M.Sc. MICROBIOLOGY
(Autonomous CBCS)

CURRICULUM
(Revised with effect from 2018-2019 onwards)

DEPARTMENT OF MICROBIOLOGY
CENTRE FOR EXCELLENCE IN LIFE SCIENCES
BHARATHIDASAN UNIVERSITY
TIRUCHIRAPPALLI – 620 024, TAMIL NADU, INDIA

Faculty Members

Dr. N. Thajuddin	**Professor and Head**
Dr. K. Natarajaseenivasan	**Professor**
Dr. V. Rajesh Kannan	**Associate Professor**
Dr. G. Muralitharan	**Assistant Professor**
Dr. D. Dhanasekaran	**Assistant Professor**
Dr. P. Thiyagarajan	**Assistant Professor**
Dr. C. Nithya	**DST – INSPIRE Faculty**

REGULATIONS FOR M.Sc. MICROBIOLOGY (2 YEARS)

(UNDER AUTONOMY)

Name of the Course:

M.Sc. Microbiology. This programme is designed with lectures / tutorials / laboratory or field work / seminar / practical training / assignments / term paper or report writing etc., to meet effective teaching and learning requirements**.**

Department offering the programme:

The Department of Microbiology, School of Life Sciences is offering the course since 1994.

Eligibility for admission:

A pass in B.Sc. with Bio Technology/Bio-Chemistry/Botany/Zoology/ Microbiology/Bioinformatics/Biology/Life Sciences/B.Sc. with Biological Sciences as one of the subjects (B.E./B.Tech in Biotechnology)/B.Pharm/B.Sc. Agriculture/B.Sc. Horticulture.

Duration of the programme:

The duration of PG programme is two years. Each year shall consists of two semesters, *viz*. Odd and Even semesters. Odd semester shall be from June/July to October/November and Even semester shall be from November/December to April/May. There shall be not less than 90 working days which shall comprise 450 teaching clock hours for each semester (exclusive of the days for the conduct of University end-semester examinations).

Course Fees:

Each student admitted to the M.Sc. Microbiology degree programme will pay Tuition, Lab, Special, Stationery, Chemical and computer and other fees as decided by the University from time to time. The student will have to pay additionally the fees prescribed by the University for recognition, matriculation *etc*. In addition, the student has to pay a sum of Rs. 2,000/- as Laboratory Caution Deposit, which would be refunded depending upon breakages *etc*., at the end of the course.

Board of Studies:

The Board of Studies for academic programme, syllabi *etc*., will consist of all the members of the faculty of Department of Microbiology and external experts including academician, industrialist and alumni. The Head of the Department of Microbiology will be the Chairman.

Syllabus:

The Syllabi for the various courses are designed keeping in view the usefulness of the course to the students for (1) continuation of academic activity leading to research, (2) employability in microbiology related vocations and (3) self-employment.

Academic visits to institutions and/or industries related to the courses during the semesters of study will form part of the curriculum. The students depending on their performance and choice would either have to carry out a project or undergo training or submit a report at the end of the final semester in an area of microbiology.

From the academic year (2002-2004) **Choice Based Credit System** (**CBCS**) is introduced in all departments of the University. According to this system the M.Sc., Microbiology Course requires a student to earn 90 credits in four semesters. The basic course structure and the scheme of examinations are given in tables that follow.

A student has to take five core courses including practical in the first semester and four core courses including practical and two elective courses in the second and third semesters. The fourth semester would be entirely devoted to the self study review and a project work.

Semesters:

In each semester, this PG course is offered in 15 teaching weeks and the remaining 5 weeks are to be utilized for conduct of examinations and evaluation purposes. Each week shall have 30 working hours spread over 5 days a week.

Credits:

The term "Credit" refers to the weightage given to a course, usually in relation to the instructional hours assigned to it. For instance, a six hour Course is assigned four to six credits, four/five hour Course is assigned three to five credits. However, in no instance the credits of a Course can be greater than the hours allotted to it. The total minimum credits required for awarding all PG programmes is 90.

Examinations:

The question paper setters for the examinations in theory will be from out of a panel of examiners suggested by the course teachers and the board of studies. There will be a single valuation of the theory papers by the external examiner. There will be two examiners for each lab course examination of whom one will be internal. There will be combined evaluation of the students by the two examiners. Each lab course examination will include a viva-voce component.

i. There shall be examinations at the end of each semester, for odd semesters in the month of October/November; for even semesters in April/May.

ii. A candidate who does not pass the examination in any course(s) may be permitted to appear in such failed course(s) in the subsequent examinations to be held in October/November or April/May. However, candidates who have arrears in Practicals shall be permitted to appear for their arrears Practical examination only along with Regular Practical examination in the respective semester.

iii. A candidate should get registered for the first semester examination. If registration is not possible owing to shortage of attendance beyond condonation limit/regulation prescribed OR belated joining OR on medical grounds, the candidates are permitted to move to the next semester. Such candidates shall re-do the missed semester after completion of the course.

iv. Candidates shall submit the two copies of dissertation to the Department through the Supervisor not earlier than 5 months but within 6 months from the date of start of the fourth semester. If a candidate is not able to submit his/her dissertation within the period stated above, he / she shall be given an

extension time of 4 months in the first instance and another 4 months in the second instance with penalty fees. The dissertation shall be valued by both external examiner and concerned Supervisor for a Maximum of 100 marks and the average shall be taken. The valuation of M.Sc. Dissertations and *viva voce* examination shall be done on the same day by both the external and internal examiners at the Department. The maximum marks for the *viva* shall be 50 (joint evaluation) and the average mark should be handed over to the chairman of examination on the same day.

v. The results of all the examinations will be published through the department where the student underwent the Course.

Condonation:

Students must have 75% of attendance in each semester to appear for the examination. Students who have attendance between 65% and 74% shall apply for condonation in the prescribed form with the prescribed fee. Students who have attendance between 50% and 64% shall apply for condonation in prescribed form with the prescribed fee along with the Medical Certificate. Students who have attendance below 50% are not eligible to appear for the examination. They shall re-do the semester(s) after completion of the Programme (i.e. 2 years).

Question Paper Pattern:

Time: 3 Hours Max. Marks = 75

Section	No. of Questions	Marks / Question	Total Marks	Remarks
A	10	02	20	Two questions from each unit
B	05	05	25	Internal choice and one set of questions from each unit
C	03	10	30	Answer any three out of 5 questions and one question from each unit

Evaluation:

The performance of a student in each course is evaluated in terms of percentage of marks with a provision for conversion to grade points. Evaluation for each course shall be done by a Continuous Internal Assessment (CIA) by the course teacher concerned as well as by an end semester examination and will be consolidated at the end of the semester. The components for continuous internal assessment are:

Theory:

Best 2 tests out of 3	= 15 Marks
Seminar	= 05 Marks
Assignments	= 05 Marks
Total	= 25 Marks

Practical:

Continuous performance & observation	= 15 Marks
Model practical	= 10 Marks
Total	= 40 Marks

Attendance need not be taken as a component for continuous assessment, although the students should secure a minimum of 75% attendance in each semester. In addition to continuous evaluation component, the end semester examination, which will be a written type examination of at least 3 hours duration, would also form an integral component of the evaluation. The ratio of marks allotted to continuous internal assessment and to end semester examination is 25:75. The evaluation of laboratory component, wherever applicable, will also be based on continuous internal assessment and on an end-semester practical examination with 25:75 ratio. In the case of core course 18MICCC14 - self - study review in the IV semester 100% external assessment will be done and there will be no internal evaluation.

Passing Minimum:

A candidate shall be declared to have passed in each course if he/she secures not less than 40% marks in the University Examinations and 40% marks in the CIA and not less than 50% in the aggregate, including CIA and University Examinations marks.

Candidates who have secured the pass marks in the end-semester Examination (U.E.) and in the CIA, but failed to secure the aggregate minimum pass mark (U.E. + C.I.A.) are allowed to secure aggregate minimum pass mark only by appearing for University Examination.

Candidates who have failed in the Internal Assessment are permitted to appear for their Internal Assessment marks in the subsequent semesters (two chances will be given) by writing the CIA tests and assignments.

A candidate shall be declared to have passed in the Project work if he/she gets not less than 40% in each of the Project Report and Viva voce but not less than 50% in the aggregate of both the marks for Project Report and Viva voce.

A candidate who gets less than 40% in the Project must resubmit the Project Report. Such candidates need to defend the resubmitted Project at the Viva voce with a month. A maximum of two chances will be given to the candidate.

Grading System:

Once the marks of the CIA and end-semester examinations for each of the courses are available, they will be added. The marks, thus obtained will then be graded as per the scheme provided in Table 1.

From the second semester onwards the total performance within a semester and continuous performance starting from the first semester are indicated by **Semester Grade Point Average (GPA)** and **Cumulative Grade Point Average (CGPA)**, respectively. These two are calculated by the following formulae:

$$\textbf{GPA} = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

$$\text{WAM (Weighted Average Marks)} = \frac{\sum_{i=1}^{n} C_i M_i}{\sum_{i=1}^{n} C_i}$$

where 'C_i' is the Credit earned for the course i; 'G_i' is the Grade Point obtained by the student for the course i. 'M' is the Marks obtained for the course I and 'n' is the number of Courses **passed** in that semester.

CGPA = GPA of all the courses starting from the first semester to the current semester.

Table 1

GRADING OF THE COURSES

Marks Range	Grade point	Corresponding Grade	Classification of Final Results
90 and above	10	O	Outstanding
80 and above but below 90	9	A+	Excellent
70 and above but below 80	8	A	Very Good
60 and above but below 70	7	B+	Good
50 and above but below 60	6	B	Above Average
Below 50	N.A.	R.A.	R.A.

N.A. = Not Applicable; R.A. = Re-Appearance

FINAL RESULT

CGPA	Corresponding Grade	Classification of Final Results
9.00 and above	O	Outstanding
8.00 to 8.99	A+	Excellent
7.00 to 7.99	A	Very Good
6.00 to 6.99	B+	Good
5.00 to 5.99	B	Above Average
Below 5.00	R.A.	(Re-Appearance)

Credit based weighted Mark System is to be adopted for individual semesters and cumulative semesters in the column 'Marks Secured' (for 100).

Conferment of the Master Degree:

A candidate shall be eligible for the conferment of the Degree only after he/she has earned the minimum required credits for the Programme prescribed thereof (i.e. 90 credits for all P.G. Programme).

University Ranking:

A candidate shall be eligible for the conferment of the University Ranking Certificate only after he/she scores top in the University Examinations.

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M.Sc., MICROBIOLOGY

PROGRAM STRUCTURE

The two year M. Sc., Microbiology program will have four semesters.

The Course structure will be as given below

Semester	Course	Hours per week	Total credits	Credits per semester
I	Five core courses	30	24	24
II	Four core courses	30	19	23
	Two Elective course		4	
III	Four core courses	30	19	23
	Two Elective course		4	
IV	Self Study Review	6	4	20
	Project and Dissertation	24	16	
Total		**120**	**90**	**90**

Note: Library utilization: 5-8 hrs weekly

DETAILED PROGRAM STRUCTURE

Semester	Course code	Name of the Course	Hrs/Week	Credits	Exam Hrs.	Internal	External	Total Marks
I	18MICCC1	Fundamentals of Biological Sciences (or) Mycology and Phycology (T)	6	5	3	25	75	100
	18MICCC2	Biological Macromolecules	6	5	3	25	75	100
	18MICCC3	Microbial Cell Biology and Physiology	6	5	3	25	75	100
	18MICCC4	Microbial Genetics and Molecular Biology	6	5	3	25	75	100
	18MICCC5	Practical (18MICCC2, 18MICCC3, 18MICCC4)	6	4	6	25	75	100
II	18MICCC6	Immunotechnolgy	6	5	3	25	75	100
	18MICCC7	Medical Microbiology (or) Public Health Microbiology	6	5	3	25	75	100
	18MICCC8	Virology	6	5	3	25	75	100
	18MICCC9	Practical (18MICCC6, 18MICCC7, 18MICCC8)	6	4	6	25	75	100
	18MICNME1	Biological Techniques (T)	3	2	3	25	75	100
	18MICEDC1	Molecular Taxonomy and Phylogeny (or) Medical Entomology (or) Extremophiles (or) Microalgal Technology (or) Pharmaceutical Microbiology (T)	3	2	3	25	75	100
III	18MICCC10	Food and Industrial Microbiology	6	5	3	25	75	100
	18MICCC11	Recombinant DNA Technology	6	5	3	25	75	100
	18MICCC12	Environmental and Agriculture Microbiology (or) Rhizosphere Biology	6	5	3	25	75	100
	18MICCC13	Practical (18MICCC10, 18MICCC11, 18MICCC12)	6	4	6	25	75	100
	18MICNME2	Commercial Biotechnology and IPR (T)	3	2	3	25	75	100
	18MICEDC2	Bio-Informatics and Bio-Statistics (or) Microbial Nanotechnology (or) Biology of Probiotics (or) Microbial Remediation (or) Microbiome Science (T)	3	2	3	25	75	100
IV	18MICCC14	Self Study Review	6	4	3			100
	18MICCC15	Project and Dissertation	24	16	3			100
		Cumulative	120	90				1900

PROGRAMME OUTCOME

- PG Granduands are **Professionally Competent** with characteristic **Knowledge-bank, Skill-set, Mind-set** and **Pragmatic Wisdom** in their chosen fields.
- PG Granduands demonstrate the desired sense of being **Seasoned** and exhibit unequivocal **Spiritedness** with excellent qualities of productive contribution to **society** and **nation** in the arena Science and Technology.
- PG Graduands are mentored such that they exert **Leadership Latitude** in their chosen fields with **commitment to novelty** and **distinction**.
- PG Graduants are directed in understanding of ethical principles and responsibilities, moral and social values in day-to-day life thereby attaining **Cultural** and **Civilized** personality.
- PG Graduants are able to **Collate** information from different kinds of sources and gain a coherent understanding of the subject.

PROGRAMME SPECIFIC OUTCOME

- Apply the knowledge of biological, microbial and biochemical fundamentals to find the solution for complex molecular functions and physiology.
- Developing skilled persons in the sector of Disease diagnosis, treatment and prevention.
- Pest control using microbes and improving soil quality and agricultural output through sustainable microbiological applications.
- To train the students in both theory and practical to accommodate them in both higher education and industries.
- To augment problem-solving skills of students through industry oriented training programmes at various levels.
- To enrich the Graduates with solid fundamentals of microbiologyand advanced technologies.
- To enable them to employ the acquired theoretical knowledge wherever necessary.
- To occur hands on skills in Industry and/or Institutes, to better placement.

First Year: Semester- I
Fundamentals of Biological Sciences (Theory)

Code: 18MICCC1 **Credits: 5**

Objectives:

- Elaborate study about life cycle of fungi and thallophytes and its economic value.
- Diverse invertebrates classification and characteristics; its economic value.
- Details about chordate classification and reptilian salient features; fiscal value of vertebrates.

Syllabus:

Unit – I

Thallophytes: Algae-General characteristics- Economic importance- Types of life cycle- Outline of various classifications. Fungi: General characteristics- Classifications and Economic importance. General characteristics- Economic importance and outline of reproduction methods in Bryophytes, Pteridophytes and Gymnosperms.

Unit – II

Classification of Angiosperm, Systems of classification - Artificial, Phylogenetic and Natural, Outline of Bentham and Hooker's classification. Technical description of flower and floral diagram- Microsporangium and structure of *Polygonum* type embryo sac.

Unit – III

General characteristics and outline classification of invertebrates - Protozoa, Porifera, Coelenterata, Platyhelminthes, Ashelminthes, Mollusk and Echinodermata. Economoic importance of invertebrates - Insect pests of rice, sugarcane, coconut, cotton, vegetables, fruits and stored products (with an example of each). Principles of insect control: physical, mechanical, chemical, biological and integrated methods of pest control.

Unit – IV

Classification of Chordata – Characteristic features - protochordata class – Pisces and Amphibia up to orders. Salient features of Reptilia, Aves and Mammalia- Economic importance of Vertebrates.

Unit – V

Significance of Experimental plants (Arabidopsis, Neurospora, *Chlamydomonas*) and Animals *(Caenorhabditis elegans*, *Danio rerio* (Zebra fish) and *Galleria bimaculatus*). Importance of in vitro studies with specific to cell lines.

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

A general quiz on the topic- classification of animal kingdom, display of structure models of organs of human body, dissection procedures for *in vivo* studies (plants and animals).

References:

1. Vashishta PC, Sinha AK., Kumar A . (**2010)**. Pteridophyta, S Chand. Delhi, India.
2. Kochhar SL. (**2009).** Economic Botany in Tropic. Macmillan and Co. New Delhi
3. Judd WS, Campbell CS, Kellogg EA, Stevens PF and Donoghue MJ. (**2008)**. Plant Systematics- A Phylogenetic Approach. Sinaner Associates Inc, Massachusetts, USA.
4. Lee RE. (**2008)**. Phycology, Fourth Edition, Cambridge University Press, USA.
5. Slater A, Scott NW and Fowler MR. (**2008).** Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.
6. Sambamurty. (**2008).** A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishers.
7. Webster J and Weber R. (**2007).** Introduction to Fungi. 3rd edition, Cambridge University Press, Cambridge.
8. Simpson MC. (**2006)**. Plant Systematics. Elsevier, Amsterdam.
9. Taiz L, Sunderland MA. and Zeiger E. (**2006).** Plant Physiology. (4th edition) Sinauer Associates, Inc.
10. Wickens GE. (**2004).** Economic Botany: Principles and Practices, Springer- Kuwer Publishers, Dordrecht, The Netherlands.
11. Angiosperm Phylogeny Group. **2003**. An update of the Angiosperm Phylogeny Group classification for the orders and families of the flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
12. Pough Harvey F, Christine M .Janis and John B. Heiser. (**2002)**. Vertebrate Life (6th Edition). Pearson Education Inc. New Delhi.

13. Jordon EL and Verma PS. (**2000**). Chordata Zoology, S Chand & Co., New Delhi.

14. Buchanan B, Gruissem W and Jones R. (**2000).** Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.

15. Shaw AJ and Goffinet B. (**2000).** Bryophyte Biology. Cambridge University Press.

1. 18. Kotpal RL. (**1992).** Protozoa, Porifera, Coelenterata, Helminthes, Arthropoda, Mollusca, Echinodermata. Rastogi Publications, Meerut.

2. 19. http://www.biologydiscussion.com/algae/algae-characters-and-economic-importance-plant-kingdom/52154

3. 20. https://www.eolss.net/ebooklib/ebookcontents/E6-71-ThemeContents.pdf.

Outcomes:

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

- ✓ To give better understanding to carry out the advance research on algae.
- ✓ To grasp the economical importance of the algae which motivates to start their own business like *Spirulina* production
- ✓ To understand the fundamentals of important chapter to understand about microorganism
- ✓ To understand the general character and classification of invertebrates to carry research on it
- ✓ To understand the major problem of agriculture is insects – it helps to know about physical and biological interaction of pests to control it.
- ✓ To understand that the In vitro study is very important in biological research to prove its activity. This significance of experimental plants and animals and its importance is gives more knowledge about this.
- ✓ To classify Chordata, reptilian and economical importance of vertebrate is more important to start research on mammals.
- ✓ To study about each species with its global perspectives are very important to utilize the animal for human welfare.

First Year: Semester - I
Phycology and Mycology (Theory)

Code: 18MICCC1 **Credits: 5**

Objectives:

- To understand the relevance of algal- fungal interactions in maintaining aquatic periodicity.
- To implement the biomimetic products by studying the real internal symbiotic mechanisms in lichen.
- To acquire knowledge regarding harmful environmental changes occurred due to anthropogenic activity via lichen indicator.

Unit I

Classification – History of Indian Phycology. Habitat – distribution of algae – Freshwater –Marine. Morphology – plastids, pyrenoids, stigma, flagella, nuclear division, growth. Reproduction – sexual – asexual – life cycle. General characteristics of Cyanophyta – Dinophyta – Crytophyta - Rhodaphyta – Chrysophyta – Bacillariophyta – Xanthophyta – Phaeophyta – Chlorophyta – Charophyta - Euglenophyta.

Unit II

Algal protein – algal peptides – SCP. Pigments – carotenoids – phycocyanin – phycoerythrin. Lipids – FAME – Growth promoting substance from microalgae – extracellular polymeric substance – Toxins. Phycoremediation – heavy metal remediation – dye degradation – hydrocarbon degradation. Biofuels – biodiesel – biobutanol – biohydrogen – nanoparticles from microalgae - Algal in Transgenics – antimicrobials from microalgae – CO_2 sequestration – Algae in Space.

Unit III

General Characters; origin, occurrence and distribution; vegetative structure; nutrition; ecological groups; respiration and reproduction strategies.

Unit IV

Outline of fungal taxonomy, nomenclature and classification and their types Characteristic features in brief of Ascomycetes, Basidiomycetes and Imperfecti fungi.

Unit V

Useful and harmful aspects of fungi: Fungi as food and natural recycler; manures; antibiotics and medicine; fermented products; organic acids and enzymes; pigment production. Fungal diseases in plants and animals: diagnostic methods and control measures.

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

During the course of study to learn the basic techniques of quality of microbial load in water and food. Mass cultivation of algae to the pharmaceutical industry, Visit the food processing industry and microbiologists to learn about the quality control of foods.

References:

1. Microbiology by Michael J Pelczar
2. Introductory Mycology by Constantine J. Alexopoulos
3. Text Book of Medical Mycology by Jagdish Chander, Mehta Publishers, New Delhi
4. An Introduction to mycology by Mehrotra. New Age International.
5. Khan M. (**1970**). Algae today, Gajendra Singh Gahlot at Siva Printers, Dehra Dun, India.
6. Amrik SA. (**2003**). Phycology: Principles, processes and applications. Daya Publishing House, Delhi.
7. Rajarao VN. (**1990**). Perspectives in Phycology, Today and Tomorrow Printers and publishers, New Delhi.
8. Steve P. (**2009**). Protozoans, Algae & Other Protists - Capstone Press.
9. Hoek C, Mann DG and Jahns HM. (**1995**). Algae, an introduction to phycology, 39; Cambridge University Press.
10. Stephen JO. (**1993**). Bacteria, Algae, and Protozoa - Cold Spring Harbor Laboratory Press
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12. Textbook of Algae. Sharma OP, Tata McGraw Hill Company, New Delhi.
13. Text book of fungi. Sharma OP, Tata McGraw Hill Company, New Delhi.
14. Casselman KL. (1993). Craft of the Dyer - colour from Plants and Lichens. Dover Publications, Inc., NY.

15. Esslinger TL and Egan RS. (**1995**). A Sixth Checklist of the Lichen-forming, Lichenicolous, and Allied Fungi of the Continental United States and Canada. The Bryologist 98(4).
16. Hale ME. (**1979**). How to know the lichens. Pictured Key Nature Series.
17. Hale ME. (**1983**). The Biology of Lichens. 3rd Ed. Contemporary Biology Series. Edward Arnold
18. Hawksworth DL and Hill DJ. (**1984**). The Lichen-Forming Fungi. Chapman and Hall, New York.
19. Galloway DJ. (**1985**). Flora of New Zealand Lichens. Government Printer, Wellington.
20. http://www.ifremer.fr/avano/

Outcomes:

Upon completion the students will be able:

- ✓ To modify of the mushroom cultivation in a scientific way for livelihood.
- ✓ To understand the bioremediation based on algae and fungi.
- ✓ To explore more biomolecules from algae and fungi this can be subjected for applications.
- ✓ To understand the natural biodiversity for controlling pollution rate.
- ✓ To recognize of the toxic fungi and algae for avoid the hazardous affects.
- ✓ To support the food industry in curbing the growth of toxic mold in food and animal feed.
- ✓ To support antibiotic production and application studies.
- ✓ To focus on associative benefits of algae and fungi.

First Year: Semester- I
Biological Macromolecules (Theory)

Code: 18MICCC2 **Credits: 5**

Objectives

- This course emphasizes the basic concepts of macromolecules and their importance in various biological functions.
- Describes the significance of various metabolic pathways involved in cells and its regulations.
- This course facilitates to learn the various energy production mechanisms in cells.

Unit – I

Carbohydrates: Classification, structure, occurrence and biological functions of monosaccharides, disaccharides and polysaccharides. Carbohydrate metabolism - Glycolysis, Gluconeogenesis, Citric acid cycle, Glyoxylate cycle, HMP shunt pathway: energetcis and regulation.

Unit – II

Amino acids: Nomenclature and classification, structure, and biological functions - Titration curve - isoelectric point. Metabolism: deamination, transamination, decarboxylation, desulphuration, degradation and biosynthesis of individual amino acids, transglutaminase cycle and urea cycle and regulation.
Proteins: Classification, structure, peptide bond, properties and biological functions of proteins. Elucidation of proteins structure: determination of primary and secondary structure of protein – alpha helix, beta sheet, beta turns, Ramachandran Plot. Super secondary structures - helix-loop-helix. Tertiary and quaternary structures. Factors responsible for protein folding of amino acids. Amino acid sequencing techniques and Chemical synthesis of polypeptides, salting in and salting out of proteins.

Unit – III

Structure, classification, properties and biological functions of saturated and unsaturated fatty acids. Structure and biological functions of phospholipids, sphingolipids, glycolipids. Steroids – structure and functions of cholesterol, bile acids and bile salts. Amphipathic lipids - membranes, micelles, emulsions and liposomes. Lipogenesis: biosynthesis of fatty acid, triglycerides, phospholipids, and cholesterol.

Regulation of triacylglycerol, phospholipids and cholesterol biosynthesis. Oxidation of lipids. Role of carnitine cycle in the regulation of β-oxidation. Ketogenesis and its control. Lipoprotein metabolism - exogenous and endogenous pathways.

Unit – IV

Structure of purine and pyrimidines, Composition of RNA, DNA, PNA (Peptide nucleic acid) features of DNA doubles helix. Denaturation and annealing of DNA, structure and different types of RNA and DNA. Biosynthesis of Nucleotides – synthesis of purine and pyrimidines – *De nova, salvage* and its regulations.

Unit – V

Vitamins - Definition, nomenclature, structure and biochemical properties and biological availability. Synthesis, storage, metabolism, sources, biochemical functions, deficiency diseases, daily requirements of water soluble and fat soluble Vitamins.

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

Current developments related to the recent advancements in energy production, metabolism of various organisms during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation. To be sourced from multiple reliable informative sources- Print, Internet, Interaction, Social Media, Webinars and so on. Quiz and Self reading on "Protein sequencing and structure prediction". Presenting a group project on recent publications and inputs in Ramachandran plot/Protein sequencing/Next generation sequencing/Vitamin metabolism etc.

References:

1. Nelson, D.L., Cox, M.M. **2012**. Lehninger Principles of Biochemistry. 6th edition, Mac Millan Eworth Publishers.
2. Bender, D.A., Kennelly, P.J., Rodwell, V.M. **2015**. Harpers Illustrated Biochemistry. 30th edition, The McGraw-Hill companies, Inc.
3. Lewin, B. **2013**. Genes XI. Student edition, Jones & Bartlett Learning.
4. Campbell, M.K. **2007**. Biochemistry, 5th edition, Cengage Learning India Pvt Ltd.
5. Geoffrey L. Zubay **1998**. Biochemistry, William C. 4th edition, Brown Publishers.
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7. Voet, D., Voet, J. **2011**. Bichemistry, 4th edition, John Wiley and Sons Inc.
8. Freifelder, D. **2004**. Molecular Biology, 2nd edition, Narosa Publishing House.

9. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A.F., Levine, M., Losick, R.M. **2013**. Molecular Biology of the Gene, 7th edition, The Benjamin & Cummings Publishing Company.
10. Bender, D.A. **2003**. Nutritional biochemistry of vitamins, 2nd edition, Cambridge University Press.
11. Devlin, T.M. **2010**. Text Book of Biochemistry with clinical correlation, 7th Edition, John Wiley & Sons.
12. https://ocw.mit.edu/courses/biology/7-51-graduate-biochemistry-fall-2001/download-course-materials/
13. https://online-learning.harvard.edu/course/principles-biochemistry-1
14. https://pubs.acs.org/doi/abs/10.1021/ed084p1866
15. https://www.mooc-list.com/course/principles-biochemistry-edx
16. https://www.mooc-list.com/course/biochemical-principles-energy-metabolism-coursera

Outcomes:

After successful completion of the course student will be able to:

- ✓ Acquire knowledge on the chemical properties, classification and the biological functions of macromolecules.
- ✓ Narrate the various pathways involve in the metabolism of nutrients.
- ✓ Analyze the role and essentials of vitamins and hormones.
- ✓ Understand the basics and applications of proteomics.
- ✓ Discuss the chemical properties of nucleic acid their importance in normal functioning of living organisms.
- ✓ Explain the Structure and biological functions of saturated and unsaturated fatty acids.
- ✓ Describe and analyze the various metabolics related ubnormalties.
- ✓ List out the role and importance of vitamins in metabolism.

First Year: Semester- I
Microbial Cell Biology and Physiology (Theory)

Code: 18MICCC3 **Credits: 5**

Objectives

- Understand Historic Background of Cell Biology
- Understand current role of Cell Biology in scientific research
- Brief understanding of Cell Structure and Function

Unit – I

Introduction – Contributions of early microbiologists, Classification of microorganisms - Haeckel's three kingdom concept. Whittaker's five kingdom concept. Three domain concept of Carl Woese. Basis of microbial classification. Classification and salient features of bacteria according to the Bergey's manual of systematic Bacteriology [1994]. Modern trends in classification of microorganisms. Cyanobacteria: Distribution, conventional and modern classification. General form and structure. Reproduction, gas vacuoles, movements and symbiosis. Prochloron, Cyanelles, Microfungi, Mycorrhiza and Lichens– a brief account (Remove)

Unit – II

Light Microscopy – Bright field, Dark field, Phase contrast, Fluorescent and Polarization microscopes, Electron Microscopy – TEM & SEM, Confocal Microscopy – applications. Sterilization - Physical and chemical control of micro organisms. Isolation, purification of different types of microorganisms. Preservation methods, (Remove). Identification of microorganisms using morphological, physiological, biochemical and molecular biological techniques.

Unit – III

Morphological types – Archeabacteria, Gram negative and Gram positive Eubacteria (Monera), eukaryotes (Protista). Ultrastructure of prokaryotic and eukaryotic cells. Structure and functions of cell wall, cell membrane, flagella, cilia, pili, gas vesicles, chlorosomes, carboxyomes, magnetosomes and phycoblisomes. Capsule structure, composition and properties. Reserve food materials – polyhydroxybutyrate, polyphosphate, oil droplets, cyanophycin granules and sulphur inclusions. Cell division, Endospore – Structure and properties.

Unit – IV

Nutrition and nutritional types – nutrients – organic – inorganic. autotrophs – heterotrophs – lithotrophs – organotrophs – phototrophs. Autotrophy.

Chemolithotrophy – sulphur – iron – hydrogen – nitrogen oxidation. Growth phases – kinetics – asynchronous – synchronous - batch – continuous culture. Factors affecting growth; Measurement of growth – dry weight – wet weight – protein – Kjeldhal nitrogen – chlorophyll.

Unit – V

Photosynthesis - Anoxygenic – oxygenic. Respiratory metabolism – Aerobic and anaerobic - glycolysis – Kreb's cycle – pentose phosphate pathway, the Entner – Doudoroff pathway – homo and hetero lactic fermentations. Biological nitrogen fixation – nitrogenase enzymes – structure and properties – '*nif*' gene – regulation – functions. Assimilation of inorganic nitrogen – nitrate, nitrite – dinitrogen – ammonia. Physiology and regulation - methanogenesis, bioluminescences and quorum sensing.

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

Cell culture – Immunostaining – Computational genomics – DNA Microarray – Cell Fractionation – Flow Cytometry.

References:

1. Joanne M. Willey, Linda Sherwood, Christopher J. Woolverton 2007. Prescott, Harley, Klein's Microbiology, 7th edition, McGraw Hill Medical Publication division.
2. Pelczar Jr. M.J., Chan, E.C.S., Krieg, N.R. 1993. Microbiology – Mc Graw Hill. Inc, New York.
3. Gerherdt, P., Murray, R.G., Wood, W.H., Kreig, N.R. 1994. Methods for General and Molecular. Bacteriology, American Society for Microbiology, Washington DC.
4. Good Fellow, M., O' Dennell, A.G. 1994. Chemical methods in Prokaryotic Systematics. John Wiley and Sons, New York.
5. Holt, J.S., Kreig, N.R., Sneath, P.H.A., Williams, S.T. 1994. Bergeys Manual of Determinative Bacteriology, 9th edition, William and Wilkins, Baltimore.
6. Landecker, E.M., 1996. Fundamentals of Fungi –Prentice Hall International Inc.
7. Rao, A.S. 1997. Introduction to Microbiology, Nagarjuna University , Prentice Hall of India, New Delhi.
8. Tauro, T., Kapoor, K.K.T., Yadav, S. 1997. An Introduction to Microbiology, Haryana Agricultural University, Hissar, Prentice Hall of India Pvt. Ltd., Delhi.

9. Essential cell biology: an introduction to the molecular biology of the cell Bruce Alberts Science
10. Harvey F. Lodish, Arnold Berk - Science – 2008 Molecular cell biology-
11. Cell Biology by Delhi University
12. Introduction to Cell and Developmental Biology Dr. Steve Rogers, Dr. Jason Reed
13. Plant Cell Biology Delhi University

Outcome:

- ✓ Account for the structure and function of the prokaryotic and eukaryotic cell and its organelles.
- ✓ Account for cell motility and regulation of cell form and movement
- ✓ To describe and carry out basic molecular genetics methods; including work with bacteria, PCR amplification and analysis and electrophoresis of nucleic acid.
- ✓ To understand the basic cell culture and microscopy.
- ✓ To explain the theory behind the practical parts in the course and be able to compile and interpret experimental results in both written and oral form.
- ✓ To inculcate the spirit of research in young minds.
- ✓ To understand the molecular dynamics of cell.

First Year: Semester- I
Microbial Genetics & Molecular Biology (Theory)

Code : 18MICCC4 **Credit: 5**

Objective:

- To be highly experienced in prokaryotic and eukaryotic genetic transformation
- Introduction to mutation and its effects
- Develop basic knowledge in DNA damage and repair mechanism

Unit - I

Molecules of Life – Discovery of genetic material - DNA (Griffith, Avery and Hershey and Chase experiments), RNA (Frankal and Contrat) and protein (prions). Organization of Gene in Prokaryotes and Eukaryotes. Mechanism of Gene transfer - Bacterial Transformation – competence cells, regulation, general process; Transduction – general and specialized; Conjugation – *Hfr*, triparental mating, self transmissible and mobilizable plasmids, sex pili.

Unit II

Gene as a unit of mutation and recombination. Mutagenesis, mutations and mutants – biochemical basis of mutations, spontaneous and induced mutations (physical, chemical and biological). Discovery of mobile genetic elements – IS elements and Transposons. Mechanism – Transposons of *E.coli*, Bacteriophage and Yeast. Isolation of mutants, reversion, suppression, genetic analysis of mutants. Mutant detection methods. Uses of mutants.

Unit III

DNA replication - Meselson – Stahl experiment, Molecular mechanisms of DNA Replication – bidirectional and rolling circle replication. Differences in prokaryotic and eukaryotic replication. Pi x 174 replication. DNA repair – mechanism of excision repair, recombination repair, SOS repair and mismatch repair. Plasmids – types, structure and replication.

Unit – IV

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

Unit – V

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

Quiz related to CRISPR –mediated analogue multi-event recording apparatus system- Round table chat section on Molecular computation strategy for classifying complex gene expression- spliceDetector- Nanobot- imotifs inside human cells, literature Seminar on Genome editing technique in embryo- Open talk on Dbx2 gene activity in brain aging-,Biomedical tattoo, Disorder due to Mutation to the FGFR2 gene.

References:

1. Meneely P, Hoang RD, Okeke IN and Heston K (2017). Genetics: genes, genomes, and evolution, Oxford University Press.
2. Clark DP and Pazdernik NJ (2013). Molecular biology, Elsevier.
3. Hanawalt P (2012) Molecular mechanisms for repair of DNA, Springer Science & Business Media, Vol. 5.
4. Klug WS and Cummings MR (2003). Concepts of genetics, Pearson Education, Inc, Edn. 7.
5. Hughes KT (2007). Advanced bacterial genetics: use of transposons and phage for genomic engineering, Elsevier, Vol. 421.
6. Syvanen M and Kado CI (2001). Horizontal gene transfer, Academic Press.
7. Thomas CM (2003). Horizontal gene pool: bacterial plasmids and gene spread, CRC Press.
8. Shapiro J (2012). Mobile genetic elements, Elsevier.
9. Wilson K and Walker J (2010). eds., Principles and techniques of biochemistry and molecular biology, Cambridge University press.
10. White S (2011). Principles and techniques of biochemistry and molecular biology.

11. Buchanan BB, Gruissem W and Jones RL (2000). Biochemistry & molecular biology of plants, Rockville, MD: American Society of Plant Physiologists, Vol. 40.

12. Krebs JE, Lewin B, Goldstein ES and Kilpatrick ST (2014). Lewin's genes XI, Jones & Bartlett Publishers.

13. Craig N, Green R, Greider C, Storz G, Cohen-Fix O and Wolberger C (2014). Molecular biology: principles of genome function, OUP Oxford.

14. Cox MM and Nelson DL (2008). Lehninger principles of biochemistry, WH Freeman.

15. http://science.sciencemag.org/content/early/2018/02/14/science.aap8992

16. https://www.nature.com/articles/s41598-018-23245-1

17. http://www.dailymail.co.uk/sciencetech/article-4884760/DNA-nanobot-deliver-medicine-human-bloodstream.html

18. https://cen.acs.org/biological-chemistry/genomics/DNAmotifs-found-human-cells/96/i18

19. https://www.technologyreview.com/s/608350/first-human-embryos-edited-in-us/

20. https://www.medicalnewstoday.com/articles/321575.php

21. https://ghr.nlm.nih.gov/gene/FGFR2#

Outcome:

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

- ✓ Explain the processes behind mutations and other gene transfer mechanism
- ✓ Understand genetic regulatory mechanisms at different aspects
- ✓ Can perform basic experiments in microbial genetics
- ✓ Mechanisms of transcription, translation and gene expression can be discussed.
- ✓ Understanding of fundamental concepts in microbial genetics replication and repair
- ✓ Used to investigate interesting biological problems
- ✓ Insight into current topics in microbial genetics and related fields.
- ✓ Relate microbial genetics to biotechnology

First Year - Semester- I
Practical (18MICCC2, 18MICCC3, 18MICCC4)

Code: 18MICCC5 **Credits: 4**

Objectives:

- To make well verse in molecular aspects
- Practically motivate for innovative findings in microbial molecular mechanism

Biological Macromolecules (Lab Course)

Quantification of Macromolecules:

1. Carbohydrate reducing sugars - Anthrone method/Benedicts method.
2. Amino acids - Ninhydrin method
3. Protein - Lowry's method/ Biuret method
4. Cholesterol estimation - Acetic anhydride method, 9. Estimation of lipid.
5. DNA - Diphenylamine method
6. RNA - Orcinol method
7. Determination of Phosphorous content of nucleic acids - perchloric acid test.
8. Pigments (chlorophyll - carotenoids – phycobiliproteins) – Spectrophotometric
9. Separation of proteins by SDS-PAGE and native gel
10. Seperation of biological molecules (amino acids, sugars and pigments) using TLC method.

References:

1. Boyer, R. **2001**. Modern Experimental Biochemistry, 3rd edition, Benjamin and Cummings Publishing Company Inc.
2. Wilson, K., Walker, J. **2000**. Practical Biochemistry Principles and Techniques, 5th Edition, Cambridge University Press.
3. Jayaraman, J. **1981**. Laboratory manual in Biochemistry, New Age International Publishers, New Delhi.
4. Plummer, D.T. **1987**. An introduction to Practical Biochemistry, 3rd edition, Tata McGraw Hill, New Delhi.
5. Switzer, R.L., Garrity, L.F. **1999**. Experimental Biochemistry, 3rd edition, WH Freeman and Co.

Microbial Cell Biology and Physiology (Lab Course)

Experiments:

1. Microscopy, Micrometry, Microphotography and CLSM
2. Preparation of culture media and sterilization procedures.
3. Isolation of aerobic and anaerobic bacteria, cyanobacteria, actinobacteria, microalgae and fungi.
4. Pure and axenic culture techniques – serial dilution – pour plate, spread plate, streak plate methods and stab culture techniques.
5. Bacterial Staining methods –Simple, Gram's, Acid fast, Capsule, Spore and metachromatic staining.
6. Fungal Staining methods – Lacto-phenol cotton blue.
7. Motility of bacteria- Hanging drop technique, Semisolid agar method.
8. Determination of growth – growth curve – generation time – estimation of growth – microscopic – plate – membrane filter – turbidometry – dry weight – wet weight – chlorophyll content.
9. Effect of physical and chemical factors on the growth of bacteria and cyanobacteria – temperature, pH, oxygen, radiation, water activity, macro and micro nutrients and chelators.

References:

1. James cappuccino, Natalie Sherman **2004**. Microbiology: A Laboratory manual, 7th edition.
2. Karen Messley **2003**. Microbiology Lab manual, 2nd edition, Berjamin cummings Publisher.
3. Collins, C.H, Lyne P.M **1985**. Microbiological methods, Butterworths, London.
4. Harry W. Seeley Jr., Paul J. Vandemark **2003**. A Laboratory manual of Microbiology, W.H Freeman and Company Publisher.
5. John P. Harley **2007**. Microbiology Lab Manual, 1st edition, McGraw-Hill Publication.

Experiments:

1. Isolation of microbial genomic DNA, RNA
2. Isolation of plasmid DNA from *E.coli* (mini preparation).
3. Extraction and purification of DNA from yeast cells.
4. Quantification of DNA/plasmid by spectrophotometric methods.
5. Characterization of DNA/plasmid by agarose gel electrophoresis and molecular weight determination.
6. Isolation of antibiotic resistant microbes from clinical specimens.
7. Mutagenesis by ultra-violet radiation and chemical mutagens – NTG, MNNG.
8. Transformation (competent cell preparation) and Transduction using P1.
9. Conjugation – *Hfr*

References:

1. Current protocols in molecular biology (2007). John Wicey & Sons Inc, Vol. 1 & 2.
2. Sambrook J and Russell DW (2001). Molecular cloning - A laboratory manual, Cold Spring Laboratory Press, New York, 3rd edition, Vol 1,2,3.
3. Surzyeki S (2000). Basic Tecniques in Molecular Biology, Springer.

Outcome:

After the completion of the course students will able to

- ✓ Practicing for handling the clinical samples
- ✓ Get the clear practical knowledge on molecular techniques.
- ✓ Study about the Antibiotic resistance
- ✓ Understand the Transformation mechanisms.
- ✓ Learning the quantification of macromolecules in industrial point of view.
- ✓ Describe the separation of industrially important molecules like pigments.
- ✓ Applications of various instruments to analyse the quality of macromolecules in a solution.
- ✓ Identify the types of staining and its application in detection of microorganisms

First Year: Semester- II
Immunotechnology (Theory)

Code: 18MICCC6 **Credits - 5**

Objective

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

Unit – I:

Historical background, general concepts of the immune system; Innate and adaptive immunity; Inflammation - general properties; Structure, properties and functions of the immune cells & organs: Hematopoeisis, T and B-lymphocytes, NK cells; monocytes, ~~and~~ macrophages, neutrophils, eosinophils, and basophils, Mast cells ~~and~~ dendritic cells, Thymus and bone marrow, Lymph nodes, spleen, MALT, GALT and CALT.

Unit – II:

Types and properties of antigen (foreignness, molecular size, heterogeneity of antigen). B and T cell epitopes. T-dependent and T- independent antigens. Antibodies: Structure, function and properties of the antibodies; Different classes and biological activities of antibodies; Antibody as B cell receptor, antigenic determinants on antibodies (isotype, allotype and idiotype); Genesis of antibody variability; Hybridoma technology, monoclonal antibodies and abzymes; Complement system: Components of the complement activation - classical, alternative and lectin pathways.

Unit – III:

B-cell maturation in bone marrow; humoral immune response; primary and secondary immune response; generation of plasma and memory B cells. T cell maturation in thymus, clonal expansion, generation of effector and memory T cells. Antigen presenting cells, antigen processing and presentation pathway (cytosolic and endocytic). Cytokines - properties and functions of interleukins (IL-1 to IL-5, IL-10, IL-12) and inferferon (IFN-γ).

Unit – IV:

Affinity and avidity; cross reactivity; precipitation;, agglutination; immunodiffusion; immunoelectrophoresis; ELISA (indirect, sandwich, competitive, chemiluminescence, ELISPOT assay); Western blotting; immunofluorescence; flow cytometry, ~~and~~ fluorescence, and immune electron microscopy. Types of grafts, immunologic basis of graft rejection, properties and types of rejection; tissue typing, immunosuppressive therapy and transplants to immunologically privileged sites.

Unit – V:

Types and mechanism of hypersensitive reactions; Autoimmune diseases: Hashimoto's thyroiditis, Goodpasture's syndrome, SLE, and rheumatoid arthritis. Immunodeficiency disorders: SCID, CGD, congenital neutropenia and Chediak-Higashi Syndrome.

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:

1. Abul Abbas Andrew H. Lichtman., 2017. Cellular and Molecular Immunology, 9th Edition. Elsevier.
2. Abul Abbas Andrew H. Lichtman, Shiv Pillai., 2016. Basic Immunology, 5th Edition. Elsevier.
3. Judith A Owen, Jenni Punt, Sharon A Stranford, Patricia P Jones, Janis Kuby Thomas J Kindt., 2014. Kuby Immunology, 7th Edition. Dunod, Paris
4. William E. Paul. 2012. Fundamental Immunology, Seventh 7th Edition. Lippincott Williams & Wilkins.
5. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt., 2012. Roitt's Essential Immunology, 12th Edition. Wiley-Blackwell.
6. Charles A. Janeway, Paul Travers, Mark Walport, Mark J. schlomchick., 2005. Immunobiology, 6th Edition. Garland Science Publishing.
7. Ivan M. Roit., 2004. Essential Immunology 10th Edition. Blackwell Scientific Publications, Oxford.
8. Kuby J., 2001. Immunology, 4th Edition. WH Freeman and Company, New York.

9. Richard M. Hyde., 1995. Immunology, 3rd Edition. National Medical series, Williams and Wilkins, Harward Publishing Company.
10. Donal M. Weir, John Steward., 1993. Immunology, 7th Edition. ELBS, London
11. https://www.sciencedirect.com/science/book/9780128098196
12. http://mbbshelp.com/2017/03/31/lange-review-of-medical-microbiology-immunology-13th-edition/
13. http://www.immunology.utoronto.ca/online-learning

Outcome:

After the completion of the course, students will able to

1. Understands how the immune system was discovered and how its attributes were recognized.
2. Understands cells and organs of immune system
3. Apply the significance of cellular coordination in the generation of immune responses
4. Understands the roles of molecules of the major histocompatibility complex and their function
5. Analysis the immune class regulation and immune responses
6. Demonstrate the importance of immunotechniques
7. Demonstrate the crucial role of the Hypersensitivity and immune disorder
8. Analyse the current development in immunosensors

First Year: Semester – II
Medical Microbiology (Theory)

Code: 18MICCC7 **Credits: 5**

Objectives

- To acquire a basic understanding with the common infections and diseases of medical importance, their microbial causes, pathogenic action,
- Multiple assignment-task skill in the diagnosis of infection, the latter in the context of the treatment, epidemiology and prophylaxis of infectious diseases.
- To understand the fungal and protozaon diseses and preventive measures

Unit – I

History, Koch &River's postulates, Role of Microbiology in Medicine, Classification of medically important microbes, Normal Microbial flora, Infections- Source, Mode of transmission, etiology & epidemiology of nosocomial infections, Prevention of medically important microbes. Host-microbe interactions.

Unit – II

Mechanism of Bacterial pathogenesis of medically important bacteria: Staphylococcus aereus, Group A Streptococci. Enterobacteriaceae: E. coli, Salmonella, Shigella, Klebsiella, Proteus, Brucella, Vibrio, Nieserriae,H. influenza, Pseudomonas, Mycoplasama.Anaerobic bacteria & infections: Clostridium,Corynebacteria, Mycobacterium tuberculosis, Atypical Mycobacterium, Clamadiya, Bacillus, Rickettsia, Spirochetes,Helicobacter pylori, Zoonotic bacteria.

Unit – III

Fungi: Description and pathology of Mycotic diseases-Dermatomycosis, Mycetoma, Histoplasmosis, Blastomycosis, Candidiasis, Crptococcosis, Opportunistic – Zygomycosis *Protozoa*: Description and pathology of diseases caused by *Leishmania donavani, L. Tropica, Trypanosoma gambiense*; intestinal flagellates; *Trichomonas, Giardia, Entamoeba histolytica*. Malarial parasites. *Helminthes*: Round, pin, tap, Hook worm. Filarial parasites.

Unit – IV

Animal viruses and infection on host. *Oncogenic viruses (tumor viruses)*: DNA containing oncogenic viruses (papova, human adenovirus), RNA containing oncogenic viruses (Retroviruses AIDS virus). Unclassified viruses, hepatitis. Bacterial phages & viruses - Ff phage, MS2, F2, QB, μ phages. Viral interference; Antiviral agents - chemical and biological agents – Interferons.

Unit – V

Laboratory Diagnosis of Bacterial Diseases I: Culture & Handling: Cases illustrating collection & handling of specimens, types of pathogens to be expected from various body fluids & tissues. Infections related to epidemiologic surveillance. *Laboratory Diagnosis of Viral Disease***:** Cases illustrating use of cytology, electron microscopy, viral isolation & growth (cell culture), detection of viral proteins & genetic material, viral serology- Molecular diagnosis. *Laboratory Diagnosis of Protozoan & Other Parasitic Diseases:* Cases illustrating the general considerations of life cycle and pathogenesis of infection for intestinal, urogenital & blood infections (collection of specimens, techniques for specimen examination), alternatives to microscopic methods- Molecular diagnosis.

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

Survey of dermatophytic infections in students communities. Analysis of worm infections in animal and human stool samples. Daily news and research paper collection and recording of recent outbreak of bacterial, fungal, viral, protozoan diseases. Making awerness and celebration of world AIDS day, World TB Day, Pulse polio immunization day etc., awerness programme on personel hygine, vaccination, and in rurual.

References:

1. John P. (2007). Harley Microbiology Lab Manual 7th edition McGraw Hill Medical Publication division.
2. Prescott, Harley**,** Klein's. (2007). Microbiology 7th edition McGraw Hill Medical Publication division.
3. Chatterjee K.D (2007). Medical Parasitology, 7th edition.
4. Cathleen park Talaro. (2005). Foundations in Microbiology 6th edition, McGraw Hill Medical Publication division.
5. Jawetz, Melnickand Adelberg's (2013) Medical Microbiology 22nd edition McGraw Hill Medical Publication division

6. David Greenwood, Richard Slack and John Peutherer. (2000). Medical Microbiology.15th edition, Church Hill Living stone Publication.
7. Ananthanarayanan and Jeyaram Paniker. 2016. Textbook of Microbiology, 7th Edition, Orient Publication, New Delhi
8. Kenneth j. Ryan, C. George Ray, 2014. Sherris Medical Microbiology, 4th edition. McGraw-Hill Medical Publishing Division. New York.
9. https://www.mooc-list.com/tags/bacteriology
10. https://mycology.adelaide.edu.au/
11. https://www.aspergillus.org.uk/mycology-courses?page=5
12. https://www.cdc.gov
13. http://nvbdcp.gov.in/
14. https://www.mooc-list.com/tags/human-parasitology
15. https://www.mooc-list.com/tags/tropical-parasitology

Course Outcome

After completion of this course the student can able to

- ✓ Exploring the role of microbiology in medicine
- ✓ Skilled at diagnosis of bacterial, viral, protozoan and other prasitic diseases
- ✓ Learning the concept, etiology and epidemology of infections
- ✓ List out the prevention of medically important microbes
- ✓ Understand the Host-microbe interactions
- ✓ Analyse the molecular biology of animal virus and various antiviral agents.
- ✓ Describe the various types of parasite and its control measures
- ✓ Understand the description and pathology of Mycotic diseases

First Year: Semester – II
Public Health Microbiology

Code: 18MICCC7 **Credits: 5**

Objectives:

- To Acquaint the student with basic concept of public health and prophylactic measures.
- To Understand air, Food, water, insect borne infectious diseases
- To Public awareness, individual behavior, and disease prevention

Unit I

Definition, scope, concept and importance of public health microbiology, Roles of microbiologist in public health, Concept of health and disease, Indicators of health. Public health and health planning, National health programs and public health hazard in the community.

Unit II

Vaccinology- History of vaccination, vaccine type- live, killed, toxoid, recombinant, edible vaccine, domestic and international vaccine policy, vaccination schedules, ethical considerations and regulatory issues, vaccines for pediatric and adolescent adults, tropical diseases & travelers' vaccines, new vaccine schedules.

Unit III

Microbial air pollution, Indicator of air pollution - WHO guideline (microbial pollution). Air borne diseases: Transmission of pathogens, Respiratory infection, Sources of infection, characters of organisms and controls of: Bacterial pneumonia, Diphtheria, Tuberculosis, Influenza, Measles. Method of measuring microorganisms in air.

Unit IV

Food borne diseases: Transmission of pathogens from food, Types of food borne diseases, Food poisoning and food intoxication. Food borne infection, Water pollution and sanitation, Microorganisms in water: Transmission of pathogens, Water borne diseases: Hepatitis, Cholera, Typhoid, Amoebiasis, Giardiasis, Poliomyelitis.

Unit V

Various sexual transmitted infections. Characters of causal organisms and control of: Syphilis, HIV/AIDS, Herpes, Hepatitis B and C, Gonorrhoea, Control of other sexual transmitted infections, Technique used for the diagnosis of sexually transmitted infection.

Unit VI

Vector and its types- Vector transmitted diseases, Transmission, character, and control of: Kala-azar, Malaria, Arboviral diseases (JE, Dengue, etc.), Plague, Techniques used in the diagnosis of vector borne infections. Hospital-Acquired Infection, Disposal of infective hospital and laboratory materials, Monitoring of sanitation in community, Technique used for the diagnosis of hospital acquired infection.

Unit – VII: Current Contours (For Continuous Internal Assessment only)

Public awareness, individual behavior, and disease prevention, Making vaccination schedules for rural community. Public awareness about vaccination and celebration of Vaccinidation day in local community. Public awareness about water, air , insect borne diseases and preventives measures.

References:

1. Robert S. Burlage. 2012. Principles of Public Health Microbiology.Jones & Bartlett learning LLC, Canada.
2. Spencer, John F. T., Alicia L. Ragout de Spencer. 2004. Public Health Microbiology-Methods and Protocols. Springer.
3. Ghimire P. & Parajuli K. 2005. A Text Book of Microbiology, Vidhyarthi Pustak Bhandar Publication, Kathmandu.
4. Brownson, RC., Baker, EA., Leet. TL., Follespie. KN., 2003. Evidence Based Public Health. Oxford University Press.
5. Dixit H. 1999.The Quest for Health, Educational Enterprises, Kathmandu,
6. Friis, RH., and Sellers, TA, (1999). Epidemiology for Public Health Practice, 2nd Edition, Gaithersburg, MD: Aspen Publication.
7. Park JE and Park K., 2005. Textbook of preventive and social medicine.18th edition. Banarsidas Bhanot Publishers.
8. Jay, J, H, Modern. 1987. Food Microbiology, 3rd Edition CBS Publication and Distributors Delhi.
9. http://www.careersinpublichealth.net/careers/public-health-microbiologist
10. https://www.mooc-list.com/tags/vaccines
11. https://www.mooc-list.com/course/vaccines-coursera

12. https://www.coursera.org/learn/international-travel/lecture/SrMPZ/food-and-waterborne-diseases

Outcome

After completion of this course the student can able to

- ✓ Public health Microbiology refers to all organized measures (whether public or private) to prevent disease, promote health, and prolong life among the population as a whole.
- ✓ Its activities aim to provide conditions in which people can be healthy and focus on entire populations, not on individual patients or diseases.
- ✓ This course helps and protects the health of people and the communities where they live, learn, work and play.
- ✓ Public health sets safety standards to protect workers and develops school
- ✓ awareness of HIV, TB and HBV is still low among rural residents.
- ✓ National disease control plans for major infectious diseases should emphasise effective and comprehensive health education campaigns to increase public awareness of these diseases in rural areas of India
- ✓ This course support for the investigation, management and control of infection and outbreaks of communicable disease
- ✓ Assistance during field investigations by processing clinical samples

First Year: Semester –II
Virology (Theory)

Code: 18MICCC8 **Credits : 5**

Objectives

- Virology course is to describe the molecular level, replication strategies of representative DNA and RNA viruses and the effects of virus infection on cell growth control and survival.
- Helps the student to learn the process of virus latency and describe in molecular terms control of the process and activation of viral genomes during reactivation.
- Describe the growth behaviour differences between normal cells and cells transformed by oncogenic DNA and RNA viruses.

Unit – I

Discovery of virus and recent development in virology. Virus taxonomy, nomenclature, evolution, classification and ICTV. Methods used in virus cultivation, isolation, detection and genetics. Viroids, prions, satellite RNAs and virusoids. Brief account of cyano, myco and phycophages and insect viruses.

Unit - II

Lambda, ΦX174, T4, M13 and Mu phages: Nomenclature, structure, morphology, physical and biochemical properties, genome organization and their function and life cycle. Phage conversion and replication strategies. Plaque assay – Temperate, growth curve and gene transfer.

Unit - III

Tobacco mosaic virus (TMV) and Cauliflower mosaic virus (CaMV): Nomenclature, structure, morphology, physical and biochemical properties, genome organization and their function and life cycle. Transmission of plant viruses by vectors and without vectors. Common viral diseases in paddy, cotton, tomato and sugar cane-: name of diseases, pathogens and symptoms.

Unit – IV

General characters, chemical, physical nature, life cycle, epidemiology, pathogenicity, disease caused and immunologic response of: Poxviruses (Smallpox), Herpes viruses (Herpes simplex virus), Hepatotropic viruses (Hepatitis B virus), Retro viruses (HIV), Influenza viruses (H1N1), Rhabdo viruses (Rabies), Filo viruses (Ebola) and Flavi viruses (Dengue, Chikungunyavirus).

Unit - V

Strategies of anti-viral agents and viral vaccination. Antiviral chemotherapy and agents with special reference to Acyclovir, Ganciclovir, Ribavirin, Zidovudine and Lamirudine. Vaccination: Types, protein and peptides vaccines, DNA vaccines. Pre-cautions and issues of vaccination.

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 virus infected plants. In order to enhance their research skills, a mini project in various recent research topics related to virology was given.

References:

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6. Timbury. M.C. (1994) Medical Virology. X edition. Churchill Livingston.
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8. Saravanan. P. (2006). Virology. MJP Publishers.
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10. Méthot, P. O. (2016). Writing the history of virology in the twentieth century: Discovery, disciplines, and conceptual change. Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences, 59, 145-153.
11. https://www.sciencedirect.com/journal/virology

12. https://www.news-medical.net/health/What-is-Virology.aspx

Outcomes

After the completion of the course students would be able

- ✓ To understand the basics of the learning of Virology.
- ✓ To impart the knowledge regarding the diagnostics clinical aspects
- ✓ To classify the related implications of human viral disease
- ✓ To gain knowledge about newer emerging viral infections including the viral mutan forms for emerging.
- ✓ To study the nature of viruses
- ✓ To unravel the mechanisms by which viruses infect cells and cause disease.
- ✓ To employ methods from molecular and cell biology, immunology, biochemistry and biophysics, structural biology, systems biology and mathematical modelling.
- ✓ The M.Sc., student in virology subject will have an opportunity to carry out independent experimental or theoretical work, with a focus on basic science, medical science or veterinary science.

First Year – Semester - II
Practical (18MICCC6, 18MICCC7, 18MICCC8)

Code: 18MICCC9 **Credits: 4**

Objective

- To study the basic principles behind immunological techniques
- To learn the basic forms of apparatus description
- To learn about the application of immunological diagnostic methods

Experiments

1. Collection of venous blood from human and separation and preservation of serum/plasma
2. Immunization protocols and raising antibody
3. Dissection of primary and secondary lymphoid organs in a selected animal
4. Agar gel diffusion – Ouchterlony's method
5. Counter immuno electrophoresis
6. Rocket immuno electrophoresis
7. SDS- PAGE Electrophoresis – serum proteins
8. Blood grouping
9. Latex agglutination test
10. Widal tube and slide agglutination technique, VDRL test
11. Enzyme Linked Immunosorbent Assay (ELISA), Dot ELISA
12. Western blotting technique

References:

1. Benjamin E, Coico R and Sunskise (2000) Immunology a short course. IVth Edition. Wiley – Liss publication, NY.
2. Daniel C. Adelman, Thomas B. Casale, Jonathan (2002) Manual of allergy and Immunology. 4th Edition. Lippincott Williams and Wilkins.
3. Barbara Detrick, Robertv G. Hamilton, James D. Folds (2006) Manual of Molecular and Clinical Laboratory Immunology. 7th Edition. ASM press.
4. Talwar GP, Gupta SK (2012) A Handbook of Practical & Clinical Immunology. CBS Publishers.
5. Frank C. Hay, Olwyn M. R. Westwood (2008) Practical Immunology, 4th Edition, Blackwell Science Ltd.
6. Hilary Warren (2003) Practical Immunology. Wiley-Blackwell Science Ltd.

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Outcome

- ✓ Understanding the theoretical explanation behind the experiment
- ✓ Learn about the detailed Principle followed by a detailed step by step Procedures.
- ✓ Knowledge about the application of laboratory finding to the diagnosis and monitoring of representative disease states.
- ✓ Hands on training on blood collection, serum & plasma separation.
- ✓ Hands on training on blood grouping technique
- ✓ Hands on training on immuno electrophoresis technique
- ✓ Learn how to immunize and raise antibody
- ✓ Learn how to dissect animal and to identify primary and secondary lymphoid organs.

Medical Microbiology (Lab course)

Objectives

- Aim of the course is to concentrate on principles of clinical microbiology like collection and transport of clinical specimens for microbiological examinations.
- Students will become familiar with diagnostic and public health microbiology, modern techniques for the identification of pathogens in diagnostic laboratories.

Experiments

1. Collection and transport of clinical specimens for microbiological examinations
2. Laboratory diagnosis of upper respiratory tract infection
3. Laboratory diagnosis of lower respiratory tract infection
4. Laboratory diagnosis of gastrointestinal infection
5. Laboratory diagnosis of urinary tract infection
6. Laboratory diagnosis of Typhoid fever
7. Laboratory diagnosis of Leptospirosis
8. Laboratory diagnosis of Dengue fever
9. Laboratory diagnosis of Mycotic diseases- Aspergillosis, Candiadiasis
10. Laboratory diagnosis of parasitic infections- amoebiasis, Malaria, Filaria, Round and Hook worm
11. Laboratory identification of medically important vectors.

References:

1. James cappuccino, Natalie Sherman.(2004) Microbiology: A Laboratory manual. 7th Edition.
2. Karen Messley.(2003) Microbiology Lab manual. Berjamin cummings Publisher. 2nd Edition
3. Michael J Leboffe, Burton E. Pierce (2005) A Photographic Atlas for the Microbiology Laboratory. Berjamin cummings Publisher. 3rd Edition
4. Harry W.Seeley Jr and Paul J Vandemark,W.H Freeman (2003). A Laboratory manual of Microbiology.
5. John P Harley (2007), Microbiology Lab Manual McGraw-Hill Publication. 1st Edition,
6. Frances Duncan (2005) Applied Microbiology laboratory manual. 4th Edition.

7. Ronald M. Atlas, Lawrence C. Parks, Alfred E. Brown. (1994). Laboratory Manual of ExperimentalMicrobiology
8. https://www.cdc.gov/parasites/education_training/index.html
9. https://www.mooc-list.com/course/tropical-parasitology-protozoans-worms-vectors-and-human-diseases-coursera
10. https://www.mooc-list.com/tags/malaria
11. https://www.gaffi.org/online-fungal-microscopy-course-will-teach-rapid-diagnosis-of-fungal-infection-for-everyone-worldwide/
12. https://www.youtube.com/watch?v=S5TQ3q9P3k0
13. https://www.afwgonline.com/education/laboratory-courses/
14. https://www.medialabinc.net/ascls_sexually_transmitted_bacterial_infections.aspx
15. http://www1.rmit.edu.au/courses/001121

Outcome

After completion of this course the student can able to

- ✓ Describe the collection and transportation of clinical specimens and diagnosis of various important infections.
- ✓ Learn the propogation of various plant and animal viruses.
- ✓ Understand the Laboratory diagnosis of upper and lower respiratory tract infections.
- ✓ Explain the concept of vector and identification of medically important vectors

Virology (Lab Course)

Objectives

- To visualize cytopathic effects of viruses.
- To diagnose viral infections of humans.

Experiments

1. Isolation and characterization of bacteriophage from natural sources.
2. Preparation of bacteriophage stock - Lambda & T4
3. Phage Titration - T_4 and M_{13}
4. Burst size determination - A one step growth curve of bacteriophage T_4
5. Determination of lysogeny by using Lambda phage
6. Isolation of Cyanophage
7. Study of virus infected plant samples
8. Transmission methods of plant viruses - Southern Sunhemp Mosaic Virus (SSMV) - local and systemic plants
9. Thermal characterization, Longevity *in vitro* - Dilution end point.
10. Animal Virus Propagation - Egg inoculation and cell culture methods.

References:

1. Miller JH. (1992). A short course in bacterial genetics. Cold Spring Harbor.
2. Gerhardt P, Murray RG, Wood WA and Kreig NR. (ed) (1994) Methods for General and Molecular Bacteriology– American Society for Microbiology, Washington D.C.
3. Dharmalingam K (1986). Experiments with M13 gene cloning and DNA sequencing. Published by Wasani for Macmillan India Limited.
4. Brown W.M.C. (1994). Microbiological Applications. 6th edition, Publishers, a division of W.M.C. Brown Communications, Inc.
5. Dejkstra J, Ces P. de Jager (1998). Practical Plant Virology (protocols and exercises) Springer Lab Manual, Berlin, Heidelberg, NewYork.
6. Cappucino, James G (1996). Microbiology - A laboratory Manual. Addison - Wesley Publishin Company Inc.

7. G Sridharan, PAbraham, AMAbraham, R Kannangai, TS Vijaykumar, M Tibbetts. (2006). Practical Manual of Medical Virology.
8. http://eprints.usm.my/29021/1/ISOLATION_AND_CHARACTERIZATION_OF_BACTERIOPHAGE_FROM_RAW_SEWAGE_SPECIFIC_FOR_Escherichia_coli_0157-H7.pdf

Outcome

After the completion of the course students would be able

- ✓ To determine features of proliferating immune cells by CFSE staining and analysis of the dye distribution amongst cell generations.
- ✓ To isolate and characterize bacteriophage from natural sources.
- ✓ Gain knowledge in Preparation of bacteriophage stock - Lambda & T4
- ✓ Understands the Phage Titration - T_4 and M_{13}
- ✓ Learns to determine burst size - A one step growth curve of bacteriophage T_4
- ✓ To Determine the lysogeny by using Lambda phage
- ✓ To isolate of Cyanophage
- ✓ Gains knowledge about animal virus oropagation - egg inoculation and cell culture methods.

First Year : Semester – II
NME- Biological Techniques (Theory)

Code: 18MICNME1 **Credits : 2**

Objectives

- This course gives the student the basic understanding about the principle and application of various instruments in biological science laboratories.
- This course equips the students to attain the knowledge of designing biological experiments.
- This course provides scientific understanding of analytical techniques and detail interpretation of results.

Unit – I

Light Microscopy: Microscopic optics, components of microscopes. Basic principles and applications of Bright field, Dark field, Phase contrast, Fluorescence, Atomic Force and Confocal microscopes. Electron Microscopy – Principle, Techniques and applications of Transmission Electron microscope (TEM) and Scanning Electron Microscope (SEM).

Unit – II

Centrifugation - Basic principles of sedimentation, types of centrifuges and rotors. Preparative ultracentrifugation - differential and density gradient. Chromatography Principles & Applications: General principles and definitions, Rf value. Methods based on polarity - Partition chromatography, adsorption chromatography, TLC, HPTLC, gas liquid chromatography, and reverse phase liquid chromatography. Methods based on partition - Gel filtration and Affinity chromatography. HPLC, Nano-LC, FPLC and Ion-exchange chromatography.

Unit – III

Spectroscopic methods – UV-Visible, Atomic Absorption and Atomic Emission Spectroscopy.Electroanalytical methods – electrolytic – Potentiometric, conductimetric, coulometric & voltametric analysis. Radioactive analysis: Principles of radioactivity, GM counter & LS counter. Basic principles and methods used for structural elucidation: X-ray diffraction, fluorescence, ORD\CD, NMR, IR and MS. Biosensors.

Unit – IV

Electrophoresis - basic principles, PAGE - Native-PAGE, SDS-PAGE, Isoelectricfocussing and 2- Dimensional gels. Capillary electrophoresis. Principle and application of Agarose gel electrophoresis, DGGE, PFGE, Mobility shift electrophoresis.

Unit – V

Polymerase chain reaction – Principle, types and applications. Cloning techniques – vectors, enzymes and stratergies. Blotting Techniques (Southern, Northern, western and dot plots).

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

Current developments related to the recent advancements in instrumentation and advance instrumentation techniques through collection of information from Internet, Interaction, Social Media, Webinars and discussion and evaluation will be done. Quiz will cover the principle and application of instrumentation learned in each unit.

References:

1. Spector, D.L., Goldman, R.D. **2006**. Basic methods in microscopy: Protocols and concepts from cells: A laboratory manual, 1st edition, Cold Spring Harbor Laboratory Press, New York.
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3. Webster, J.G. **2008**. Bioinstrumentation, University of Wisconsin, John Wiley & Sons, Inc.
4. Sambrook, J., Russell, D.W. **2013**. Molecular Cloning – A Laboratory Manual (4th eidition, Vol. 1,2,3) Cold Spring Laboratory Press, New York. Indian edition: Viva Books Private Limited, India.
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9. Willett, J.E. **1991**. Gas Chromatography, John Wiley & Sons.
10. Wilson, K., Walker, J. **2000**. Practical Biochemistry Principles and Techniques, 5th edition, Cambridge University Press.
11. https://www.gtac.edu.au/gel-electrophoresis-online-course/

12. https://www.coursera.org/learn/dna-decoded/lecture/Misfj/practical-dna-gel-electrophoresis
13. https://onlinecourses.nptel.ac.in/noc16_bt04/preview

Outcomes:

After successful completion of the course student will be able to:

- ✓ Describe the basic principles, types and application of light and electron microscopy.
- ✓ Differentiate the principle and application of photometry and colorimetry.
- ✓ Understand the overall concept of Chromatography and its appropriate use in separation of molecules.
- ✓ Explain the basic principle of centrifugation and its vital application in molecule separation.
- ✓ Develop useful skills on preparation of samples for a variety of analytical methods.
- ✓ Bridge the gap between academics and application of various instruments in scientific experiments.
- ✓ Obtain a basic inspiration on how to design and perform a biological research.
- ✓ Gain insight knowledge about the strengths, limitations and creative use of techniques for problem-solving.

First Year : Semester – II
Elective Course (EDC)
Molecular Taxonomy and Phylogeny

Code: 18MICEDC1 **Credits: 2**

Objectives:

- To gain knowledge about combination of molecular and statistical techniques.
- To explore source of information for phyogenetic analyses
- Grasp the speed of technological change in molecular biology and its impact on phylogenetic research

Unit I

Introduction to microbial taxonomy – morphological taxonomy, biochemical taxonomy, molecular taxonomy, numerical taxonomy – basic concepts of taxonomy. Positive and negative aspects of each taxonomical method.

UNIT II

Chemotaxonomy – aspects, significance- primary – proteins, nucleic acid, chlorophyll, polysaccharides and secondary constituents- phenolic compounds, flavonoids, terpenoids. Finger printing, Isozyme typing, pigments & polyamines.

UNIT III

Molecular taxonomy – G + C content, DNA –DNA hybridization, DNA- RNA hybridization, Plasmid profiles, RFLP, RAPD, AFLP, STRR & LTRR.- DNA sequencing- PCR, Real Time-PCR, PFGE (Pulse Field Gel Electrophoresis); Indirect analysis - SDS-PAGE, Western blotting, ELISA, 2D-gel electrophoresis.

Unit IV

Types of rRNA, Importance of 16S rRNA in microbial identification and taxonomy. Methods of 16S rRNA / rDNA fingerprinting, Isolation of DNA, amplification of 16S rDNA using PCR, Cloning, transformation, Blue-white screening, Plasmid isolation, Dot Blot/Southern blot hybridization using specific probes. Sequencing of 16S rDNA using chain-termination method.

UNIT V

Introduction to Sequence alignment. Substitution matrices, Scoring matrices – PAM and BLOSUM. Submission of rDNA sequences in GenBank – BankIt & Sequin guidelines. NCBI, EMBL, PDB, DDBJ – retrieving sequences. *In silico* RNA structure prediction, Restriction enzyme patterns. Ribosomal Database Project - Designing primers, probes and *in silico* PCR. Evolutionary analysis: distances, Cladistic and Phenetic methods. Sequence comparison, alignment and data base searching – ClustalW, FASTA & BLAST. DNA barcoding.

Unit VI- Current Contours: (For Continuous Internal Assessment only):
Field trip and Hands on training on algae sample collection – montering algal diversity – Hands on training on microalgal identification using standared monographs –hand drawings of algae - Phylogentic tree construction.

References

1. Andréa D, Baxevanis BF. Francis O. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.
2. Brendan Wren and Nick Dorrell. (2002). Functional Microbial Genomics (Volume 33) (Methods in Microbiology), Academic Press, UK.
3. Brown TA. (2006). Genomes, John Wiley and Sons, Pvt. Ltd., Singapore.
4. Campbell A, Heyer. 2004, Discovering Genomics, Proteomics and Bioinformatics , Pearson Education, New Jersey
5. Huson DH and Scornavacca C. (2012). Dendroscope: An Interactive Tool for Rooted Phylogenetic Trees and Networks. Syst. Biol:1–7.
6. Kenneth WA. (1996). Microbial Genome Methods - Boca Raton : CRC Press,
7. Masatoshi N and Sudhir K. (2000). Molecular Evolution and Phylogenetics - Oxford University press, Inc.
8. Molecular Phylogeny of Microorganisms. (2010). by Aharon O and Thane P. Academic Press,
9. Rastogi SC, Namita M and Parag R. Bioinformatics – Concepts, Skills, Applications".
10. Roderic DM and Edward CH. (2009). Molecular Evolution: A Phylogenetic Approach. John Wiley and Sons.
11. Sambrrok, J and Ruseell DW. (2012). Molecular Cloning – A Laboratory Manual (4th edition, Vol. 1, 2, 3) Cold Spring Laboratory Press, New York.
12. Sandy B. Primrose RM and Twyman. (2009). Principles of Genome Analysis and Genomics, 3rd edition, John Wiley and Sons.
13. Mount D. (2004). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press, New York.
14. Baxevanis AD and Francis O. (2009). Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins. Wiley India Pvt Ltd.
15. http://smart2.ums.edu.my/pluginfile.php/106327/mod_resource/content/2/Molecular20Plant%20Taxonomy.pdf

O**utcome:**
Upon completion of the course the students will be able:

- ✓ To do detailed study about modern evolutionary theory
- ✓ To deliberate and apply principles of delimitation and identification of species and other taxa
- ✓ To consider and apply the method of generate relevant molecular data, mainly sequence data
- ✓ To explore the ways in understanding the processes of evolution of molecular data
- ✓ To interpret tree topologies and nodal support the molecular level
- ✓ To pick up Learning about different methods for phylogenetic analysis
- ✓ To know the potential of next generation sequencing
- ✓ To Perceptive, how crop the robust tree and fundamental tool for modern taxonomists, systematists

First Year : Semester – II
Elective Course (EDC)
Medical Entomology (Theory)

Code: 18MICEDC1 **Credits: 2**

Objectives:

- Describe the different types of medically related effects caused by arthropods (direct and indirect)
- Define the terms associated with disease transmission
- To describe about vector ecology

Unit I

Introduction to Arthropods of public health importance Arthropods as vectors of human diseases – Arthropods of Public health nuisance – Anthroponotic diseases – Zoonotic diseases.

Unit II

Mosquitoes Life cycle – mating, host seeking, feeding, resting, oviposition behaviour – longevity, gonotrophic cycle, fecundity. Salient features and distribution of important vector species of Anopheles (An. stephensi, An. culicifacies, An. fluviatilis), Aedes (Ae. aegypti, Ae. albopictus), Culex (Cx. quinquefasciatus, Cx. tritaeniorhynchus), Mansonia (Ma. annulifera, Ma. uniformis).

Unit III:

Viral Vectors – Biology, adenovirus, adeno associated virus, retroviral vectors, Herpes virus, vaccinia virus. Impact of Oncolytic viruses in Cancer Treatment. Human Genome Project and its perspectives. Ethical issues in Animal Biotechnology.

Unit IV

Sand flies and other Dipterans of public health importance Life cycle: Sandflies, Black flies, Horse flies, Tsetse flies, House flies, Myiasis causing flies, Biting midges. Fleas, bugs and lice Life cycle: Fleas (species of Xenopsylla and Ctenocephalides), Triatomine bug, bed bug, head and body louse.

Unit V

Ticks and Mites Life cycle: Ixodid (Haemaphysalis, Ixodes, Dermacentor, Rhipicephalus, Amblyomma), Argasid (Argas, Ornithodorous) and Mites (Sarcoptes, Leptotrombidium, Dermatophagoides).

Unit VI

Vector Ecology and Population Dynamics Introduction to vector ecology and Ecosystem, habits and habitat – Population interaction with abiotic and biotic factors – Dispersal and Migration.Natality, mortality, survivorship, age distribution – Life table analysis.

References

1. Ananthakrishnan, T.N. (**1982)**. Bioresources Ecology, Oxford & IBH Publishing Co., New Delhi.
2. Advances in Parasitology **2011**. Vols. 1-4 Annual Reviews Inc.
3. Annual Review of Ecology, Evolution & Systematics **2011**. Annual Reviews Inc.
4. Annual Review of Entomology **2011**. Annual Reviews Inc.
5. Chaterjee, K.D. **1981**. Parasitology, Protozoology and Helminththology : Introduction to Clinical Medicine, 12th edition, Chaterjee Medical Publishers.
6. Harwood, R.F., James, M.T. **1979**. Entomology in Human and animal health, 7th edition, Macmillan Publishing Co., Inc, London, pp 548.
7. Imms, A. D. **1977**. A general text book of Entomology, ELBS, London.
8. Indian Council of Medical Research **2012**. Perspectives of Indian Medicinal plants in the management of lymphatic filariasis, ICMR.
9. Kochchar, S.K. **2009**. A Text Book of Parasitology. Wisdom Press Krebs, C.J. 1972. Ecology: The experimental analysis of distribution and abundance, Harper and Row Publishers, New York.
10. Laird, M. **1988**. The natural history of larval mosquito habitats. Academic Press Ltd., New York.
11. Marquardt, W.C. **2005**. Biology of disease vectors, 2nd edition, Doody Enterprises, Inc., USA.
12. Mullen, G., Durden L. **2009**. Medical and veterinary entomology, Academic press, London.
13. Nicholas R. H. Burgess **1981**. Arthropods of Medical importance, Published by Noble Books Ltd. Hampshire.
14. Odum, E.P. **1971**. Fundamentals of Ecology, Saunders College Publishing, Philadelphia. 15. Odum, E.P. **1983**. Basic Ecology, Saunders College Publishing, Philadelphia.
15. Kannan, S., Krishnan, M., Thirumurugan, R., Achiraman, S., **2012**. Methods in Molecular Biology – From Cell to Molecules, 1st edition, UVN- Press, India.
16. Gupta, P.K **2012**. Biotechnology and Genomics, Rastogi Publications, Meerut, India.

17. Marx, J.L. **2007**. A Revolution in Biotechnology, Cambridge University Press, Cambridge.
18. Strachan, T., Read, A.P. **2006**. Human Molecular Genetics, John Wiley & Sons, Pvt., Ltd., Singapore.
19. Medical entomology : a textbook on public health and veterinary problems caused by arthropods by Eldridge, Bruce F; Edman, John D. (John David)
20. Handbook of Medical Entomology by O. A. Johannsen and William A. Riley (2010)

Course outcome:

- ✓ This course combines theoretical and practical training in biology and control of disease vectors and the human pathogens they transmit.
- ✓ Students will gain specialised skills in the molecular biology of infectious diseases, and will cover all aspects of major vector-borne diseases.
- ✓ The course also offers a thorough grounding in the systematics of medically important arthropods, processes regulating vector populations, and the biology of vector–parasite and vector–vertebrate interactions.
- ✓ Graduates enter operational control programmes, applied basic research and academic fields.
- ✓ Students benefit from close interaction with staff who have extensive international expertise.
- ✓ To gain knowledge about the various types of Mosquitoes
- ✓ To understand the physiology of mosquitoes
- ✓ To upgrade the knowledge based on Oncogenic viruses

First Year : Semester – II
Elective Course (EDC)
Extremophiles (Theory)

Code: **18MICEDC1** **Credits : 2**

Objectives

- This course will provide a sound basis in principle features of extremophilic microbial life and its habitats
- This course will emphasize the adaptability of microbes in extreme environments.
- This course will facilitate to understand the application and relevance of extremophiles in climate change.

Unit-I

Life at hyper-extremities: Extreme habitats in universe, extreme communities in following econiches: desserts (Atacama, Mojave), ore deposits/ mining areas (Fe, Mn, Cu), animal systems, deep biosphere (terrestrial and marine), hydrothermal vents. - Gene expression in hyperthermophilic bacteria and archaea. Genome analysis from extremophiles - Protein stability in hyper - extremophiles.

Unit-II

Thermophiles and Psychrophiles: Classification, habitats and ecological aspects. Extremely Thermophilic Archaebacteria, Thermophily, commercial aspects of thermophiles. Applications of thermozymes. Methanogens: Classification, Habitats, applications.

Unit-III

Classification, alkaline environment, soda lakes and deserts, calcium alkalophily, Applications. Acidophiles: Classification, life at low pH, acidotolerence, applications.

Unit-IV

Classification, Dead Sea, discovery basin, cell walls and membranes – Purple membrane, compatible solutes. Osmoadaptation / halotolerence. Applications of halophiles and their extremozymes. Barophiles: Classification, high-pressure habitats, life under pressure, barophily, death under pressure.

Unit - V

Introduction to Exomicrobiology. Life detection methods - Evidence of metabolism - Evidence of photosynthesis (autotrophic and heterotrophic) - ATP production -

Phosphate uptake and Sulphur uptake. Hyper-extremophiles and their novel metabolic machinery and biomolecules- future unique applications.

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

Quiz and Self reading on Current developments related to the extremophiles during the semester through collection, discussion and evaluation. To be sourced from multiple reliable informative sources- Print, Internet, Interaction, Social Media, Webinars and so on.

References

1. Brock, T. D. **2012**. Thermophilic microorganisms and life at high temperatures, Springer, New York.
2. Rainey, F. A., Oren, A. **2004**. Extremophile microorganisms and the methods to handle them. In: Extremophiles, Methods in Microbiology, vol. 35, Elsevier, Amsterdam.
3. Horikoshi, K., Grant, W. D., **1998**. Extremophiles-microbial life in extreme environments, Wiley, New York.
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8. Milton Keynes. Microbiology of Extreme Environments and its potential for Biotechnology. Edited by Da Costa, M.S., Duarate, J.C., Williams, R.A. D. Elsiever Applied Science, Low Extreme Environment. Mechanism of Microbial Adaptation. Edited by Milton R. Heinrich, Academic Press.
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10. Milton R. Heinrich **1976**. Extreme Environment. Mechanism of Microbial Adaptation Academic Press.
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12. Jerome J. Perry, James T. Staley **1996**. Microbiology: Dynamics and Diversity, Saunders College Pub.
13. Ronald M. Atlas **2005**. Microbial Ecology. Fundamentals and Applications. Pearson Education Limited.

14. Campbell, R. **2009**. Microbial Ecology, 2nd edition, Blackwell Scientifc Publication.
15. Michael T. Madigan, John M. Martinko, Jack Parker **2015**. Brocks Biology of Microorganisms, 14th edition, Prentice Hall Internation Inc.
16. Wayne W. Umbreit, Pearlman, D., **1981**. Advances in Applied Microbiology, Vol. 26, Academic Press.
17. https://study.com/academy/lesson/extremophiles-definition-examples.html
18. https://www.mooc-list.com/course/extremes-life-microbes-and-their-diversity-edx
19. https://www.coursera.org/learn/life-on-other-planets

Outcomes

After successful completion of the course student will be able to:

- ✓ Spread out their knowledge in microbiology by understanding about extreme and unusual microorganisms.
- ✓ Acquire knowledge on some of the remarkable physiological adaptations that helps them to succeed in extreme conditions.
- ✓ Solve some complex evolutionary questions in extremophiles.
- ✓ List out the Life detection methods involved in exploring extreme environments.
- ✓ Discuss the origin and diversity of microbe's adapted to extreme environments.
- ✓ Analyse the Genetic information of extremophiles.
- ✓ Explore the future of extremophiles in various biotechnological applications.
- ✓ Read and understand the recent advancements and ongoing research in extremophiles.

First Year : Semester – II
Elective Course (EDC)
Microalgal Technology (Theory)

Code: 18MICEDC1 **Credits: 2**

Objectives:

- To Learn about classification, characteristics of microalgae.
- Formulation of algal cultures and importance of culture collections.
- Upstream and downstream techniques of microalgae.

Unit I

Habitat – distribution of microalgae – cyanobacteria – diatom – Freshwater – Marine. Morphology – Reproduction – sexual – asexual – life cycle. General characteristics of microalgae – Photosynthesis.

Unit II

Culturing techniques and photo bioreactor based production; downstream processing. heterotrophic production; Mass cultivation - Circular – Tubular column – Raceway pond – Pit method. Mass cultivation of *Chlorella – Spirulina – Dunaliella*. Algal bloom. Factor influence algal growth – nutrients – temperature – light.

Unit III

Microalgal protein – peptides – SCP- pigments – carotenoids – phycocyanin – phycoerythrin. Lipids – FAME – Growth promoting substance from microalgae – extracellular polymeric Substance – Toxins.

Unit IV

Microalgae in Human welfare –Nutraceuticals; Pharmaceuticals; Biofertilizers; and pollution control. Biofuels – biodiesel – biobutanol – biohydrogen – Bioethanol and nanoparticles from microalgae - Algal in Transgenics – antimicrobials from microalgae – food colorant – CO_2 sequestration – Algae in Space.

Unit V

Targeted genetic modifications: Genome shuffling and evolutionary engineering- *Chlamydomonas reinhardtii* as model organism; Application of synthetic biology in algae. Evolution at morphological and ultra structural level, horizontal gene transfer and evolution of algal chloroplast. Quorum sensing in microalgae - Introns. CRISPR-CAS discovery, mode of action and application.

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

Quiz on Microalgal pigments to bring out its importance and reliability- Preparation of bio fertilizer using microalgae- interactive sessions depicting the role of microalgae in various fields- online virtual class regarding various harvesting techniques and synthetic biology of algae

References:

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Outcomes:

Upon completion of the course the students will be able:

- ✓ To learn about algae and its benefits to environment
- ✓ To describe commercial production of fuels, microbial enzymes.
- ✓ To know about microbial degradation of pesticides and Biofertilizers
- ✓ To Basic cultivation technology of microalgal cultivation technical
- ✓ To have insight on removal of heavy metals from contaminated water using microalgae
- ✓ To brief the idea about Bioremediation using microalgae
- ✓ To know about different molecular approaches involved microalgae to enhance its application
- ✓ To work on recent research of CRISPER/Cas9 on microalgae

First Year : Semester – II
Elective Course (EDC)
Pharmaceutical Microbiology (Theory)

Code: 18MICEDC1 **Credit: 2**

Objectives:

- To get overview knowledge of microbes in pharma in both positive and negative aspects.
- To be familiar in antibiotics and advanced drug delivery system.
- To know about drug formulation regarding to guidelines and regulations.

Unit - I

Antibiotics - Natural and synthetic - antifungal agents, antitumor substances. Peptide antibiotics, Chloramphenicol, Sulphonamides and Quinolinone antimicrobial agents. Chemical disinfectants, antiseptics and preservatives- Basic aspects of the structure and functioning of the immune system- Laboratory evaluation of antimicrobial agents- Mechanism of action of antibiotics and synthetic anti-infective agents- Bacterial resistance to antibiotics- Clinical uses of antimicrobial drugs.

Unit - II

Molecular principles of drug targeting. Drug delivery system in gene therapy- Bacterial resistance to antibiotics. Mode of action of non-antibiotic antimicrobial agents. Delivery systems – formulations, targeted drug delivery, Sustained release drugs. Drug distribution in body, bio-availability and pharmacokinetic studies.

Unit - III

Ecology of microbes as it affects the pharmaceutical industry- Microbial contamination and spoilage of pharmaceutical products – infection risk and contamination control - and their sterilization. Manufacturing procedures in process control of pharmaceuticals. Chemical disinfectants, antiseptics and preservatives- Other pharmaceuticals produced by microbial fermentations. New vaccine technology, DNA, synthetic peptide, multivalent subunit vaccines.

Unit - IV

Bioassay of antibacterial agents in liquid media and in agar media using standard guidelines (e.g. (NCCLS) / (CLSI)) - Factors affecting bioassay, Laboratory methods to assess activity of antimicrobial combinations (antagonism, synergism and additive effect). Methodologies for testing of antimycobacterial, antifungal, antiparasitic and antiviral drugs *(in vivo* and *in vitro* infectivity models).

Unit - V

Government regulatory practices and policies, Regulatory aspects of quality control. Sterilization control and sterility testing- Chemical and biological indicators. Regulatory authorities for introduction of medicines in market – Role of Food and Drug Administration, FDA guidelines for drugs / biologicals, Validation (GMP, GLP, GCP, etc.). Clinical studies: Phase I, phase II, phase III and phase IV of clinical trials – Objectives, Conduct of trials, Outcome of trials.

Unit – VI: Current counters (For Continuous Internal Assessment only)

Literature rap section on New drug target for chikungunya virus- Antibacterial substance in toothpaste fight lung disease- new study aims to turn MRSA's strength against it- Discussion on addressing antimicrobial resistance through industry- Updated quiz on Good bacteria is bad news for atherosclerosis, Host nitric oxide distrupts microbial cell to cell communication to inhibit staphylococcal infection.

References

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2. Frederick Kavanagh (2014). Analytical Microbiology, Elsevier.
3. Vyas SP and Dixit VK (2010). Pharmaceutical Biotechnology, CBS Publishers & Distributors, New Delhi.
4. Joseph D Nally (2016). Good Manufacturing Practices for Pharmaceuticals, CRC Press, 6th edn.
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19. https://www.eurekalert.org/pub_releases/2018-05/uon-nlb050918.php
20. https://pubs.acs.org/stoken/presspac/presspac/full/10.1021/acsami.8b04433
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Outcome:

- ✓ Gain overview knowledge on all type of drugs and its effects
- ✓ Mode of action and mechanism behind antibiotic resistance will be studied.
- ✓ Drug targeting towards various challenging diseases will be studied.
- ✓ Gain basic knowledge to pharmacokinetic studies for drug disposition.
- ✓ Can explain microbial contamination during pharmaceuticals formulations and production.
- ✓ Expertised in vaccine development
- ✓ Know the guidelines of international standards of antibacterial agents
- ✓ Know various regulations in terms of quality control of drugs.

Second Year: Semester - III
Food and Industrial Microbiology (Theory)

Code: 18MICCC10 **Credits: 5**

Objectives

- The main objective of this course is to train students practically in basic principles of food and industrial microbiology.
- The course involves demonstration and on-hand training of various microbiological techniques like isolation of food poisoning bacteria and mycotoxigenic fungi
- It also emphasis to learn about the production of various fermented products and field trip to dairy, food industries, sewage treatment plants.

Unit – I

Introduction- Importance of food microbiology- Factors influencing (intrinsic and extrensic) microbial growth in food. Food preservations: principles- methods of preservations-Physical and chemical methods. Contamination, spoilage and preservation of cereals and cereals products, Vegetables and fruits, meat and meat products – fish and other sea foods, egg and poultry. Food hygiene and control - food sanitation in food manufacture and in the retail trade. Food control agencies and its regulations.

Unit – II

Food borne diseases, intoxication and food poisoning – bacterial and non-bacterial food borne diseases: *Staphylococcus* spp, *Clostridium* spp, *Escherichia coli* and *Salmonella* spp. infections, Mycotoxins, Viral and Parasitic food borne diseases, Sea Food toxicants.

Unit – III

Microflora of milk -sources of contamination -methods of minimizing contamination. Milk borne infection –intoxication. Milk preservation methods – pasteurization – sterilization. Fermented dairy products – microbes involved in fermentation -starter lactic acid cultures -butter milk, cream, yoghurt, kafir, kumiss, acidophilous milk and cheese production and its types.

Unit- IV

Fermentation and bioreactor technology – principle, construction and design of fermenter, types - aseptic containment, control and monitoring variables, strain improvement of industrially important microorganism, fermentation - batch, fed batch and continuous. Fermentation medium formulation, anti-foaming agent. Down-stream processing – recovery and purification of fermented products – cell distruption, solvent extraction, chromatography and drying.

Unit – V

Industrial production of beverages – wine, beer, alcohol; microbial production of organic acids (vinegar, lactic acid, citric acid), enzymes (amylase, and protease) and antibiotics (penicillin). Fermented vegetables, single cell protein. Probiotics and prebiotics foods.

Unit – VI: Current Contours (For Continuous Internal Assessment only): Field trip to dairy, beverage Industry and Food processing research Institutes. Analysis of microbiological quality milk and other food products. Fermented food preparation. Mycotoxin detection in food samples. Public Awernes about the prevention of food contamination and importance of SCP, probiotics and fermented food. Daily news and research paper on food borne out breaks and food preservation.

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3. Thomas J. Montville, Karl R. Matthews.2005. Food microbiology:
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13. http://foodscience.psu.edu/workshops/food-microbiology
14. https://www.canr.msu.edu/foodpreservation/food_preservation_online_course
15. https://www.mooc-list.com/tags/food-industry
16. http://www.who.int/topics/foodborne_diseases/en/
17. https://www.pdfdrive.net/food-microbiology-books.html
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Course Outcome

After completion of this course the student can able to

- ✓ Learn the fundamental principles and concepts of food microbiology
- ✓ Understand the basics of food borne diseases and its economic importance
- ✓ Understanding food control agencies and its regulations.
- ✓ Gain a general understanding of the Microflora of milk and its fermentation process.
- ✓ Familiar with the concept of food hygiene/control and their role in retail trade.
- ✓ Apply the knowledge of molecular biology and microbial genetics to develop industrially important microorganism.
- ✓ Recognize the fundamentals of fermentor and fermentation technology
- ✓ Use the most common equipment, materials and methods related to fermentation processes, microbial growth and cultivation and sterilization.

Second Year – Semester - III

Recombinant DNA Technology - (Theory)

Code -18MICCC11 **Credits-5**

Objective:

- A main focus is to understand~~ing~~ the strategy of recombinant DNA technology
- Disceimination of the molecular tools, cloning stratergies
- For future concern Important application and the current affairs and understand of genetic engineering.

Unit I:

Basic techniques involved in rDNA technology: Restriction Enzymes; DNA methylation systems in *E. coli*; Enzymes used in cloning (DNA polymerases, RNA Polymerases, Reverse Transcriptase, Ligases, terminal polymerase, RNAase, DNAase, phosphatase, polynucleotide kinase, S1 nuclease).

Cloning vectors: Plasmids, bacteriophage based vectors: M13 phage based, phagemid. High capacity vectors: Cosmids, YAC, BAC, TA, animal viral vectors, shuttle vectors.

Unit II:

Cloning stratergies: construction of rDNA (linker and adapter), Genomic and cDNA libraries. Sequence dependent and independent screening. Expression of cloned genes (Prokaryotic and eukaryotic system). Expression vectors (lac promoter, tryptophan promoter, Lambda promoter, arabinose promoter based). Opti mization of protein expression in heterologous systems, Fusion proteins, Probe preparation via nick translation (radiolabelled and non-labelled probes) and random priming.

Unit III:

Hybridization: colony and plaque hybridization, *in-situ* chromosomal hybridization and chromosome walking. Nucleic acid blotting: Southern, Northern, Western, dot and slot blot.

Restriction mapping: DNA sequencing (dideoxy chain termination, chemical degradation, shotgun sequencing, contig assembly and pyrosequencing). VNTRs, DNA fingerprinting, SNPs, RFLPs and Polymerase Chain Reaction.

Unit IV:

Site directed mutagenesis, Protein engineering. *Comparative genomics:* analysis and comparison of size and complexity of genomes. RNA level expression profiling with microarrays, MPSS, Chromatin immunoprecipitation. Protein level expression - yeast two hybrid system, yeast surface display, phage display.
Loss of function Knockout, knockdown, antisense RNA and RNAi, CRISPR-Cas system. Expression analysis by Real Time - PCR.

Unit V:

Production of recombinant proteins in bacterial and eukaryotic cells: Recombinant insulin, growth hormone (HGH), factor VIII, recombinant vaccines etc. Identification of genes responsible for human diseases, diagnostics and gene therapy. Ethical, legal and social issues.

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

Debate on: Controversy about the labeling, producing of genetically modified food good or bad. Seminar on Societal Concerns about Alteration of Nutritional Content of Food. Review on Impact of Genetically Engineered Crops on Biodiversity.
Quiz: Engineering Bacteriophages. Engineered Embryonic Stem Cell Method. Transgenic Mice as Test Systems. Genetically

References

1. Bernard R. Glick, Cheryl L. Patten (2017) Molecular biotechnology : principles and applications of recombinant DNA. 5th Edition. Washington, DC ASM Press.
2. Brown, TA (2016) Gene cloning and DNA analysis: an Introduction. John Wiley & Sons.
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5. Saunders VA (2012) Microbial Genetics Applied to Biotechnology: Principles and Techniques of Gene Transfer and Manipulation. Springer Science & Business Media.

6. Nicholl, DS (2008) An Introduction to Genetic Engineering. Cambridge University Press.
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Course Outcome:

- ✓ Understand the enzymes and vector which serves an indispensable tools in recombinant DNA technology
- ✓ Understand the principle and the concept of cloning strategies
- ✓ Apply the techniques of blotting and restriction mapping
- ✓ Exicute the the expression analysis
- ✓ Understand the recombinant DNA technology and its applications
- ✓ Understand the recent advances in this exciting field
- ✓ Analyze the significance of recombinant DNA technology in gene therapy
- ✓ Understand the societal concerns and impact of genetically engineered foods and crops

Second Year: Semester - III
Environmental and Agriculture Microbiology (Theory)

Code: 18MICCC12 **Credits: 5**

Objectives

- The aim of the course is to introduce students to basic characteristics of microorganisms (morphology, cytology, metabolism), their ecologies and importance for life cycles in the nature, for plants growing, animal husbandry and processing of plant and animal products.
- To give an overview about role of microorganisms for the cycle of carbon, nitrogen, phosphorus and sulphur in the nature with a special focus on agrosystems.
- Importance of microorganisms for agricultural production and commercial composts.
- To explain the use of microbial preparates, enzymes, and secondary metabolites in agricultural practices.

Unit – I

Microbial adaptation in natural and extreme condition: Edaphic and climatic factors dependent microorganisms in different environments of atmosphere, hydrosphere, lithosphere and biosphere. Characteristic features of environmental microflora and their role in ecosystem functions. Exploring of site specific microbiomes and metagenomics.

Unit – II

Aerobiology: Droplet nucleus, aerosols, air borne transmission of microbes and diseases. Air-borne microbial survival and assessment of air quality. Aquatic microbiology: Factors influencing microbial growth in aquatic systems. Occurrence and distribution of microbes in aquatic habitats - fresh water, sea water, hydrothermal vents, saltpans, eusturies, coral reefs and mangroves.

Unit – III

Definition and characterization of waste and their types. Bioremediation: Basic principles and types of bioremediation. bioadsorption, bioaccumulation and biomagnifications. Bioleaching and biodegradation. Degradation of polymers: Plastic, polyethylene and polyhydroxyalkanoates. Microbial degradation of xenobiotics: Hydrocarbons, methane alkanes, halogenate, sulfonated compounds, heavy metals

and cosmetic substance of triclosan, domestic and industry waste and agrochemical residuals. Biosorbtion of heavy metals.

Unit – IV

Agroecosystems: Populations measures and diversification. Microbial interactions: Plant & microbe, microbe & microbe interactions. Principles of quorum sensing and quenching mechanisms in microbes and crops interactions. Agrobiodiversity assessment and management, threats to agrobiodiversity and the need for conservation management: Impact of genetically modified crops and invasive species. Outline of biogeochemical cycles: transformation, fixation and mobilization of soil nutrients. Strengthening of below ground diversity. R:S ratio.

Unit – V

Concepts of sustainable agriculture and functioning of traditional agricultural practices, organic farming, integrated agriculture systems and hydroponics. Structure and function of rhizosphere and rhizosphere engineering. Biofertilizers: symbiotic, associative and free living microorganisms. Biocontrol agents - Microbial herbicides and microbial insecticides, entomopathogenic fungi. Modern agricultural practices and its application to the agro-food safety and agro-medicine.

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. A project was assigned in the topic of leguminous plants submission. Mini project in various recent research topics related to subject was given.

References: -

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9. Dighton, J and White, J. F. (Eds.). (2017). The fungal community: its organization and role in the ecosystem. CRC Press.
10. https://microbewiki.kenyon.edu/index.php/Agricultural_microbiology
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Outcomes

After the completion of the course students would be able

- ✓ To understands the role of microorganism in recycling soil nutrients
- ✓ To gain knowledge about biodegradation of complex plant polymers, sustaining and improving plant growth through improving nutrient availability,
- ✓ Learns to produce plant growth promoting substances and inhibiting pathogens.
- ✓ To study microorganisms in various fields of agricultural and environmental microbiology like bioremediation, biofertilizers and waste water treatment.
- ✓ To classify various aspects of N2 fixation, P solubilization, PGPR, biodegradation are easily grasped by students
- ✓ To gain knowledge about bioremediation mechanisms provided by microbes
- ✓ To understand about beneficial microbes and their uses in protecting agriculture, preserving food, enhancing the value of food products and providing general benefits to health and well being.
- ✓ To study about microbial interactions microbial processes and microbial communities in the environment.

Second Year: Semester - III
Rhizosphere Biology (Theory)

Code: 18MICCC12 **Credits: 5**

Objective

- This course provides knowledge about the physical, chemical, and biological processes in the rhizosphere and their effect on plant growth.
- Give an introduction to fundamental processes in the rhizosphere and their applications in environmental technology and sustainable agriculture.
- Enhance knowledge about concepts of root systems and the rhizosphere.

Unit 1

Definition, general features and concepts. Historical backgrounds - Hiltner (1906) to Darrow (1993). Research importance in rhizosphere biology and international Research centres. Techniques used in rhizosphere biology (Basics to High throughput screening, Rhizotomy camera, pyrolysis and Rhizosphere water movement). Recent development and understanding in rhizosphere biology.

Unit 2

Biosphere; agroecosystem and soil formation; rhizosphere soil and bulk soil; root soil ratio; root development; rhizodeposition; oligotropic and mesotropic evolution, edaphic-climatic-biological nature, community structure.

Unit 3

Ecology of rhizosphere (antagonism, competition, neutralism and mutualism) Biological interactions: Plants – microflora - microfauna. Microbiome and Metabolomics of rhizosphere; signalling and establishment of rhizosphere. Root exudate functions and rhizosphere effects. Rhizosphere affecting edaphic-climatic-biological factors.

Unit 4

Analysis of rhizosphere components and tools. Improvement of plant and soil health. Modification and adaptation strategies of soil-microbes-plant parameters and holobiont paradigm. Engineered strains and crop improvements; rhizosphere competence and biosafety measures.

Unit 5

Contribution of microbial ecosystems in biogeochemical cycles and regulation. Sustainable agriculture for food security, biodiversity conservation, mitigating climate change and energy production.

Unit – 6: 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. A project was assigned in the topic of root nodule plants submission. Mini project in various recent research topics related to subject was given.

References:

1. Rhizosphere engineering and management for sustainable agriculture. Plant and soil (2009). Vol. 32, 1-2 .363- 383.
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Outcomes

After the completion of the course students would be able

- ✓ Physical, chemical and biological paramaters of rhizosphere soil was studied
- ✓ Soil factors include pH, water content, solubility, bioavailability of nutrients, and temperature, analysing procedures are learnt
- ✓ Gains knowledge about root nodule bacteria from the rhizosphere soil.
- ✓ The bacteria present in the rhizosphere are generally capable of great environmental stress, such as low water levels in the soil are taught to students
- ✓ Ecological linkages between soil processes, plant growth, and community dynamics are learnt
- ✓ Rhizosphere organisms that have been well studied for their beneficial effects on plant growth.
- ✓ Understanding rhizosphere processes help feed the world and save the environment

Second Year: Semester - III
Practical (18MICCC10, 18MICCC11, 18MICCC12)

Code : 18MICCC13 **Credits : 4**

Food and Industrial Microbiology (Lab Course)

Objectives

- The main objective of this course is to train students practically in basic principles of food and industrial microbiology.
- It also emphasis to learn about the production of various fermented products and field trip to dairy, food industries, sewage treatment plants.

Experiments

1. Isolation of food poisoning bacteria from contaminated food products
2. Direct microscopic count and standard plate count from milk and milk dairy products
3. Milk quality assessment test (Resazurin/Methylene blue)
4. Extracellular enzyme activities – amylase, cellulase, protease and lipase
5. Enzyme/Cell immobilization in different matrices
6. Protein precipitation – Ammonium sulphate and TCA methods; Purification by Thin layer and column chromatography
7. Production of fermented product- citric acid, ethanol, wine
8. Preservation of potato/onion by UV radiation
9. Isolation of mycotoxigenic fungi from contaminated food
10. Extraction and detection of aflatoxin in foods by TLC method
11. Cultivation of Oyster mushroom, SCP, yeast.
12. Field trip to dairy, food industries, sewage treatment plants

References

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2. Spencer J. F. T., Alicia L. Ragout de Spencer. Food microbiology protocols Humana press, USA

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5. Chris Bell, Paul Neaves, Anthony P. Williams. 2005. Food microbiology and laboratory practice.
6. https://foodscience.psu.edu/workshops/food-microbiology
7. https://www.mooc-list.com/tags/food-safety
8. http://www.cftri.com/
9. https://fri.wisc.edu/
10. http://www.naro.affrc.go.jp/english/nfri/
11. https://www.fda.gov/

Outcome

After completion of this course the student can able to

- ✓ The course involves demonstration and on-hand training of various microbiological techniques like
- ✓ isolation of food poisoning bacteria
- ✓ mycotoxigenic fungi from food products and their significance
- ✓ Food preservation methods and importance
- ✓ Employability opportunity in dairy industry for learning the quality analysis of milk
- ✓ Qualitative and quatitative analysis of extracellular enzyme from industrially improant microbes
- ✓ Upstream and downstream process in Microbail prodcuts production and analysis
- ✓ Microbial cell immobilization in different matrices
- ✓ Entrepreneurial skill on production and marketing of oyster mushroom.

Recombinant DNA Technology (Lab Course)

Objectives

- To study the basic principle behind recombinant DNA technique
- To learn the basic forms of apparatus description
- To learn about the application on

Experiments

1. Genomic DNA isolation
2. Plasmid DNA isolation

3. Restriction digestion, gene mapping
4. Competent cell preparation
5. Cloning, Transformation and selection of clones
6. Gradient, Colony, Nested, Real time PCR
7. Western Blotting
8. RAPD Fingerprinting
9. Southern and Northern Blotting

References:

1. Ashok Kumar. 2011. Molecular Biology and Recombinant DNA Technology: Practical Manual
2. Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, J. G. Seidman, John A. Smith, Kevin Struhl 2002. Short Protocols in Molecular Biology. 5th Edition.
3. Joseph Sambrook, David W Russell Molecular Cloning: A Laboratory Manual (2001) Cold Spring Harbor Laboratory Press
4. Judith W. Zyskind and Sanford I. Bernstein. 1989. Recombinant DNA Laboratory Manual

Course outcome:

- ✓ Understanding the theoretical explanation behind the experiment
- ✓ Learned about the detailed Principle followed by a detailed step by step Procedure.
- ✓ Gain hands-on experience on isolating genomic DNA and plasmid
- ✓ Gain hands on training on cloning strategy
- ✓ Hands on training on transformation
- ✓ Hands on training on all the types of PCR
- ✓ Blotting techniques such as western, southern, northern techniques were learnt experimentally

Environmental & Agriculture Microbiology/Rhizosphere Biology (Lab Course)

Objectives

- To analyse the role of microorganism in recycling soil nutrients,
- To study biodegradation of complex plant polymers

Experiments

1. Quantification of microorganisms in air through solid and liquid impengement technique.
2. Physical, Chemical & Microbial assessment of water. Colour, pH, alkalinity, acidity, COD, BOD, anions, cations, MPN index – presumptive, completed and confirmative tests.
3. Isolation of microflora from different industrial waste.
4. Degradation of phenols – colorimetric assay.
5. Microflora from different soil types & habitats.
6. Isolation of N_2 fixing, phosphate solubilizing microbes (PSM).
7. Localization of AMF.
8. Isolation and identification of heavy metal and pesticide resistant microbes from environmental samples
9. Mass propagation of *Azolla-Anabaena* for biofertilizer.

References:

1. Collins CH, Lyne PM. (1985). Microbiological methods. Butterworths, London.
2. Benson HJ. (1994). Microbiological Applications. Wm. C. Brown Publishers, Oxford.
3. Clesceri LS, Greenberg AE, Eaton AD. (1998). Standard methods for examination of water & waste water. American Public Health Association.
4. Aaronson S. (1970). Experimental Microbial Ecology, Academic Press, New York.
5. Official Methods of Analysis (1995), Arlington, Virginia, USA.
6. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=5231
7. https://www.uni-due.de/imperia/md/content/water
8. Darshan Dharajiya, Hitesh Jasani, (2015). Environmental Microbiology and Biotechnology - A Practical Manual

Outcome

After the completion of the course students would be able

- ✓ To analyse the role of microorganism in recycling soil nutrients, biodegradation of complex plant polymers,
- ✓ To sustain the improving plant growth through improving nutrient availability, production of plant growth promoting substances and inhibiting pathogens.
- ✓ To study the application of microorganisms in varied fields of agricultural and environmental microbiology like bioremediation, biofertilizers and waste water treatment.
- ✓ To analyse various aspects of N2 fixation, P solubilization, PGPR, biodegradation and bioremediation mechanisms provided by microbes.
- ✓ To isolate and identify heavy metal and pesticide resistant microbes from environmental samples
- ✓ To classify physical, chemical & microbial assessment of water. Colour, pH, alkalinity, acidity, COD, BOD, anions, cations, MPN index
- ✓ Gains knowledge to mass propagate *Azolla-Anabaena* for biofertilizer.

Second Year : Semester – III
NME - Commercial Biotechnology and IPR (Theory)

Course Code: 18MICNME II **Credits: 2**

Unit - I: Industrial microbes

Biology of industrially important microorganisms - *Streptomyces*, yeasts, *Spirulina* and *Penicillium*. Strain improvement (mutation, rDNA, protoplast, metabolic regulation) Culture preservation - Stock culture collection centres – Criteria used for the selection of microorganisms for fermentation. Genetic Manipulation of Microorganisms.

Unit - II: Large-scale cultivation

Fermentation media - Desired qualities - media formulation strategies - economic means of providing energy, carbon - nitrogen - vitamin and mineral sources - role of

buffers, precursors, inhibitors, inducers and antifoams. Concepts of basic modes of fermentation - Batch, batch and Continuous fermentation.

Fermenters and its types : Basic functions, design and components - asepsis and containment requirements - body construction and temperature control - aeration and agitation systems. Air and media sterilization. Control and monitor system in bioreactors.

Unit - III: Microbial products

Alcohol production – beer and wine –organic acids (Vinegar, lactic acid), Production of antibiotics (Penicillin, Streptomycin), Production of amino acids (Tryptophan), Enzymes (Amylase), Vitamins (Vitamin B12), Biotransformation (Steroid). Vaccines – (BCG, Polio) and Insulin.

Unit – IV: Commercialization

Objectives - market potential - economic measures in plant and equipment - media, heating and cooling; productivity of culturing and recovery costs.

Unit – V: Legal protection & IPR

Biotechnological regulations IPP, IPR, process of patenting, Indian and international agencies involved in IPR & patenting, Global scenario of patents and India's position, patenting of biological material, GLP, GMP. General Introduction to IPR (Patents, Plant Breeders Rights) – Trade Marks, Industrial Design, Trade Secrets; Copy Right and right related to copy right; Patent – Patent Principle, International Standards and Patent Validity, Recent developments in patent system and patentability of biotechnology invention IPR issues of the Indian context.

References:

1. Raledge, C., Kristiansen, B. **2001**. Basic Biotechnology, 2nd edition, Cambridge University Press.
2. Crueger, W., Crueger A. **2000**. A text of Industrial Microbiology, 2nd edition, Panima Publishing Corp.
3. Prescott and Dunn **2002**. Industrial Microbiology, Agrobios (India) Publishers.
4. Glaser A.N., Nilaido, H., **1995**. Microbial Biotechnology, W.H Freeman & Co.
5. Stanbury, P.F, Whitaker, H., Hall, S.J. 1997. Priciples of Fermentation Technology, Aditya Books (P) Ltd.

6. Young, M. M. **2004**. Comprehensive Biotechnology. The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Edited by, Reed Elsevier India Private Ltd, India.
7. Behrens, D. Kramer, P. 1990. Bioprocess engineering: Down Stream processing & recovery of bioproducts, safety in biotechnology and regulations.

Second Year : Semester – III
Elective Course (EDC)
Bioinformatics and Biostatistics (Theory)

Course code: 18MICEDC2 **Credit: 2**

Objective:

- To develop Expertise in biological websites
- To develop overview knowledge in genome assembly
- Biostatistics related to analyzing the scientific data will be introduced.

Unit – I

Basics of computers – servers, workstations, operating systems, Unix, Linux. Computational Approaches to Biological questions. World Wide Web. Search engines, finding scientific articles - Pubmed – public biological databases.

Unit – II

Sequence analysis – Sequencing genomes – sequence assembly – pairwise sequence comparison - genome on the web – annotating and analysing genome sequences. Multiple sequence alignments, Genbank – sequence queries against biological databases – BLAST and FASTA– multifunctional tools for sequence analysis. Phylogenetic alignment – profiles and motifs.

Unit – III

Protein Data Bank, Swiss-prot - biochemical pathway databases -Predicting Protein structure and function from sequence – secondary structure prediction – predicting 3 D structure- Determination of structure – feature detection –- protein modeling.

Unit – IV

Introduction – Measures of Central tendency – mean (arithmetic, harmonic & geometric) median and mode -Population and sample – Variables – Collection and presentation of data – Descriptive statistics– Measures of dispersion – range, mean deviation, variance & standard deviation, Skewness and Kurtosis.

Unit – V

Inferential statistics – Probability and distributions – Poisson, Binomial and Normal distribution – Chi-square test – Hypothesis test - Student's t-test – Correlation and Regression – ANOVA.

Unit – VI: Current counters (For Continuous Internal Assessment only)

Literature seminar on ProLego- Sequence similarity analyses using the stationary discrete wavelet transform (SDWT)- Conversation related to CrossCheck- CE-BLAST- PECAN- Group discussion on Prot-SpaM.

References:

1. Eidhammer I, Jonassen I, Taylor WR (2004). Protein Bioinformatics: An algorithmic approach to sequence and structure analysis. Wiley, Vol.1.
2. Lesk A (2013). Introduction to bioinformatics, Oxford University Press.
3. Xiong J (2006). ***Essential bioinformatics***, Cambridge University Press.
4. Attimonelli M (2002). Bioinformatics, a Biologist's Guide to Biocomputing and the Internet.
5. Higgins D and Taylor WR (2000). Bioinformatics: sequence, structure, and databanks: a practical approach (No. Sirsi) i9780199637904).
6. Speicher DW (2004). Proteome analysis: interpreting the genome, Elsevier
7. Twyman RM (2013). Principles of proteomics, Garland Science.
8. Mishra NC (2011). Introduction to proteomics: principles and applications, John Wiley & Sons, Vol. 148.
9. Reinders J (2016). Proteomics in Systems Biology: Methods and Protocols, Springer.
10. Pagano M, Gauvreau K and Pagano M (2000). Principles of biostatistics, Pacific Grove, CA: Duxbury, Vol. 2.
11. Gerstman BB (2014). Basic biostatistics, Jones & Bartlett Publishers.
12. Le CT and Eberly LE (2016). Introductory biostatistics, John Wiley & Sons.
13. Altman D, Machin D, Bryant T and Gardner M (2013) Statistics with confidence: confidence intervals and statistical guidelines, John Wiley & Sons.
14. Allen AO (2014). Probability, statistics, and queueing theory, Academic Press.
15. Ryan TP (2011). Statistical methods for quality improvement, John Wiley & Sons.
16. https://bmcbioinformatics.biomedcentral.com/articles/10.1186/s12859-018-2155-9
17. https://bmcbioinformatics.biomedcentral.com/articles/10.1186/s12859-018-2171-9
18. https://www.nature.com/articles/s41598-017-05960-3
19. https://www.nature.com/articles/s41467-018-04171-2
20. https://www.nature.com/articles/nmeth.4390
21. https://www.biorxiv.org/content/early/2018/04/23/306142.full.pdf+html

Course Outcome:

- ✓ Know the theory behind fundamental bioinformatics
- ✓ Ability to analyze protein and nucleotide sequences Know concepts of probability and statistics.
- ✓ Ability to analyze biological results statistically
- ✓ Know the applications and limitations of bioinformatics methods.
- ✓ Be able to study the protein and nucleotide interaction through bioinformatics tools.
- ✓ Familiar in most of the Insilco analysis
- ✓ Understand the significance of experimental data.

Second Year : Semester – III
Elective Course (EDC)
Microbial nanotechnology (Theory)

Code: 18MICEDC2 **Credits: 2**

Objectives:

- Detailed introduction about history of nanotechnology and its development.
- Synthesis of nanoparticles and its vast applications.
- Different characterization methods for nano particles to know about its physical and chemical properties.

Unit I

History of nanotechnology, concept and future prospects – application in Life Sciences. Terminologies – nanotechnology, microbial nanotechnology, nanomedicine, nanowires, quantum Dots, nanocomposite, nanoparticles. Present status and future prospects of microbial nanotechnology.

Unit II

Molecular nanotechnology-nanomachines and collagen. Uses of nanoparticles- cancer therapy and manipulation of cell and biomolecules. Types of nanoparticles- physical, chemical and biological. Microbial synthesis of nanoparticles- mechanism.

Unit III

Nanoparticles-types and functions Physical and chemical properties of nanoparticles. carbon nanotubes - Characterization of nanoparticles using UV-Vis, FTIR spectroscopy, Electron Microscopy – HRTEM, SEM, AFM, EDS, XRD and nano particle size analyzer.

Unit IV

Advantages of nanoparticles: drug targeting, protein detection, MRI, development of green chemistry – commercial viability of nanoparticles. Disadvantages – health risk associated with nanoparticles, inadequate knowledge on nanoparticles research.

Unit V

Drug delivery-protein and nanoparticle mediated. Uses of nanoparticles in MRI, DNA and protein microarrays. Nanotechnology in health sectors. Toxicology in nanoparticles- Dosimetry.

UNIT VI

Oral presentation about any one of the above topic - Quiz program related to the course during the middle of the semester - Spotters identifications – Analytical instruments explanations.

References:

1. David SG. (2004). Bionanotechnology, Lessons from nature, John Wiley & Sons Inc. publication
2. Parthasarathy BK. (2007). Introduction to Nanotechnology, Isha Publication.
3. Elisabeth P and Aravind P. (2007). Bionanotechnology. Morgan & Claypool Publishers.
4. Bernd R. (2006). Microbial Bionanotechnology: -. Horizon Scientific Press.
5. David ER and Joseph DB. (2009). Bionanotechnology: Global Prospects. CRC Press.
6. Ehud G. (2013). Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology, World Scientific Publishers.
7. Silva GA and Parpura V. (2011). Nanotechnology for Biology and Medicine: At the building block level, Springer Science.
8. Ibrahim K, Khalid S and Idrees K. (2017). Nanoparticles: Properties, applications and toxicities. Arabian Journal of Chemistry.
9. https://www.igi-global.com/chapter/microbial-nanotechnology/165227

Outcomes:

After completion of the course would be able,

- ✓ To carry out the latest environmentally friendly research to human welfare.
- ✓ To give brief introduction about different analytical instruments.
- ✓ To assess types of nanoparticles for various medical research to find out the solution of human diseases.
- ✓ To overcome the disadvantages of nanoparticle application.
- ✓ To Physical and chemical properties of nanoparticles give idea about the biological process.
- ✓ To apply the nanoparticle research in human health sector for their healthy society.
- ✓ To motivate the researchers to carry the better advanced research on this field.
- ✓ To gain a better knowledge about targeting drug delivery by nanoparticles

Second Year : Semester – III
Elective Course (EDC)
Biology of Probiotics (Theory)

Code: 18MICEDC2 **Credits: 2**

Objective

- Understand the basic knowledge of Gastrointestinal Ecosystem
- Acquire the knowledge and utilization of probiotics and prebiotics in our life
- To develop the Entrepreneurial Skill production and assessment of probiotic microbes

Unit I

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

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. Prebiotics- Definition, Prebiotics vs. Probiotics, Prebiotics in diet and health benefits.

Unit III

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

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, Bacteriocin production, Bile salt hydrolase activity, Production of digestive enzymes, *In vivo* assessment of probiotic microbes in chicken model.

Unit V

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 Peptides, 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:

1. Kenji Sonomoto and Atsushi Yokota (2011), Lactic acid bacteria and *Bifidobacteria*, Caister Academic Press Publisher.
2. Charalampopoulos, Dimitris, Rastall and Robert (2009), Prebiotics and Probiotics Science and Technology, Springer Publication.
3. Nicholas Joseph Talley and Christopher J. Martin (2006), Clinical gastroenterology: a practical problem-based approach, Elsevier Publication.
4. Gary B. Huffnagle and Mairi Catherine Noverr (2008), GI microbiota and regulation of the immune system, Springer Publication.
5. Malago (2011), Probiotic Bacteria and Enteric Infections: Cytoprotection by Probiotic Bacteria, Springer Publication.
6. Wolfgang Kneifel and Seppo Salminen (2011), Probiotics and Health Claims, John Wiley and Sons Publication.
7. Natasha Trenev (1998), Probiotics: nature's internal healers, Penguin Publication.
8. Dash, Allan N. Spreen and Beth M. Ley (2000), Health Benefits of Probiotics, BL Publications.
9. Yuan Kun Lee and Seppo Salminen (2008), Handbook of probiotics and prebiotics, Wiley-Interscience Publication.
10. https://www.udemy.com/probiotics-and-microbes-healing-your-microbiome/
11. http://www.warriorsouleducation.com/courses/probiotic-course
12. https://www.culturesforhealth.com/learn/free-ebooks/
13. https://www.springer.com/in/book/9783642208379
14. http://internationalprobiotics.org/

Outcome:

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
- ✓ To explain the definition and types of probiotics
- ✓ To characterize the limitation and dosage of probiotics
- ✓ To 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

Second Year : Semester – III
Elective Course (EDC)
Microbial Remediation (Theory)

Code: 18MICEDC2 **Credit: 2**

Objective:

- To motivate against environmental pollution.
- To find solution for pollution using microbes.
- To study the remediation process by plants, fungi, plants and algae

UNIT 1

Bioremediation - process and organisms involved; Constraints and priorities of bioremediation. Major pollutants and polluted sites. Bioaugmentation; Ex-situ and in-situ processes; Intrinsic and engineered bioremediation. Pollutants and associated risks; Polyaromatic hydrocarbon pollution; organic pollutant dergradation . Water treatment- BOD, COD, dissolved gases. Advantages and disadvantages of bioremediation.

Unit II

Microbes involved in aerobic and anaerobic processes in nature; removal of heavy metals, Biotransformation of heavy metals and xenobiotics, Petroleum biodegradation; Microbial leaching of ores- process, microorganisms involved and metal recovery with special reference to copper and iron, reductive and aerobic dechlorination. A brief account of biodegradable plastics and super bug.

UNIT III

Aerobic and anaerobic digesters: design; various types of digester for bioremediation of industrial effluents; Pros and cons of anaerobic process. Dendroremediation. Composting of solid wastes, methane production and important factors involved, sulphur, iron and nitrate reduction, hydrocarbon degradation, dechlorination, nitroaromatic compounds degradation, bioremediation of dyes, bioremediation in paper and pulp industries.

UNIT IV

Fungi, mushrooms and their enzymes due to having ability to degrade a wide variety of environmentally persistent pollutants, transform industrial and agro-industrial wastes into products. Characteristic of solid and liquid waste, sewage treatment- Primary, secondary, tertiary treatment.

UNIT V

Phycoremediation of domestic wastewater; Advantages of phycoremediation. Potentials of micro algae, industrial effluents, Conventional methods vs Algal technology.

UNIT VI: Current Counters (For Continuous Internal Assessment only)

Updated quiz on Metalloid oxide reducing bacteria in gold mine tailings- Microalgae and aquatic plants can help to decrease radiopollution- Literature seminar on Glutathione-S-transferase in detoxification of pesticides- Implementation, Challenges and considerations in microbial remediation- Open forum on *Thauera aromatic* mechanism in breakdown of toluene.

References:

1) Singh SN (2014). Biological Remediation of Explosive Residues, Springer International Publishing, Switzerland.
2) Anjum NA, Pereira ME, Ahmad I, Duarte AC, Umar S and Khan NA (2013).Phytotechnologies – Remediation of Environmental Contaminants, CRC Press, Boca Raton, FL, USA.
3) Chandrappa R and Das DB (2012). Solid Waste Management Principles and Practice, Springer-Verlag, Heidelberg.
4) Tchobanoglous G and Burton F L (1991). Wastewater Engineering, Treatment, Disposal and Reuse, Metcalf and Eddy (Eds), Tata Mac Graw Hill Publishing Co. Ltd. New Delhi, 3rd Edn.
5) Cheremisinoff NP (2013). Biotechnology for Waste and Wastewater Treatment, Elsevier, UK.
6) Sathyanarayana T, Johri BN and Prakash A (2012). Microorganisms in Environmental Management – Microbes and Environment, Springer, Heidelberg
7) Dhir B (2013). Phytoremediation: Role of Aquatic Plants in Environmental Clean-Up, Springer India.
8) Anjum NA, Pereira ME, Ahmad I, Duarte AC, Umar S and Khan NA (2013). Phytotechnologies Remediation of Environmental Contaminants, CRC Press, Boca Raton, FL, USA.
9) Gupta DK (2013). Plant-Based Remediation Processes, Springer-Verlag, Berlin Heildelberg.
10) . Gupta DK and Sandalio LM (2013). Metal Toxicity in Plants: Perception, Signaling and Remediation Springer, Berlin Heidelberg.
11) Khan MS, Zaidi A, Goel R, Mussarat J (2012). Biomanagement of Metal-Contaminated Soils, Springer, Dordrecht.

12) https://www.brightsurf.com/news/article/021417420911/new-metalloid-oxide-reducing-bacteria-found-in-manitobas-nopiming-gold-mine-tailings.html
13) https://www.brightsurf.com/news/article/032414338045/new-perspective-for-soil-clean-up-microscopic-ciliates-transport-poisonous-tar-substances.html
14) https://www.brightsurf.com/news/article/010914335026/microalgae-and-aquatic-plants-can-help-to-decrease-radiopollution-in-the-fukushima-area.html
15) https://www.firstpost.com/tech/news-analysis/genes-from-a-resilient-pest-can-be-used-to-detoxify-pesticides-present-in-the-environment-and-in-our-food-supply-finds-study-4294995.html
16) https://pepmobile.org/bioremediation-putting-good-bugs-work/
17) http://news.mit.edu/2015/using-microbes-clean-oil-spills

Course outcome:

Understand the applications of microorganisms for remediation process.

- ✓ Develop knowledge about the environmental risk assessment and remediation.
- ✓ Gain knowledge on role of microorganisms in their environment
- ✓ Basic environmental microbiology skills will be developed.
- ✓ Will understand the microbial metabolism of environmental contaminants
- ✓ Understand the principle of remediation process by various aspects.
- ✓ Knows how to classify and characterize microbiological remediation methods
- ✓ Scientific problem related to pollution and remediation process will be explained.
- ✓ Discuss the scientific problem related to pollution and remediation process.

Second Year : Semester – III
Elective Course (EDC)
Microbiome Science

Code: 18MICEDC2 **Credits:2**

Objectives

- Undestand the importance of human and animal Microbiome
- Addresses challenges microbiome's role in diseases
- Creative problem solver of microbiome data analysis using Computational techniques

Unit I

Definition and discovery of the microbiome, Types of Microbiomes- Human microbiome-Gut, Genital, skin, oral, Respiratory microbiomes, Animal, Plant microbiomes, Root Microbiome, Environmental microbiomes, Bacteriabiome, Mycobiome, Phycobiome, Actinobiome, Virome, Phytobiome.

Unit II

Metagenomics- Definition, Metagenomics work flow- sample collection and processing, Metagenomic DNA isolation, 16S, 18SrRNA rRNA gene amplicon sequencing and shotgun metagenomics sequencing methods, Next Generation Sequencing (NGS) methods-Illumina Genome Analyzer (HiSeq/MiSeq), Pyrosequencing.

Unit III

QIIME (Quantitative Insights into Microbial Ecology) pipeline, Mothur pipeline, metagenomeSeq R package -Sequence data (fastq), Metadata about samples (mapping file), Preprocessing: Operational Taxonomic Units (OTUs) Picking , Taxonomic Assignment, Phylogenetic Analysis, Downstream analysis and Visualization-knowledge discovery- Alpha, Beta-diversity.

Unit IV

Functional analysis of the microbiome from DNA sequence functional analysis, metatranscriptome, metabolome, proteome, and glycome- Metatranscriptomic analysis- nano-LC MSMS, Proteome Discoverer software v1.4, Functional mining of metagenomes, Plant growth promoting genes in metagenome.

Unit V

Microbiome distrbutions in healthy individuals; composition of specific body sites microbiome (nose, skin, teeth, urogenital, etc.), microbiome's role in diseases such as inflammatory bowel diseases, colitis, obesity, diabetes; effects of diet on microbiome, Ecological concepts of disease eg. Dysbiosis

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

Daily news and research paper on Microbiome. Public awareness of microbiome importance in human and animal health. Scientific model on plant, animal, human microbiome concept. Computational analysis microbiome data, metagenomic data from Web Resources. Collection metadata about samples and and creation mapping file for OTUs

References:

1. Angela E. Douglas . 2018. Fundamentals of Microbiome Science: How Microbes Shape Animal Biology, Princeton University Press, New Jersey, USA
2. Broberg et al. 2018. McDonald. Integrated multi-omic analysis of hostmicrobiota interactions in acute oak decline. Microbiome (2018) 6:21
3. Bordenstein SR, Theis KR (2015) Host Biology in Light of the Microbiome: Ten Principles of Holobionts and Hologenomes. PLoS Biol 13(8): e1002226.
4. Saleem, Muhammad. 2015. Microbiome Community Ecology Fundamentals and Applications, Springer, New York, USA.
5. Tatusova T, DiCuccio M, Badretdin A, et al. Prokaryotic Genome Annotation Pipeline. 2013 Dec 10. In: The NCBI Handbook. 2nd edition. Bethesda (MD): National Center for Biotechnology Information (US).
6. http://qiime.org/tutorials/index.html
7. https://www.coursera.org/learn/microbiome
8. https://fn.academy/microbiome-course/
9. https://www.edx.org/course/nutrition-health-human-microbiome-wageningenx-nutr104x
10. http://metabolomics.metabolon.com/acton/media/17033/microbiome-ebook
11. https://www.mooc-list.com/tags/microbiome
12. https://www.mooc-list.com/tags/human-microbiome
13. https://www.mooc-list.com/tags/gut-microbiota
14. https://www.sciencedirect.com/science/article/pii/S1672022915001424

Outcomes:

After completion of this course the student can able to

- ✓ Learning the Definition and discovery of the microbiome
- ✓ Understanding the types of microbiomes
- ✓ Exploring the metagenomics and its application in microbiome research
- ✓ To learn about the computational techniques in Microbiome Data analysis
- ✓ To characterize the Functional analysis of microbiome
- ✓ Exploring the Metaproteomic analysis
- ✓ Understanding the Importance of the microbiome of the plant holobiont.
- ✓ To analyze the microbiome's role in diseases

Medical Laboratory Technology (VAC I)

Code: 18MICVAC1 **Credits: 2**

Ojectives:

- Medical Laboratory Students with the necessary skills, attitudes, and professional integrity to become contributing professionals in the health care community.

- Provide the student with the cognitive and psychomotor competencies to meet the entry requirements for the profession of medical laboratory science.

- Display ethical conduct during classes and interactions with instructors, other students, patients, and additional members of the healthcare team.

Unit I

Blood cells, Haemoglobin, Coagulation Factors, Anaemia, Collection and storage of blood, Separation of serum, Plasma, Blood groups, Determination of Hemoglobin, Complete, Differential Blood Counts, Platelet Count, Determination of ESR, PCV

Unit II

Urine, stool analysis- normal & abnormal constituents. CSF & Semen Analysis Hyperglycemia & hypoglycemia-Diabetes mellitus, Histopathology: Tissue Processing- Fixing, Embedding, Microtomy, Staining, mounting, decalcifications.

Unit III

Culture Techniques, Bacterial, Fungal culture media & their uses, Antibiotic sensitivity test, Diagnostic test for HIV, Hepatitis B, Hepatitis, Malaria, Tuberculosis. WIDAL, VDRL, RA, CRP, ELISA, Pregnancy test, Hyper sensitivity reactions. Stool examination-Identification of different ova & cysts.

Unit IV

Liver, Renal Functions & their Assessment, Jaundice, its types and their biochemical findings, Blood urea estimation, Serum uric acid, total protein, albumin, globulin, glucose, total, HDL LDL cholesterol, Triglyceride, Bilirubin total estimation, Serum SGOT, SGPT estimation.

Unit V

Hormones of the Thyroid gland- chemistry and normal physiology, Thyroid test. Hormones of the gonads- Estimation of FSH, LH, hCG, Progesterone, Testosterone. Cancer-Estimation of cancer marker, Pap smear test for cervical cancer.

References:

1. Baker F. J. and R. E. Silverton. 1976. Introduction to Medical Laboratory Technology. Fifth Edition,
2. Mehdi SR. 2013 Essentials of Blood banking. Jaypee Brothers, Medical Publishers Pvt. Limited.
3. Satish Gupte. 2014. The short text book of Medical Laboratory for technicians-Jaypee Brothers Pvt. Limited
4. Sood Ramnik. 2009. Medical Laboratory Technology: Methods and Interpretations. Jaypee Brothers, Medical Publishers Pvt. Limited.
5. Ganendrakumar Chakravarti. 1978. A hand book of Clinical Pathology, Academic Publishers, Calcutta.
6. Ochei.J and A.Kolhatkar, 2000. Medical Laboratory science: Theory and practice, McGraw Hill Education.
7. Dacie and Lewis, 2016. ParcticalHaematology, Elsevier
8. Praful Godkar, Darsan, 2014. Text book of Medical Laboratory Technology Vol I & II, Bhalani Publishing House
9. https://www.mooc-list.com/tags/medical-diagnosis
10. https://www.mooc-list.com/tags/clinical-diagnostics
11. http://www.winthrop.org/diagnostic-technology-techniques
12. http://www.ttsglobalinitiative.com/newsletter/clinical-diagnostic-technologies-face-new-obstacles/

Course Outcome:

After completion of this course the student can able to

- ✓ Ability to think critically and solve problems in a laboratory setting.
- ✓ Act as ethical and responsible members of the health care team.
- ✓ Eligible for employment in a hospital, public or private health laboratory, health care clinic, veterinary office, research lab, Forensic lab, or pharmaceutical lab
- ✓ Maintain confidentiality of patient information and test results.
- ✓ Display honesty, reliability and integrity when performing laboratory procedures.

- ✓ Operate and calibrate clinical laboratory instruments or equipment after proper orientation.
- ✓ Knowledge about pharmaceutical lab, performing and analysing various biological tests including hematological, biochemical, microbiological, immunological, and other clinical laboratory tests.

Able to do antibiotic sensitivity test, diagnostic test for HIV, Hepatitis B, Hepatitis, Malaria, Tuberculosis

ENTREPRENEURSHIP IN MICROBIOLOGY (VAC II)

Code: 18MICVAC2 **Credits: 2**

Objectives:

- The main objective of this course is to concentrate on development role of resource government and non-government schemes for entrepreneurship programmes.
- To know the role of skills for entrepreneurs, communication skills, problem solving skills; Business plan development.
- To acquire a basic understanding on button, oyster Mushroom cultivation, Single cell protein SCP Production of Yeast and *Spirulina*.
- To learn about the mass multiplication, production cost analysis and marketing of different types of biofertilizer.

Syllabus

Unit I

Concept of entrepreneur and Entrepreneurship: Definitions-concept of Entrepreneurship, development- role of resource. Government and non Govt. schemes for Entrepreneurship programmes

Unit II

Skills for entrepreneurs - communication skills, problem solving skills; Business plan development; Market need- distribution, price, promotion and market goal setting. Financial plan -Financial support for business, business insurance.

Unit III

Project: identification, classification, formulation, appraisal. Small, large scale production and cost benefit analysis and marketing of button, oyster Mushroom cultivation, Single cell protein- SCP Production of Yeast and *Spirulina.*

Unit: IV

Mass multiplication, production cost analysis and marketing of Cyanobacterial Biofertilizers, Bacterial Biofertilizers- *Rhizobium, Azospirillum,* Fungal Biofertilizers -VAM, Actinobacterial Biofertilizer- *Frankia* sp.

Unit V

Mass production and marketing of Compost- Vermicomposting and microbial compost - Types of compost pits- Laboratory and field application; cost-benefit analysis.

References

1. Nagendra S., (2008) Entrepreneurship and management Sanguine technical publishers

2. Bhatia, B.S. and G.S Batra, (2003) Entrepreneurship and small business management. Deep and deep publications

3. Naidu, N.V.R, (2008) Management and entrepreneurship. I.K. International Pvt. Ltd.

4. Greene, (2000) Entrepreneurship ideas in action. Thomson learning

5. Tilak, K.V.B.R., (1990). Bacterial Biofertilizers. IARI Publications, New Delhi.

6. Venkataraman, G.S. (1972). Algal Biofertilizers and Rice Cultivation, Today and Tomorrow's Printers and Publishers, New Delhi.
7. Sandera, F.E., B.Mosse and P.B.Tinke, (1975). Endomycorrhizae, Academic Press, London.
8. Rao,N.S,(1980) Biofertilizers in Agriculture. Oxford & IBH Publishing Co. Pvt. Ltd., Bombay
9. https://study.com/microbiology_courses.html
10.https://study.com/academy/lesson/what-is-an-entrepreneur-definition-characteristics examples.html
11. https://study.com/academy/lesson/institutional-entrepreneurship-theory-examples.html
12.https://study.com/articles/Fermentation_Microbiologist_Job_Description_Salary_and_Career Outlook.html

Course Outcomes

After completion of this course the student can able to

- ✓ Understand the basic knowledge of entrepreneurship programmes
- ✓ Learn the resource for government and non-government schemes for entrepreneurship
- ✓ Knowledge about different types of mushrooms
- ✓ Able to do the mass multiplication, production cost analysis and marketing the types of biofertilizer.
- ✓ Awareness about the button, oyster mushroom cultivation, Single cell protein SCP Production of Yeast and *Spirulina.*

Bioethics and IPR (VAC III)

Code: 18MICVAC3 **Credits: 2**

Objectives:

- The main objective of this course is to s to adhere to the ethical practices appropriate to the discipline at all times
- to adopt safeworking practices relevant to the bioindustries & field of research

Unit I

Bioethics – Definition - Basic human values such as the rights to life and health - The use of nature, Different views of Nature, Dynamic Nature, Interfering with Nature, Integrity of Species; Reducing Genetic Diversity; Biological Warfare; General Ethical Concerns for recombinant research

Unit II

History of Medical Ethics: The Hippocratic tradition: A Profession, Philanthropy, Do no harm. Adoption to the Oath by Western Medicine - Retaining the Hippocratic Oath – modern medical code of ethics – essential features of a good physician.

Unit III

Status of Human Embryo: Human Embryonic Development; Ethics through Embryo Development: Fertilization, The Fetus and feeling pain; Scientific Research on Human Embryos and its Experimental goals - Ethical issues in Embryo Research.

Unit IV

Animal Rights: Making New Strains of Animal: Ethical limits and regulations of Animal use: Religious views of Animal status. Human Gene Therapy: Ethical issues in Gene Therapy: Efficiency of treatment; Safety of Transferred Genes; Human rights, Ethical guidelines for genetically modified foods.

Unit V

Intellectual Property Rights (IPR): Definition, types, tools – Patenting; Trademark; Trade secret; Copyrights; related rights; Geographical Indications; Industrial Designs. TRIPS. National (IPO) and International Agencies (WTO, WIPO) involved in IPR and Patenting.

References

1. Nancy, S. Jecker, Albert R. Johnson, Robert A. Pearlman. (2011). Bioethics: An Introduction to history, methods and practice. Jones and Barlett Publishers.
2. Tom, L. Beauchamp., Childress, F. (2013). Principles of biomedical ethics, 5th Edition, - Oxford Univerisity Press, USA.
3. Vaughan Manomy (2009) Animal Experimentation: A guide to the issues, 2nd edition, - Cambridge university press.

4. Lewis Vaughn (2013) Bioethics: Principles, Issues and Cases, Oxford University Press, USA.
5. Beauchamp T, Childress J (2013) A Principles *of Biomedical Ethics, 7th Edition*, - New York: Oxford University Press.
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7. Frederic H. Erbisch and Karim M. Maredia. Intellectual Property Rights in Agricultural Biotechnology, CABI publisher. 2004
8. Bioethics and Biosafety (2008) M.K.Sateesh, I.K.International Pvt. Ltd,New Delhi, India.
9. IPR, Biosafety and Bioethics (2013), 1st Edition, Deepa Goel and Shomini Parashar,Pearson Education, India.

Course Outcomes

After completion of this course the student can able to

- ✓ Students will gain awareness about Intellectual Property Rights (IPRs) to takemeasure for the protecting their ideas
- ✓ They will able to devise business strategies by taking account of IPRs
- ✓ They will be able to assists in technology upgradation and enhancing competitiveness.
- ✓ They will acquire adequate knowledge in the use of genetically modified organisms and its effect on human health
- ✓ They will gainmore insights into the regulatory affairs.

Second Year: Semester - IV

18MICCC14– SELF STUDY REVIEW

(Topic will be announced each year)

18MICCC15: PROJECT & DISSERTATION WORK

RULES GOVERNING THE EVALUATION OF PROJECT AND *VIVA VOCE*

1. Students can select a research problem pertaining to their course, individually in consultation with the Guide.
2. The project report should be submitted on or before the last working day of the fourth semester to the Head of the Department through the Guide.
3. Each student has to submit three copies of his/her project report for evaluation.
4. The project report shall contain a maximum of 50 pages excluding bibliography and appendix.
5. The project report will be valued for a total of 80 marks. For a pass in the project report, the student should secure a minimum of 32 marks. If a student fails to secure 32 marks in the evaluation of the project report, he/she may be permitted to resubmit his/her project report once again after incorporating the necessary correction as suggested by the Examiner within a period of six months from the date of publication of the results of Examinations.
6. For those candidates who have qualified in the evaluation of the project report, there will be a *viva-voce* on the above. The *viva-voce* carries a maximum of 20 marks and it will be conducted jointly by the guide and the external examiner.
7. For a pass in this paper as a whole, a student should secure a minimum of 50 marks in Project report and *viva-voce* put together.

Guidelines in the preparation of M.Sc Dissertation

References

Single author journal article: Author's last name, initials. Year. Title of paper. Full name of journal, v. x, p. xx–xx.

Single author chapter or paper in a book: Author's last name, initials. Year. Chapter title in Editor's or compiler's initials and last name, book title. City of publication, publisher, p. xx–xx.

Single author book: Authors last name, initials. Year. Book title. Publisher, city of publication, xxx p.

Multiple authors: First author's last name, initials, the initials and last name of second author, initials and last name of third author (etc.), year, title, etc.

Computer programs on disk: Organization name. Year. Program name, version number. name of distributor, city of distributor.

Internet: Author name(s). Year of publication or last revision (if known). Title of document, title, or complete work (if applicable). <URL> date of access.

Reference Examples:

Stockton, P. and D.A. Gillette. 1990. Field measurements of the sheltering effect of vegetation on erodible land surfaces. Land Degradation & Rehabilitation v. 2, p. 77-85.

Stout, J. E. 1998. Effect of averaging time on the apparent threshold for aeolian transport. Journal of Arid Environments v. 39, n. 3, p. 395-401.

Webb, W. P. 1931. The Great Plains. University of Nebraska Press, Lincoln, p525.

Zobeck, T. M., T. E. Gill, J. E. Stout, M. L. Zhang, A. C. Kennedy, and J. M. Gregory. 1997. Analysis of laboratory-generated dust suspensions derived from soils and roads. Presented at the 1997 ASAE Annual International Meeting, Paper No. 972030. ASAE, 2950 Niles Road, St. Joseph, MI 49085-9659 USA.

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Three hard bound copies (One to the Department, One for the candidate and one for the guide) of the thesis are required to be submitted for final dissertation examination. Hard bound means permanently stitched and bound in **BLUE COVER** with the title of the dissertation and your name clearly inscribed on the cover as per format given at the first page of template.

Title of M.Sc Dissertation

(Binding Page)

Dissertation submitted to the Bharathidasan University in partial fulfillment of the requirements for the award of the degree of

Master of Science in Microbiology

Submitted by

Name of Student
(Student's Registration Number)

Under the Guidance of

Name of Supervisor

DEPARTMENT OF MICROBIOLOGY
CENTRE FOR EXCELLENCE IN LIFE SCIENCES
BHARATHIDASAN UNIVERSITY
TIRUCHIRAPPALLI – 620 024

Month Year

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TIRUCHIRAPPALLI – 620 024

Month Year

DEPARTMENT OF MICROBIOLOGY
BHARATHIDASAN UNIVERSITY
SCHOOL OF LIFE SCIENCES
TIRUCHIRAPPALLI – 620 024

M. Sc., MICROBIOLOGY

DISSERTATION

This is to certify that the work entitled "**.....** " is a bonafide work of Mr./Ms. **……**(Reg. No. ……) student of M.Sc., Microbiology, Department of Microbiology, Bharathidasan University, Tiruchirappalli carried out under the supervision of **……..**, Department of Microbiology, Bharathidasan University, Tiruchirappalli as a partial fulfillment for the award of **Master of Science in Microbiology** during the academic year of **20XX – 20XX**.

Internal Guide/Examiner **Head of the Department**

External Examiner

CERTIFICATE FROM THE ACTUAL GUIDE IN HIS / HER

LETTER PAD WITH SIGNATURE

(no photocopy / scanned copy)

CERTIFICATE

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Signature of the Guide & Supervisor