University of Kerala

Career-related First Degree program

Under CBCS System

Group 2 (a)

BOTANY & BIOTECHNOLOGY

Course Structure & Syllabus

Foundation Courses, Core Courses Complementary Courses and Open /Elective Courses

2010

Aim and Objective

The Career related first degree programme in **Group 2(a)** is a two main course with **Botany** as core and **Biotechnology** as **Vocational Core** subject is designed to develop a scientific attitude and an interest towards the modern areas of biotechnology in particular and life science in general. It is aimed to get an aptitude in Biotechnology with out losing the importance of basic science such as Botany. It will help the students to become critical and curious in their outlook. The courses are designed to impart the essential basics in botany, Zoology, chemistry, Biochemistry and Biotechnology.

The programme consists of Language courses, foundation courses, Complementary courses, Core courses and open or Elective courses. There are two foundation courses, one is focused on the modern information technology, statistics and its application in modern life sciences, and a general introduction and awareness on Biotechnology and its influence in human life. The second foundation course is to give a general introduction and awareness in the general instrumentation and its principles and application in biology and biotechnology, in addition to give biophysical basics.

The various courses in the programme is aimed to develop proficiency in the theory as well as practical experiments, common equipments, laboratory, along with the collection and interpretation and presentation of scientific data in proper manner. In addition to this, students will be equipped with knowledge in the modern areas of biotechnology and its application in medical science, agriculture, industry, proteomics, genomics, metabolomics, bioinformatics, nanobiotechnology etc. Apart from understanding biotechnology and its power in developing the nation, it will create awareness about biotechnology and will help in eliminating public fear about the contribution of biotechnology and confusion on GM crops, GM foods and transgenic organisms. Students, who pursue this programme and pass out successfully, will surely have an urge to continue higher studies in Biotechnology and contribute significantly in its development.

The total minimum credits of the programme is 120 and the various courses and its corresponding credits are depicted in the following table, which is followed by the general structure and semester wise allocation of courses, its credits and contact hours.

Career Related First Degree Programme
Group 2(a)

BOTANY & BIOTECHNOLOGY

Summary of courses

Study Components			No. of courses	Credits /course		Max / Total Credits
1	**Languages**					
	1	**English**	**4**	**3**		**12**
	2	**Additional Language**	**2**	**3**		**6**
2	**Foundation Course**		**2**	**2-3**		**5**
	1	Methodology and Perspective of Biotechnology	1	3		
	2	Biophysics and Instrumentation	1	2		
3	**Complementary Courses**		**5**	**2-4**		**14**
	Biochemistry			**T**	**P**	
	1	Introduction to Biochemistry		3		
	2	General Biochemistry		3		
	3	Physiological aspects of Biochemistry		4		
	4	Metabolism		2		
	5	Practical Biochem IV (Practical of 1, 2, 3 & 4)			2	
4	**Core Courses**		**27**	**2-4**		**75**
	Botany		13	**L**	**P**	35
	1	Phycology, Mycology, Lichenology & Plant Pathology		4		
	2	Bryology, Pteridology, Gymnosperms & Paleobotany		2		
	3	Practical Botany I (Practical of 1 & 2)			2	
	4	Angiosperm Anatomy and Reproductive Botany		3		
	5	Environmental Studies and Phytogeography		3		
	6	Horticulture, Mushroom Cultivation & Marketing		2		
	7	Cell biology, Plant breeding and evolutionary biology		2		
	8	Practical Botany II **(**Practical of 4, 5,6 & 7)			2	
	9	Plant Physiology		4		
	10	Genetics		4		
	11	Angiosperm Morphology & Systematic Botany		3		
	12	Economic Botany, Ethanobotany & Medicinal Botany		2		
	13	Practical Botany III **(**Practical of 9, 10,11 & 12)			2	
7	**Biotechnology (Vocational)**		14			40
	1	Microbiology	1	4		
	2	Microbial Metabolism, Genetics & Diseases	1	3		
	3	Biotechniques I (Practical of 1 and 2)			2	
	4	Protista and Animal Diversity	1	4		
	5	Animal Physiology and Anatomy	1	3		
	6	Molecular Biology	1	3		
	7	Immunology	1	2		
	8	Biotechniques II (Practical of 4,5,6,& 7)			2	

	9	Recombinant DNA Technology	1	4		
	10	Plant Biotechnology	1	3		
	11	Animal Biotechnology	1	3		
	12	Industrial Biotechnology	1	3		
	13	Environmental Biotechnology	1	2		
	14	Biotechniques III (Practical of 9,10,11,12 & 13)			2	
8	**Open / Elective Courses of Vocational Subject**		**2**	**2**		**4**
	1	Bioinformatics	1	2	-	
	2	Food and dairy Biotechnology	1	2		
	3	Genetic Engineering	1	2		
6	**1**	**Project**			**4**	**4**
				Total C		**120**

T- Theory
P- Practical

Course structure and syllabus of Career Related First Degree in Biotechnology (2a) as per the regulations of CBCS

The Career related first degree programme in Group **2(a)** Botany as core subject Biotechnology as Vocational Core subject consists of total of 42 courses including the language courses distributed in eight categories. They are language courses, foundation courses, Complementary courses, Core courses, Core course of Vocational subject, Open course of core subjects and vocational core subject and a project. The project is compulsory and the students may be assigned a topic for the project in the 5^{th} semester itself and should be completed and submitted during the practical assessment at the end of VI semester.

The total credits of the entire programme is 120, and the distribution of credits, contact hours etc for each course in each semester is summarized below as tables. Total credits for each semester is 20 and contact hours is 25 per week and the total working hours for a semester is 450.

Each course title is represented by a course code consisting of a two letter subject code followed by four digits. The first digit indicates the first degree programme, which is always one. The second digit indicated the semester number which is 1-6, the 3^{rd} digit denotes the category of the course which ranges from 1-8, since there are eight categories and the last digit indicates the serial number of the course with in a semester. The following are the category of courses included in the Career Oriented First Degree Programme under the group 2(a).

. **The subject code is BB (Botany & Biotechnology)**

BB	Botany & Biotechnology	5	Open / Elective course of Core
1	Language	6	Project
1.1	Additional Language	7	Vocational Core Course
2	Foundation course	8	Open / Elective Course of Vocational
3	Complementary Course		
4	Core courses		

Summary of the course structure and syllabus

Semester I

Course code	Course Title	Teaching hrs./week		Total Hrs	Total Credits	Duration of University Exam	Weightage of Evaluation	
		T	P				CE	ESE
EN1111	English	5		90	3	3Hrs.	5	30
1111.1	Additional language	5		90	3	3Hrs.	5	30
BB1121	Methodology and Perspective of Biotechnology	3		54	3	3Hrs.	5	30
BB1131	Introduction to Biochemistry	3	2	90	3	3Hrs.	5	30
BB1141	Phycology, Mycology, Lichenology & Plant Pathology	2	2	72	4	3Hrs.	5	30
BB1171	Microbiology	2	1	54	4	3Hrs.	5	30
	Total	25		450	20			

Hour distribution: BT-3+3, BO-4, CC- 5, LC-5+5 = 25

Semester II

Course code	Course Title	Teaching hrs./week		Total Hrs	Total Credits	Duration of University Exam	Evaluation Weightage	
		T	P				CE	ESE
EN1211	English	5		90	3	3Hrs.	5	30
1211.1	Additional language	5		90	3	3Hrs	5	30
BB1221	Biophysics and Instrumentation	2		36	2	3Hrs	5	30
BB1231	General Biochemistry	3	2	90	3	3Hrs	5	30
BB1241	Bryology, Pteridology, Gymnosperms & Paleobotany	3	2	90	2	3Hrs	5	30
BB1242	**Practical Botany I** (Practical of BB1141 & BB1241)				2	3Hrs	5	30
BB1271	Microbial Metabolism, Genetics and Diseases	2	1	54	3	3Hrs	5	30
BB1272	**Biotechniques I** (Practical of BB1171, BB1271)				2	3Hrs	5	30
	Total	25		450	20			

Hour distribution: BT-3+2, BO- 5, CC-5, LC-5+5 = 25

Semester III

Course code	Course Title	Teaching hrs.		Total Hrs	Total Credits	Duration of University Exam	Evaluation	
		T	P				CE	ESE
EN1311	English	5		90	3	3 Hrs	5	30
BB1331	Physiological aspects of Biochemistry	3	2	90	4	3 Hrs.	5	30
BB1341	Angiosperm Anatomy and Reproductive Botany	3	1	72	3	3 Hrs	5	30
BB1342	Environmental Studies and Phytogeography	3	1	72	3	3 Hrs	5	30
BB1371	Protista and Animal Diversity	3	1	72	4	3 Hrs	5	30
BB1372	Animal Physiology and anatomy	2	1	54	3	3 Hrs	5	30
	Total	25		450	20			

Hour distribution: BT-7, BO-8, CC-5, EN-5 = 25

Semester IV

Course code	Course Title	Teaching hrs.		Total Hrs	Total Credits	Duration of University Exam	Weightage for Evaluation	
		T	P					
EN1411	English	5		90	3	3 Hrs.	5	30
BB1431	Metabolism	3	2	90	2	3 Hrs.	5	30
BB1432	**Practical Biochem IV** (Practicals of BB1131, BB1231, BB1331, & BB1431)				2	3 Hrs.	5	30
BB1441	Horticulture, Mushroom Cultivation & Marketing	3	1	72	2	3 Hrs.	5	30
BB1442	Cell biology, Plant breeding and evolutionary biology	3	1	72	2	3 Hrs.	5	30
BB1443	**Practical Botany II** **(**Practicals of BB1341, BB1342, BB1441 & BB1442)				2	3 Hrs.	5	30
BB1471	Molecular Biology	3	1	72	3	3 Hrs.	5	30
BB1472	Immunology	2	1	54	2	3 Hrs.	5	30
BB1473	**Biotechniques II** (Practical of BB1371, BB1372, BB1471 & BB1472)				2	3 Hrs.	5	30
	Total	25		450	20			

Hour distribution: BT-7, BO-8, CC-5, EN-5 = 25

Semester V

Course code	Course Title	Teaching hrs.		Total Hrs	Total Credits	Duration of University Exam	Weightage for Evaluation	
		T	P				CE	ESE
BB1541	Plant Physiology	4	2	108	4	3 Hrs.	5	30
BB1542	Genetics	4	2	108	4	3 Hrs.	5	30
BB1571	Recombinant DNA Technology	3	1	72	4	3 Hrs.	5	30
BB1572	Plant Biotechnology	3	1	72	3	3 Hrs.	5	30
BB1573	Animal Biotechnology	2	1	54	3	3 Hrs.	5	30
BB1581	Bioinformatics	2		36	2	3 Hrs.	5	30
	Total	19	6	450	20			

Hour distribution: BT-11+EC 2, BO-12 = 25

Semester VI

Course code	Course Title	Teaching hrs.		Total Hrs.	Total Credits	Duration of University Exam	Weightage for Evaluation	
		T	P				CE	ESE
BB1641	Angiosperm Morphology, Systematic Botany,	4	3	126	3	3 Hrs.	5	30
BB1642	Economic Botany, Ethanobotany & Medicinal Botany	4	2	108	2	3 Hrs.	5	30
BB1643	**Practical Botany III** **(**Practical of BB1541, BB1542, BB1641, BB1642)				2	3 Hrs.	5	30
BB1671	Industrial Biotechnology	3	2	90	3	3 Hrs.	5	30
BB1672	Environmental Biotechnology	2	2	72	2	3 Hrs.	5	30
BB1673	**Biotechniques III** (Practical of BB1571, BB1572, BB1573, BB1671 & BB1672)				2	3 Hrs.	5	30
BB1681	Food & Diary Biotechnology	2		36	2	3 Hrs.	5	30
BB1661	Project on Biotechnology	Tutorial 1		18	4	3 Hrs.	5	30
		25		450	20			

Hour distribution: **BT-10+EC2, BO-7+6 =25**

Total work Load in Hours

Subject	**Work Load in Hours**
Biotech	900
Botany	900
Biochem	360
English	360
Sec.LC	180
Total	**2700**

Semester I

Foundation Course

BB1121 Methodology and Perspective of Biotechnology

Credits 3

Contact hours- 54

Aim and Objective of the course

The aim is to introduce the modern scientific methods and to familiarize biotechnology and its various areas. The students will be able to understand how science works. Students will learn how to apply statistics and IT in Biological science. They will receive a general awareness about biotechnology and its application in various fields.

Module I

Science and Scientific studies- 6 hrs

Types of Knowledge: practical, theoretical and scientific knowledge.

Information

What is science and what is not science, science vocabulary and science disciplines.

Revolution in science and technology

Experimentation in Science 10 hrs

Design of an experiment; experimentation; observation; data collection; interpretation and deduction.

Necessity of units and dimensions; repeatability and replication;

Documentation of experiments, record keeping, Connection between measurements and underlying theory.

Types of experiments. Experiments to test a hypothesis, to measure a variable, or to gather data by preliminary and explorative experiments.

Planning of experiments: Design, selection of controls, observational requirements, and instrumental requirements

Scientific instruments; sensory extension, choice and selection of instruments, sensitivity of instruments; Accuracy and precision and errors

Types of instruments- Historical development and evolution of scientific instruments. Robotics .

(Only a general orientation of scientific instruments required)

Making observations; direct and indirect observations, controlled and uncontrolled observations, human and machine observations, human error

Module II

Data handling in science and Biostatistics 10 hrs

Documentation of experiments – Nature and types of Data- typical examples, data interpretation, significance of statistical methods in biological investigations,

Sampling techniques, statistical evaluation of results, probability theory, Probability calculation (classical and axiomatic definition of probability, theorem on total and compound probability), variables in biological data, standard distribution with important properties, simple problems involving binomial, Poisson and normal variables, methods of sampling, collection of data; primary and secondary data, classification and tabulation, graphical and diagrammatic representation, confidence level, idea of sampling, distribution, standard deviation and standard error, large samples, normal tests, measurement of dispersion (measures of location and dispersion), basic idea of significance test, hypothesis testing, level of significance.

Module III

Overview of Information of Technology **10 hrs**

Features of modern personal computers and peripherals, computer networks and Internet, Introduction to mobile phone technology, Introduction to ATM,

Purchase of technology-license, guarantee, warrantee,

Overview of Operating systems and major application software

Data, information and knowledge-knowledge management- internet as knowledge repository, academic search techniques, - creating your cyber presence,

Introduction to use of IT in teaching and learning- case study of educational software, INFLIBNET, NICNET, BRNET-academic services.

Social Informatics **6 hrs**

IT and Society, Cyber ethics, cyber crime, security privacy issues,

Overview of IT- application in medicine, healthcare Business, Commerce , Industry, Defense, Law, crime detection, publishing, communication, resource management, weather forecasting, education, film and media

Typesetting with latex, Introduction to Scilab and Metlab

Module IV

Origin and development of Biotechnology- **6 hrs**

Introduction and definitions, Historic perspectives- biotechnology in prehistoric times, microorganisms and fermentation, Origin of genetics, DNA and genetic Engineering, Hybridoma technology,

Beginning of modern Biotechnology

Classical and modern concepts of Biotechnology

Scope of Biotechnology- Commercial potential, Biotechnology in India and its global trends, Major Biotechnology institutes and companies in India,

Application of biotechnology- **4 hrs**

Industrial Biotechnology- Bioprocess and Fermentation Technology, Environmental Biotechnology- Biological fuel generation, Single cell protein, sewage and Effluent treatment;

Medical Biotechnology- safer and cheaper medicines by biotechnology, antibiotics, medicines from cell cultures, New medicines through genetic engineering, Biopharming;

Agriculture and Forest Biotechnology- Traditional methods of Crop improvement, Crop improvement through Biotechnology, Genetically Modified crops- Herbicide tolerance, Insect resistance, Virus tolerance, other engineered products, Genetically modified Livestock and poultry ;

Food and Beverage Biotechnology- Food and health, application of biotechnology in food processing, Traditional and modern food processing,

Module V

Safety and Ethics in Biotechnology- 2 hrs

Good Laboratory Practices (GLP), Good Laboratory Practices for Students, Quality control in manufacturing, Good manufacturing Practices (GMP), Marketing of Biotechnology Products. Impact of Biotechnology on Society, IPR and Patents in Biotechnology- basic concepts of IPR, patents and copyrights, plagiarism.

Suggested Readings

1. An Introduction to Biostatistics: A Manual for studies in Health Sciences., P. Sundar Rao, and J.Richard., Prentice Hall .
2. Biotechnologies and the Public: An International Study of Policy, Media Coverage and Public Attitudes from 1973 to 1996 (1995-1998), Helge Torqersen, Institute of Technology Assessment.
3. Biotechnology and Ethics: A Blueprint for the Future, Daniel Callahan President, Hastings Center, Center for Biotechnology, Northwestern University.
4. Biotechnology: Issues, Ethics and Regulations, Tina M. Prow, Communications Specialist, Office of Agricultural Communications and Education.
5. Computers Today, Alexis Leon and Mathews Leon., Leon Vikas.
6. Conceptual Integrated science, Hewitt, Paul G, Suzanne Lyons, ohn A. Suchocki & ennifer Yeh., Addison-Wesley.2007.
7. Cultural Boundaries of Science, Gieryn, T.F. University of Chicago Press, 1999.
8. Fundamentals of Information Technology, Alexis and Mathew Leon., Leon Vikas
9. Introduction to Genetic Engineering & biotechn9ology, Nair, A.J., Infinity Science Press, USA.
10. Introduction to Information Technology, V.Rajaraman., Prentice Hll.
11. Learning Computer Fundamentals., Ramesh Bangia ., Khanna Book Publishers
12. Methods for Teaching Science as Inquiry, Bass, Joel,E and et. al., Allyn & Bacon, 2009 The truth of science, Newton R.G.,
13. Patenting in Biotechnology - Part I, R. Stephen Crespi, Tibtech, Vol. 9, 117-122, 1991.
14. People's Perception of Biotechnology, Renato Schibeci, Ian Barns.
15. Plant Biotechnology: Facts and Public Perception, D. Boulter, Department of Biological Sciences, University of Durham, South Road, Durham DH1 3LE, U.K. *'Phytochemistry' (Vol. 40, No.1, pp.1-9, 1995).*
16. Public Attitudes to Genetically Engineered Products, Wendy Ross, Katy Marsh, Alexi Jackson, Jaqui Skoyles, (1998), John Innes Centre, Norwich, U.K.
17. Social issues in Science and Technology: An Encyclopedia, David E. Newton (ABC-CLIO, Santa Barbara), 1999.
18. The Golem: What every one should know about science, Collins H. and T. Pinch,Cabridge University Press, 1993.

Semester I
Complementary Course
BB1131 Introduction to Biochemistry

Credits 3
Total Contact Hours: 90 (Theory 54 + Practical 36)

Aim and Objective: To give basic awareness about the concepts and physical aspects in biochemistry and to develop analytical skills in students in order to prepare them to use instruments.

Module I
Structural features of water molecule, dissociation of water, ionic product of water, acids and bases, concepts of pH, pOH, theoretical calculations of pH and pOH, dissociation of weak acids , buffers buffer action and buffer capacity, buffers in biological system, Henderson – Hasselbalch equation, titration curve of weak acids, simple numerical problems involving application of this equation.

Module II
Solutions: Meaning of normality, molality, molarity, percentage solution, mole fraction, parts per million, simple numerical problems from the above, fundamental principles of diffusion, osmosis, osmotic pressure, Vant Hoff's laws of osmotic pressure, simple numerical problems, definition of isotonic, hypotonic and hypertonic solutions, biological importance of osmosis, surface tension, viscosity.

Module III
Colloids: Definition of true solutions, suspensions, colloids and crystalloids, distinction between lyophilic and lyophobic colloids, properties of colloids, biological significance of colloids, emulsions and emulsifying agents, Donnan membrane equilibrium, Donnan equation and its significance.

Module IV
Thermodynamics: laws of conservation of energy- first and second laws and its relevance in the biological system, entropy and enthalpy, Gibbs free energy, bioenergetics- endothermic and exothermic reactions of biological systems, energy change in the biochemical reactions, sources of heat limits to temperature, heat dissipation and conservation.

Module V
Chromatography: Principle procedure and application of paper, TLC, ion-exchange, affinity and gel filtration chromatography.
Electrophoresis; Principle, procedure and application of zone electrophoresis- paper electrophoresis, gel electrophoresis (native PAGE, SDS-PAGE).
Colorimetry and Spectrophotometery: Beer-Lambert's law, visible absorption spectrum, molar extinction coefficient, colorimeter, spectrophotometer, fluorescence, phosphorescence.
Centrifugation: Principle of sedimentation technique, different types of centrifuge and rotors, principle and procedure and application of differential centrifugation, density gradient centrifugation, ultra centrifugation rate zonal centrifugation, Isopycnic centrifugation
pH meter: Principle and working.

Module VI

Bio-organic chemistry: (Common functional groups and their significance in biomolecules – OH, -SH, -CHO, -C=O, -COOH, -NH_2, -NH. Intra and Intermolecular interactions in biological system: Hydrogen bond, Covalent bond, hydrophobic interaction, disulphide bond, Peptide bonds, glycosidic bond, Phosphodiester linkage, Watson- Crick base pairings, Vander Wall's force. Classification of isomerism with examples.

Practical

1. Weighing in Chemical balance
2. Preparation of solutions -percentage, molar & normal solutions, dilution from stock solution etc.
3. Demonstration of dialysis
4. Demonstration of PAGE
5. Demonstration of Paper Chromatography
6. Demonstration of Thin Layer Chromatography
7. Colorimetry and Spectrophotometry techniques
8. Verification of Beer Lambert's law
9. Verification of molar extinction coefficient of any known compound

Suggested Readings

1. Physical Biochemistry by David Freifelder Publisher: W.H.Freeman & Co Ltd (September 1976)
2. A Biologist's Guide to Principles and Techniques of Practical Biochemistry by BryanL.Williams, Keith Wilson Hodder Education,
3. Principles and Techniques of Practical Biochemistry by Keith M. Wilson, John M. Walker Cambridge University Press.
4. The Tools of Biochemistry by Cooper, T. G. 1977. Publisher: John Wiley & Sons
5. Biophysical Chemistry Principles & Techniques Handbook (2003) by Avinash Upadhyay, Kakoli Upadhyay, Nirmalendu Nath Publisher: Himalaya Publishing House.
6. Hawk's Physiological Chemistry, Bernard L. Oser (ed) TATA McGraw Hill Publishing Company LTD, New Delhi p 10- 15.
7. Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande, I.K International Pvt. LTD, New Delhi.
8. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi.
9. Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain (2008) Publishers: S. Chand & Co Ltd.
10. Text Book of Medical Biochemistry by MN Chatterjea and R Shinde, 3rd edition, JAYPEE Publishers, New Delhi.
11. Introduction to Biophysics by Pranab Kumar Banerjee (2008) Publishers: S. Chand & Company ltd ISBN: 81-219-3016-2.
12. Biochemistry: A Students survival Guide by Hiram. F. Gilbert (2002) Publishers: McGraw-Hill
13. Practical Biochemistry Principles and Techniques, Keith Wilson and John Walker, 4th edition.

Semester 1

Core Course

BB1141 Phycology, Mycology, Lichenology & Plant pathology

Credit 4

Contact hours 72 (Theory 36 + Practical 36)

Aim and Objective: To impart basic knowledge about lower plants such as algae, fungi, Lichen and the diseases caused by these organuisms in plants. This will give an account on the life cycle, habitat, anatomy, classification and its involvement in the life cycle of other memebers of living world.

Module-I **14 hrs**

Phycology

1. Introduction – Range of thallus structure – Phylogenic trends – Pigments – Reproduction –Life cycle – Classification based on F .E Fritsch
2. Salient features of the following major groups with reference to the structure, reproduction and life cycle of the types given below ***(Excluding the developmental details)*** –

a. Cyanophyceae – *Nostoc*
b. Chlorophyceae - *Chlorella*, *Volvox, Oedogonium, Cladophora,*and *Chara*
c. Xanthophyceae – *Vaucheria*
d. Bacillariophyceae – *Pinnularia*
e. Phaeophyceae – *Sargassum*
f. Rhodophyceae - *Polysiphonia*

Economic importance of algae

a. Role of algae in soil fertility- Fertilizer – Nitrogen fixation- Symbiosis
b. Commercial products of algae – Agar, Alginates, Carrageenin, Diatomaceous earth
c. Algae - medicinal aspects, algal blooms and red tides

Module -II **12 hrs**

Mycology

1. Introduction, structure, reproduction, life cycle, evolutionary trends, Classification based on Ainsworth; Alexopoulos (1996). Modern trends of classification
2. Distinguishing characters of different classes of fungi representing the following genera ***(Excluding Developmental details)***

a. Myxomycotina -General characters.
b. Zygomycotina - *Rhizopus*
c. Ascomycotina

- Hemiascomycetes - *Saccharomyces*
- Plectomycetes - *Penicillium*
- Pyrenomycetes - *Xylaria*
- Discomycetes – *Peziza*

d. Basidiomycotina

- Teliomycetes - *Puccinia*
- Hymenomycetes - *Agaricus*

e. Deuteromycotina - *Cercospora.*

3. Economic importance of Fungi

Module-III

Lichenology **4 hrs**

Lichens - nature of association-classification-habit and habitat- thallus morphology – internal structure – reproduction-economic importance.

Module-IV **6 hrs**

Plant Pathology

1. History of plant pathology – Classification of plant diseases on the basis of causative organisms and symptoms – Host parasite interaction.
2. Study of the following diseases with emphasis on symptoms, disease cycle and control measures of Leaf mosaic of Tapioca, Citrus Canker, Blast disease of Paddy, Root wilt of Coconut
3. Brief account of the following fungicides- Bordeaux mixture, Lime sulphur, Tobacco decoction, Neem cake & oil.

Practical **36 Hrs**

Phycolcogy **16 hrs**

1. Make micro preparations of vegetative and reproductive structures of the types mentioned in the syllabus.
2. Identify the algal specimens up to the generic level and make labelled sketches of the specimens observed

Mycology **10 hrs**

A detailed study of structure and reproductive structures of types given in the syllabus and submission of record.

Rhizopus, Saccharomyces, Penicillium, Xylaria, Peziza. Puccinnia. Agaricus and Cercospora

Lichenology **4 hrs**

Make micropreparation of vegetative and reproductive parts of Usnea. Make sketches of the specimens observed.

Plant Pathology **6 hrs**

1. Identify the Diseases mentioned with respect to causal organism and symptoms
2. Students should be trained to prepare the fungicide Bordeaux mixture &Tobacco decoction.

Suggested Readings

1. Alain Durieux 2009, Applied Microbiology, Springer International Edition
2. Alexopoulos C.J & MIMS C.V 1988. Introductory Mycology, John Wiley & Sons.
3. Chapman V.J & Chapman D.J, The Algae, Macmillan.
4. Dr. G. Gunasekharan - Labortary Manual of Microbiology – New Age Pub:
5. Fritsch F. B 1945, Structure and Reproduction of Algae Vol.I & II. Cambridge University Press.
6. Heritage. L. 2007, Introductory Microbiology, Cambridge University Press India Pvt Ltd
7. Jim Deacon 2007, Fungal Biology, 4th edition, Blackwell Publishing, Ane Books Pvt. Ltd.
8. Kanika Sharma 2009, Manual of Microbiology, Ane Books Pvt. Ltd.
9. Mamatha Rao 2009, Microbes and Non flowering plants, Impact and applications; Ane Books Pvt. Ltd.
10. R .C .Dubey & D .K .Maheswari - A text Book of Microbiology – Chand & Co:
11. Schlegel ,2008 General Microbiology , Cambridge University Press India Pvt Ltd
12. Singh V, Pandey PC and Jam D.K 1998, A Text Book of Botany for Under Graduate Students, Rastogi Publications.
13. Singh V., Pandey P.C and Jain D.K 1998, A Text book of Botany for Undergraduate Students, Rastogi Publications.
14. Smith G.M 1955, Cryptoganiic Botany, Vol.I McGraw Hill.
15. Vashishta B.R. 1990, Botany for Degree Students, Fungi, S.Chand & Co.
16. Vasishta B.R 1990, Botany for Degree Students, Algae, S.Chand & Co.
17. Webster J 1970, Introduction to Fungi, Cambridge University Press.

Semester I
Core Course Vocational
BB1171 Microbiology
Credits- 4
Contact hours-54 (T 36 + P 18)

Aim and Objective: The course on microbiology is destined to give a thorough and basic understanding in various aspects of classical Microbiology, which forms the basis of any biotechnology application. Students were expected to master the major theoretical and practical expertise from this course.

Module I
Introduction **8 hrs**
Scope and history of microbiology: Pasteur's experiments, concept of sterilization, methods of sterilization -dry heat, wet heat or steam, radiation, chemical and filtration.

Classification of microorganisms: bacteria, virus, fungi, protozoa, mycoplasma, concept of microbial species, strains; microbial cell surfaces, gram positive and gram negative bacteria, classification of bacteria, Motility in bacteria, kinds of flagella, nutritional classification of bacteria.
Viruses:
Viruses, phage culture, Bacteriophage, DNA and RNA phages, T4 phage, Lytic and lysogenic cycles, Host cell adsorption and penetration, synthesis phage nucleic acid.

Module t II
Genetic homogeneity **4 hrs**
Spontaneous and induced variations in microbes,
Isolation of auxotrophs- replica plating technique and analysis of mutations in biochemical pathways,
Microbial assays for vitamins and antibiotics, and other chemotherapeutic agents

Module III
Microbes in extreme environments 8 **hrs**
Thermophiles and alkalophiles, pathogenic microorganisms- bacteria, fungi, viruses, protozoans and mycoplasma, defense mechanism against microorganisms, symbiosis and antibiosis among microbial population, nitrogen fixing bacteria in agriculture and forestry, photosynthetic bacteria, Role of bacteria in carbon, nitrogen, sulphur and phosphorous cycle in nature.

Module IV
Bacterial nutrition 8 **hrs**
Culture media – requirements of bacterial culture media, types and uses, Bacterial growth curve, microbial metabolism, fermentation, different types of fermentation, methanogenic bacteria.
Isolation of pure culture: Spread plate, streak plate, pour plate etc., synthetic media, simple and complex media. Isolation of anaerobs and its culture techniques, slant culture and stab culture.

Module V

Industrial microbes and their uses **6 hrs**

Production of food (dairy and SCP) and drugs (antibiotics such as penicillin & streptomycin), products of fermentation, Strain improvement by enrichment mutation and recombinant DNA technique, production of heterologous proteins of interest in microorganisms.

Module VI

Control of microorganisms **2 hrs**

Physical agents, chemical agents, antibiotics and other therapeutic agents

Experiments for Microbiology Practical **18 hrs**

1. Use of Microscope
2. Sterilization and aseptic techniques-preparation and sterilization of glassware and solutions
3. Media Preparation- Preparation of Luria-Bertani medium and Nutrient agar and sterilization (Broth and plates)
4. Isolation of bacteria from soil, water and air-a) Pour plate method, b) Streak plate method for isolation and colony purification.
5. Staining of bacteria- Gram staining, Acid fast staining, Negative staining.
6. Growth of Bacteria in liquid media: Determination of kinetics of bacterial growth
7. Microscopic tests for bacterial motility
8. Identification of bacterial and fungal cultures microscopically
9. Fermentation techniques- Determination of substrate utilization with respect to growth kinetics
10. Antibiotics sensitivity tests
11. Serial dilution of bacterial cultures and plating to find out population density of microbes in a given sample.
12. Microbiological examination of various types of waters including commercial and ordinary drinking water.

Suggested Readings

1. A Textbook of Microbiology – P. Chakraborthy, New central Book agency Pvt. Ltd, calcutta
2. Modern concept of Microbiology – D D Kumar, S Kumar; Vikas Publishing House Pvt. Ltd. New Delhi
3. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston,USA.
4. Introduction to Microbiology- J Heritage, E G V Evans, R A Killington; Cambridge University Press.
5. Microbiology – L M Prescott, Brown Publishers, Australia
6. Principles of Biotechnology – A. J. Nair Laxmi Publications New Delhi
7. Advances in Microbiology – J P Tewari, T N Lakhanpal, I Singh, R Gupta and B P Chanola; A P H Publishing Corporation, New Delhi.
8. Microbiology: Principles and Explorations – Jacquelyn G. Black. Prentice Hall, New Jersey.

Semester II

Foundation Course

BB1221 Biophysics & Instrumentation

Credits: 2

Contact hours 36

Aim and Objectives of the Course

The aim is to introduce the physical aspects and bioenergetics of the living system and to familiarize the principle and working of various instruments used in biotechnology experiments. The students will be able to understand the fundamentals of biophysics and the general instrumental techniques used in biotechnology.

Module I

Principles of thermodynamics: **5 hrs**

Laws of conservation of energy- first and second laws and its relevance in the biological system, entropy and enthalpy, Gibbs free energy, bioenergetics- endothermic and exothermic reactions of biological systems, energy change in the biochemical reactions, sources of heat limits to temperature, heat dissipation and conservation.

Electrical properties of biological compartments: **4 hrs**

Electricity as a potential signal, electrochemical gradients, membrane potential, ATP synthesis, and chemi-osmotic hypothesis

Module II

Biophysics of Photosynthesis **5 hrs**

Primary events in photosynthesis, light harvesting pigments, resonance energy transfer in photosynthetic pigments, fluorescence and phosphorescence, absorption spectra and action spectra of photosynthetic pigments, photosynthetic reaction center and accessory pigments, light reception in microbes, plants and animals,

Biophysics of Vision, Muscle movements and Hearing: **3 hrs**

Mechanism of vision, muscular movements and hearing, correction of vision faults, generation and reception of sonic vibrations, hearing aids.

Intra and intermolecular interactions in biological systems: **3 hrs**

Various types of molecular interactions, inter and itra molecular interactions, special and charge compatibility in molecular interactions.

Module III

Microscopy: **3 hrs**

Principle of Microscopy, various types of Microscopy- Simple, phase contrast, fluorescence and electron microscopy (TEM and SEM), Modern developments in Microscopy.

Basic principles and working of instruments: **7 hrs**

pH meter, spectrophotometer (UV and Visible) and colorimeter- Beer-Lambert law,

Brief account of densitometry, fluorimetry, manometry, polarography, centrifugation, atomic absorption spectroscopy, IR, NMR and X-ray crystallography and Mass spectrometry.

Electrophoresis: **3 hrs**

Principle of electrophoresis, native gel electrophoresis, SDS electrophoresis, immuno electrophoresis, isoelectric focusing, polymerization of acrylamide and bis-acrylamide, electrophoresis in agarose gel and Submarine electrophoresis

Isotopes and radioisotopes: **3 hrs**

Isotopes and radioisotopes, radiations- ionizing radiations,

Application of isotopes and radioisotopes in biological research, radioisotope tracer technique and autoradiography.

Practicals-

Familiarizing the working of the following instruments

1. pH Meter – Use of pH Meter, Familiarization of the instrument and Preparation Phosphate buffers and determination of pH.
2. Spectrophotometer – Familiarization of the working of the instrument , Quantitative estimation of Sugars by Dinitrosalysilic acid and Proteins by Lowry's Method
3. Development of absorption spectra of chlorophyll or any other biological sample
4. Electrophoresis – demonstration of PAGE and Agarose Gel Electrophoresis

Suggested Readings

1. A Textbook of Biophysics- R N Roy, New central Book Agency Pvt. Ltd, Calcutta.
2. Biochemistry ., Voet,D & Voet, J.G
3. Biophysics- S.Thiruvia Raj , Saras Publications , Tamilnadu.
4. Biophysics, Volkenstein, M.V
5. Introduction to biophysical chemistry Martin
6. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston,USA.
7. Lehninger's Biochemistry , Nelson D.L and Cox, M.M., Worth Publishers, New York
8. Molecular Biology of the gene, Watson et al.
9. Principles of Biotechnology- AJ Nair, Laxmi Publications, New delhi

Semester-II

Complementary Course

BB1231 General Biochemistry

Credits: 3

Contact Hours: 90 (T 54 + P 36)

Aim and Objective: To familiarize the students with the building blocks of living matter, the biomolecules, their structure, components, reactions, their derivatives, biological significance and the basic tests to identify them..

Module I

Chemistry of carbohydrates : Classification, optical isomerism, D and L series, epimers, aldoses and ketoses, structural relationships of aldoses, ring structure of monosaccharides, anomers, mutarotation, chemical reactions of glucose and fructose, glycosides, deoxy sugars, amino sugars, sugar alcohols and sugar acids, O- acyl O-methyl derivatives of monosaccharides, ozazone, disaccharides, structure and important properties of sucrose, maltose, isomaltose, lactose and cellobiose, Trisaccharide (examples only), structure and important properties of polysaccharides- starch, glycogen, cellulose, and chitin.
Qualitative test for carbohydrates.

Module II

Chemistry of Lipids**:** Classification, fatty acids, structure and properties , reactions of fatty acids, triglycerides- general structure and properties, acid number, Saponification number and iodine number fats, glycerol, Acrolein test, phospholipids, derivatives of phospholipids- glycerophosphates, sphingosine phosphate, non-phosphorylated sphingolipids,- cerebrosides, gangliosides, sulphatides, (structure only) Steroids- structural features, sterols, structure of cholesterol and ergosterol . Colour reactions of sterols.

Module III

Chemistry of Amino acids and proteins: Classification of amino acids, amino acids occurring in proteins, optical activity, UV absorption, Zwitterions, chemical reactions of amino acids, proteins, biological significance, classification – fibrous proteins, globular proteins, conjugated proteins, hydrolysis of proteins and separation of amino acids.

Module IV

Proteins: Physical properties, solubility, isoelectric point and isoelectric precipitation, elementary study of primary secondary, tertiary and quaternary structure of proteins , colour reactions, precipitation reactions, denaturation, oligopeptides, amino acid analysis of proteins, hemoglobin- functions and components of plasma proteins.

Module V

Chemistry of Nucleic acids: Base compositions, structure of purines and pyrimidines, ribose and deoxy ribose, nucleoside structure , nucleotides- nomenclature, structure of polynucleotide –DNA,RNA primary structure and inter nucleotide linkage Watson and Crick double helix model of DNA, different types of RNA.

Module VI

Enzymes: Classification and nomenclature, units of enzyme activity, progress curve, effect of enzyme concentration, substrate concentration, temperature and pH on reaction velocity of

enzyme catalyzed reactions. Michaelis- Menten constant, enzyme affinity, Michaelis- Menten equation (Derivation not expected),Enzyme specificity, different types , enzyme activation , enzyme inhibition- competitive and non-competitive , Line weaver – Burk plot, application of LB plot, allosteric regulation (Brief study) purification of enzymes, criteria of purity, coenzymes.

Practical

1. **General reactions of Carbohydrates and Lipids**

   Carbohydrates-Glucose, Fructose, Galactose, Xylose, Sucrose, Maltose, Lactose, Starch & Dextrin
   Carbohydrates- Molisch's test, Anthrone test, Fehling's test, Benedict's test, Picric acid test, Barfoed's test, Bial's test, Seliwanoff's test, Foulger's test, Phloroglucinol test, Mucic acid test, Iodine test, Hydrolysis of Sucrose and Starch, Ozazone test.
   Fatty acids: Stearic acid, Oleic acid.
   Tests- Solubility, Translucent spot tests, Test for Unsaturation
   Glycerol
   Tests- Acrolein, Solubility.
   Triglycerides
   Tests-Solubility, Saponification, Translucent spot test
   Cholesterol
   Tests- Solubility, Salkowski reaction, Liebermann-Burchard reaction

Suggested Readings

1. Lehninger Principles of Biochemistry, 4th Edition by David L. Nelson
2. E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen, A Text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 1974.
3. Biochemistry (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc
4. Principles Of Biochemistry (1995) by Geoffrey L Zubay, William W Parson, Dennis E Vance Publisher: McGraw-Hill Book Company – Koga
5. Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain (2008) Publishers: S. Chand & Co Ltd.
6. Text Book of Biochemistry, 5th edition by DM Vasudevan and Sreekumar S, JAYPEE Publishers, New Delhi,.
7. Hawk's Physiological Chemistry, Bernard L. Oser (ed) TATA McGraw Hill Publishing Company LTD, New Delhi p 10- 15.
8. Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande, I.K International Pvt. LTD, New Delhi.
9. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi.

Semester II
Core Course

BB1241 Bryology, Pteridology, Gymnosperms & Paleobotany
Credit: 2
Contact hours: 90 (Theory 54 + Practical 36)

Aim and Objective: Students should be trained in basic botany such as lower plants like Bryophytes, Pteridophytes, Gymnosperms, etc. to get an in-depth knowledge in the4 various aspects of Biotechnology. This is the main purpose of this course.

Module -I
Bryology **16 hrs**

1. Introduction and Classification
2. Study of the habit, thallus organization, vegetative and sexual reproduction and alternation of generation of the following types ***(Developmental details are not required)***.
   Riccia, Marchantia, Polytrichum
3. Economic Importance of Bryophytes.

Module- II **8 hrs**
Pteridology

1. Introduction: General characters morphological and phylogenetic classification.
2. Study of the habitat, habit, internal structure, reproduction and life cycle of the following types ***(Developmental details not required)***.
   Psilotum, Lycopodium, Selaginella, Equisetum, Adiantum and *Marsilea.*

Module- III **8 hrs**

3. General Topics: Stelar evolution in Pteridophytes, heterospory and seed habit, relationships of pteridophytes with bryophytes and gymnosperms, economic importance of pteridophytes.

Module- IV **18 hrs**
Gymnosperms

1. Introduction and classification of gymnosperms.
2. Study of the Habit, Anatomy, Reproduction and life cycle of the following types ***(Developmental details are not required)*** –
   Cycas, Pinus and *Gnetum*
3. Evolutionary trends in gymnosperms - Relationship of gymnosperm with pteridophytes and angiosperms
4. Economic importance of gymnosperms.

Module-V
Plaeobotany **4 hrs**

1. Objectives of palaeo botany. Fossil formation – Techniques of study.
2. Geological time scale. Evolutionary trends
3. Primitive land plants - Precambrian flora - Algae, Fungi and Bryophyta.
4. Fossil pteridophytes – *Rhynia* , *Lepidodendron*, *Lepidocarpon* . Fossil Gymnosperm - *Lygenopteris*.
5. Applied aspects of Palaeobotany - Exploration of fossils – Exploration of fuels.

Practical **36 Hrs**

Bryology **10hrs**

1. *Riccia* – Habit - Internal structure of thallus – V. S. of thallus through archegonia, antheridia and sporophyte
2. *Marchantia* –Habit- thallus T. S., thallus with Archegonial receptacle, Antheridial receptacle,Male receptacle V .S., Female receptacle e VS., T.S . of thallus through gemma, Sporophyte V. S .
3. *Polytrichum* – Habit, V. S. of archegonial cluster, V .S. of antheridial cluster, Sporophyte V. S.

Pteridology **12 hs**

1. *Psilotum* : External features , stem T .S . , synangium T. S .
2. *Lycopodium* : Habit, stem T. S. , stobilus V. S.
3. *Selaginella* : Habit , rhizophore T. S , stem T . S, axis with strobilus, V .S. of strobilus, Megasporophyll and microsporophyll.
4. *Equisetum* - Habit, rhizome and stem T .S. and V. S. of strobilus.
5. *Adiantum* - Habit, Petiole T. S., sporophyll T. S. , prothallus
6. *Marsilea* - Habit, Rhizome and petiole T. S., sporocarp T.S, V. S. & R.L .S.

Gymnosperms **10 hrs**

1. *Cycas* – seedling, coralloid root and coralloid root T. S., T. S. of leaflet and petiole, micro and mega sporophyll, male cone V. S., micro sporophyll T. S. , entire and V. S. of ovule.
2. *Pinus* - Branch of indefinite growth, spur shoot, T. S of old stem and needle R .L .S andT. L. S. of stem, male and female cone, V .S. of male and female cone.
3. *Gnetum* -: Habit, stem T. S (young and mature), leaf T. S, male and female strobilus, V. S. of male and female cone, ovule V. S. and seed

Plaeobotany **4 hrs**

1. Fossil pteridophytes – *Rhynia* Stem, *Lepidodendron*, *Lepidocarpon*.
2. Gymnosperm - *Lygenopteris*

Suggested Reading

1. Andrews H.N. (1967) - Studies on Palaeobotany – C .J. Felix.
2. Arnold C. A (1947) - Introduction to Palaeobotany - McGraw Hill Co. New Delhi.
3. Chopra RN and P. K. – Biology of Bryophytes - Wiley Eastern Ltd. New Delhi
4. Coutler. J. M. - and Chamberlain C. J. (1958) – Morphology of Gymnosperms - Central Book Depot , Allahabad
5. Gupta V .K. and Varshneya U. D (1967) – An Introduction to Gymnosperms – Kedarnath, Ramnath – Meerut.
6. Parihar N .S. – An introduction to Bryophyta - Central Book Depot. Alahabad
7. Smith G.M. (1955) - Cryptogamic Botany – Vol.II – Mc Graw Hill Co. New Delhi
8. Sporne K. R. (1966) - Morphology of Pteridophytes - Hutchin University Library , London
9. Sporne K. R. (1967) - Morphology of Gymnosperms - Hutchin University Library , London
10. Vashista B. R. (1993) - Pteridophyta – S.Chand and co. New Delhi
11. Vashista B. R. (1993) Gymnosperms - S. Chand and co. New Delhi
12. Vasishta B. R. - Bryophyta - S. Chand and Co. New Delhi

Semester II

Core Course

BB1242 Practical Botany- I

(Practical of BB1141 & BB1241)

Credit 2

Contact Hours: 72

Practical of BB 1141 **36 Hrs**

Phycolcogy **16 hrs**

1. Make micro preparations of vegetative and reproductive structures of the types mentioned in the syllabus.
2. Identify the algal specimens up to the generic level and make labelled sketches of the specimens observed

Mycology **10 hrs**

1. A detailed study of structure and reproductive structures of types given in the syllabus and submission of record.
2. *Rhizopus, Saccharomyces, Penicillium, Xylaria, Peziza. Puccinnia. Agaricus* and *Cercospora*

Lichenology **4 hrs**

Make micropreparation of vegetative and reproductive parts of Usnea. Make sketches of the specimens observed.

Plant Pathology **6 hrs**

1. Identify the Diseases mentioned with respect to causal organism and symptoms
2. Students should be trained to prepare the fungicide Bordeaux mixture &Tobacco decoction.

Practical of BB1241 **36 Hrs**

Bryology **10hrs**

1. *Riccia* – Habit - Internal structure of thallus – V. S. of thallus through archegonia, antheridia and sporophyte
2. *Marchantia* –Habit- thallus T. S., thallus with Archegonial receptacle, Antheridial receptacle,Male receptacle V .S., Female receptacle e VS., T.S . of thallus through gemma, Sporophyte V. S .
3. *Polytrichum* – Habit, V. S. of archegonial cluster, V .S. of antheridial cluster, Sporophyte V. S.

Pteridology **12 hs**

1. *Psilotum* : External features , stem T .S . , synangium T. S .
2. *Lycopodium* : Habit, stem T. S. , stobilus V. S.
3. *Selaginella* : Habit , rhizophore T. S , stem T . S, axis with strobilus, V .S. of strobilus, Megasporophyll and microsporophyll.
4. *Equisetum* - Habit, rhizome and stem T .S. and V. S. of strobilus.
5. *Adiantum* - Habit, Petiole T. S., sporophyll T. S. , prothallus
6. *Marsilea* - Habit, Rhizome and petiole T. S., sporocarp T.S, V. S. & R.L .S.

Gymnosperms

Practical **10 hrs**

1 *Cycas* – seedling, coralloid root and coralloid root T. S., T. S. of leaflet and petiole, micro and mega sporophyll, male cone V. S., micro sporophyll T. S. , entire and V. S. of ovule.

2. *Pinus* - Branch of indefinite growth, spur shoot, T. S of old stem and needle R .L .S andT. L. S. of stem, male and female cone, V .S. of male and female cone.

3. *Gnetum* -: Habit, stem T. S (young and mature), leaf T. S, male and female strobilus, V. S. of male and female cone, ovule V. S. and seed

Plaeobotany **4 hrs**

1. Fossil pteridophytes – *Rhynia* Stem, *Lepidodendron, Lepidocarpon*.
2. Gymnosperm - *Lygenopteris*

Semester II
Core Course Vocational
BB1271 Microbial Metabolism, Genetics and Diseases
Credits: 3
Contact hours- 54 (T 36+ P 18)

Aim and Objective: This course is designed to get an in-depth knowledge in Microbial metabolism, microbial genetics, and microbial diseases. This knowledge is very important as far as Biotechnology is concerned. The students are expected to master all microbial related techniques to pursue studies in biotechnology.

Module I **12 Hrs**

Bacterial Metabolism

Introduction

Bacterial cell structure and Growth - Eukaryotic cells and prokaryotic cells, Glycocalyx, bacterial cell membranes, bacterial cell wall, cytoplasm, spores, organs of locomotion, chemotaxis in bacteria, ribosomes in bacteria, bacterial nucleus and chromosomes, bacterial nucleoid.

Bacterial Growth curve, Measurement of growth, factors affecting growth of bacteria.

Nutrition in bacteria-classification based on nutrition- autotrophic and heterotrophic organisms, Photosynthetic and chemosynthetic organisms- purple sulfur bacteria, Saprophytes and parasites-pathogenic parasites.

Anabolism of carbohydrates- Photosynthetic bacteria and cyanobacteria- photosynthetic pigments of bacteria, mechanism of photosynthesis in bacteria, carbon sources

Nitrogen Metabolism- Biological nitrogen fixation, symbiotic nitrogen fixation, components involved in the process of nitrogen fixation, Inorganic nitrogen metabolism, assimilation of inorganic nitrogen, Nitrogen cycle.

Energy production in bacteria- Energy and ATP, aerobic respiration, Glycolysis and tricarboxylic acid cycle, Electron transport and oxidative phosphorylation in Bacteria, catabolism of other carbohydrates.

Anaerobic respiration- Fermentation, alcohol fermentation by yeasts and bacteria, lactic acid fermentation , Methnogenic bacteria, Acetobacter and acetic acid fermentation.

Application of bacterial metabolism in industry and agriculture.

Module II **12 Hrs**

Bacterial genetics

Bacterial chromosome-

Transfer of genetic information in bacteria, Bacterial chromosomes- DNA, Plasmids, different types of plasmids- non-conjugative, mobilizable plasmids, resistance plasmids

Bacterial Mutation – Spontaneous mutation, induced mutations, Repair mechanisms, Transposable genetic elements in bacteria, overlapping genes,

Bacterial recombination:

Conjugation- Fertility factors, F+ and F- cells, F pili, High frequency recombination

Transformation- Griffith's effect, evidence of DNA as genetic material,

Transduction- general characteristics of bacteriophages, Lambda pahage-general structure, general multiplication in bacteria- lytic phase and lysogenic phase, bacterial recombination through transduction.

Phages and plasmids as vectors for genetic engineering,

Bacterial recombination and transferable drug resistance

Module III **12 Hrs**

Microbial Diseases of Humans

Airborne bacterial diseases – streptococcal; diseases, tuberculosis, Pneumococcal Pneumonia, *Klebsiella* Pneumonia,

Foodborne and waterborne bacterial diseases- Foodborne and waterborne intoxications- Botulism, Staphylococcal food poisoning;

Foodborne and waterborne infections- Typhoid fever, salmonellosis, Cholera, Shigellosis, *E.coli* Diarrheas, Brucellosis

Soilborne bacterial diseases- Anthrax, Tetanus, Leptospirosis,

Viral diseases of Humans- Pneumotropic viral diseases-Influenza, Adenoviral infections, Rhinoviral infections,

Dermatoviral diseases- Herpes simplex, chickenpox, Measles, Rubella,

Viscerotropic Viral diseases- yellow fecer, Dengu fever,

Neurotropic viral diseases- rabies, Polio,

Practical **18 Hrs**

1. Isolation and identification of E.coli from water samples and its identifications.
2. Screening of enterobacteria from water samples and its identification
3. Examination of microbial flora of the available soil and water samples,
4. Isolation of microorganisms from spoiled food materials
5. Isolation of starch degrading microorganisms- fungus and bacteria and the assay of the enzymes.
6. Isolation of lactobacillus from curd and its identification
7. Isolation of yeast from fruit samples and its culturing.
8. Examination of microbial flora of the skin
9. Examination of the microbial flora of mouth.
10. Environmental distribution of microorganisms
11. Gram staining of bacteria
12. Methylene blue stain
13. bacterial spore staining
14. Isolation and examination of Throat and nasopharyngeal cultures
15. Inhibition and destruction of microorganisms by antibacterial chemicals.
16. Production of exoenzymes by bacteria- isolation of alpha amylase producing bacteria and its culturing for the production of alpha amylase
17. Plaque-forming Bacteriophage

Suggested Readings

1. A Textbook of Microbiology – P. Chakraborthy, New central Book agency Pvt. Ltd, calcutta
2. Modern concept of Microbiology – D D Kumar, S Kumar; Vikas Publishing House Pvt. Ltd. New Delhi
3. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston,USA.
4. Introduction to Microbiology- J Heritage, E G V Evans, R A Killington; Cambridge University Press.
5. Microbiology – L M Prescott, Brown Publishers, Australia
6. Principles of Biotechnology – A. J. Nair Laxmi Publications New Delhi
7. Advances in Microbiology – J P Tewari, T N Lakhanpal, I Singh, R Gupta and B P Chanola; A P H Publishing Corporation, New Delhi.
8. Microbiology: Principles and Explorations – Jacquelyn G. Black. Prentice Hall, New Jersey.

Semester II
Core Course Vocational
BB1272 Biotechniques- I
(Practical of BB1171 & BB1271)
Credit 2
Contact hours: 36 (Practical hours of BB1171, BB1271)

Practical of BB1171

Experiments for Microbiology Practical 18 hrs

1. Use of microscope
2. Sterilization and aseptic techniques-preparation and sterilization of glassware and solutions
3. Media Preparation- Preparation of Luria-Bertani medium and Nutrient agar and sterilization (Broth and plates)
4. Isolation of pure culture from soil, water and air- a) Pour plate method, b) Streak plate method for isolation and colony purification.
5. Staining Methods of bacteria- Gram staining,
6. Acid fast staining and Negative staining.
7. Methylene blus stain
8. Bacterial spore staining
9. Growth of Bacteria in liquid media: Determination of kinetics of bacterial growth
10. Microscopic tests for bacterial motility
11. Serial dilution of bacterial cultures and plating to find out population density of microbes in a given sample.
12. Microbiological examination of various types of water samples including commercial and ordinary drinking water.
13. Microbial flora of the class laboratory
14. Microbial diversity of selected area or ecosystem.

Practical of BB1271

Experiments for Microbial Metabolism, genetics & diseases 18 hrs

15. Isolation of lactic acid bacteria from curd.
16. Lactic acid fermentation using lactose as substrate.
17. Isolation of yeast from fruit samples.
18. Isolation of starch degrading microorganisms- fungus and bacteria and the assay of the enzymes.
19. Production of alpha amylase by *Aspergillus niger*.
20. Fermentation techniques- Determination of substrate utilization with respect to growth kinetics
21. Isolation and identification of E.coli from water samples and its identifications.
22. Environmental distribution of microorganisms -Examination of microbial flora of the available soil and water samples,
23. Isolation of microorganisms from spoiled food materials
24. Isolation of lactobacillus from curd and its identification
25. Examination of microbial flora of the skin
26. Examination of the microbial flora of mouth.
27. Isolation and examination of Throat and nasopharyngeal cultures.
28. Inhibition and destruction of microorganisms by antibacterial chemicals.
29. Production of exoenzymes by bacteria- isolation of alpha amylase producing bacteria and its culturing for the production of alpha amylase
30. Plaque-forming Bacteriophage

Semester-III
Complementary Course
BB1331 Physiological aspects in Biochemistry
Credits 4
Contact Hours: 90 (Theory 54, Practical 36)

Aim and Objective: The course is intended to introduce the student to the basics of physiological aspects and to familiarize the students with the basics of human nutrition.

Module I **10 Hrs.**

Biochemistry of Blood: Physical properties and constituents of blood, types of blood cells- RBC, WBC, lymphocytes and platelets. Hemoglobin: Structure and function of hemoglobin, types of hemoglobin, abnormal hemoglobin, bile pigments formation, iron metabolism- absorption and transport. Blood clotting: Mechanism of blood clotting (Intrinsic and extrinsic pathway), clotting factors, anticoagulants, bleeding time, clotting time, hemopoesis, - blood forming organs, erythropoeisis, leucopoiesis. Blood groups: Classification, chemical basis for blood group specificity.

Module II **10 Hrs.**

Nutrition, Digestion and Absorption: Vitamins: Definition, classification- fat soluble and water soluble, source, chemical nature (without structure) functions of vitamins. Deficiency diseases. Nutrition: Caloric value, Caloric requirements, food energy, BMR- Carbohydrates, fats and proteins. Minerals: Outline the study of requirements, sources and functions of Ca, P, Mg, Na, K, Cl, I, Cu, Zn, Mn, and Fe. Digestion and absorption: Digestion and absorption of carbohydrates, proteins and fats, enzymes involved in digestion, and their action, composition and function of bile, enterohepatic circulation.

Module III **7 Hrs**

Detoxification: Metabolism of foreign compounds in the liver- oxidation, conjugation, hydrolysis, reduction, examples of each type. Liver function test. Structure of nephron, formation of urine, renal function test, renal threshold, constituents of urine.

Module IV **9 Hrs**

Respiration and Acid- Base balance**:** Respiration: Partial pressure of gases, chemical and physiological events affecting the diffusion of O_2 and CO_2, exchange of CO_2 during respiration, transport of gases in blood , carbonic anhydrase, chloride shift, oxygen dissociation curve, Bohr effect. Acid Base balance: Body water balance, buffers in blood, respiratory acidosis and alkalosis, metabolic acidosis and alkalosis.

Module V **9 Hrs**

Clinical Biochemistry and Endocrinology: Elementary study of: Diabetes, hypercholesterolemia, Hemophilia, Arthrosclerosis, Obesity and Jaundice.

Endocrinology: Organization of endocrine system, classification and functions of adrenalin, nor adrenalin, cortisone, Cortisol, corticosterone, deoxycorticosterone, Estradiol, thyroxine, TSH, ACTH, Gonadotropin, GH, Oxytocin and vasopressin, peptide hormones.(Structure not needed).

Module VI **9 Hrs**

Photosynthesis: Outlines of cyclic and non-cyclic photophoshorylation, photosystems I and II, Path of carbon in dark reaction-Calvin cycle, photorespiration and C_4 pathway (basic study), nitrogen cycle, nitrogen fixation-nitrogenase complex, nitrogen assimilation -role of glutamate dehydrogenase and synthetase (outline study only).

Practical **36 Hrs**

General reactions of Amino acids & Proteins

Amino acids-Tests- Solubility, Ninhydrin reaction, Xanthoproteic reaction, Millons test, Morners test, Glyoxalic acid test, Ehrlich's test, Nitroprusside test, Lead acetate, Test for Methionine, Aldehyde test, Sakaguchi reaction, Isatin test.

Proteins-Tests-Solubility, Ninhydrin reaction, Xanthoproteic reaction, Folin's, Lowry, Heat denaturation, TCA precipitation, Metal precipitation, Alcohol precipitation.

Demonstration experiments

Enzyme Assays

- Urease/Trypsin
- Kinetics of Urease / Trypsin (Effect of pH, substrate Concentration, enzyme concentration and temperature)
- Progress curve of Urease/Trypsin
- Digestion of carbohydrates –action of salivary amylase

Suggested Readings:

1. Advanced Text Book on Food and Nutrition, Vol I and II, Dr. MS Swaminathan.2nd edition. The Bangalore Printing and Publishing Co Ltd.
2. Arthur Vander, James Sherman, and Dorothy Luciano Vander et al.: Human Physiology: The Mechanism of Body Function, Eighth Edition © The McGraw-Hill Companies.
3. Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande, I.K International Pvt. LTD, New Delhi,
4. Hawk's Physiological Chemistry, Bernard L. Oser (ed) TATA McGraw Hill Publishing Company LTD, New Delhi p 10- 15.
5. Human Physiology (2001) by Andrew Davies, GH Blakeley, Cecil Kidd Publisher**:** Churchill Livingstone
6. Human Physiology (2001) by Bipin Kumar Publisher: Campus Books International
7. Human Physiology (2001) by KC Sawant Publisher: Dominant Publishers & Distributors
8. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi,
9. Plant Biochemistry by Hans-Walter Heldt Professor Em (3ed 2004) Publisher: Academic
10. Principles Of Biochemistry, 6e (1959) by Abraham White, Philip Handler Publisher: Tata McGraw-hill Publishing Company Limited
11. Textbook of Medical Biochemistry for Medical Students by DM Vasudevan and Sreekumari S. 5th edition, Japee Brothers, Medical Publishers,
12. Textbook of Medical Physiology, 11/e with Student Consult Access (2005) by Arthur C Guyton, John E Hall Publisher**:**

Semester III

Core Course

BB1341 Angiosperm Anatomy and Reproductive Botany

Credits 3

Contact Hours 72 (T 54+P 18)

Aim and objective: The course is aimed to bring the basic concept and understanding bout the anatomy of the flowering plants and its relation ship to the physiology and environmental adaptability of the plants. It also gives a basic idea on the reproduction and development of the flowering plants and its adaptation to suit to its environment.

Module- I

Angiosperm Anatomy **8 hrs**

1. Objective and scope of plant anatomy
2. Cell wall organization - Gross structure - Primary and secondary wall pits – plasmodesmata -microscopic and sub microscopic structures – Extra cell wall material. Non living inclusions of the cell – Reserve food - secretary products, by products.

Module –II **15 hrs**

3. Tissues – Meristems, Definition, Classification based on origin, position, growth patterns, functions.
4. Apical meristems & theories on apical organization - Apical cell theory, Histogen theory, Tunica -Corpus theory. Organization of root apex in dicots & monocots.
5. Permanent tissues – Definition, classification - simple, complex and secretory.
6. Tissue systems – Epidermal tissue systems-stomata, structure and functions, Ground tissue systems & vascular tissue systems. Different types of vascular arrangements

Module III **13 hrs**

7. Primary structure – Root, stem and leaf [Dicot & Monocot].
8. Secondary growth - Root and stem- cambium (structure and function) annular rings, heart wood and sap wood, tyloses, ring porous wood and diffuse porous wood, periderm formation-phellum, phellogen and phelloderm ; lenticels
9. Anomalous secondary growth - *Bignonia*, *Boerhaavia*, *Dracaena*.

Module IV

Reproductive Botany **14 hrs**

1. Introduction to angiosperm embryology with special reference to Indian embryologists.
2. Micro sporogenesis - structure and functions of wall layers.
3. Development of male gametophyte - Dehiscence of anther.
4. Megasporogenesis - Development of female gametophyte - Embryo sac - Development andtypes - Monosporic – *Polygonum* type, Bisporic - *Allium* type, Tetrasporic – *Adoxa* type.
5. Pollination - Fertilization - Barriers of fertilization - Germination of pollen grains – Double fertilization.
6. Structure of Embryo- Dicot [*Capsella*], Monocot [*Sagittaria*] Endosperm types, its development and functions.

Module V **4hrs**

Palynology: Pollen structure, pollen morphology, pollen allergy - viability test for pollen grains, Economic importance and its importance in taxonomy

Practical

Anatomy **18hrs**

1. Non living inclusions - Cystolith, Raphide, Sphaero-raphide, Aleurone grains.
2. Starch grains (Eccentric, concentric, compound)
3. Simple permanent tissue – Parenchyma, Chlorenchyma , Aerenchyma , Collenchyma and Sclerenchyma
4. Primary structure – Dicot stem: *Hydrocotyle, Eupatorium.*
5. Monocot stem: Grass and *Asparagus*.
6. Dicot root: Pea and *Limnanthemum*
7. Monocot root: *Colocasia* or any monocot root.
8. Secondary structure - Stem [Normal type]- *Vernonia*
9. Secondary structure - Root [Normal type]- *Tinospora, Ficus, Carica papaya*, or any normal type
10. Secretory tissue: Resin canal, Nectary, Latex vessel, Lysigenous and Schizogenous cavities. Laticifers – Articulated and non articulated.
11. Epidermal structures –Stomata.
12. Anomalous secondary thickening - *Bignonia, Dracaena, Boerhaavia*
13. Leaf anatomy - Dicot leaf: *Ixora*. Monocot leaf : Grass

Reproductive Botany

Students should be familiar with the structure of anther and embryo
(Permanent slides can be used)

Palynology

Study of pollen morphology of the following plants –*Hibiscus, Vinca, Balsm, Ixora, Crotalaria, Bougainvillea.* by Acetolysis method

Suggested Readings

1. Esau K. (1965) - Plant Anatomy – Wiley Eastern, New York.
2. Fahn A. (1985) - Plant Anatomy – Pergamon Press, Oxford.
3. Maheswari P. - Embryology of Angiosperms - Vikas Pub:
4. Nair PKK Palynology of Angiosperms
5. Pandey, B .P. (1997) - Plant Anatomy - S.Chand and co. New Delhi Biology - McGraw Hill Co, New York.
6. Prasad and Prasad (1972) Out lines of Botanical Micro technique, Emkay publishers, New Delhi Coutler E. G. (1969) Plant Anatomy – Part I Cells and Tissues – Edward Arnold, London.
7. Vashista .P. C (1984) - Plant Anatomy – Pradeep Publications – Jalandhar

Semester III
Core Course
BB1342 Environmental Studies and Phytogeography
Credits 3
Contact Hours 72 (T 54+P 18)

Aim and Objective: Students should acquire a basic understanding about the structure function of the environment and its interaction with the living systems. It will impart the geographical distribution of plants and the impact of human intervention in the environment and the delicate balance of various factors in the environment. It gives an idea about the various types of biodiversity and the influence of environmental pollution on the biodiversity.

Module I **14 hrs**

1. Definition- Scope and relevance to society and human environment. Need for public awareness

Natural Resources

2. Renewable and non-renewable resources. Natural resources and associated problems.
3. Forest resources: Use and over exploitation. Deforestation, Timber extraction, mining, dams and their effects on forests and tribal people.
4. Mineral resources: Use and exploitation, Environmental effects of extracting and using mineral resources.
5. Water resources: Use and over exploitation of surface water and ground water, floods, drought, conflicts over - water, dams, benefits and problems.
6. Food resources: World food problems, Changes caused by agriculture and over grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging and salinity.
7. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources.
8. Land resources: Land as a resource, land degradation, Man induced land slides, soil erosion and desertification.
9. Role of an individual in conservation of natural resources.
10. Equitable use of resources for sustainable life styles.
11. Ecosystems-Concept of an ecosystem- structure and function of an ecosystem-
12. Biotic and abiotic components- Energy flow in an ecosystem.
13. Ecological succession-Definition & types.
14. Food chains -Food web & ecological Pyramids.
15. Introduction- types, characteristic features, structure and functions of the following ecosystems.
    - A 1. Forest ecosystem 2. Grassland ecosystem 3. Desert ecosystem 4 .Aquatic ecosystems- Ponds, Streams, Rivers, Oceans, Estuaries.
    - B Morphological, anatomical& physiological adaptations of –Hydrophytes, Xerophytes, Halophytes, Epiphytes, Parasites.

Module II **14 hrs**

Biodiversity and its conservation

1. Introduction
2. Definition- genetic, species and ecosystem diversity.
3. Bio-geographical classification of India.
4. Value of bio-diversity: consumptive use, productive use, social, ethical, aesthetic and option values.
5. Biodiversity at global, National and local levels. India as mega-diversity nation.

6. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wild life, man-wild life conflicts.
7. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Ecological niche, eco-types & ecological indicators.

Environmental pollution

1. Definition causes, effects and control measures of – 1. Air pollution 2. Water pollution 3. Soil pollution 4. Marine pollution 5. Noise pollution 6. Thermal pollution 7. Nuclear hazards.
2. Solid waste Management: Causes, effects and control measures of urban and industrial wastes.
3. Role of an individual in prevention of pollution. Pollution case studies.
4. Disaster management : Floods, earthquake, cyclone and land slides

Module III **14 hrs**

Social issues and the Environment

1. From unsustainable to sustainable development. Urban problems related to energy. Water conservation, Rain water
2. Harvesting, water shed management. Resettlement and rehabilitation of people: its problems and concerns.
3. Environmental ethics: Issues and possible solutions.
4. Climate change. Global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.
5. Waste land reclamation. Consumerism and waste products.
6. Environment protection Act. Air [prevention and control of pollution] Act. Water [prevention and control of pollution] Act. Wildlife Protection Act. Forest conservation Act. Hill preservation Act.
7. Issues involved in enforcement of environmental legislation.
8. Public awareness .Forest Management.
9. Brief study of the major forests in India. Influence of forest on environment. Social forestry.
10. Mangrove vegetation of Kerala
11. Need of protection of mangrove vegetation .National parks &wildlife sanctuaries.

Module IV **6 hrs**

Human Population and the Environment.

1. Population growth, variation among nations.
2. Population explosion -Family welfare programme.
3. Environment and human health.
4. Human Rights. Intellectual Property Rights (IPR) Value of education. HIV/AIDS. Women and Child Welfare.
5. Role of information technology in Environment and human health.

Module V

Phytogeography **6 hrs**

Principles and vegetational types of India-tropical rain forest, sholas and deciduous forest-sand dunes and mangroves, scrub jungle, phytogeographical regions of India.

Practical **18 hrs**

1. Visit a local polluted site and documentation of major pollutants.
2. Study of ecological and anatomical modifications of Xerophytes, Hydrophytes, halophytes, epiphytes and Parasites.
3. Study of plant community by quadrat method.
4. Observation and study of different ecosystems mentioned in the syllabus.
5. Determination of frequency and density constituent of plant species in a terrestrial community through quadrate and transect (line, belt).
6. Phytogeographical regions of India.

Suggested Reading

1. Ahluwalia VK and Sunitha Malhotra 2009, Environmental science, Ane Books Pvt. Ltd.
2. Ambasht R.S. – Text book of Plant Ecology, Students and Friends & Co. Varanashi.
3. Chandoco.S Weaver and Clements – Plant Ecology, McGraw Hill Publications, New York.
4. Chapman J.L. (2006) Ecology-Principles and Application. Cambridge University Press India Pvt. Ltd
   Courses, Universities Press, University Grants Commission
5. Erach Bharucha – Text book of environmental Studies for undergraduate
6. Kumaresan B. – *Plant Ecology & Phytogeography* – Rastrogi Pub:
7. Misra SP and Pandey SN, 2009, Essential Environmental studies, Ane Books Pvt. Ltd.
8. Odum Eugene P – Fundamentals of Ecology, Edn. Philladephia & Saunders, Tokyo, Toppon.
9. Periasamy, K. – Elements of Plant Ecology, (M.K. Publications).
10. Prithipal Singh 2007- An Introduction to Biodiversity. Ane Books Pvt. Ltd
11. Sharma, P.D. – Elements of Ecology (Rastogi's Company Ltd., Publications).
12. The Geography of Flowering Plants - Good
13. Vashista P.C – Plant Ecology Edu. Vishali Publications.
14. Verma and Agarwal – Principles of Ecology, S. Chand and Co.
15. Verma, P. S. and V. K. Agrawal. 2004. *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology.* S. Chand & Company Ltd., New Delhi.

Semester III
Core Course Vocational
BB1371 Protista and Animal Diversity
Credits 4
Contact Hours 72 (Theory 54+Practical 18)

Aim and Objective: This course is designed in such a way to get a basic insight into the diversity of animals and its morphological and physiological adaptations suited to their ecosystems.

Module I
Classification of organisms **2 hrs**
Two kingdom system; Three kingdom system; Four kingdom system; Five kingdom system

Module II
Kingdom Protista **6 hrs**
Taxonomic positions, general features and classification.
Salient features of the following phyla with brief note on the examples cited
Phylum Rhizopoda. eg. *Entamoeba*
Phylum Dinoflagellata eg. *Noctiluca*
Phylum Parabasalia eg. *Trichonympha*
Phylum Ciliophora eg. *Paramecium*
Phylum Apicomplexa eg. *Plasmodium* (Detailed study of life history and pathogenecity)

Module III
Kingdom Animalia **6 hrs**
Salient features
Levels of organization: cellular, tissue, organ and system
Branches: Mesozoa, parazoa and eumetazoa
Eumetazoa: Radiata and bilateria
Bilateria : Protostomia and deuterostomia;
Acoelomata, pseudocoelomata and eucoelomata;
Schizocoela and enterocoela
Body segmentation , metamerism and pseudometamerism

Salient features of the following phyla; Classification up to classes; External features, adaptations and economic importance of examples cited

Phylum Porifera **2 h**r
Class Calcarea eg. *Sycon*
Class Hexactinellida
Class Demospongiae

Phylum Cnidaria (**Coelenterata**) **2 hrs**
Class Hydrozoa eg. *Obelia* (mention alternation of generation)
Class Scyphozoa eg. *Aurelia*
Class Anthozoa eg. Sea anemone

Phylum Platyhelminthes **2 hrs**

Class Turbellaria eg. *Bipalium*
Class Cestoda eg. *Taenia solium*
Class Trematoda eg. *Fasciola*

Phylum Nematoda **2 hrs**

Class Secernentea (Phasmida) eg. *Ascaris* and *Wuchereria*
Class Adenophorea (Aphasmida) eg. *Trichinella*

Phylum Annelida **2 hrs**

Polychaeta
Class Polychaeta eg. *Nereis*
Clitellata
Class Oligochaeta eg. Earthworm
Class Hirudomorpha eg. *Hirudinaria*

Phylum Mollusca **4 hrs**

Class Aplacophora eg. *Neomenia*
Class Monoplacophora eg. *Neopilina*
Class Bivalvia (Pelecypoda or Lamellibranchiata) eg. Pearl oyster
Class Polyplacophora eg. *Chiton*
Class Gastropoda eg. *Pila*
Class Cephalopoda eg. *Sepia*
Class Scaphopoda eg. *Dentalium*

Phylum Onychophora eg. *Peripatus*

Phylum Arthropoda **10 hrs**

Subphylum Trilobitomorpha
Class Merostomata eg. *Limulus*
Class Arachnida eg. Scorpion
Class Pycnogonida
Subphylum Mandibulata
Class Crustacea eg. Prawn (*Penaeus*)
Class Chilopoda eg. *Scolopendra*
Class Symphyla eg. *Scutigeralla*
Class Diplopoda eg. *Spirostreptus*
Class Pauropoda eg. *Pauropus*
Class Insecta eg. Cockroach (External characters, mouth parts; digestive system and nervous system)

Pests of:
(1) Paddy: *Leptocorisa acuta* and *Spodoptera mauritia*
(3) Stored foodgrains: *Sitophilus oryzae* and *Tribolium*

Phylum Echinodermata **4 hrs**

Class Asteroidea eg. Star fish
Class Ophiuroidea eg. Brittle star
Class Echinoidea eg. sea urchin
Class Holothuroidea eg. Sea cucumber
Class Crinoidea eg. Sea lily

Module III
Phylum Chordata **12 hrs**

Salient features of the phylum chordata; Classification upto classes; External features, adaptations and economic importance of examples cited.

Subphylum Urochordata eg. *Ascidia*
Subphylum Cephalochordata eg. *Amphioxus*
Subphylum Vertebrata
Superclass Agnatha eg. *Petromyzon*
Superclass Pisces eg. *Scoliodon*
Superclass Tetrapoda
Class Amphibia: Frog (*Rana*) - detailed study
eg. *Ichythyphis, Ambystoma* (mention axolotl larva) and *Rhacophorus*
Class Reptilia eg. *Calotes, Draco,*
Snakes: Identification of nonpoisonous and poisonous snakes
Nonpoisonous snakes eg. *Lycodon,*and *Ptyas*
Poisonous snakes eg. *Naja, Viper, Bungarus* and *Enhydrina*

Class Aves (Birds): Flightless birds. eg. *Ostrich*
Flying birds eg. Pigeon (morphology and different types of feathers); Peafowl
Flight adaptations of birds
Class Mammalia
eg. *Echidna,* kangaroo, Bat, *Loris,* Whale

Adaptations of aquatic mammals

Practicals **18 Hrs**

Identification and assigning the systematic position of the following specimens:

1. Protozoa - any 4.
2. Porifera - any 2.
   - study of gemmules.
3. Coelenterata - any 5.
4. Aschelminthes - any 2.
   - Ascaris T.S. of male and female.
5. Platyhelminthes - any 4 (adaptations of parasitic forms to be stressed)
6. Annelida - any 4.
7. Minor phyla - any 2.
8. Arthropoda - any 10 (including at least 5 insect pests of paddy/banana plant/stored food grains and 2 beneficial insects).
9. Mollusca - any 8 (including any 2 beneficial and any 2 harmful species).
10. Echinodermata - any 5 (representing one each from five different classes).
11. Prochordates - Ascidia, Branchiostoma (Amphioxus).
12. Pisces - any 8 (including 2 cartilaginous fishes, 2 fishes with accessory respiratory organs, 4 common food fishes).
13. Amphibia - any 3 (representing the orders Apoda, Urodela and Anura).

14. Reptilia - any 5 (includung at least one poisonous and one non-poisonous snake of Kerala).
15. Aves - any 3 common birds of Kerala (based on museum specimens or field observations).
16. Mammalia - any 5 (based on museum specimens or field observations).

Note:

Practical examinations shall give emphasis on systematics of animals. Questions on taxonomy may be designed so as to assess the student's knowledge in identification of organisms and assigning the systematic position down to the prescribed taxa. Students may be asked to arrange a miscellaneous group of animals into different taxonomic groups in chart form mentioning the salient features of the groups.

Suggested Readings

1. Ruppert E.E., Fox R and Barnes R.D. (2004) Invertebrate Zoology. Thomson Books/Cole. USA.
2. Ekambaranatha Ayyar, M. and Ananthakrishnan, T. N. A Manual of Zoology. Vol II
3. Jordan, E. L. and Verma, P. S. Invertebrate Zoology. S. Chand and Co.
4. Jordan, E. L. and Verma, P. S. Vertebrate Zoology. S. Chand and Co.
5. Kotpal, R. L. (2002) Modern Text Book of Zoology: Invertebrates. Rastogi Publishers.
6. Kotpal, R. L. (2002) Modern Text Book of Zoology: Vertebrates. Rastogi Publishers.
7. Mayer E. (1980) Principles of Systematic Zoology. Tata McGraw Hill Publishing Co. New Delhi.
8. Vijayakumaran Nair K, J. Jayakumar and P.I. Paul (2007) Protista and Animal Diversity. Academica.
9. Nayar, K. K. et al. General & Applied Entomology TMH
10. Nigam S. (1978) Invertebrate Zoology. S. Nagin and Co.
11. Hickman C.P. and Roberts L.S. (1994) Animal Diversity. Wm. C. Brown, Dubuque, IA
12. Venugopal Rao et al. (2003) Integrated Insect Pest Management. Agro.
13. The New Encyclopedia Britannica, Macropedia, (1998). Encyclopedia Britannica Inc., Chicago.
14. Green N.P.O., et al (2000) Biological Science. Cambridge University Press.
15. Outlines of Zoology- Ekambaranatha Iyer; Chand Publications, New Delhi
16. Brusca R.C. and Brusca G.J. (1990) Invertebrates. Sinauer Associates, Sunderland,MA.
17. Pearse V and Pearse J, Buchsbaum M and Buchsbaum R. (1987) Living Invertebrates Blackwell Scientific Publications, California.
18. Chandler, A.C. and Read. Parasitology.
19. Dhami, P. S. and Dhami, J. K. Invertebrate Zoology. R. Chand and Co.
20. Dhami, P. S. and Dhami, J. K. Vertebrate Zoology. R. Chand and Co.
21. Ekambaranatha Ayyar, M. and Ananthakrishnan, T. N. A Manual of Zoology. Vol I
22. Invertebrate Zoology- Chand publications, New Delhi
23. Manual of Zoology – Ekambaranatha Iyer; Chand Publications, New Delhi
24. Vertebrate Zoology - Chand Publications, New Delhi

Semester III

Core Course Vocational

BB1372 Animal Physiology and Anatomy

Credits 3

Contact Hours 54 (T 36 + P 18)

Aim and Objective: This course will give very fundamental and essential information about the anatomy and functioning of the various types of cell, tissues and organs in selected model organisms.

Module I **2 hrs**

Animal cell, Tissues, organs and organ systems

Module II **3hrs**

Nutrition: feeding mechanisms, digestion-types of digestion, basic mechanisms of digestion, digestive system and its function, Human digestive system

Module III **4 hrs**

Respiratory system- Respiration, types of respiration, cellular respiration- oxidation of glucose, Human respiratory system, pulmonary respiration

Module IV **5 hrs**

Circulatory system: Circulation, types of circulation- open and closed circulation,
Human circulatory system, Human Heart, heart beat;
Tissue fluid, Lymphatic system-comparison of blood and lymph

Module V **5 hrs**

Reproductive system- reproduction, types of reproduction- asexual, sexual and vegetative reproduction
Human reproductive system- gametogenesis, spermatogenesis, structure of human sperm, Oogenesis, Menstrual cycle, Human embryogenesis

Module VI **5 hrs**

Excretory system: Excretion and its significance, excretory products of body,
Excretory organs of invertebrates, excretory organs of vertebrates,
Nephrones- structure and function, Kidneys –structure and function, Formation of urine, Dialysis,
Accessory excretory organs- skin, its structure and function.

Module VII **4 hrs**

Bioregulatory system: Glands, Hormones, Endocrine glands and feedback mechanism

Module VIII **5 hrs**

Nervous system: Neurons- structure and function, nervous system of invertebrates and vertebrates, Human Nervous system

Module IX **3 hrs**

Skeletal and muscular system- Human skeleton and muscular system

Practical **18 hrs**

Minor Practicals

1. Nereis - parapodium.
2. Earthworm - body setae.
3. Earthworm - coelomocytes.
4. Cockroach - mouth parts.
6. Cockroach - salivary glands.
7. Prawn - appendages.
8. Fishes - different types of scales (placoid, ctenoid and cycloid scales).

Major practicals

1. Earthworm - nervous system.
2. Cockroach- alimentary canal.
3. Cockroach - nervous system.
4. Prawn - nervous system.

Osteology

1. Study of the disarticulated bones of frog and identification of the following bones: Limb bones, pectoral and pelvic girdles, typical vertebra, atlas, 8^{th} and 9^{th} vertebrae, urostyle.
2. Mammalian pectoral and pelvic girdles.

Suggested Readings

1. Arthur C. Guyton, Textbook of Medical Physiology, W.B.Suanders Co.
2. C.C. Chatterjee, Human Physiology Vol. 1 & 2 -; Medical Allied Agency
3. Chandler, A.C. and Read. Parasitology.
4. Dhami, P. S. and Dhami, J. K. Invertebrate Zoology. R. Chand and Co.
5. Dhami, P. S. and Dhami, J. K. Vertebrate Zoology. R. Chand and Co.
6. Ekambaranatha Ayyar, M. and Ananthakrishnan, T. N. A Manual of Zoology. Vol II
7. Ekambaranatha Ayyar, M. and Ananthakrishnan, T. N. A Manual of Zoology. Vol I
8. HT Yost , Cellular physiology, Prentice Hall
9. John B. West, Physiological Basis of Medical Practice, William & Wilkins
10. Jordan, E. L. and Verma, P. S. Invertebrate Zoology. S. Chand and Co.
11. Jordan, E. L. and Verma, P. S. Vertebrate Zoology. S. Chand and Co.
12. Kotpal, R. L. (2002) Modern Text Book of Zoology: Invertebrates. Rastogi Publishers.
13. Kotpal, R. L. (2002) Modern Text Book of Zoology: Vertebrates. Rastogi Publishers.
14. Mayer E. (1980) Principles of Systematic Zoology. Tata McGraw Hill Publishing Co. New Delhi.
15. Vijayakumaran Nair K, J. Jayakumar and P.I. Paul (2007) Protista and Animal Diversity. Academica.
16. William S Hoar General and Comparative physiology, Prentice Hall

Semester IV
Complementary Course
BB1431 Metabolism
Credits: 2
Contact Hours: 90 (Theory 54, Practical 36)

Aim and Objective: The course aims at providing an overview of energy production by explaining the general principles of cellular energy metabolism and schematizing the different metabolic pathways.

Module I
Metabolism of carbohydrates: Digestion of carbohydrates and absorption (outline study). Glycolysis- Reactions, fate of pyruvate, regulation of glycolysis, Gluconeogenesis-reaction pathway, reciprocal regulation of gluconeogenesis and glycolysis. Cori cycle. Pentose Phosphate Pathway- reactions, biological significance, regulation of pathway. Glycogen metabolism-glycogenesis, glycogenolysis, control of glycogen metabolism-allosteric and hormonal regulation. (Only pathway outlines without structures).

Module II
Metabolism of Lipids: Digestion and absorption of lipids (outline study). Scheme of β-oxidation, ATP yield in β-oxidation (Stearate & Palmitate as examples) and regulation. Basics of ω- and α-oxidation. Ketone body formation. Cytoplasmic system of fatty acid biosynthesis and regulation of the pathway. Essential fatty acids. Synthesis of Triacylglycerols (outline study). Outline study of biosynthesis of cholesterol and bile acids. Physiological functions of phospholipids (Structure of intermediates of metabolic pathway not required).

Module III
Metabolism of Aminoacids and Proteins: Zymogen activation of proteolytic enzymes of GI tract. Digestion of proteins and absorption of amino acids-role of glutathione cycle. Reactions involved in the metabolism of amino acids- deamination, transamination and decarboxylation-coenzymes involved in these reactions. Urea cycle.

Module IV
Bioenergetics: Redox reactions, redox potential and free energy, mitochondrial electron transport chain, coenzymes and prosthetic groups of respiratory chain enzymes- sites of ATP production, P/O ratio, inhibitors of electron transport chain, oxidative phosphorylation-chemiosmotic hypothesis (outlines only), uncouplers of oxidative phosphorylation. Formation of ATP- oxidative and substrate level phosphorylation. High energy compounds with structures (ATP, ADP, Creatine phosphate, 1, 3 bisphosphoglycerate, PEP etc.). Role of high energy phosphate groups.

Module V
Genetic aspects of Metabolism**:** DNA structure-nucleosomes, 30nm fibers and radial loops. Prokaryotic DNA replication-DNA polymerases, replication forks, Okazaki fragments and accessory proteins. Brief study of structure and types of RNA and their functions. Prokaryotic transcription process. Genetic code-properties of genetic code. Protein biosynthesis in prokaryotes-synthesis of aminoacyl tRNA, initiation-Shine Dalgarno sequence, elongation-aminoacyl tRNA binding, peptide bond formation, translocation followed by termination.

Practical **18 Hrs**

Quantitative Analysis of Amino acids and Proteins

Estimation of Tyrosine by Folin-Lowry method.
Estimation of Protein by Biuret method.
Estimation of Protein by Folin-Lowry method.
Estimation of Protein by Bradford's method.

.**Quantitative Analysis of Nucleic Acids**

Estimation of DNA by diphenylamine method.
Estimation of RNA by Orcinol method

Demonstration experiments

Enzyme Assays

- Urease/Trypsin
- Kinetics of Urease / Trypsin (Effect of pH, substrate Concentration, enzyme concentration and temperature)
- Progress curve of Urease/Trypsin
- Digestion of carbohydrates – action of salivary amylase

Suggested Readings

1. Lehninger Principles of Biochemistry, 4th Edition by David L. Nelson David L. Nelson Michael M. Cox Michael M. Cox (Author) , Publisher: W. H. Freeman; Fourth Edition (April 23, 2004)
2. E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen, A Text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 1974
3. Biochemistry (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc
4. Principles Of Biochemistry (1995) by Geoffrey L Zubay, William W Parson, Dennis E Vance Publisher: McGraw-Hill Book Company – Koga
5. Principles Of Biochemistry, 4/e (2006) by Robert Horton H , Laurence A Moran, Gray Scrimgeour K Publisher: Pearsarson
6. Biochemistry (2008) by Rastogi Publisher: McGraw Hill.
7. Plant Biochemistry by Hans-Walter Heldt Professor Em (3ed 2004) Publisher: Academic.
8. Text Book of Biochemistry, 5th edition by DM Vasudevan and Sreekumar S, JAYPEE Publishers, New Delhi.

Semester-IV
Complementary Course
BB1432 Practical Biochemistry
(Practical of BB1131, BB1231, BB1331, & BB1431)

Credits: 2
Contact Hours: 144 (4 x 36 + 144)

Practical of BB 1131 — 36 hrs

- Weighing in Chemical balance
- Preparation of solutions -percentage, molar & normal solutions, dilution from stock solution etc.
- Demonstration of dialysis
- Demonstration of PAGE
- Demonstration of Paper Chromatography
- Demonstration of Thin Layer Chromatography
- Colorimetry and Spectrophotometry techniques
- Verification of Beer Lambert's law
- Verification of molar extinction coefficient of any known compound

General reactions of Carbohydrates

Qualitative analysis of Carbohydrates.

Carbohydrates-Glucose, Fructose, Galactose, Xylose, Sucrose, Maltose, Lactose, Starch & Dextrin

***Tests*-** Molisch's test, Anthrone test, Fehling's test, Benedict's test, Picric acid test, Barfoed's test, Bial's test, Seliwanoff's test, Foulger's test, Phloroglucinol test, Mucic acid test, Iodine test, Hydrolysis of Sucrose and Starch, Osazone test.

Quantitative Analysis of carbohydrates

Estimation of glucose by Nelson-Somogyi method
Estimation of reducing sugar by anthrone method.
Estimation of pentose by Orcinol method.
Estimation of ketose by Roe-Papedopaulose method.

Practical of BB 1231 — 36 hrs

Qualitative analysis of Lipids

Fatty acids: Stearic acid, Oleic acid.
Tests- Solubility, Translucent spot tests, Test for Unsaturation

Glycerol
Tests- Acrolein, Solubility.

Triglycerides
Tests-Solubility, Saponification, Translucent spot test

Cholesterol
Tests- Solubility, Salkowski reaction, Liebermann-Burchard reaction

Quantitative Analysis of Lipids

Estimation of Cholesterol by Carr-Drecktor method.
Estimation of Cholesterol by Zak's method.

Determination of Acid Value.
Determination of Saponification value.
Determination of Iodine number of oil

Practical of BB 1331 **36 Hrs**

Amino acids and Proteins

Qualitative analysis of Amino acids and Proteins

Amino acids- (Tyrosine, Glycine, Tryptophan, Histidine, Arginine, Cysteine, Cystine, Proline, Methionine) (single components only need be given)

Tests- Solubility, Ninhydrin reaction, Xanthoproteic reaction, Millons test, Morners test, Glyoxalic acid test, Ehrlich's test, Nitroprusside test, Lead acetate, Test for Methionine, Aldehyde test, Sakaguchi reaction, Isatin test

Proteins-Ovalbumin and Casein

Tests-Solubility, Ninhydrin reaction, Xanthoproteic reaction, Folin's test, Lowry's test, Biuret test, Heat denaturation, TCA precipitation, Metal precipitation, Alcohol precipitation.

Practical of BB1431 **36 hrs**

Quantitative Analysis of Amino acids and Proteins

Estimation of Tyrosine by Folin-Lowry method.
Estimation of Protein by Biuret method.
Estimation of Protein by Folin-Lowry method.
Estimation of Protein by Bradford's method.

.**Quantitative Analysis of Nucleic Acids**

Estimation of DNA by diphenylamine method.
Estimation of RNA by Orcinol method

Demonstration experiments

Enzyme Assays

- Urease/Trypsin
- Kinetics of Urease / Trypsin (Effect of pH, substrate Concentration, enzyme concentration and temperature)
- Progress curve of Urease/Trypsin
- Digestion of carbohydrates – action of salivary amylase

Suggested Readings

1. Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande (ed), I.K International Pvt. LTD, New Delhi ISBN 81-88237-41-8.
2. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9.
3. Standard Methods of Biochemical Analysis, S. K. Thimmaiah (Ed), Kalyani Publishers, Ludhiana ISBN 81-7663-067-5.
4. Hawks Physiological Chemistry, Bernard L.Oser (ed).TATA McGRAW Hill Publishing Company LTD, New Delhi.
5. ES West, WR Todd, HS Mason and JT van Bruggen. A text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 1974.

Semester IV

Core Course

BB1441 Horticulture, Mushroom Cultivation & Marketing

Credits: 2

Contact hours: 72 (T 54+ P 18)

Aim and Objective: This course will give an idea about the application of biological science particularly plant science in business generations and self employment. This focuses on the horticulture, Mushroom cultivation, its marketing and also in forest depended economy and its impact on society.

Horticulture

Module I **12 hrs**

Introduction

Divisions of horticulture, Importance and scope of horticulture., Principles of garden making, Types of pots and containers, Potting mixture and potting media – soil, sand, peat, sphagnum moss, vermiculite, Soil types, Soil preparation, Irrigation methods, Hydroponics

Propagation methods- Cuttings, Layering – Air layering, Ground layering (Tip, Trench and Compound)

Budding – T- budding, Grafting – Approach grafting, Bridge grafting, whip and tongue grafting. , Garden tools and implements

Manures and fertilizers- Farmyard manure, compost, vermicompost and biofertilizers. Chemical fertilizers – NPK., Time and application of manures and fertilizers. Foliar sprays

Module II **14 hrs**

Components of Garden- Lawns and landscaping, Trees, shrubs and shrubberies, climbers and creepers, Flower beds and borders, ornamental hedges, edges, Drives, roads, walks and paths, Carpet beds, topiary, trophy, rockery, Conservatory or green houses

Indoor garden, Roof garden, Bonsai

Flower Arrangement- Containers and requirements for flower arrangements, Free style, Shallow and Mass arrangement, Japanese – Ikebana, Bouquet and garland making, Dry flower arrangement

Harvesting- Methods, Storage, Marketing of Fruits, vegetables and flowers, Preservation and processing of fruits and vegetables

Module III **10 hrs**

Growth regulators in horticulture- Rooting hormones, Growth promoters, Flower induction, Parthenocarpy

Plant protection- Common diseases of fruits and vegetable crops, Weedicides, Fungicides, Pesticides

Practical **18 hrs**

- Propagation methods- Layering, Budding and grafting
- Flower arrangement

Field Study: Visit to a Botanical garden under the guidance of the teacher is encouraged.

Module IV

Mushroom Cultivation and Marketing

10 hrs

History and introduction: Edible mushrooms and Poisonous mushrooms.
Systematic position, morphology, distribution, structure and life cycle of *Agaricus* and *Pleurotus.*
Nutritional value, medicinal value and advantages- types- milky, straw, button and poisonous mushrooms
Cultivation: Paddy straw mushroom – substrate, spawn making. Methods – bed method, polythene bag method, field cultivation.
Oyster mushroom cultivation –Substrate, spawning, pre-treatment of substrate. Maintenance of mushroom.
Cultivation of white button mushroom – Spawn, composting, spawning, harvesting.

Module V **8 hrs**

- Diseases- Common pests, disease prevention and control measures.
- Processing - Blanching, steeping, sun drying, canning, pickling, freeze drying.
- Storage – short term and long tem storage.
- Common Indian mushrooms.
- Production level, economic return, Foreign exchange from Mushroom cultivating countries and international trade.

Field Study: Visit to a mushroom cultivating Laboratory, Collection and Identification of Mushrooms

Suggested Readings

1. Anil Kumar Dhiman. 2003. Sacred plants and their medicinal uses. Daya publishing house, New Delhi.
2. Arora J.S 1990, Introductory Ornamental Horticulture, Kalyani Publications
3. Bailey L.H 1901, The Standard Cyclopaedia of Horticulture Volume 1,2 and 3, Macmillan Publications.
4. Bose T.K and Mukerjee D 1987, Gardening in India, Oxford Book House
5. Chauhan V.S, Vegetable Production in India, RamPrasad & Sons
6. Gupta P.K. Elements of Biotechnology.
7. Harander Singh. 1991. Mushrooms- The Art of Cultivation- Sterling Publishers.
8. Indian Journal of Mushrooms**.** Published by I.M.G.A. Mushroom Research Laboratory. College Agriculture, Solan
9. Kaul T N 2001. Biology and conservation of mushrooms. Oxford and IBH publishing company N.Delhi
10. Kumar N 1989, lntroduction to Horticulture, Rajalakshmi Publications
11. Manibhushan Rao K 1991, Text Book of Horticulture, Macmillan Publications
12. Pandey B P 1996. A textbook of fungi. Chand and company N Delhi.
13. Sharma P.D. 2004. Ecology and Environment. Rastogi publications, Meerut
14. Shujnrnoto, 1982, The Essentials of Bonsai, David & Charles, Newton

Semester IV
Core Course
BB1442 Cell Biology, Plant Breeding and Evolutionary Biology
Credits 2
Contact hours: 72 (Theory 54 + Practical 18)

Aim and Objective: This course will provide a basic understanding in cell biology, plant breeding and evolution, which is needed as a student of biology and can supplement in understanding and pursuing studies in Biotechnology.

Module-I
Cell biology **30 hrs**

1. History and progress of cell biology
1. Ultra structure and functions of the cell components and organelles (A brief account only)-Cell wall; The cell membrane, Endoplasmic reticulum, Ribosomes, Golgi apparatus, Lysosomes, Peroxisomes, Vacuole, Mitochondria, Chloroplast & Nucleus
3. The chromosomes- Chromosome morphology- Eukaryotic chromosomes and its molecular organization. Chromatin - composition and structure; hetero chromatin and euchromatin; Chemical organization .Nucleoproteins – histones and non – histones. Nucleosome model of DNA organization.
4. Special types of chromosomes- Salivary gland, Lamp brush and B chromosomes
5. Variation in Chromosome number (Numerical aberrations)- anueploidy and Euploidy- haploidy , polyploidy- significance
6. Variation in Chromosome structure (Structural aberrations) - deletion, duplication, inversion and translocation; significance.
7. Mitosis and Meiosis: Transmission of genetic information - cell cycle : Significance of mitosis and meiosis

Module II **14 hrs**
Plant breeding

1. **Introduction**, objectives in plant breeding**.**
2. **Plant introduction**. Agencies of plant introduction in India, Procedure of introduction - Acclimatization - Achievements.
3. **Selection** - mass selection, pure line selection and clonal selection. Genetic basis of selection methods.
4. **Hybridization**: Procedure of hybridization, inter generic, inter specific, inter varietal hybridization with examples. Composite and synthetic varieties.
5. **Heterosis** and its exploitation in plant breeding.
6. **Mutation breeding** – method – achievements in India.
7. **Breeding for pest**, diseases and stress resistance.

Module -III
Evolutionary Biology **10 hrs**

1. Progressive and Retrogressive evolution.
2. Parallel and Convergent evolution.
3. Micro and Macro evolution.

4. Theory of Lamarck, Wiesman and De Vries, Darwinism, Neo- Darwinism
5. Isolation, Mutation, Genetic drift, Speciation
6. Variation and Evolution – Hybridization and Evolution – Polyploidy and evolution – Mutation and evolution.

Practical **18 Hrs**

1. Study of Microscopes- different magnification of light microscopes
2. Examination of different types of cells- single celled and multicellular systems
3. Make acetocarmine squash preparation of onion root tip and to identify different stages of mitosis
4. Determination of Mitotic Index
5. Make squash preparation of the flower buds of any of the following plants. *Rhoeo, Capsicum* (To identify Meiosis)
6. Preparation of Karyotype
7. Microscopical examination and assessment of starch granules from potato, rice, tapioca etc
8. Fixation of specimens for cytological studies, Preparation of cytological stains like acetocarmine and safranin.

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Suggested Readings

1. Aggarwal SK (2009) Foundation Course in Biology, 2nd Edition, Ane Books Pvt. Ltd
2. Allard RW (1960) Principles of Plant Breeding. John willey and Sons. Inc. New York
3. BD Singh (2003) Plant Breeding. Kalyani Publishers
4. Cohn, N.S. (1964) Elements of Cytology. Brace and World Inc, New Delhi
5. Darnel, J.Lodish, Hand Baltimore, D. (1991) Cell and molecular biology. Lea and Fibiger, Washington.
6. De Robertis, E.D.P and Robertis, E.M.P (1991) Cell and molecular biology Scientific American books.
7. Dobzhansky, B (1961) Genetic and origin of species, Columbia university Press New York
8. Durbin (2007) Biological Sequence Analysis. Cambridge University Press India Pvt. Ltd
9. Gerald Karp (1985) Cell biology, Mc Graw Hill company..
10. Lewin, B, (1994) Genes, Oxford University Press, New York.
11. Lewis, W.H (1980) Polyploidy. Plenum Press, New York.
12. Nicholl T (2007) An Introduction to Genetic Engineering, Cambridge University Press India Pvt. Ltd
13. Roy S.C. and Kalayan kumar De (1997) Cell biology. New central Boos Calcutta
14. Sandhya mitra,(1998)Elements of molecular biology. Macmillan, India Ltd.
15. Sharma JR (1994) Principles and Practices of Plant Breeding. Tata McGraw-Hill Pub. Co. New Delhi
16. Sharma, A.K and Sharma a (1980) Chromosome technique Theory and practice, Aditya Books, New York
17. Swanson, C.P (1957) Cytology and Genetics. Englewood cliffs, NewYork.
18. Taylor (2008) Biological Sciences. Cambridge University Press India Pvt. Ltd
19. Twymann, R.M. (1998) Advanced molecular biology Viva books New Delhi.
20. Veer Bala Rastogi (2008), Fundamentals of Molecular Biology Ane Books Pvt. Ltd

Semester IV
Core Course
BB 1443 Practical Botany II
(Practical of BB1341, BB1342, BB1441 & BB1442)
Credits: 2
Contact Hours: 72

BB1341 Angiosperm Anatomy and Reproductive Botany 18 Hrs

Anatomy

1. Non living inclusions - Cystolith, Raphide, Sphaero-raphide, Aleurone grains.
2. Starch grains (Eccentric, concentric, compound)
3. Simple permanent tissue – Parenchyma, Chlorenchyma , Aerenchyma , Collenchyma and Sclerenchyma
4. Primary structure – Dicot stem: *Hydrocotyle, Eupatorium.*
5. Monocot stem: Grass and *Asparagus*.
6. Dicot root: Pea and *Limnanthemum*
7. Monocot root: *Colocasia* or any monocot root.
8. Secondary structure - Stem [Normal type]- *Vernonia*
9. Secondary structure - Root [Normal type]- *Tinospora, Ficus, Carica papaya*, or any normal type
10. Secretory tissue: Resin canal, Nectary, Latex vessel, Lysigenous and Schizogenous cavities. Laticifers – Articulated and non articulated.
11. Epidermal structures –Stomata.
12. Anomalous secondary thickening - *Bignonia, Dracaena, Boerhaavia*
13. Leaf anatomy - Dicot leaf: *Ixora*. Monocot leaf : Grass

Reproductive Botany

Students should be familiar with the structure of anther and embryo
(Permanent slides can be used)

Palynology

Study of pollen morphology of the following plants –*Hibiscus, Vinca, Balsm, Ixora, Crotalaria, Bougainvillea.* by Acetolysis method

BB1342 Environmental Studies and Phytogeography

18 hrs

1. Visit a local polluted site and documentation of major pollutants.
2. Study of ecological and anatomical modifications of Xerophytes, Hydrophytes, halophytes, epiphytes and Parasites.
2. Study of plant community by quadrat method.
3. Observation and study of different ecosystems mentioned in the syllabus.
4. Determination of frequency and density constituent of plant species in a terrestrial community through quadrate and transect (line, belt).
5. Phytogeographical regions of India.

BB1441 Practical

Practical of Horticulture, Mushroom Cultivation & Marketing 18 hrs

1. Familiarization and use of tools in Horticulture
2. Practice of Horticultural methods –
3. Cuttings , Layering – Air layering, Ground layering
4. Budding – T- budding, Grafting – Approach grafting, Bridge grafting, whip and tongue grafting. , Garden tools and implements
5. Preparation of Farmyard manure, compost, vermicompost and biofertilizers.
6. Flower arrangement
7. Study of the Common Indian mushrooms- *Agaricus* and *Pleurotus*
8. methods of cultivation of selected edible mushrooms using paddy straw as substrate

Field Study: Visit to a Botanical garden under the guidance of the teacher is encouraged.
Field Study: Visit to a mushroom cultivating Laboratory

BB1442 Cell Biology, Plant Breeding and Evolutionary Biology 18 Hrs

1. Study of Microscopes- different magnification of light microscopes
2. Examination of different types of cells- single celled and multicellular systems
3. Make acetocarmine squash preparation of onion root tip and to identify different stages of mitosis
4. Determination of Mitotic Index
5. Make squash preparation of the flower buds of any of the following plants. *Rhoeo, Capsicum* (To identify Meiosis)
6. Preparation of Karyotype
7. Microscopical examination and assessment of starch granules from potato, rice, tapioca etc
8. Fixation of specimens for cytological studies, Preparation of cytological stains like acetocarmine and safranin.

Semester IV
Core Course Vocational
BB1471 Molecular Biology
Credits 3
Total contact hours 72 (Theory 54 + Practical 18)

Aim and Objective: Molecular biology is basis of modern biology and biotechnology. This course imparts a very essential foundation for the proper understanding of life at molecular level, which is essential for further studies related to genetic engineering, immunology and other modern applied aspects of biology.

Module I **8 hrs**

Introduction

History and significant discoveries in molecular biology,

Molecular basis of life, Experiments demonstrating DNA as the genetic material,

Structure of DNA, replication of DNA – both prokaryotic and eukaryotic, enzymes of DNA replication

Module II **8 hrs**

Genes

Structure of prokaryotic gene: operon, organization of operon, prokaryotic mRNA and its translation, polysomes.

Eukaryotic genes: structure of a gene, reading frame, and regulatory sequences, promoters and enhancers

Module III **12 hrs**

Gene expression:

Transcription- transcription products, types of RNA-mRNA, tRNA, rRNA and small nuclear RNA (snRNA);

Eukaryotic transcription, post-transcriptional modification of mRNA,

Translation- translation of prokaryotic and eukaryotic mRNA, different stages of protein synthesis,

Genetic code: properties of genetic code, codon assignment, start codon and termination codons

Module IV **12 hrs**

Gene regulation: prokaryotic gene regulation, regulation of operon, (lac, his and trp operon), catabolic repression;

Regulation of eukaryotic gene expression, level of control of gene expression, transcriptional factors, regulation of RNA processing, mRNA translation, mRNA degradation and protein degradation control, post translational modification of proteins.

Module V **8 hrs**

Eukaryotic chromosomes- molecular organization, nucleosomes, Insertional elements and transposons, different types of transposons

Module VI **6 hrs**

Cytoplasmic genome – mitochondrial DNA-structure and important genes chloroplast DNA – structure, important genes and its expression

Practical 18 hrs

Experiments for Molecular biology

1. Instruments and equipments used in molecular biology and rDNA techniques.
2. Isolation of Genomic DNA
3. Examination of the purity of DNA by agarose gel electrophoresis.
4. Quantification of DNA by UV-spectrophotometer
5. Isolation and purification of plasmid DNA
6. Agarose gel analysis of plasmid DNA
7. Restriction digestion of plasmid DNA

Suggested Readings

1. Applied Molecular genetics – R L Miesfeld; Wiley.Liss , New Delhi.
2. Basic Biotechnology- A. J. Nair, Laxmi Publications, New Delhi
3. Essential molecular Biology- A practical Approach, T A Brown; Oxford, New York
4. Gene VIII- Benjamin Lewin; Offord University Press.
5. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston,USA.
6. Introduction to Molecular biology- P. Paolella; Mc Graw Hill, New York
7. Molecular Biology of the gene – Watson, Baker, Bell Gann, Lewinw, Losick; Pearson Education Pvt.Ltd, New Delhi
8. Molecular cell biology H S Bhamrah; Anmol Publications Pvt. Ltd., New Delhi.
9. PCR 3 - Practical Approach – C. Simon Hearington & John J O'Leary; Oxford, New York
10. Principles of Gene manipulation- R.W.Old & S.B. Primrose; Blackwell Scientific Publications

Semester IV
Core Course
BB1472 Immunology
Credits-2
Contact hours 54 (Theory 36+ Practical 18)

Aim and Objective: To give a basic training to the students of Biotechnology on immune system, immunology and immunology related techniques. Training in this course will create an interest in immunology and is essential for further studies in Biotechnology.

Module I **3 hrs**

The Human Immune System: Organs and cells of immune system

Module II **6 hrs**

Historical perspective of immunology:
Immune system and immunity, innate and specific or acquired immunity,
Immune system- organs, tissues and cells involved in immunity, Humoral immunity and cell mediated immunity, antigens, antibodies, immunogens, haptens.

Module III **6 hrs**

Immunoglobulins:
Antibody structure in relation to function and antigen binding: types of antibodies and their structures: isotypes, allotypes and idiotypes.

Module IV **7 hrs**
Measurment of antigen
Antibody-antigen interaction, antigen-antibody reactions, agglutination, immuno-diffusion, immuno-electrophoresis, ELISA, RIE, production of polyclonal and monoclonal antibodies, hybridoma technology,

Module V
Immunoglobulin gene **6 hrs**
Genetic basis of antibody diversity; effect of T cell functions
Immunity to infections of diseases: vaccines - attenuated and recombinant vaccines, vaccination.

Module VI **4 hrs**
Antibodies in targeting therapeutic agents- therapeutic antibodies

Module VII **4 hrs**
Autoimmunity and autoimmune diseases: Hashimoto's thyroiditis; Myasthenia gravis; Rheumatoid Arthritis, Pernicious anemia, Asthma.

Experiments for Immunology Practical **18 hrs**

1. Immune cells –observation by staining and cell counting
2. Separation of immune cells from lymphoid organs of lab animals / blood.
3. Blood grouping –Determination of blood groups
4. Agglutination tests and immunological precipitation
5. Neutralization and complement fixation reaction
6. Demonstration of Radio immunoassay and ELISA
7. Demonstration of Immuno-electrophoresis

Suggested Readings

1. An Introduction to Immunology – C V Rao, Narosa Publishing House, New Delhi
2. Basics of Biotechnology- A J Nair; Laxmi Publications, New Delhi
3. Immunology – Joshi, Osama; AgroBotanica, New Delhi
4. Immunology – R A Goldsby, T J Kindt, B A Osborne, Janis Kuby; W H Freeman & Company, New York
5. Instant Notes in Immunology – P M Abbas, A H Lichtman, M W Fanger; Viva Books Pvt.Ltd, New Delhi.
6. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston,USA.
7. Principle Cellular and Molecular Immunology- Jonathan M Austyn 7 Kathryn J Wood; Oxford, New York

Semester IV
Core Course Vocational
BB1473 Biotechniques II
(Practical of BB1371, BB1372, BB1471 & BB1472)

Credits: 2
Contact Hrs: 72
(Practical Hours of the above courses)

Practical of **BB1371**
Protista and Animal Diversity 18 hrs

Identification and assigning the systematic position of the following specimens:

1. Protozoa - any 4.
2. Porifera - any 2.
   - study of gemmules.
3. Coelenterata - any 5.
4. Aschelminthes - any 2.
   - Ascaris T.S. of male and female.
5. Platyhelminthes - any 4 (adaptations of parasitic forms to be stressed)
6. Annelida - any 4.
7. Minor phyla - any 2.
8. Arthropoda - any 10 (including at least 5 insect pests of paddy/banana plant/stored food grains and 2 beneficial insects).
9. Mollusca - any 8 (including any 2 beneficial and any 2 harmful species).
10. Echinodermata - any 5 (representing one each from five different classes).
11. Prochordates - Ascidia, Branchiostoma (Amphioxus).
12. Pisces - any 8 (including 2 cartilaginous fishes, 2 fishes with accessory respiratory organs, 4 common food fishes).
13. Amphibia - any 3 (representing the orders Apoda, Urodela and Anura).
14. Reptilia - any 5 (includung at least one poisonous and one non-poisonous snake of Kerala).
15. Aves - any 3 common birds of Kerala (based on museum specimens or field observations).
16. Mammalia - any 5 (based on museum specimens or field observations).

Note:

Practical examinations shall give emphasis on systematics of animals. Questions on taxonomy may be designed so as to assess the student's knowledge in identification of organisms and assigning the systematic position down to the prescribed taxa. Students may be asked to arrange a miscellaneous group of animals into different taxonomic groups in chart form mentioning the salient features of the groups.

Practical of BB 1372
Animal Physiology and Anatomy **18 hrs**

Minor Practicals

1. Nereis - parapodium.
2. Earthworm - body setae.
3. Earthworm - coelomocytes.
4. Cockroach - mouth parts.
6. Cockroach - salivary glands.
7. Prawn - appendages.
8. Fishes - different types of scales (placoid, ctenoid and cycloid scales).

Major practicals

1. Earthworm - nervous system.
2. Cockroach- alimentary canal.
3. Cockroach - nervous system.
4. Prawn - nervous system.

Osteology

1. Study of the disarticulated bones of frog and identification of the following bones: Limb bones, pectoral and pelvic girdles, typical vertebra, atlas, 8^{th} and 9^{th} vertebrae, urostyle.
2. Mammalian pectoral and pelvic girdles.

Practical of BB1471
Experiments for Molecular biology Practical **18 Hrs**

1. Instruments and equipments used in molecular biology and rDNA techniques.
2. Isolation of Genomic DNA
3. Examination of the purity of DNA by agarose gel electrophoresis.
4. Quantification of DNA by UV-spectrophotometer
5. Isolation and purification of plasmid DNA
6. Agarose gel analysis of plasmid DNA
7. Restriction digestion of plasmid DNA

Practical of BB1472
Experiments for Immunology Practical **18 hrs**

1. Immune cells –observation by staining and cell counting
2. Separation of immune cells from lymphoid organs of lab animals / blood.
3. Blood grouping –Determination of blood groups
4. Agglutination tests and immunological precipitation
5. Neutralization and complement fixation reaction
6. Demonstration of Radio immunoassay and ELISA
7. Demonstration of Immuno-electrophoresis

Semester V

Core Course

BB1541 Plant Physiology

Credit 4

Contact Hours 108 (Theory 72 + Practical 36)

Aim: To give basic information on plant physiology and the related biochemical and biophysical aspects to the students of Biotechnology. This course will equip the students to understand the functions of the plant system on biophysical and biochemical approach.

Module I **3 Hrs**

Introduction to plant physiology- Physiological processes, their significance other applications

Module II **10 Hrs**

Water relations of Plants

Water absorption

a. Importance of water to plants- the physical and chemical properties of water.
b. Organs of absorption—root and root hairs.
c. Membranes- permeable, differentially permeable and impermeable.
d. Physical aspects of absorption, imbibition, diffusion and osmosis.
e. Plant cell as an osmotic system, osmotic pressure, turgor pressure, wall pressure and diffusion pressure deficit, water potential osmotic potential, pressure potential matrix potential Plasmolysis and its significance.
f. Mechanism of absorption of water—active and passive absorption -root pressure.

Ascent of Sap

Vital theories.
Physical theories—Cohesion—tension theory.
Loss of water from plants:

a. Transpiration- cuticular, lenticular and stomatal mechanism.
b. Factors affecting transpiration
c. Significance of transpiration.
d. Guttation.
e. Water stress and its physiological significance.

Module III **6 Hrs**

Mineral Nutrition

Gross chemical analysis of plant-—Essential and non-essential elements
Criteria of essentiality of elements, Essential elements: major end minor.
Role of essential elements their deficiency diseases.
Culture methods: Solution culture, Sand culture, Hydroponics, Aeroponics, Foliar nutrition
Soil as source of nutrients
Mechanism of mineral absorption
(a) Passive absorption -ion exchange -Donnan equilibrium.
(b) Active absorption — Carrier concept

Module IV **10 Hrs**

Enzymes

1 .Structure- coenzymes, cofactor
2. Properties
3. Nomenclature
4. Classification - IUB system
5. Enzyme action
6. Competitive inhibition and non competitive inhibition

Module V **10 Hrs**

Photosynthesis

1. Significance and general equation
2. Photosynthetic apparatus and pigment systems-chromatographic techniques for the separation of photosynthetic pigments
3. Raw materials of photosynthesis
4. Mechanism

a) Light reaction

i) Radiant energy and its effects on chlorophyll pigments
ii) Cyclic and non-cyclic photophosphorylation
iii) Source of oxygen liberated
iv) Hill reaction

b)Dark reaction

i) Trace the path of carbon in photosynthesis
ii) Calvin cycle
iii C3 and C4 plants. CAM plants .
iv) Photorespiration
v) Factors affecting photosynthesis. Law of limiting factors

Module VI **8 Hrs.**

Respiration

1. Definition and general equation
2. Significance
3. Respiratory substrates
4. Mechanism-Glycolysis, Kerb's cycle, terminal oxidation
5. Oxidative pentose phosphate path way
6. Factors affecting respiration
7. Anaerobic respiration-Alcoholic fermentation and lactic acid fermentation
8. Energy relations — aerobic and anaerobic respiration
9. Respiratory quotient and its significance

Module VII **8 Hrs.**

Nitrogen metabolism

1. Source of nitrogen
2. Nitrification, Denitrification and Ammonification
3. Symbiotic nitrogen fixation
4. Rotation of crops
5. Nitrogen Cycle

Module VIII **6 Hrs.**

Fat metabolism

1. Definition and significance of fat
2. Types of fatty acids - Synthesis of fatty acids
3. Synthesis of glycerol from Dihydroxy acetone phosphate
4. Synthesis of fat
5. Fat breakdown
6. Cholesterol and its importance

Module IX **4 Hrs**

Translocation of solutes

1. Pathway of organic solutes
2. Mechanism of pholem transport
3. Mass flow hypothesis
4. Protoplasm streaming theory

Module X **5 Hrs**

Growth end Development

1. Definition
2. Dormancy and germination of seeds.
3. Phases of growth -measurement and factors affecting growth.
4. Differentiation, morphogenesis and senescence.
5. Growth Hormones —Auxins, Gibberellins, Kinins, Abscissic acid, Ethylene and their practical applications
6. Photoperiodism
7. Vernalization

Module XI **5 Hrs**

Plant Movements and Stress Physiology

Tropic and nastic movements, Circadian rythm

General account on Stress physiology(brief study) -

Practicals **36 Hrs**

1. Water potential of onion peel, Rheo peel by plasmolytic method
2. Separation of plant pigments by paper chromatography

Demonstration Experiments

1. Thistle funnel experiment
2. Tissue tension
3. Root Pressure
4. Suction force due to transpiration
5. Foliar transpiration by using bell jar
6. Transpiring surface - 4 leaf experiment
7. Potometer — Farmer and Ganong's,
8. Water balance — Relation between transpiration and absorption.
9. Evolution of oxygen during photosynthesis
10. Necessity of chlorophyll, CO_2 and light in photosynthesis

11. Measurement of photosynthesis.
12. Simple respiroscope
13. Resperometer of R.Q.
14. Anaerobic respiration
15. Fermentation
16. Geotropism and phototropism — Klinostàt
17. Hydrotropism
18. Measurement of growth — Arc and Liver Auxonometer

Textbooks

1. Devlin & Witham – Plant Physiology, C B S publishers.
2. Devlin R.M (1979) Plant Physiology
3. Dieter Hess;(1975):Plant physiology
4. Jain .V.K(1996) Fundamentals of Plant Physiology
5. Kochhar P. L . & Krishnamoorthy H. N . – Plant Physiology. Atmaram & Sons Delhi, Lucknow.
6. Kumar & Purohit – Plant Physiology - Fundamentals and Applications, Agrobotanical publishers
7. Malic C. P. & Srivastava A. K .– Text book of Plant Physiology Kalyani Publishers New Delhi.
8. Noggle G R & Fritz G J (1991) Introductory Plant physiology, Prentice Hall of India.
9. Pandey S.N. & Sinha B. K. (1986) – Plant physiology, Vikas publishing House- New Delhi.
10. Salisbury.F.B and Ross.C.W(2006): Plant Physiology 4e, Wadsworth publishing company
11. Sundara Rajan S . – College Botany Vol.IV, Himalaya publishing House.
12. William G. Hopkins – Introduction to Plant Physiology John Wiley & Sons, New York.

Semester V
Core Course
BB1542 Genetics
Credits 4
Contact Hours: 108 (T 72+ P 36)

Aim and Objective: This course is supposed to supplement the basic knowledge in genetics in general and Mendelian genetic in particular. This is essential to study the various branches of biology like molecular biology and gene technology.

Module:I

Classical Genetics **30 hrs**

1. Mendelian Genetics- Mendel and his experiments, Mendel's success, Mendelian principles, Mendelian ratios, monohybrid and dihybrid crosses, back cross and test cross
2. Genetics after Mendel- Modified Mendelian ratios; Incomplete dominance -Flower color in Mirabilis ; Interaction of genes- Comb pattern in poultry. 9:3:3:1. Epistasis - Recessive. Coat color in mice. 9:3:4; Dominant epistasis. Fruit colour in summer squash. 12:3:1; Complementary genes. Flower color in Lathyrus 9:7; Duplicate gene with cumulative effect. Fruit shape in summer squash. 9:6:1; Duplicate dominant genes in shepherd's purse. 15:1; Inhibitory factor. Leaf color in Paddy. 13:3
3. Multiple alleles-General account. ABO blood group in man. Rh factor. Self sterility in *Nicotiana*.
4. Quantitative characters- General characters of quantitative inheritance, polygenic inheritance; Skin color in man, ear size in Maize.

Module II **28 hrs**

5. Linkage and crossing over- Linkage and its importance, linkage and independent assortment. Complete and incomplete linkage.Crossing over – a general account, two point and three point test cross. Determination of gene sequence. Interference and coincidence. Mapping of chromosomes.
6. Sex determination- Sex chromosomes, chromosomal basis of sex determination XX- XY, XX-XO mechanism. Sex determination in higher plants (*Melandrium album*) Genic balance theory of sex determination in *Drosophila*. Sex chromosomal abnormalities in man. Klinefelter's syndrome, Turner's syndrome. Sex linked inheritance. Eye color in *Drosophila*, Hemophilia in man. Y- Linked inheritance.
7. Extra nuclear inheritance- General account, maternal influence. Plastid inheritance in *Mirabilis*. Shell coiling in snails, kappa particle in *Paramecium*.

Module-III

Molecular Genetics **14 hrs**

1. **DNA as genetic material**- Structure of DNA; A, B and Z forms of DNA, satellite and repetitive DNA
2. **Replication of DNA**, Circular and helical DNA. Semi conservative model, experimental support, Meselson and Stahl experiment. Enzymology of replication: topoisomerase, helicase, primase, polymerase and ligase. DNA repairing mechanism.
3. **RNA structure**- Properties and functions of tRNA, mRNA and rRNA. Genetic code.
4. **Synthesis of protein**: Transcription, translation -Central dogma-reverse transcription
5. **Concept of gene**-Units of a gene, cistron, recon, muton; Types of genes- House keeping genes (constitutive genes), Luxury genes (non constitutive genes), interrupted genes (Split genes) - introns, overlapping gene.

6. **Transposable genetic elements**- General account, Characteristic, Transposons (jumping genes), Cellular oncogenes (general account only).

Practical **36 hrs**

Work out problems in

1. Monohybrid cross (Dominance and incomplete dominance)
2. Dihybrid cross (Dominance and incomplete dominance)
3. Gene interactions (All types of gene interactions mentioned in the syllabus)
    a. Recessive epistasis 9: 3: 4.
    b. Dominant epistasis 12: 3: I
    c. Complementary genes 9: 7
    d. Duplicate genes with cumulative effect 9: 6: 1
    e. Inhibitory genes 13: 3
    f. Duplicate dominant gene 15: 1
    g. Comb pattern in poultry 9:3: 3:1
4. Linkage and crossing over
5. Two point and three point crosses
6. Construction of genetic map.

Suggested Reading

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1. Aggarwal SK (2009) Foundation Course in Biology, 2nd Edition, Ane Books Pvt. Ltd
2. Dobzhansky, B (1961) Genetic and origin of species, Columbia university Press New York
3. Durbin (2007) Biological Sequence Analysis. Cambridge University Press India Pvt. Ltd
4. Gardner,E.J and Snustad,D.P(1984) Principles of Genetics. John Wiley, New York.
5. Gupta P. K. – Genetics (Rastogi publications).
6. Gupta, P. K. Genetics, Rastogi Publications.
7. John Ringo (2004) Fundamental Genetics. Cambridge University Press India Pvt. Ltd.
8. Lewin, B, (1994) Genes, Oxford University Press, New York.
9. Lewis, W.H (1980) Polyploidy. Plenum Press, New York.
10. Nicholl T (2007) An Introduction to Genetic Engineering, Cambridge University Press India Pvt. Ltd
11. Sharma, A.K and Sharma a (1980) Chromosome technique Theory and practice, Aditya Books, New York
12. Swanson, C.P (1957) Cytology and Genetics. Englewood cliffs, NewYork.
13. Taylor (2008) Biological Sciences. Cambridge University Press India Pvt. Ltd
14. Veer Bala Rastogi (2008), Fundamentals of Molecular Biology Ane Books Pvt. Ltd

Semester V
Core Course Vocational
BB1571 Recombinant DNA Technology
Credits-4
Contact hours 72 (Theory 54+ Practical 18)

Module I **8 hrs**

Introduction to gene cloning and its applications,
Tools of recombinant DNA technology-
Restriction endonucleases, classification and general characteristics of endonucleases;
Other enzymes used in the recombinant DNA technique-
DNA ligase, alkaline phosphatase;

Module II **15 hrs**

Vectors, the vehicle for cloning: special features needed for a vector,
Various types of cloning vectors- plasmid cloning vectors- pBR322,
Expression vectors, the pUC series,
Bacteriophage cloning vectors -phage λ cloning vectors, M13 based vectors,
Phagmids and Cosmid vectors,
Artificaial Chromosomes:
Yeast Artificial vectors (YACs), Bacterial artificial Vectors (BACs),
Application for YAC and BAC,- genome sequencing
Shuttle vectors for animals and plants, mammalian vectors;
Gene Therapy- Vectors for gene therapy.

Module III **15 hrs**

Construction of recombinant DNA, host cells, competent cells, bacterial transformation, screening methods of transformed cells,
DNA libraries: genomic libraries and cDNA libraries. Application of genomic libraries and cDNA libraries, Various methods of genetic transformation in eukaryotes- Direct gene transfer and vector mediated gene transfer, Screening methods of transformed cells and organisms.

Module **IV** **16 hrs**

Molecular hybridization techniques for genome analysis Genome analysis: RFLP, AFLP, RAPD, Southern hybridization
PCR: Principle and applications
Nucleic acid sequencing: Principle and applications, Genome sequencing methods, Human genome project– a brief account.
Gene expression analysis – Northern hybridization and microarrays.
Transgenic organisms and its impact in agriculture, Medicine and Environment
Biosafety and Ethics in Genetic Engineering

Practical **18 Hrs**

Experiments for Practical of rDNA Technology

1. Preparation of the reagents for rDNA experiments
2. Purification of Plasmid from bacterial Cultures.
3. Electrophoresis and evaluation of plasmid DNA-pUC 18 / pBR 322
4. Estimation of plasmid DNA by UV-VIS spectrophotometer
5. Restriction Digestion of pUC 18 and analysis by agarose gel electrophoresis
6. Transformation of *E. coli* with pUC 18 and selection of ampicillin resistant clones
7. Extraction and purification of Genomic DNA

Suggested Readings

1. Animal cell culture- John R W Master; Oxford University Press
2. Cuture of animal cells – A manual of basic technique, R Ian Freshney; Wiley-Liss Publication, New York.
3. Basics of Biotechnology- A. J. Nair; Laxmi Publications, New Delhi.
4. Introduction to Biotechnology & Genetic Engineering, Jones & Bartlett Publishers, Boston.
5. Modern concept of Biotechnology- H D Kumar; Vikas Publishing House, Pvt. Ltd., New Delhi.
6. Introduction to Genetic Engineering & Biotechnology- Nair, A. J., Jones & Bartlett Publishers, Boston,USA.
7. Biotechnology – B D SinghKalyani Publishers, New Delhi

Semester V
Core Course Vocational
BB1572 Plant Biotechnology
Credits 3
Contact hours 72 (T 54+P 18)

Aim: This course is designed to impart basic knowledge in the applied aspects of plant biotechnology for the improvement of agriculture and plant based industries. It will give an outline of plant tissue culture cell culture and plant genetic transformation methods, which will help the students to pursue further studies in this aspects.t

Module I **8 hrs**

Fundamental principles of *in vitro* plant cultures: use of plant growth regulators, composition of tissue culture media- media components and its functions.

Sterilization Methods - Steam sterilization, Dry sterilization, Filter sterilization, surface sterilization of explants

Module II **8 hrs**

Types of *in vitro* cultures

Callus cultures, cell suspension cultures, organ cultures- root cultures, hairy root cultures, embryo cultures, anther culture;

Module III **10 hrs**

Application of in vitro cultures

embryogenesis and organogenesis a brief understanding, clonal multiplication and micropropagation- meristem culture, axillary bud and shoot tip culture, anther and pollen culture- production of haploids and its uses;

Plant secondary metabolites production through cell, tissue and organs cultures, Advantages and disadvantages of *in vitro* methods

Module IV **6 hrs**

Somaclonal variation

Possible reasons of Somaclonal variations, applications of Somaclonal variations in agriculture and Horticulture, merits and demerits of Somaclonal variation

Module V **6 hrs**

Protoplast culture

Protoplast- isolation and culturing of protoplast- principle and application, regeneration of protoplasts, protoplast fusion and somatic hybridization- selection of hybrid cells.

Module VI **8 hrs**

Genetic engineering of plants

Methods of gene transfer in plants –Physical, chemical and biological methods

Agrobacterium tumefaciens, tumor formation in plants by *A. tumefaciens*, application of *A. tumefaciens* in plant genetic engineering, Virus mediated gene transfer in plants.

Module VII **8 hrs**

Transgenic plants

Transgenic crops, Impact of transgenic plants in agriculture and Horticulture, Non Agricultural applications of transgenic plants- Biopharming- production of therapeutic proteins in transgenic plants, edible vaccines, disease resistant, salt tolerant, pest resistant and stress tolerant crop and medicinal plants;,

Metabolic engineering of plants for enhanced and controlled production of plant products.

Practical **18 Hrs**

Experiments for Plant Biotechnology Practical

1. Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS Media.
2. Preparation of M S Media
3. Surface sterilization of plant materials for inoculation (implantation in the medium)
4. Development of callus cultures and its sub-culturing
5. Organogenesis- shoot regeneration, root regeneration, somatic embryogenesis
6. Micropropagation of potato/tomato/ - Demonstration
7. Familiarization of instruments and special equipments used in the plant tissue culture experiments- Laminar Airflow chamber,
8. Protoplast isolation and culturing – Demonstration

Suggested readings

1. An Introduction to Plant Tissue Culture – M K Raxdan; Oxfird & IBH Publishing Co.Pvt. Ltd., New Delhi
2. Basics of Biotechnology- A. J. Nair; Laxmi Publications, New Delhi.
3. Biotechnology-Fundamentals and Application- S S Purohit and S K Mathur; Agrobotanica, India.
4. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston,USA.
5. Introduction to Plant Biotechnology- H S Chawla; Oxford & IBH publishing Co.Pvt.Ltd., New Delhi.
6. Modern concept of Biotechnology- H D Kumar; Vikas Publishing House, Pvt. Ltd., New Delhi.
7. Plant biotechnology, Recent Advances- P C Trivedi; Panima Publishing Corporation, New Delhi.
8. Plant vell, Tissue and Organ Culture- Fundamental Methods, O L Gamborg, G C Philips; Narosa Publishing House, New Delhi.
9. Role of Biotechnology in Medicinal and aromatic plants- Irfan A Khan and Atiya Khanum ; Ukaaz Publications, Hyderabad.

Semester V

Core Course Vocational

BB1573 Animal Biotechnology

Credits 3

Contact hours 54 (Theory 36+Practical 18)

Aim and Objective: To introduce the subject of animal biotechnology and its applications to the students in an attractive and simple manner

Module I **6 hrs**

Animal cell culture

History, animal organ, tissue and cell culture, animal cell culture techniques,
Primary cell cultures and secondary cell cultures, immortalized cell cultures, cell lines,
Media – media components and physical parameters,
Instruments and equipments needed for animal cell cultures, uses of animal cell cultures.

Module II **12 hrs**

Application of Animal Cell Cultures

Characterization of cell lines,
Products of animal cell cultures- hormones (insulin, growth hormones), interferon, t-plasminogen activator, factorVIII, Factor IX and virus cultivation;
Expression of cloned proteins in animal cells, production of vaccines in animal cells, production of polyclonal and monoclonal antibodies-hybridoma technology

Module III **8 hrs**

Scale up of animal cell cultures

Special bioreactors for large-scale cultivation of animal cells, anchor depended cells and suspension cultures,
Roller bottles and spinner flasks

Module IV **10 hrs**

Stem cell technology

Stem cell culture and its clinical uses, types of stem cells; gene therapy and tissue grafting;
Growth factors promoting proliferation of animal cell cultures
Preservation and maintenance of animal cell cultures- cryopreservation and transport of animal cell cultures;
Transgenic animals and its practical uses,
Bioethics in animal cell culture, stem cell technology and transgenic animals

Practical **18 hrs**

Experiments for Practical in Animal Biotechnology

1. Familiarization of methods, equipments and techniques of animal cell culture
2. Isolation of lymphocytes from blood
3. Cell viability assay by die exclusion method and cell counting
4. MTT assay of cells Evans blue assay of pollen grains or blood cells
5. Demonstration of ELISA technique
6. Protein purification by ion exchange chromatography from serum

Suggested Readings

1. Biotechnology-Fundamentals and Application- S S Purohit and S K Mathur; Agrobotanica, India.
2. Basics of Biotechnology- A. J. Nair; Laxmi Publications, New Delhi.
3. Animal cell culture- John R W Master; Oxford University Press
4. Culture of animal cells – A manual of basic technique, R Ian Freshney; Wiley- Liss Publication, New York.
5. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston,USA.
6. Modern concept of Biotechnology- H D Kumar; Vikas Publishing House, Pvt. Ltd., New Delhi.
7.

Semester V
Open / Elective course (vocational)

BB1581 Bioinformatics

Credits: 2
Contact hours: 36

Aim and Objective: To introduce the subject of bioinformatics to the students of biology. Students should be familiarized to the importance of the bioinformatics, databases, genomics and proteomics, tools and software of bioinformatics at the elementary levels.

Module I

Bioinformatics- definition

History and evolution of bioinformatics, Impact of bioinformatics in modern biology,

Databases- various types of databases, Biological Databases- Importance of databases in biotechnology,

NCBI, Gene bank, PubMed. Etc.

Module II

Internet resources for Biotechnology, a short introduction to genome analysis, genome sequencing projects, genome similarity,

Tools (software) in Bioinformatics.

Tools for sequence alignments- BLAST and Fasta.

Module III

Genomics and Proteomics-Definitions, Application of Proteomics and genomics in Biotecnology.

Practicals in Bioinformatics

1. Use of Computers in Biological science- Data base creation, Data base retrieval – Online use of Computational tools.
2. Identification of a given sequence as DNA, RNA or Proteins
3. To analyze the sequence of a given DNA and find out sequence composition
4. To find out the number of times a sequence is repeated in a given DNA sequence
5. To find out the complementary sequence of a given nucleotide sequence

Suggested Readings

1. Introduction to Bioinformatics – V. Kothekar, Druv Publication
2. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston, USA.
3. Bioinformatics- Genomics and Post-genomics, Frederich Dardel & Francois Kepes; John Wiley & Sons.

Semester VI

Core Course

BB1641 Angiosperm Morphology and Systematic Botany

Credit 3

Contact hours: 126 (Theory 72 + Practical 54)

Aim and Objective: The course is designed to give a basic awareness in systematic botany and morphology of higher plants and the course should generate interest on students to pursue continuous studies in systematic botany.

Module I

Morphology **12 hrs**

Brief account on the various types of inflorescence including special types (Cyathium, Verticillaster, Hypanthodium, Coenanthium and Thyrsus) with examples; floral morphology- Flower-as a modified shoot, Flower parts, their arrangements, relative position, numeric- plan, cohesion, adhesion, symmetry of flower, aestivation types, placentation types; floral diagram and floral formula

Fruit types: simple, aggregate and multiple. Seeds: albuminous and exalbuminous .

Module -II **8 hrs**

Systematic Botany

Definition, scope and significance of Taxonomy, Fossil Angiosperms. Historical development of the systems of classification:

1. Artificial- Linnaeus sexual system
2. Natural - Bentham and Hooker (detailed account)

3 Phylogenetic- Engler and Prantl (Brief account only)

Module -III **7 hrs**

Basic rules of Binomial Nomenclature and International Code of Botanical nomenclature (ICBN). Importance of Herbarium, Herbarium techniques and Botanical gardens. A brief account on the modem trends in taxonomy; Chemotaxonomy, Numerical Taxonomy, Cytotaxonomy and Molecular taxonomy

Module -IV **45 hrs**

A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker's system)

1	Annonaceae	9	Apiaceae	17	Acanthaceae	25	Poaceae
2	Nymphaeaceae	10	Rubiaceae	18	Verbenaceae		
3	Malvaceae	11	Asteraceae	19	Amaranthaceae		
4	Rutaceae	12	Sapotaceae	20	Euphorbiaceae		
5	Anacardiaceae	13	Apocynaceae	21	Orchidaceae		
6	Leguminosae	14	Asclepiadiaceae	22	Scitaminae		
7	Myrtaceae	15	Solanaceae	23	Liliaceae		
8	Cucurbitaceae	16	Scrophulariaceae	24	Arecaceae		

Practical **54 hrs**

1. Study on various types of inflorescences with vivid record of practical work.
2. Students must be able to identify the angiosperm members included in the syllabus up to the level of families.
3. Draw labeled diagram of the habit, floral parts, L S of flower, T S of ovary, floral diagram, floral formula and describe the salient features of the member in technical terms
4. Students must submit practical records, Herbarium sheets (25 Nos:) and Field book at the time of practical examination.
5. Field trips are to be conducted for three days either as continuous or one day trips.

Suggested Readings

1. Davis, P.11. and Haywood, V.H, 1963. Principles of Angiosperm Taxonomy. Oliver and Royd, London.
2. Heywood, V.H. and Moore D.M. 1984. Current Concepts in Plant Taxonomy. Academic Press, London.
3. Jeffrey, C. 1982. An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge London.
4. Jones, S.B. Jr. and Luchsinger, A.E. 1986. Plant Systematics (2nd edition). McGraw-Hill Book Co., New York.
5. Kapoor LD, 2001 Hand Book of Ayurvedic Medicinal Plants, CRC Press New York, Ane Books Pvt. Ltd
6. Lawrence. G.H.M. 1951. Taxonomy of Vascular Plants. Macmillan, New York.
7. Naik, V.N. 1984. Taxonomy of Angiosperms. Tata McGraw Hill, New York.
8. Nordenstam. B.., El-Gazaly, G. and Kassas. M. 2000. Plant Systematics for 21st Century
9. Pandey SN and Misra SP, 2008 Taxonomy of Angiospenus; Ane Books Pvt. Ltd.
10. Radford. A.E.1986. Fundamentals of Plant Systematics Harper and Row, New York.
11. Singh. G. 1999. Plant Systematics: Theory and practice Oxford & IBH Pvt, Ltd. New Delhi.
12. Sivarajan,V.V. Introduction to the principle of plant taxonomy, Oxford and IBH Publishing Company
13. Stace. C.A. 1989. Plant Taxonomy and Biosystematics. 2nd ed. Edward Arnold,London.
14. Verma V, 2009 Text Book of Economic Botany; Ane Books Pvt. Ltd.
15. Woodland. D.E. 1991. Contemporary Plant Systematics. Prentice Hall, NewJersay.

Semester VI

Core Course

BB1642 Economic Botany, Ethnobotany & Medicinal Botany

Credit 2

Contact hours 108 (Theory 72 + Practical 36)

Aim and Objective: This gives awareness about the importance of Medicinal plants and its useful parts, economically important plants in our daily life and also about the traditional medicines and herbs, and its relevance in modern times**.**

Module I **5 hrs**

Economic botany

1. Study of the major crops in Kerala with special reference to their Methods of cultivation, Botanical description, morphology of the useful part and economic importance – Coconut and Paddy.
2. A brief account on the utility of the following plants, specifying the Binomial, family and morphology of the useful parts. **25 hrs**

Fruits & Vegetables- Banana, Jackfruit, Pineapple, citrus, Apple, Cashew, Watermelon, Tomato, Brinjal, Common bean, Sword bean, Pumpkin, Cucumber, Snake gourd, Bitter gourd, Ash gourd, Bottle gourd.

Cereals and millets	- Wheat and Ragi
Pulses	- Black gram and Bengal gram
Sugar yielding Plants	–Sugar cane
Spices	- Pepper and Cardamom
Beverages	-Coffee
Fibre yielding plant	- Cotton
Dye Yielding plants	- Henna and *Bixa orellana*
Resins	- Asafoetida
Tuber crops	- Tapioca
Oil yielding Plants	- Sesame and Coconut
Insecticides	- Neem

Module II

Ethnobotany **20 hrs**

1. Definition — importance, scope, categories and significance.
2. Study of various methods to collect Ethno botanical data.
3. Plant parts used by tribes in their daily life as food, clothing, shelter, agriculture and medicine.
4. Study of common plants used by tribes. *Aegle marmelos*, *Ficus religiosa*, *Cynadon dactylon,* *Ocimum sanctum* and *Trichopus zeylanicus*
5. Ethnobotanic aspect of conservation and management of plant resources
6. Preservation of primeval forests in the form of sacred groves of individual species

Module III **15hrs**

Medicinal botany

1. Importance and the need for its conservation- Sacred groves. Role of ICAR,IMPB,BSI, NBGRI in conservation and cultivation of medicinal plants
2. A general account of the methodology of cultivation of medicinal plants- Rhizome-*Curcuma* and *Gingiber;* Bulb-*Allium cepa* and *A. sativa*; Root-*Asparagus, Hemidesmis , Acorus calamus; Adhatoda vasica, Ctharanthus roseus, Phyllanthus amarus, Andrographis paniculata;* Leaves-*Aloe vera, Centella asiatica* Asoka (*Saraca indica*) and Brahmi (*Bacopa monnieri*) Aswagandha (*Withania somnifera*), Sarpagandha (*Rauvolfia serpentina*)
3. Production of herbal drugs. Extraction procedure-Adulteration of drugs

Module IV **7 hrs**

1. Definition and scope of Pharmacognosy –Ancient and modern medicines -Sidha, Ayurveda, Unani , Acupuncture, Homoeopathy and Allopathy
2. Sources of crude drugs – roots, rhizome, bulb, corm, leaves, stems, flowers, fruits and seeds

Practical **36 hrs**

1. Collection and study of economically important plants and morphology of the useful parts.
2. Identify the economic products obtained from the plants mentioned under Economic Botany
3. Visit a tribal area and collect information on their traditional method of treatment using crude drugs.
4. Familiarize with at least 5 folk medicines and study the cultivation, extraction and its medicinal application.
5. Observe the plants of ethno botanical importance in your area
6. Visit to an Ayurveda college or Ayurvedic

Suggested Readings

1. Verma V, 2009 Text Book of Economic Botany; Ane Books Pvt. Ltd.
2. Kapoor LD, 2001 Hand Book of Ayurvedic Medicinal Plants, CRC Press New York,
3. Davis, P.11. and Haywood, V.H, 1963. Principles of Angiosperm Taxonomy,Oliver and Royd, London.
4. K. Jain. Glimpses of Ethnobotany. Oxford and IBH Publishing Company, New Delhi.
5. S.K. Jain, 1987. A Manual of Ethno botany. Scientific Publishers, Jodhpur
6. T.E Walles. Text book of Pharmacognosy,
7. Rajiv K Sinha. Ethnobotany.

Semester VI

Core Course

BB1643 Practical Botany III

(Practical of BB1541, BB1542, BB1641, BB1642)

Credit 2

Contact Hours: 162

Practical of BB1541

Plant Physiology **36 Hrs**

1. Water potential of onion peel, Rheo peel by plasmolytic method
2. Separation of plant pigments by paper chromatography

Demonstration of the following Experiments

1. Thistle funnel experiment
2. Tissue tension
3. Root Pressure
4. Suction force due to transpiration
5. Foliar transpiration by using bell jar
6. Transpiring surface - 4 leaf experiment
7. Potometer — Farmer and Ganong's,
8. Water balance — Relation between transpiration and absorption.
9. Evolution of oxygen during photosynthesis
10. Necessity of chlorophyll, CO_2 and light in photosynthesis
11. Measurement of photosynthesis.
12. Simple respiroscope
13. Resperometer of R.Q.
14. Anaerobic respiration
15. Fermentation
16. Geotropism and phototropism — Klinostàt
17. Hydrotropism
18. Measurement of growth — Arc and Liver Auxonometer

Practical of BB1542

Genetics **36hrs**

Work out problems in

1. Monohybrid cross (Dominance and incomplete dominance)
2. Dihybrid cross (Dominance and incomplete dominance)
3. Gene interactions (All types of gene interactions mentioned in the syllabus)
    a. Recessive epistasis 9: 3: 4.
    b. Dominant epistasis 12: 3: I
    c. Complementary genes 9: 7
    d. Duplicate genes with cumulative effect 9: 6: 1

e. Inhibitory genes 13: 3
f. Duplicate dominant gene 15: 1
g. Comb pattern in poultry 9:3: 3:1

4. Linkage and crossing over
5. Two point and three point crosses
6. Construction of genetic map.

Practical of BB1641
Angiosperm Morphology and Systematic Botany **54 hrs**

1. Study on various types of inflorescences with vivid record of practical work.
2. Students must be able to identify the angiosperm members included in the syllabus up to the level of families.
3. Draw labeled diagram of the habit, floral parts, L S of flower, T S of ovary, floral diagram, floral formula and describe the salient features of the member in technical terms
4. Students must submit practical records, Herbarium sheets (25 Nos:) and Field book at the time of practical examination.

5. Field trips are to be conducted for three days either as continuous or one day trips.

1	Annonaceae	9	Apiaceae	17	Acanthaceae	25	Poaceae
2	Nymphaeaceae	10	Rubiaceae	18	Verbenaceae		
3	Malvaceae	11	Asteraceae	19	Amaranthaceae		
4	Rutaceae	12	Sapotaceae	20	Euphorbiaceae		
5	Anacardiaceae	13	Apocynaceae	21	Orchidaceae		
6	Leguminosae	14	Asclepiadiaceae	22	Scitaminae		
7	Myrtaceae	15	Solanaceae	23	Liliaceae		
8	Cucurbitaceae	16	Scrophulariaceae	24	Arecaceae		

Practical of BB1642
Economic Botany, Ethanobotany & Medicinal Botany **36 hrs**

1. Collection and study of economically important plants and morphology of the useful parts.
2. Identify the economic products obtained from the plants mentioned under Economic Botany
3. Visit a tribal area and collect information on their traditional method of treatment using crude drugs.
4. Familiarize with at least 5 folk medicines and study the cultivation, extraction and its medicinal application.
5. Observe the plants of ethno botanical importance in your area
6. Visit to an Ayurveda college or Ayurvedic Research Institute / Hospital

Semester VI

Core Course Vocational

BB1671 Industrial Biotechnology

Credits: 3

Contact Hours: 90 (T 54 + P 36)

Aim and Objective: The students will be introduced to the industrial application of Microbiology and Bioprocess technology in Biotechnology through this course. Students should be trained to understand commercial importance of biotechnology through its industrial aspects.

Module I **8hrs**

Industrial Microbiology

Microbes in industry- Industrially important microorganisms, screening and isolation, industrially important enzymes and chemicals, Industrial production of enzymes and chemicals, Microbial production of antibiotics, vitamins, amino acids and other organic acids

Module II **16 hrs**

Fermentation

The biological process of fermentation- various types of fermentation , alcohol fermentation, Respiration vs Fermentation – Important products of fermentation**.** Fermentation as an industry, selection of industrial microorganisms for specific products and reactions,

Laboratory scale biological process- scale up of biological reactions in to bioprocess;

Bioreactors-types of bioreactors / Fermentors, Bioreactors for bacteria and yeast cells, Fermentors for plant cell cultures and animal cell cultures,

Module III **12 hrs**

Upstream Processing

Media for fermentation, media sterilization and media aeration, pH, temperature, batch fermentation, continuous fermentation, chemostatic cultures, fermentation by immobilized cells and enzymes;

Down stream processing

Down stream processing and product recovery, Different physical and chemical methods for the separation of fermentation products;

Module IV **8 hrs**

Agricultural waste and food industry wastes as the substrate for fermentation, solid state fermentation; production of single cell proteins, microbial production of enzymes;

Module V **6 hrs**

Food Biotechnology

Microorganism in food spoilage, types of spoilage, canning, microbes in the spoilage of canned foods, principles of preservation of foods, Hazardous effect of food spoilage, mycotoxins;

Microbial processing Foods- Confectionery, Fermented foods,

Dairy industry **4 hrs**

Microbes in dairy industry, dairy products; microbial processing of foods- enzymes in food processing

Practicals

Experiments for Industrial Biotechnology Practical **36 hrs**

1. Preparation of media and sterilization for alcohol fermentation by yeast.
2. Preparation of Ethyl alcohol from glucose by Yeast fermentation- separation of ethanol by distillation (demonstration)
3. Growth Curve of bacteria or yeast cultures in nutrient broth
4. Isolation of microorganisms from spoiled food and identification
5. Isolation of organisms from curd/ milk and fermentation of lactose
6. Demonstration of setting laboratory fermentor- basic features, purpose, procedure and application- Demonstration of running a laboratory fermentor.

Suggested Reading

1. Modern Concept of Biotechnology- H D Kumar; Vikas Publishing House Pvt. Ltd., New Delhi.
2. Food Processing – Biotechnolgical Applications- S S Marwaha & J K Arora, Asiatech Publishers Inc., New Delhi
3. Food Microbiology- M R Adamas & M O Moss; Panima Publishing Corporation, New Delhi.
4. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston, USA.
5. Industrial Microbiology – A H Patel, Panima Publishing House New Delhi.
6. Fermentation technology- Whittaker,
7. Fundamentals of Microbiology, Jones & Bartlett Publishers, Boston, USA.

Semester VI
Core Course Vocational
BB1672 Environmental Biotechnology
Credits: 2
Contact hours 72 (T 36 + P 36)

Aim and Objective: This course is aimed to bring an enthusiasm on environmental protection and it should give the contribution of biotechnology techniques to keep the environment clean and healthy. As well it should highlight the economic aspects and bioprocess technology in the application of biotechnology in protecting the environment from pollution.

Module I **4 hrs**

Introduction

Ecosystem, Biodiversity, Types of ecosystem and biosphere;

Module II **5 hrs**

Pollution: sources of pollution, general characteristics of domestic wastes, community wastes, agricultural wastes, effect of solid waste in the environment

Module III **5 hrs**

Water pollution

Organic load in aquatic systems, BOD and COD, microbial quality of water, drinks and food
Use of biotechnology in the treatment of municipal wastes and hazardous industrial effluents

Module IV **10 hrs**

Bioremediation: Microbial degradation of pesticides, herbicides and other toxic chemicals in the environment,
Biological control of pests and insects,
Biopesticides- *Bacillus thuringiensis*, bioherbicides;
Application of biotechnology in the production of biofertilizers and nitrogen fixation – nitrogen fixing microorganisms, mycorrhiza

Module V **4 hrs**

Renewable and non renewable energy resources: conventional fuels and their environmental impacts (fire word, animal oils, coal, petroleum)

Module VI **5** hrs

Non-conventional energy sources

Biomass: utilization of biomass as energy source– application of microbes in production of fuels from biomass- biogas and methanogenic bacteria, microbial hydrogen production,

production of methanol, ethanol and other types of chemicals from biomass and agricultural wastes, the gasohol experiment

Solar energy converter, hopes from photosynthetic pigments, vegetable oils as engine fuels, energy crops-jojoba;

Possibility of plant based petroleum industry and cellulose degradation for combustible fuels

Module VII **3 hrs**

Bioleaching

Enrichment of ores by microorganisms (bioaccumulation and biomineralisation);

Bio-assessment of environmental quality

Practical

Experiments for Environmental Biotechnology 36 hrs

1. Microbiological assessment of drinking water- water from well, river, water supply department and packaged drinking water
2. Isolation of microbes from the environment- from air, soil, floor of the lab, from water.
3. Assessment of organic load in aquatic systems and factory effluent- Determination of BOD and COD.
4. Biogas production by methanogenic bacteria or by mixed culture.
5. Isolation of nitrogen fixing bacteria from leguminous plants
6. Determination of NP and K in biofertilizers

Suggested readings

1. Environmental Biotechnology - Alan Scragg; Longman, England
2. Biotechnology fundamentals and applications – Purohit & Mathur; Agrobotanica, India
3. Biotechnology – B D Singh; Kalyani Publishers, New Delhi
4. Biological waste water treatment 2nd Edition- Grady C P L
5. Biological Conservation – Spellergerg I F
6. Environmental issues and Options – Mishra C.
7. Biodiversity- Status and Prospects- Pramod tandon etal Narosa Publishing House, New Delhi
8. Ecology 2nd Edn, Subrahmanyam N S, Sambamurty V.S.S; Narosa Publishing House.

Semester VI

Core Course Vocational

BB1673 Biotechniques III

(Practical of BB1571, BB1572, BB1573, BB1671 & BB1672)

Credit: 2

Contact hours: 126

(Practical Hours of above courses)

Practical of BB1571

Experiments for Practical of rDNA Technology 18 Hrs

1. Preparation of the reagents for rDNA experiments
2. Purification of Plasmid from bacterial Cultures.
3. Electrophoresis and evaluation of plasmid DNA-pUC 18 / pBR 322
4. Estimation of plasmid DNA by UV-VIS spectrophotometer
5. Restriction Digestion of pUC 18 and analysis by agarose gel electrophoresis
6. Transformation of *E. coli* with pUC 18 and selection of ampicillin resistant clones
7. Extraction and purification of Genomic DNA

Practical of BB1572

Experiments for Plant Biotechnology Practical 18 hrs

1. Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS Media.
2. Preparation of M S Media
3. Surface sterilization of plant materials for inoculation (implantation in the medium)
4. Development of callus cultures and its sub-culturing
5. Organogenesis- shoot regeneration, root regeneration, somatic embryogenesis
6. Micropropagation of potato/tomato/ - Demonstration
7. Familiarization of instruments and special equipments used in the plant tissue culture experiments- Laminar Airflow chamber,
8. Protoplast isolation and culturing – Demonstration

Practical of BB1573

Experiments for Practical in Animal Biotechnology 18 hrs

1. Familiarization of methods, equipments and techniques of animal cell culture
2. Isolation of lymphocytes from blood
3. Cell viability assay by die exclusion method and cell counting
4. MTT assay of cells Evans blue assay of pollen grains or blood cells
5. Demonstration of ELISA technique
6. Protein purification by ion exchange chromatography from serum

Practical of BB1671

Experiments for Industrial Biotechnology Practical 36 hrs

1. Preparation of media and sterilization for alcohol fermentation by yeast.
2. Preparation of Ethyl alcohol from glucose by Yeast fermentation- separation of ethanol by distillation (demonstration)
3. Growth Curve of bacteria or yeast cultures in nutrient broth
4. Isolation of microorganisms from spoiled food and identification
5. Isolation of organisms from curd/ milk and fermentation of lactose
6. Demonstration of setting laboratory fermentor- basic features, purpose, procedure and application- Demonstration of running a laboratory fermentor.

Practical of BB1672

Experiments for Environmental Biotechnology 36 hrs

1. Microbiological assessment of drinking water- water from well, river, water supply department and packaged drinking water
2. Isolation of microbes from the environment- from air, soil, floor of the lab, from water.
3. Assessment of organic load in aquatic systems and factory effluent- Determination of BOD and COD.
4. Biogas production by methanogenic bacteria or by mixed culture.
5. Isolation of nitrogen fixing bacteria from leguminous plants
6. Determination of NP and K in biofertilizers

Semester VI

Elective Course Vocational

BB-1681 Food & Dairy Biotechnology

Credit 2

Contact hours: 36

Aim and Objective: This course is for Biotechnology as well as non biotechnology students. Students from other disciplines are also can undergo this course to get basic knowledge in the application of Biotechnology in food processing, food spoilage, food preservation and dairy industry.

Module I

Microbes of food and fermented food- Curd, wheat and rice flour, Meat and fish, Poultry and eggs, Breads and bakery products, Grains

Microbiological contamination of foods- indicator organisms, cultural techniques, direct methods, immunological methods etc.

Module II

Food spoilage

Module Microbes involved in food spoilage- Spoilage of Canned foods Meat and dairy products.

Conditions of food spoilage- pH, physical structure, chemical composition, oxygen and temperature

Chemistry of food spoilage-microbial toxins and food poisoning

Food borne diseases and its prevention

Module III

Food Preservation- methods of food preservation, Physical & Chemical Methods, Osmotic pressure – preserving foods in sugar and salt, chemical preservatives, Radiation as a preservation methods

Module IV

Microbes of Dairy industry- Dairy products

Microbes in fermented food production

Industrial production of antibiotics (penicillin & streptomycin) and organic acids (acetic acid & Citric acids)

Microorganisms as food – fermented food, microalgae- Single cell protein, Edible amshrooms,

Textbooks

1. Food Microbiology- MR Adams and Moss
2. Food Processing- Biotechnological applications Marwah &Arora
3. Food Microbiology-William C Frazer
4. Industrial microbiology -LE Casida

BB1661 Project Work

An independent project or dissertation work has to be carried out by each student during the V or VI semester under a faculty member of the institute with in the college or outside the college, duly certified by the Head of the Department and supervising teacher, has to be submitted for evaluation at the time of examination in VI semester.

Tutorial Hours 18 hours

List & Syllabus of Open/ Elective Courses

The students have the freedom to opt any one of the open courses from the department and another one from any other Departments

Students of Biotechnology should opt an internal elective from the following courses and another one from other departments.

Open course for Biotechnology students / & students from other Departments

BB1581 Bioinformatics

Credits: 2

Contact hours: 36

Aim and Objective: To introduce the subject of bioinformatics to the students of biology. Students should be familiarized to the importance of the bioinformatics, databases, genomics and proteomics, tools and software of bioinformatics at the elementary levels.

Module I

Bioinformatics- definition

History and evolution of bioinformatics, Impact of bioinformatics in modern biology,

Databases- various types of databases, Biological Databases- Importance of databases in biotechnology,

NCBI, Gene bank, PubMed. Etc.

Module II

Internet resources for Biotechnology, a short introduction to genome analysis, genome sequencing projects, genome similarity,

Tools (software) in Bioinformatics.

Tools for sequence alignments- BLAST and Fasta.

Module III

Genomics and Proteomics-Definitions, Application of Proteomics and genomics in Biotecnology.

Practicals in Bioinformatics

6. Use of Computers in Biological science- Data base creation, Data base retrieval – Online use of Computational tools.
7. Identification of a given sequence as DNA, RNA or Proteins
8. To analyze the sequence of a given DNA and find out sequence composition
9. To find out the number of times a sequence is repeated in a given DNA sequence
10. To find out the complementary sequence of a given nucleotide sequence

Suggested Readings

1. Introduction to Bioinformatics – V. Kothekar, Druv Publication
2. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston, USA.
3. Bioinformatics- Genomics and Post-genomics, Frederich Dardel & Francois Kepes; John Wiley & Sons.

Open course for Biotechnology students / & students from other Departments

BB1681 Food & Dairy Biotechnology

Credit 2

Contact hours: 36

Module I

Microbes of food and fermented food- Curd, wheat and rice flour, Meat and fish, Poultry and eggs, Breads and bakery products, Grains

Microbiological contamination of foods- indicator organisms, cultural techniques, direct methods, immunological methods etc.

Module II

Food spoilage

Module Microbes involved in food spoilage- Spoilage of Canned foods Meat and dairy products.

Conditions of food spoilage- pH, physical structure, chemical composition, oxygen and temperature

Chemistry of food spoilage-microbial toxins and food poisoning

Food borne diseases and its prevention

Module III

Food Preservation- methods of food preservation, Physical & Chemical Methods, Osmotic pressure – preserving foods in sugar and salt, chemical preservatives, Radiation as a preservation methods

Module IV

Microbes of Dairy industry- Dairy products

Microbes in fermented food production

Industrial production of antibiotics (penicillin & streptomycin) and organic acids (acetic acid & Citric acids)

Microorganisms as food – fermented food, microalgae- Single cell protein, Edible amshrooms,

Suggested Readings

1. Food Microbiology- MR Adams and Moss
2. Food Processing- Biotechnological applications Marwah &Arora
3. Food Microbiology-William C Frazer
4. Industrial microbiology -LE Casida

Open course for students from other Departments

BB1682 Genetic Engineering

Credit 2

Contact hours: 36

Aim and Objective: This course id for non biology or non biotechnology students, who are interested to know about the methods and application of genetic engineering and its contribution in the various fields of biotechnology.

Module I

Introduction to gene cloning and its applications,

Tools of recombinant DNA technology-

Restriction endonucleases, classification and general characteristics of endonucleases;

Other enzymes used in the recombinant DNA technique- DNA ligase, alkaline phosphatase;

Module II

Vectors, the vehicle for cloning: special features needed for a vector,

Various types of cloning vectors- plasmid cloning vectors- pBR322,

Expression vectors, the pUC series,

Bacteriophage cloning vectors -phage λ cloning vectors, M13 based vectors,

Phagmids and Cosmid vectors,

Module III

Construction of recombinant DNA, host cells, competent cells, bacterial transformation, screening methods of transformed cells,

DNA libraries: genomic libraries and cDNA libraries. Application of genomic libraries and cDNA libraries. Various methods of genetic transformation in eukaryotes- Direct gene transfer and vector mediated gene transfer. Screening methods of transformed cells and organisms.

Module IV

Molecular hybridization techniques for genome analysis Genome analysis: RFLP, AFLP, RAPD, Southern hybridization

PCR: Principle and applications

Nucleic acid sequencing: Principle and applications, Genome sequencing methods, Human genome project– a brief account.

Suggested Reading

1. Animal cell culture- John R W Master; Oxford University Press
2. Cuture of animal cells – A manual of basic technique, R Ian Freshney; Wiley- Liss Publication, New York.
3. Basics of Biotechnology- A. J. Nair; Laxmi Publications, New Delhi.
4. Introduction to Biotechnology & Genetic Engineering, Jones & Bartlett Publishers, Boston.
5. Modern concept of Biotechnology- H D Kumar; Vikas Publishing House, Pvt. Ltd., New Delhi.
6. Introduction to Genetic Engineering & Biotechnology- Nair, A. J., Jones & Bartlett Publishers, Boston,USA.
7. Biotechnology – B D SinghKalyani Publishers, New Delhi