Chain Fragment Variable Recombinant Antibodies to Metal Nanoclusters - Surface-Functionalized Nanoparticles for Controlled Drug Delivery - Screening of Combinatorial Peptide Libraries for Nanocluster Synthesis - Structural DNA Nanotechnology - Nanostructured DNA Templates - Probing DNA Structure With Nanoparticles.

Unit VI: Current Contours (For Continuous Internal Assessment only)

Quiz on- medical diagnostics, drug targeting, drug delivery, nanosurgery and other biomedical field using Nano particles. Debate on – advantage and disadvantage of nanoparticles for environmental remediation and Nanotechnology in agriculture. Paper presentation on current research in nanobiotechnology. Assignment on-Future of nanobiotechnology.

References

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Course outcomes

After completion of this course the student can able to

- ✓ Understand the nanostructured materials synthesis – physical, chemical and biological methods
- ✓ Acquire the knowledge about process nanoparticles synthesis, application and role of plants in nanoparticle synthesis.
- ✓ Analyze and understand the mechanism of nanoprobes for analytical, medical diagnostics and biotechnology applications.

- ✓ Explore the strategies in the development of structural DNA nanotechnology - nanostructured DNA templates - probing DNA structure with nanoparticles
- ✓ Awareness about nanomechanics and tissue pathology and drug delivery.
- ✓ Knowledge about assays for selection of single-chain fragment variable recombinant antibodies to metal nanoclusters
- ✓ Able to do synthesis of silver nanoparticles tools for developing an optical model detection of silver nanoparticles
- ✓ Exploring the Microscopic studies- SEM, TEM, AFM, STEM Confocal Microscopy, Analytical Electron Microscopy- XRD- FT-IR- Zeta potential analyzer

Course 3: PHARMACEUTICAL MICROBIOLOGY

Course Code: 18MICRV03 **Credits: 4**

Objectives

- To learn about antibiotics and synthetic antimicrobial agents.
- To acquire the knowledge about mechanism of action of antibiotics and antimicrobial agents.
- To analysis microbial contamination and spoilage of pharmaceutical products and their importance.
- To screening s of antibacterial, antifungal, antiviral, antiprotozoan drugs from microorganisms.

Syllabus

Unit I: Antibiotics and synthetic antimicrobial agents

Antibiotics and synthetic antimicrobial agents- antifungal antibiotics, antitumor substances. Peptide antibiotics, Chloramphenicol, Sulphonamides and Quinolinone antimicrobial agents. Chemical disinfectants, antiseptics and preservatives.

Unit II: Mechanism of action of antibiotics

Mechanism of action of antibiotics. Molecular principles of drug targeting. Drug delivery system in gene therapy- Bacterial resistance to antibiotics. Mode of action of bacterial killing by quinolinones. Mode of action of non-antibiotic antimicrobial agents.

Unit III: Microbial production and Spoilage of pharmaceutical Products

Microbial contamination and spoilage of pharmaceutical products and their sterilization. Manufacturing procedures in process control of pharmaceuticals. Other pharmaceuticals produced by microbial fermentations. New vaccine technology, DNA, synthetic peptide, multivalent subunit vaccines.

Unit IV: Novel Drugs from Microorganisms

Screening methods of antibacterial, antifungal, antiviral, antiprotozoan drugs from microorganisms, Extraction, separation and purification of antimicrobial drugs from microorganisms, Characterization and identification of antimicrobial drugs, bioassay methods.

Unit V: Regulatory practices and Quality Assurance in Pharmaceuticals

Government regulatory practices and policies, Immobilization procedures for pharmaceutical applications. Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry. Regulatory aspects of quality control. Sterilization control and sterility testing Chemical and biological indicators.

Unit VI: Current Contours (For Continuous Internal Assessment only)

Quiz on- antibiotics, drug targeting, drug delivery, other pharmaceutical field using gene therapy. Debate on – advantage and disadvantage of antibiotics in human and animal health. paper presentation on current research in pharmaceutical applications. Assignment on-future of pharmaceutical products.

References

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Course outcomes

After completion of this course the student can able to

- ✓ Understand the Antibiotics and synthetic antimicrobial agents' mechanism and their importance.
- ✓ Acquire the knowledge about microbial contamination and spoilage of pharmaceutical products and their importance
- ✓ Analyse and understand the Immobilization procedures for pharmaceutical applications and Good Manufacturing Practices (GMP).
- ✓ Explore and understand the antibacterial, antifungal, antiviral, antiprotozoan drugs from microorganisms.
- ✓ Awareness about mechanism of action of antibiotics and antimicrobial agents.
- ✓ Knowledge about regulatory aspects of quality control, sterilization control and sterility testing chemical and biological indicators

- ✓ Able to do extraction, separation and purification of antimicrobial drugs from microorganisms
- ✓ Exploring the molecular principles of drug targeting, drug delivery system in gene therapy- bacterial resistance to antibiotics

Course 3: MYCOTOXICOLOGY

Course Code: 18MICRV04 **Credits: 4**

Objectives

- To impart brief knowledge on general characteristics, classification and biology of fungi
- To understand the fungal diseases, pathology, laboratory diagnosis, preventive measures and treatment
- To acquire a basic understanding on mycotoxins, co-occurrence of mycotoxins, mycotoxigenic fungi and their impact on food production and manufacturing unit
- To emphasize to learn about the genomics of mycotoxigenic fungi and the prevention and control of mycotoxins in agriculture

Syllabus

Unit I: General introduction

Morphology of fungi – Filamentous fungus and yeast, Ultrastructure and functions - cell surface & organelle function. Nutrition, Growth and reproduction, Isolation methods of Fungi. General Classification of Fungi: Biology and General Characteristics: Phylum Chytridiomycota, Zygomycota, Ascomycota, and Basidiomycota.

Unit II: Fungal diseases of Human

Introduction, Superficial mycoses, Opportunistic mycoses- Candidosis, Aspergillosis, Cryptococcosis, Pneumocystis pneumonia, Endemic systemic mycoses, Mycotoxicoses. Antifungal agents for use in Human Therapy: Introduction, Polyene antifungal agents, Azole antifungal agents, Flucytosine and other antifungal agents.

Unit III: Mycotoxins

Fungi and Mycotoxins in stored foods, Factors governing growth of fungi in stored food. Mycotoxins impacting food production and manufacturing. Damage caused by storage fungus and ways to minimize fungal contamination, Genomics of Mycotoxigenic Fungi (Fusarium, Aspergillus).

Unit IV: Mycotoxicology

Mycoses and Mycotoxicoses, Definition, Etymology and General principles, Major Mycotoxins- Aflatoxin, Fumonisins, Ochratoxin, Citrunin, Patulin, Trichothecenes, Zearalenone, Ergot alkaloids and other mycotoxins. Co-occurrence of Mycotoxins. Mycotoxins in the food chain: human health implications.

Unit V: Chemical Data

Fungal source and occurence, Biosynthesis, Toxicokinetics (Absorption, elimination and biotransformation) and Toxicodynamics of Aflatoxin, Fumonisins, Ochratoxin, Citrunin, Patulin, Trichothecenes, Zearalenone, Toxigenic mushroom, Mycotoxin prevention and control in agriculture, Global Mycotoxicology-issues and research.

Unit VI: Current Contours (For Continuous Internal Assessment only)

Daily news and research paper on mycotoxins in food and feed safety. Quiz on- Effect of mycotoxins - Types of mycotoxins: toxicity in Human and Animal health. Mini project in various recent research topics related to mycotoxins in food and feed safety, human and animal health and the economic impact.

References

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Course Outcomes

After completion of this course the student can able to

- ✓ To increase the scientific knowledge on mycotoxins and toxigenic fungi

- ✓ Learn the ways to minimize fungal contamination on food production
- ✓ Obtain the knowledge about Global Mycotoxicology-issues and research
- ✓ This course will promote the research on mycotoxins thereby leading to prevention and reduction in exposure to mycotoxins
- ✓ Create the awareness about the enhanced food safety, and prevention and control of mycotoxins
- ✓ Knowledge about toxigenic mushroom, mycotoxin prevention and control in agriculture
- ✓ Able to do mycotoxins impacting food production and manufacturing
- ✓ Exploring the damage caused by storage fungus and ways to minimize fungal contamination, genomics of mycotoxigenic fungi

Course 3: BASIC CONCEPTS AND APPLIED TOXICOLOGY

Course Code: 18MICRV05 **Credits: 4**

Objectives

- To impart brief knowledge on distinct concepts and classification of toxicants and their interactions in host tissues.
- To be aware of biotransformation of toxicants and different target organ toxicity like hematotoxicity, hepatotoxicity, nephrotoxicity, neurotoxicity, dermatotoxicity, pulmonotoxicity
- To obtain a basic understanding on environmental toxicants and various toxicological testing methods
- To learn about the different tissue culture techniques including primary and secondary culture, continuous cell lines, suspension culture and toxicogenomics.

Syllabus

Unit I: Toxicological concepts

Toxicity, toxicokinetics and toxicodynamics, classification of toxicants, absorption of toxicant – interaction of toxicant with cell, cell membrane structure, process of cellular absorption, cellular uptake of toxicants, routes of absorption. distribution of toxicant - factors affecting distribution of toxicants to tissues - storage of toxicant.

Unit II: Biotransformation and elimination of toxicants

Biotransformation, Biotransformation Reaction, Location of Biotransformation, Factors affecting Biotransformation, Phase I reactions, Phase II reactions, elimination of Toxicants, Additional Route of elimination. Target Organ Toxicity – Introduction, Hematotoxicity, Hepatotoxicity, Nephrotoxicity, Neurotoxicity, Dermatotoxicity, Pulmonotoxicity.

Unit III: Environmental Toxicants

Introduction, Pesticides, Plastics, Metals, Organic solvents and other environmental toxicants. Toxicologic testing Methods – Acute toxicity tests, prolonged toxicity tests, Chronic toxicity tests, Teratogenic tests, Reproductive tests, Mutagenic tests, Carcinogenic tests, Eye and Skin tests, Behaviour tests, Immune tests.

Unit IV: Introduction of mammalian cell culture

History of cell culture development, different tissue culture techniques including primary and secondary culture, continuous cell lines, suspension culture. Different type of cell culture media, growth supplements, serum free media. Cell counting and viability assay, staining techniques, Anti proliferative assays- MTT and Neutral red, single cell gel Electrophoresis.

Unit V: Toxicogenomics

Aims and methods, Scope and evolution of the field of toxicogenomics, Integration of data, Challenges and technical considerations, Systems toxicology, Future of toxicogenomics.

Unit VI: Current Contours (For Continuous Internal Assessment only)

Daily news and research paper on Drug Toxicity in Neonates, Infants and Young Children. Quiz on- Effect of mycotoxins - Types of mycotoxins: toxicity in Human and Animal health. Mini project in various recent research topics related to Toxicology of the Placenta, Ethical Issues in Toxic Chemical Hazard Evaluation, Risk Assessment and Precautionary Communications.

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Course Outcomes

After completion of this course the student can able to

- ✓ Acquire new information in the areas of both the fundamental and applied aspects of toxicology

- ✓ Obtain the knowledge about target organ toxicity biotransformation and elimination of toxicants
- ✓ Learn the different toxicological testing methods and cell culture techniques
- ✓ Describes the challenges, technical considerations and future of toxicogenomics
- ✓ Understanding the ethical issues in toxic chemical hazard evaluation, Risk Assessment and Precautionary Communications
- ✓ Knowledge about different tissue culture techniques including primary and secondary culture, continuous cell lines.
- ✓ Able to do toxicologic testing methods-acute toxicity tests, prolonged toxicity tests, chronic toxicity tests, teratogenic tests
- ✓ Exploring the different type of cell culture media, growth supplements, serum free media and cell counting and viability assay, staining techniques

Course 3: MOSQUITO BIOLOGY AND CONTROL

Course Code: 18MICRV06 **Credits: 4**

Objectives

- To study the mosquitos types, life cycle, and breeding habitats.
- To acquire the knowledge about larval collection, Preservation and Safety precautions
- To understand the mosquito vector born disease, pathogenicity, Diagnosis, prevention and treatments

Syllabus

Unit I: Introduction: History – classification of mosquito-External structure-life cycle; Egg, larva, pupa and adult characteristics; Differentiation between anophelines and culicines; characteristics features of genus Anopheles, Culex, Aedes and Mansonia. Epidemiology: Geographical distribution of mosquito vector Anopheles, Culex, Aedes and Mansonia-Breeding habitats larvae; resting and feeding habits of adults.

Unit II: Sapling Methods for Adult and larval mosquitoes-hand, trap, window trap and light trap collection. Larval collection methods- Dipping, netting, pipetting, collection of larvae from tree holes and axil of leaf. Preservation of mosquito vector- storing mosquito in insect box- single tube- preservation of mosquito larvae- preparation of Adult specimen and larval specimen for transportation. Vector density-Adult mosquito density- larval density.

Unit III: Mosquito borne Disease and Control: malaria- Lymphatic filariasis and Dengue, chikungunya-lifecycle, pathogenicity, Diagnosis, prevention and treatment- Chemical and Biological control of mosquito vector-Production, formulation and evaluation of biocontrol

agents- Biological and chemical larvicides, pupicides, repellents for Mosquito, Transgenic mosquitoes.

Unit IV: Larvicidal assay method, Repellent assay method, Commercial biolarvicides and repellents. Strategies in the development of novel biolarvicides-bioassay test- contact bioassay – aerial bioassay. Mosquito susceptibility to insecticides- Susceptibility test of larvae and adult mosquito. Characteristic of bio insecticide –insecticides formulation and their dosage of indoor residual spray. Experiment- laboratory trail-small scale, Filed trail experiments. Toxicity assay of other insects in the aquatic system.

Unit V: Control programs- Principles of malaria, filarial, Dengue eradication and control in India- NMCP, NMEP, MPO, PfCP, UMS, RBM, EMCP and NVBDCP. Equipment's for vector control – Different types of spray equipment's- Application methods, atomization devices- Importance of droplet size and its determination – Safety precautions.

Unit VI: Current Contours (For Continuous Internal Assessment only)

Assignment was given based on the syllabus and seminar was subjected to students related to their assignment topics individually. Then larval collection was assigned in the topic of Preservation and Safety precautions of larval collection. In order to enhance their research skills, a mini project in various recent research topics related to mosquito vector born disease - pathogenicity, Diagnosis, prevention and treatments.

References

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Course outcomes

After completion of this course the student can able to

- ✓ Understand the mosquito's types, life cycle, and breeding habitats.
- ✓ Acquire the knowledge about larval collection, Preservation and Safety precautions
- ✓ Analyse and understand the malaria- Lymphatic filariasis and Dengue, chikungunya- lifecycle, pathogenicity, Diagnosis, prevention and treatments.
- ✓ Explore the strategies in the development of novel biolarvicides.
- ✓ Awareness about vector control – Different types of spray equipment's and safety precautions.
- ✓ Knowledge about equipment's for vector control different types of spray equipment's application methods
- ✓ Able to do mosquito susceptibility to insecticides and susceptibility test of larvae and adult mosquito
- ✓ Exploring the laboratory trail small scale, filed trail experiments and toxicity assay of other insects in the aquatic system

Course 3: ADVANCES IN NANOBIOTECHNOLOGY

Course Code: 18MICRV07 **Credits: 4**

Objectives

- To study the Classification of nanostructures, nanoparticles, nano-clusters, nanotubes, nanowires and nanodots.
- To acquire the knowledge about role of microorganisms in nanoparticle biosynthesis, mechanism of synthesis of nanoparticles.
- To understand the Structural variation of Nanoparticles
- To analysis the Antimicrobial activity of nanoparticles

Syllabus

Unit I: Basic concepts in Nanotechnology

Nanotechnology - Classification of nanostructures, nanoparticles, nano-clusters, nanotubes, nanowires and nanodots, liposomes, cubosomes and hexosomes, lipid based nanoparticles- liquid nanodispersions- solid lipid nanoparticles (SLP), effects of the nanometre length scale- nanoscale dimensions affect properties.

Unit II: Synthesis of Nanoparticles

Chemical- pyrolysis- inert gas condensation, solvothermal reaction, sol-gel fabrication, structured media- physical -; attrition / milling-and biological methods of nanoparticle synthesis- silver, zinc oxide, gold and titanium; intracellular synthesis and extracellular synthesis; role of microorganisms in nanoparticle biosynthesis, mechanism of synthesis of nanoparticles, properties; assembly. Inorganic, organic and hybrid nanomaterials.

Unit III: **Characterization Techniques**

Structural studies of Nanoparticles- XRD and FT- IR. Microscopic techniques- electron Microscopy- SEM, TEM, biological sample preparation for TEM- scanning probe microscopy- STEM- AFM- confocal Microscopy- Scanning Near Field Microscopy- Spectroscopic and Electrochemical techniques- UV-Vis Spectroscopy- Energy Dispersive X-ray spectroscopy, Mass spectroscopy-types- Nuclear Magnetic Resonance (NMR) spectroscopy, Differential Scanning Calorimetry (DSC) - Electrochemistry fundamentals, Electro-analytical techniques- Voltametry- Linear scan voltametry- cyclic voltametry- impedence spectroscopy- applications.

Unit IV: Biomedical Applications

Antimicrobial activity of nanoparticles- antibacterial, antifungal, antiviral, antiparasitic, antihelmenthic, mosquito larvicidal, bacterial sporicidal, insecticidal activity, herbicidal activity. mechanism; mode of action of nanoparticles on microbial growth- changes in membrane permeability, oxygen consumption measurement, protein leakage analysis.

Unit V: Nanotoxicology

Nanotoxicity in humans and environment- - Invitro toxicity assessment methods- proliferative assay, oxidative stress assay, inflammatory assay. Invivo toxicity assessment. Nanotoxicity evaluation in aquatic and terrestrial ecosystem.

Unit VI: Current Contours (For Continuous Internal Assessment only)

Quiz - Nanotoxicity in humans and environment. Debate on – advantage and disadvantage of nanoparticles for environmental remediation and Nanotechnology in agriculture. Paper presentation on current research in nanobiotechnology. Assignment on-Future of nanobiotechnology.

References

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9. Poonam T and Sheefali MT (2011) In vitro methods for nanotoxicity assessment: advantages and applications. Archives of Applied Science Research; 3 (2):389-403.

Course outcomes

After completion of this course the student can able to

- ✓ Understand the role of microorganisms in nanoparticle biosynthesis, mechanism of synthesis of nanoparticles.
- ✓ Acquire the knowledge about Classification of nanostructures, nanoparticles, nano-clusters, nanotubes, nanowires and nanodots.
- ✓ Analyse and understand the Structural variation of Nanoparticles
- ✓ Explore the strategies in the development Nanotoxicity in humans and environment- - Invitro toxicity assessment methods.

- ✓ Awareness about Antimicrobial activity of nanoparticles.
- ✓ Knowledge about nanoparticle synthesis silver, zinc oxide, gold and titanium intracellular synthesis and extracellular synthesis
- ✓ Able to do antimicrobial activity of nanoparticles- antibacterial, antifungal, antiviral, antiparasitic, antihelmenthic, mosquito larvicidal, bacterial sporicidal, insecticidal activity
- ✓ Exploring the *Invivo* toxicity assessment and nanotoxicity evaluation in aquatic and terrestrial ecosystem.

Course 3: ACTINOBACTERIAL SYSTEMATICS AND METABOLOMICS

Course Code: 18MICRV08 **Credits: 4**

Objectives

- The objective of the course is to highlighting on the actinobacterial diversity, morphology, their ecological niches and their general characteristics.
- This course comprises the isolation and identification of actinobacterium based on phenotypic, chemotypic and genotypic characteristics; genomics of actinobacterium
- It also emphasis to learn about the various actinobacterial biotechnological products and their applications

Syllabus

Unit I: Systematics of actinobacteria- Systematics of actinobacteria- traditional phenotypic analysis, genotypic analysis, genotypic characterization based on chemical constituents. Taxonomic interpretation of phylum actinbacteria-Actinoplanates, Maduromycetes, Saccharopolyspora, Multioccularsporangia, Nacardiodes, Streptomycetes, Thermomonospora- habitat, morphology, general characteristics and their importance. Nonomura key for classification and identification of Streptomyces.

Unit II: Ecology and applications of actinobacteria-Occurrence and distribution of actinobacteria, role of actinobacteria in habitats- soil, water, human, animal, plant, secondary metabolite- antibacterial, antifungal, antiparasitic, antiviral and anticancer metabolites production and purification, biotechnological applications of Actinobacteria- antibiotics, enzymes, enzyme inhibitors, single cell protein, probiotics, pigments, bioherbicides, biolarvicides.

Unit III: Genomics of actinobacteria-Introduction, general features of genome, structure of genome, genetic instability, reductive genome, gene duplication, HGT, gene decay, genomics of mycelial actinobacteria, Streptomyces, Frankia, high throughput sequencing to analyze gene clusters involved in natural product biosynthetic pathways.

Unit IV: Genome based taxonomy of actinobacteria-Actinobacterial taxonomy based on multilocus approach, genotypic approaches for determining the relatedness- DNA- DNA hybridization, phylogeny and whole genome comparison, biosynthetic gene clusters and comparison, restriction digestion analysis of total chromosomal DNA, markers for differentiating complex actinobacteria- SsGA like proteins, SsGB marker for sporulating actinobacteria, impact of actinobacterial genomics on taxonomy.

Unit V: Actinobacterial Metabolomics-Metabolome, metabolites, actinobacterial metabolomics. General aspects of polyketides- polyketide biosynthesis pathway, polyketide synthases, biosynthetic gene clusters of Type I polyketide synthases, biosynthetic gene clusters of Type II polyketide synthases, β lactam biosynthetic genes. Genetic factors affecting the production of secondary metabolites- plasmid instability, induced mutagenesis. Discovery and molecular engineering of sugar containing natural product biosynthetic pathways in actinobacteria Detection of secondary metabolite biosynthetic genes in actinobacteria using heterologous DNA probe and using polymerase chain reaction.

Unit VI: Current Contours (For Continuous Internal Assessment only)
Quiz Actinobacterial biotechnological products and their applications. Debate on – advantage and disadvantage of antibiotics in human and animal health. Paper presentation on current research in Actinobacterial biotechnology. Assignment on-Future of Actinobiotechnology.

References

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3. Dworkin M and Falkow S (2006) The Prokaryotes: Vol. 3: Archaea. Bacteria: Firmicutes, Actinomycetes, Springer publications. New York, NY 10036.
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Course outcomes

After completion of this course the student can able to

- ✓ Problem solving skills on cultivation and preservation of actinobacterial cultures
- ✓ Genome mining of secondary metabolite biosyntheticgene clusters in actinobacteria
- ✓ Understand the ecological and pharmaceutical importance of actinobacteria
- ✓ Acquire the knowledge of taxonomic characterization and identification of actinobacteria
- ✓ Innovative actinobacterial resources of enzymes and antibiotics
- ✓ Entrepreneurial skills on the production of Frankia biofertilizer
- ✓ Technology savvy skill on industrial enzymes, pigments from Actinobacteria
- ✓ Addresses challenges directly biodegradation of pesticides and toxic pollutants using Actinobacteria

Course 3: BIOLOGY OF FRANKIA

Course Code: 18MICRV09 **Credits: 4**

Objectives

- To learn about Frankia types, cultural and morphological characters and their importance.
- To acquire the knowledge about structure and function of polyketide synthase genes (PKS I and PKS II).
- To Analysis of secondary metabolites of bioactive compounds including, Antibiotics, Herbicides, Pigments, Anti-cancer agents, Enzymes and other compounds.
- To understand the Frankia Secondary Metabolites role in Actinorhizal Plants– Control of disease, bacterial, fungal, viral and insecticides.

Syllabus

Unit I: Frankia

Definition, classification - Frankia alni, Frankia casuarinae, Frankia coriariae, Frankia elaeagni, Frankia brunchrsti, Frankia purshiae. - Habitat, morphology and general characteristics and their importance.

Unit II: Isolation and Identification of Frankia: Occurrence of Frankia. Isolation methods - enrichment methods, pretreatment of sample- physical treatments, chemical and biological treatments and use of selective media. Characterization of Frankia- Morphological- Hyphae, Vesicles, Sporangia, Sporangial structure and other structures. Cultural, physiological, biochemical and molecular phylogenetic identification of Frankia.

Unit III: **Genomics of Frankia**

Genomics of Frankia - Introduction, Structure and function of genes. Polyketide synthase genes (PKS I and PKS II) and other genes of the Frankia. Discovery and molecular engineering of sugar-containing natural product biosynthetic pathways in Frankia.

Unit IV. **Frankia Metabolomics**

Define-metabolome. Frankia metabolomics- Detection of secondary metabolite biosynthetic genes in Frankia using heterologous DNA probe and using polymerase chain reaction. Analysis of secondary metabolites of bioactive compounds including, Antibiotics, Herbicides, Pigments, Anti-cancer agents, Enzymes and other compounds.

Unit V: **Biotechnological applications of Frankia**

Frankia application - Agriculture-Environment and other filed. Frankia Secondary Metabolites role in Actinorhizal Plants– Control of disease, bacterial, fungal, viral and insecticides. Growth and yield improvement of Actinorhizal Plants. Nitrogen fixations, marginal soils, reclaiming and conditioning soil, producing timber and pulp, windbreak,

ornamental, and fuel wood plants. Frankia as biofertilizer- biodegradation of pesticides and toxic pollutants using Frankia.

Unit VI: Current Contours (For Continuous Internal Assessment only**)**

Assignment was given based on the syllabus and seminar was subjected to students related to their assignment topics individually. Then plant submission was assigned in the topic of Actinorhizal symbiotic plants. In order to enhance their research skills, a mini project in various recent research topics related to Agriculture-Environment- Growth and yield improvement of Actinorhizal Plants, Nitrogen fixations was given.

References

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Course outcomes

After completion of this course the student can able to

- ✓ Understand the Frankia types, habitats, cultural and morphological characters and their importance.
- ✓ Acquire the knowledge about structure and function of polyketide synthase genes (PKS I and PKS II).
- ✓ Analyse and understand the secondary metabolites of bioactive compounds including, antibiotics, herbicides, pigments, anti-cancer agents, enzymes and other compounds.
- ✓ Explore and understand the Frankia secondary metabolites role in actinorhizal plants– control of disease, bacterial, fungal, viral and insecticides
- ✓ Awareness about growth and yield improvement of actinorhizal plants, nitrogen fixations, biofertilizer- biodegradation of pesticides and toxic pollutants.
- ✓ Knowledge about detection of secondary metabolite biosynthetic genes in *Frankia* using heterologous DNA probe and using polymerase chain reaction
- ✓ Able to do analysis of secondary metabolites of bioactive compounds including, Antibiotics, Herbicides, Pigments, Anti-cancer agents, Enzymes and other compounds
- ✓ Exploring the actinorhizal plant disease control, bacterial, fungal, viral and insecticides

Course 3: APPLIED MICROBIOLOGY AND NANOTECHNOLOGY

Course Code: 18MICRVI01 **Credits: 4**

Objectives

- This course will introduce students to the rapidly developing field of nanoengineered materials.
- To understand the host – microbe interactions
- To discover novel drugs from marine microbes

Syllabus

Unit I: Host Microbe Interactions and Human Disease

Nonspecific Defenses of the Host, Specific Defense of the Host-Immune Respnse,Disorder Associated immune system. Microbial Diseases of the skin and eye, Microbial Diseases of the cardiovascular and lymphatic system, Microbial Diseases of the Respiratory infection, Microbial Diseases of the Urinary and Reproductive system.

Unit II: Actinobacteria

An Introduction to Actinobacteria. General Charecterization and classification of Actinomycetes. Isolation and identification of the Actinobacteria –Diversity and Biotechnology Application-Actinomycetes and Antibiotic science-Actinomycetes Fermentation.

Unit III: Marine Pharmacology And Pharmaceutical Microbiology

Term and Definitions; Medicinal compounds from marine –Antimicrobial agents.
Introduction to Marine Pharmacology and isolation techniques-Drug from sea-Marine bioactive compounds-Industrial Mari culture and Technology-Microbial Production of organic acids, Antibiotics, Vitamins,-Subculturing culture suspension preparation-Microbial assay of Antibiotic and vitamins.

Unit IV: Synthesis and Characterization of Nanosturctured Materials

Definition of a nano system dimensionality and size dependent phenomena, Quantum dots, Nano wire and Nanotubes. Methods for synthesis of Nanoscale Materials. Basic concepts and properties of nonstructural materials-Characterisation of Nonmaterials -Soft chemical process- Chemical process- Biological method of synthesis.

Unit V: Advanced Nanotechnology

Biological interaction with materials-Nanotoxicology Drug delivery system-Synthetic Materials in Medicine-Nanomedicine- Nanosensors-types and applications. Nanocarriers for Drug delivery- Nanotechnology for Cancer Research and Therapy. Nanotechnology for imaging and Detection.Environmental Nano Remediation Technology.Toxicity of Nanoparticles - Future Perspective.

Unit VI: Current contours (For continuous internal assessment only)

X-ray diffraction (XRD) - Dynamic Light Scattering (DLS). Electron microscopes: Scanning Electron Microscope (SEM) - Transmission Electron Microscope (TEM); Atomic Force Microscope (AFM) -UV - Visible Spectrophotometer - Photoluminescence (PL) Spectrophotometer - Fourier Transform InfraRed Spectrometer (FTIR) - Nuclear Magnetic Resonance (NMR) - Differential scanning calorimeter (DSC) - Thermogravimetric/Diffferential Thermal Analyzer (TG/DTA)

References

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Course Outcomes

After completion of this course the student can able to

- Provides training in interdisciplinary areas such as Nanomaterials and Biosensors.
- Nanotechnology involves creating and manipulating organic and inorganic matter at the nano level.
- It aims to provide the method of designing nanomaterials; materials with biological properties controlled by defined molecular structures and dynamics.
- It aims to provide remedy against dreadful diseases like cancer
- Nanotechnology can provide for the future development of far more precise and effective
- Nanotechnology promises not only the creation of novel and precisely defined material to remove pollutants from the environment.
- To understand the structure of nanoparticles by various methods

Course 3: DISEASE CONTROL AND VECTOR BIOLOGY

Course Code: 18MICRVI02 **Credits: 4**

Objectives

- Describe the basics of arthropods of public health importance
- Identify vector - host - pathogen relationships in arthropod-borne diseases
- Conduct studies on the epidemiology of vector-borne diseases

Syllabus

Unit I: Introduction to Disease Control

Definition, Mode of transmission, Chain of infection, Types of diseases: Communicable - Tuberculosis, Typhoid and hepatitis; Non communicable - Coronary heart disease, cancer and diabetes, levels of prevention and universal precautions.

Unit II: Introduction to Vector Biology

Definition,Classification. Vector control: Aims - objectives - goals – advantages and disadvantages - Recent trends - Alternative uses of insecticides (botanical, chemical & microbial) – Vector control on individual and community levels - Selection of appropriate control measures - Self-protection measures - Types of vector control - Selective, integrated and comprehensive vector control.

Unit III: Transmitted Diseases And Control:

Etiology, mode of infection, diagnosis and treatment for viral disease: Poliomyletis. Fungal disease: Candidiasis and Blastomycosis .Dengue: Introduction - Epidemiology -Signs and symptoms - Cause - Life cycle-Diagnosis – treatment – Prevention and control. Malaria and filaria: Introduction- Epidemiology- Signs and symptoms - Cause - Life cycle -Diagnosis – treatment – Prevention and control.

Unit IV: Control of Vectors:

Selection of host and site specific vectors and their control measures - Personal protection measures - Insecticide spraying (larviciding - indoor residual spraying - space spraying) - Biological control and environmental management including source reduction.

Unit V: Application of Nanoparticles:

Introduction of Nanoparticles-properties-role of Silver Nanoparticles -Synthesis of silver Nanoparticles from plant and bacteria. X-ray diffraction, FT-IR, SEM, TEM, UV-Vis spectroscopy. Advantages, disadvantages and its utility in disease diagnosis.

Unit VI: Vector Ecology

Introduction to ecology and ecosystem - Habits and habitats - Species diversity - Food chain, food web, ecological niche, prey predator relationships - Interaction with biotic and abiotic factors - Dispersal and migration.

References

1. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology - Hari Singh Nalwa.
2. Insect physiology by Wigglesworth, Vincent B. Sir, 1956, Methuen, Wiley edition, London.
3. Krebs, C.J. 1972. Ecology: The experimental analysis of distribution and abundance. Harper and Row Publishers, New York.
4. Medical Entomology. 3rd Edition by Mike W Service M W Service Mike Service. Manchester, UK.
5. Nanomedicine, Vol. IIA: Biocompatibility by Robert A. Freitas.
6. Odom, E.P. (1983). Basic Ecology. Saunders College Publishing, Philadelphia.
7. Pelczar Jr.J.J, Chan., E.C.S. and Kvieg. R. 2009. Microbiology, McGraw Hill, New York.
8. Price, P.W. 1971. Insect Ecology. John Wiley & Sons, New York. 17. Ananthakrishnan, T.N. 1982. Bioresources Ecology. Oxford & IBH Publishing Co., New Delhi.
9. The Insect Structure and Function - 4th Edition. by R. F. Chapman, USA.

Course Outcomes

- ✓ Arthropods affect the health and well-being of human being in a wide variety of ways, by transmitting several of the most devastating infectious diseases.
- ✓ This course provides an overview of the ways in which arthropods impact public health, laying greater emphasis on insect vectors and vector-borne diseases control.
- ✓ The course will focus on vectors of local as well as global importance.
- ✓ An epidemiological perspective will be integrated throughout the course.
- ✓ Biology, ecology and application of modern tools in the management of vectors and vector-borne diseases will be discussed in detail.
- ✓ Finally, attention will be given to the students on the development of practical skills in the implementation of operational programmes.
- ✓ Awareness about vector borne diseases is created and spirit of research is inculcated.

Course 3: MICROBIAL SIGNALING COMMUNICATION AND BIOFILM FORMATION

Course Code: 18MICRVII01 **Credits: 4**

Objectives

- The course will provide an overview of evolution, architecture and types of signaling molecules in bacteria.
- The course will focus on the regulation of signaling molecules and its biotechnological applications.
- The course will emphasize the biofilm formation, its resistance mechanism and various strategies to control biofilm.

Syllabus

Unit I: Microbial Communication:

Quorum sensing in Gram positive and Gram negative bacteria. Quorum sensing system architecture, types of autoinducers. Evolution and Maintenance of quorum sensing in bacteria.

Unit II: Quorum quenching:

Quorum quenching- prokaryote to prokaryote quorum quenching, Eukaryote to prokaryote quorum quenching. Quorum sensing signal degradation and inactivation. Inhibition of QS signals biosynthesis. Biotechnological application of quorum sensing and quorum quenching, Engineered QS system and Biosensors.

Unit III: Biofilm Formation

Biofilm formation of Gram positive and Gram negative bacteria- fungal biofilm formation, Role of biofilm in Microbial communities- Biofilm formation and diseases - Factors involved in biofilm formation.

Unit IV: Biofilm Infections

Pathogenesis of biofilm and infections, biofilm resistance to antibiotics – biofilm on Medical devices. Intervention strategies of biofilm formation.

Unit V: Antibiofilm Agents

Biofilm inhibitors from bacteria, Fungus, Cyanobacteria, Microalgae, Plants and other natural sources

Unit VI: Current Contours (For Continuous Internal Assessment only**)**

Current developments related to "Recent developed antibiofilm and quorum quenching agents from various natural resources" through paper collection, discussion and evaluation. To be sourced from news and events world over through multiple reliable informative sources- Print, Internet, Interaction, Social Media, Webinars and so on. This part will largely

involve data interpretation by the students. Assessment will be by short talk describing a relevant paper and submitting a review paper.

References

1. Allan HW (1987). Biofilms: Microbial Interactions and Metabolic activities, in Ecology of Microbial Communities, (Eds. M. Fletcher, T. R. G. Gray and J. G. Jones) Cambridge University Press, Cambridge.
2. George TO, Kaplan HB, Kolter R (2000). Biofilm formation as microbial development Annual Review of Microbiology, Vol. 54, 49-79
3. Hall-Stoodley L, Costerton JW and Stoodley P (2004). Bacterial biofilms: From The natural environment to infectious diseases, Nature reviews. Vol.2, 95-108
4. http://www.ift.org/knowledge-center/read-ift-publications/science-reports/scientific-status-summaries/quorum-sensing-in-biofilms.aspx
5. https://www.coursera.org/learn/bacterial-infections/lecture/0sAFR/6-3-evolution-in-biofilms-part-2-by-associate-professor-steve-diggle
6. https://www.hhmi.org/biointeractive/bacterial-quorum-sensing
7. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3376616/
8. LaSarre B and Federle MJ (2013). Exploiting quorum sensing to confuse bacterial pathogens, Microbiol. Mol. Biol. Rev.77(1):73
9. Waters CM and Bassler BL (2005). Quorum sensing: Cell to cell communication in Bacteria, Annu. Rev. Cell Dev. Biol. 21:319–46

Course Outcomes

- ✓ Understand the basic concepts of cellular signal in Gram positive and Gram negative bacteria
- ✓ Get deeper knowledge about the evolution of quorum sensing and its application.
- ✓ To understand how various signaling molecules control various pathogenicity in prokaryotes and eukaryotes.
- ✓ Understand the overall concept of Quorum sensing signal degradation and inactivation through quorum quenching can therefore be utilized as drug targets for drug development.
- ✓ To gain insight in the role of prokaryote to prokaryote quorum quenching, Eukaryote to prokaryote quorum quenching.
- ✓ To gain knowledge on the factors involved in biofilm formation and its role in disease development.
- ✓ To understand how cellular signaling and biofilm formation are interlinked and its role in drug resistance.
- ✓ To be able to develop new intervention strategies to control biofilm formation and multidrug resistance.

Course 3: FISHERIES MICROBIOLOGY AND MOLECULAR TECHNIQUES

Course Code: 18MICRVII02 **Credits: 4**

Objectives

- This course paper will provide an overview of Microbial communities in the aquatic environment and its biotechnological application.
- This course work will emphasize the various instrumentation and molecular techniques used in isolation and identification of bioactive compounds from natural resources.
- This course topic focuses on the mode of action and resistance development of antibiotics.

Syllabus

Unit I: Advances in Aquatic Microbiology

Microbial communities in the aquatic environment: distribution; nutrients, oxygen and pH gradients; open and heterogenous systems; microbial consortia; surface attachment and biofilm development. Methods of study sampling procedures: collection and processing. Scope of biotechnology in fisheries and aquaculture research

Unit II: Molecular Techniques in Microbiology

Microbial genetics – chemical nature and structure of genetic material; forms of DNA; Basic concepts- gene, genome, genotype, phenotype; restriction fragment length polymorphism and significance, isolation and characterization of plasmid DNA, plasmids as cloning vectors, gene transfer by conjugation, transformation, transduction. Gene expression, detection of proteins, immunoblotting. Detection of genes by polymerase chain reaction, use of gene probes. Non-radioactive probes for DNA and proteins, molecular epidemiology

Unit III: Applied Biotechnology

Principles of transgenic technology and its application in fisheries. Probiotics, single cell proteins, Nutraceuticals, Recombinant proteins of commercial importance: enzymes, hormones, bioactive compounds from microalgae and cyanobacteria, therapeutic proteins, Vaccination in fishes- DNA vaccines, Biofilm Vaccines.

Unit IV: Instrumentation for screening Bioactive Compounds

Morphological identification – Light microscope, Confocal laser scanning microscope and SEM. Screening of bioactive compounds from cyanobacteria – UV spectrophotometer – Column chromatography – Thin layer chromatography – LCMS – GCMS – NMR Spectroscopy – FTIR.

Unit V: Effects of antibiotics and resistance

Types of antibiotics – Mode of actions – Biological mechanisms of antibiotic resisrtance. Effect of resistance in bacterial physiology – Antibiotic dependent bacterial growth.

Unit VI: Current Contours (For Continuous Internal Assessment only**)**
Current developments related to "In new instrumentation and molecular techniques and its biotechnological application" through paper collection, discussion and evaluation. To be sourced from news and events world over through multiple reliable informative sources- Print, Internet, Interaction, Social Media, Webinars and so on. This part will largely involve data interpretation by the students. Assessment will be by short talk describing a relevant paper and submitting a review paper.

References

1. Aquatic Microbiology by Gerhard Rheinheime
2. Basic molecular biology: Essential techniques by P.D. Darbre.
3. Freshwater Microbiology: Biodiversity and Dynamic Interactions of Microorganisms in theAquatic Environment by David Sigee
4. Gene cloning and DNA analysis. An Introduction by T.A. Brown
5. Glick BR & Pasternak JJ (1999). Molecular Biotechnology: Principles and Applications of Recombinant DNA Technology. ASM Press.
6. https://files.eric.ed.gov/fulltext/ED407284.pdf
7. https://www.futurelearn.com/courses/antibiotic-resistance
8. https://www.mooc-list.com/course/challenges-antibiotic-resistance-point-prevalence-surveys-futurelearn
9. https://www.zuj.edu.jo/download/bioinstrumentation-john-d-enderle-pdf/
10. Jose Luis Martinez, Alicia Fajardo, Leonor Garmendia, Alvaro Hernandez, Juan Francisco Linares, Laura Martınez-Solano& Marıa Blanca Sanchez. A global view of antibiotic resistance.FEMS Microbiol Rev 33 (2009) 44–65.
11. Manipulation and expression of recombinant DNA. A laboratory manual by Varson and Robertson.
12. Microbial Ecology of the Oceans, David Kirchman,ed. Wiley-liss
13. Molecular cloning. A laboratory manual by J. Sambrook and D.W. Russell.
14. Principles of gene manipulation and genomics by I.B. Primrose and R.M. Twyman.

Course Outcomes

- ✓ Understand the basic concepts of microbial consortium in aquatic environment and its distribution
- ✓ Get deeper knowledge about the scope of biotechnology in fisheries and aquaculture research.
- ✓ Understand the basic concept of gene and structure of genetic material.
- ✓ Understand the overall concept nutraceuticals and application of transgenic technology for their improvement.
- ✓ Gain insight in the role microalgae and cyanobacteria in fisheries as probiotics, single cell proteins, Nutraceuticals.
- ✓ Gain knowledge on the types and mode of action of antibiotics.
- ✓ Understand the principle, function and application of laboratory instruments.
- ✓ Able to develop new strategies to develop the fisheries industry using cyanobacteria and microalgae.