BLDE
(DEEMED TO BE UNIVERSITY)

Choice Based Credit System (CBCS)

Curriculum

B.Sc. Programme in
Biotechnology

2020-21

Published by
BLDE
(DEEMED TO BE UNIVERSITY)
Declared as Deemed to be University u/s 3 of UGC Act, 1956

The Constituent College
SHRI B. M. PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPURA
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BLDE(DU)/REG/B.Sc.Life-Sci/2020-21/ 1877 May 12, 2020

NOTIFICATION

Sub: Curriculum for B.Sc. Programme in Life Sciences with Semester Scheme
Ref: 1. Minutes of the meeting of the 5th Standing Committee Academic Council of the University held on 06- 05-2020.
2. Approval of Board of Management dtd.08-05-2020
3. Approval of Hon'ble Vice-Chancellor vide order no.1834, dtd.09-05-2020

In accordance with the Rule-09 (ii) of the Memorandum of Association (MoA) of the Deemed to be University, the Board of Management (BoM) has approved the Curriculum of **'B.Sc. Programme in Life Sciences'** in 1) Biotechnology, 2) Microbiology, 3) Biochemistry, 4) Food, Nutrition and Dietetics, following Choice Based Credit System (CBCS) with Semester Scheme.

The Curriculum shall be effective from the Academic Session 2020-21 onwards, in the Constituent College of the University viz. Shri B. M. Patil Medical College, Hospital and Research Centre, Vijayapura.

REGISTRAR
REGISTRAR
BLDE (Deemed to be University)
Vijayapura-586103. Karnataka

To,
The Dean, Faculty of Medicine & Principal,
Shri B. M. Patil Medical College,
Hospital and Research Centre,
Vijayapura

Copy to:
- The Secretary, UGC, New Delhi
- The Dean, Faculty of Medicine & Principal
- The Controller of Examinations
- The Dean, Student Affairs
- The Prof. & HoDs of Pre, Para and Clinical Departments
- The Coordinator, IQAC
- PS to the Hon'ble Chancellor
- PS to the Hon'ble Vice-Chancellor

Vision:

- To be a leader in providing quality medical education, healthcare & to become an Institution of eminence involved in multidisciplinary and translational research, the outcome of which can impact the health & the quality of life of people of this region.

Mission:

- To be committed to promoting sustainable development of higher education, including health science education consistent with statutory and regulatory requirements.
- To reflect the needs of changing technology
- Make use of academic autonomy to identify dynamic educational programs
- To adopt the global concepts of education in the health care sector

Preamble:

Biotechnology, being one of the youngest branch of Life Science, has expanded and established as advanced interdisciplinary applied science. The study of life itself is at the core of it and the interdisciplinary networking potential of biotechnology has given it a separate status in fundamental research as well as in modern industrial enterprise. Global and local focus has slowly shifted to not only current "Century of Knowledge" but also on to technology development and application in life sciences. In the milieu of research and industrialization for economic development and social change, biotechnology is an ideal platform to work.

The interdisciplinary nature of biotechnology integrates living systems including animal, plant and microbes and their studies from molecular biology to cell biology, from biochemistry to biophysics, from genetic engineering to stem cell research, from bioinformatics to genomics-proteomics from environmental biology to biodiversity, from microbiology to bioprocess engineering, from bioremediation to material transformation and so on. The relevance and application of these studies on living organisms and their bioprocesses is extensively covered in this field with the help of technology. Green revolution and white revolution was possible in India thanks to the deeper and intrinsic understanding of biotechnology.

Economic and social renaissance is staged on biotechnology especially, since it's biomedical and cutting edge technological applications are tremendously powerful in shaping this century and exciting future.

Biotechnologists are always in demand as an efficient work force in fundamental research and industries. Education and research sectors require such interdisciplinary trained workforce to develop future generations of science leaders. Career opportunities for graduate students are created and expanding at the biotechnology parks and in manufacturing industries, teaching, research institutes and IT industry.

Introduction:

The syllabi till today had been sufficient to cater to the needs of students for building up their careers in industry and research. However, with the changing scenario at local and global level, we feel that the syllabus orientation should be altered to keep pace with developments in the education and industrial sector. The need of the hour is to design appropriate syllabi that emphasize on teaching of technological as well as the economic aspects of modern biology. Theory supplemented with extensive practical skill sets will help a graduate student to avail the opportunities in the applied fields (research, industry or institutions) , without any additional training. Thus, the university / college itself will be developing the trained and skilled man-power.

Biotechnology being an interdisciplinary subject, this restructured syllabus will combine the principles of physical, chemical and biological sciences along with developing advanced technology. Biotechnology curricula are operated at two levels viz. undergraduate and postgraduate. The undergraduate curricula are prepared to impart primarily basic knowledge of the respective subject from all possible angles while postgraduate syllabus emphasizes on more applied courses. In addition, students are to be trained to apply this knowledge particularly in day-to-day applications of biotechnology and to get a glimpse of research.

Aims of Bachelor's degree programme in Biotechnology

The overall aims of Bachelor's degree programme in Biotechnology are to:

- Provide students with learning experiences that help in still deep interests in learning biotechnology.
- Expose the students to a wide range of careers that combine biology, plants and medicine.
- Provide students with some work experience, for example a summer internship or a research project in a research laboratory to further boost the career prospects.

Objectives to be achieved:

- To introduce the concepts in various allied subjects
- To enrich students' knowledge
- To help the students to build interdisciplinary approach
- To inculcate sense of scientific responsibilities and social and environment awareness
- To help students build-up a progressive and successful career

Eligibility

1. First Year B.Sc.:

Higher Secondary School Certificate (10+2) or its equivalent Examination with English and Biology; and two of the science subjects such as Physics, Chemistry, Biotechnology.

2. Second Year B.Sc.:

Students are not directly admitted to second year of B.Sc. for Biotechnology course. Those who complete first year biotechnology course are promoted to second year.

3. Third Year B. Sc.:

Students are not directly admitted to third year of B.Sc. for Biotechnology course.

Programme Structure:

Duration of Programme: The duration of B.Sc. (Biotechnology) Degree Program shall be three years including 6 months of internship.

Medium of Instruction: The medium of instruction for the course shall be English.

To accommodate more advanced topics in the syllabi, it is necessary to build the basic science knowledge at the level of first year of students those who have chosen the Biotechnology discipline. Curricula of courses of state and central boards of higher secondary level were reviewed to avoid repetitions of introductory subjects.

At first year of under-graduation, students will be given the basic information that includes – all basic science subjects like chemistry, microbiology, computer, statistics. Relevant experimentation on these topics are included in practical course which include study of all forms of life, plants, animals and microorganisms for their morphological and structural characterization. Practical exercises include chemical and biochemical analysis. Students will also learn biostatistics principles and use of computers for data analysis and interpretation. In practical course, students will be trained in preparing laboratory manuals, standard operating practices and log books.

At second year under-graduation, students will be introduced to different areas necessary to form the basis of biotechnology like genetics, immunology, molecular biology, cell biology, environmental biotechnology. They will also be introduced to scientific writing and communication skills. The relevant practical are included to enrich their knowledge.

At third year under-graduation, six theory papers are divided into two semesters which deal with broad applied areas of Biotechnology .

CBCS Definition and Benefits:

Choice Based Credit System is a flexible system of learning. The distinguishing features of CBCS are the following:

- It permits students to learn at their own pace.
- The electives are selected from a wide range of elective courses offered by the other University Departments.
- Undergo additional courses and acquire more than the required number of credits.
- Adopt an inter-disciplinary and intra-disciplinary approach in learning.
- Make best use of the available expertise of the faculty across the departments or disciplines
- Has an inbuilt evaluation system to assess the analytical and creativity skills of students in addition to the conventional domain knowledge assessment pattern.

Definitions of Key Words:

i. **Academic Year:** Two consecutive semesters constitute one academic year.

The CBCS provides choice for students to select from the prescribed courses (core, elective or minor or soft skill courses).

iii. **Course**: Usually referred to, as "papers" is a component of a programme. All courses need not carry the same weight. The courses should define learning objectives and learning outcomes. A course may be designed to comprise lectures/ tutorials/ laboratory work/ outreach activities/ project work/ viva/ seminars/ term papers/assignments/ presentations/ self-study etc. or a combination of some of these.

iv. **Credit Based Semester System (CBSS):** Under the CBSS, the requirement for awarding a degree or diploma or certificate is prescribed in terms of number of credits to be completed by the students.

v. **Credit:** A unit by which the course work is interpreted. It functions the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week.

vi. **Cumulative Grade Point Average (CGPA):** It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the sum total of the credit points obtained by the student in various courses in all semesters and the sum of the total credits of all courses in all the semesters.

vii. **Grade Point:** It is a numerical marking allotted to each letter grade on a 10-point scale.

viii. **Letter Grade:** It is an appreciated point of the student's performance in a selected course. Grades are denoted by letters O, A+, A, B, C and RA x.

ix. **Programme:** An educational programme leading to award of a Degree certificate.

x. **Semester Grade Point Average (SGPA):** It is index of performance of all performance of work in a semester. Its total credit points obtained by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.

xi. **Semester:** Each semester will extend for 6 months and will consist of minimum of 130 teaching/learning days, exclusive of examinations and holidays. The odd semesters will be scheduled from July to December and even semesters from January to June.

xii. **Transcript or Grade Card or Certificate**: Based on the grades earned, a grade certificate shall be issued to all the registered students after every semester. The grade certificate will display the course details (code, title, number of credits, grade secured) along with SGPA of that semester and CGPA earned till that semester.

Semester System and Choice Based Credit System

The semester system accelerates the teaching-learning process and enables vertical and horizontal mobility of students in learning. The credit based semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The choice based credit system enables students to take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning

Types of Courses: Courses in the programme are of three kinds:

- **Core Course**
- **Elective Course**
- **Ability Enhancement Course**

1. **Core Course:** A course, which should compulsorily be studied by a candidate as a basic requirement to complete the program, is termed as a Core course. There are Core Theory (CT) and Core Practical (CP) Courses in every semester.

2. **Elective Course:** A course which can be chosen from a very specific or advanced subject of study or which provides an extended scope or which enables exposure to some other domain or expertise, is called an Elective Course. Elective courses may be of two types

2a. Discipline Specific Skill Elective (SEC) Course: Elective courses offered by the main subject of study are referred to as Discipline Specific Elective. The Institute may also offer discipline related Elective courses of interdisciplinary nature. An elective may be "Discipline Specific Electives (DSE)" gazing on those courses which add intellectual efficiency to the students.

2b. Generic Elective (GEC) Course: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

3. Ability Enhancement Courses (AEC): The Ability Enhancement (AE) Courses may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC).

   "AECC" courses are the courses based upon the content that leads to Knowledge enhancement (i) Environmental Science and (ii) English/MIL Communication. These are mandatory for all disciplines.

   Skill Enhancement Courses (SEC): SEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, Indian and foreign languages etc. These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge.

Assigning Credit Hours per Course: While there is flexibility for the departments in allocation of credits to various courses offered, the general formula would be:

- All core courses will be restricted to a maximum of 4 credits
- All electives will be restricted to a maximum of 3 credits
- All ability enhancement courses will be restricted to a maximum of 2 credits
- Projects will be restricted to a maximum of 3 credits

Any course requiring more than 4 credit hours for covering the syllabus content will be divided into two courses i.e., 6 Credits Course 1 - 3 credits + Course 2 – 3 credits or 6 Credits Course 1 Theory - 4 credits + Course 2 Lab – 2 credits.

XI. Credit Value per Course & Structure of Syllabus:

Following pattern of Core, Elective and Skill based courses for Biochemistry are suggested as per CBCS

A. Core Courses or Foundational Courses:

14 courses 1

4 Core theory paper courses (14 x 4 = 56 credits)

14 Practical paper courses related to respective theory papers (14 x 2 = 28 Credits)

Total Credits: 56+28 = 84 credits

B. Elective Courses: 48 Credits Electives

i. Discipline Specific Elective Courses (DSE): 4 Courses

4 Theory paper courses (4 x 4 = 16 credits)

4 Practical paper courses related to respective theory papers (4 x 2 = 8 Credits)

Total Credits: 16+8 = 24 credits

ii. Generic Elective (GE) Courses :

4 Courses 4 Theory paper courses (4 x 4 = 16 credits)

4 Practical paper courses related to respective theory papers (4 x 2 = 8 Credits)

Total Credits: 16+8 = 24 credit

B. Skill Enhancement Courses : Two Courses

These courses shall be considered under "Skill Enhancement Elective (SEE) Courses" 2 Theory paper courses each with 4 Credits each (2 x 4 = 8 Credits)

C. Ability Enhancement Compulsory Courses: Two Courses

2 Theory paper courses each with 4 Credits each (2 x 4 = 8 Credits)

Total Credits for All Courses: 84 + 24 + 24 + 8 + 8 = 148 Credits

Marks Scheme B. Sc. per course

Theory Paper = 100 Marks

Practical paper = 50 Marks

Each Theory paper in Science shall be of 100 Marks. In which 20 Marks are reserved for Internal Assessment and 80 Marks for External Examination as per the following breakup:

- One Written Test = 10 Marks
- Home Assignment = 10 Marks

Practical in Sciences shall be of 50 Marks. In which 50 Marks are reserved for Internal Practical assessment and 25 for External Practical.

Distribution of Internal Practical 25 Marks

• Day to Day Performance	12 Marks
• One Practical Test	08 Marks
• Marks for Attendance	05 Marks

Breakup of Attendance of Practical

Above 75% to 80%	02 Marks
Above 80% to 85%	03 Marks
Above 85% to 90%	04 Marks
Above 90% to 100%	05 Marks

CHOICE BASED CREDIT SYSTEM

B.Sc.(Hons.) Biotechnology

SEMESTER I		SEMESTER II	
C1	Chemistry	C3	Biophysics
C2	Cell Biology	C4	Biochemistry & Metabolism
AECC 1	English/EVS/MIL communication	AECC2	English/EVS/MIL communication
GE	GE1	GE	GE2

SEMESTER III		SEMESTER IV	
C5	Bioanalytical Tools	C8	Molecular Biology
C6	General Microbiology	C9	Immunology
C7	Mammalian Physiology	C10	Genetics
SEC	SEC1	SEC	SEC2
GE	GE3	GE	GE4

SEMESTER V		SEMESTER VI	
C11	Fermentation Technology	C13	Animal Biotechnology
C12	Recombinant DNA Technology	C14	Genomics and Proteomics
DSE	DSE1	DSE	DSE3
DSE	DSE2	DSE	DSE4

C: Core Courses; **GE:** Generic Elective; **AECC:** Ability Enhancement Compulsory Course; **SEC:** Skill Enhancement Courses; **DSE:** Discipline Specific Elective

Generic Elective (any one per semester in semesters 1-4)

- Entrepreneurship Development
- Bioethics and Biosafety
- Community health and Human Welfare
- Developmental Biology

Skill Enhancement (any one per semester in semesters 3-4)

- Molecular Diagnostics
- Industrial Fermentations
- Enzymology
- Drug Designing
- Basics of Forensic Science

DISCIPLINE CENTRIC SUBJECTS (any two per semester in semesters 5-6)

- Bioinformatics
- Biostatistics
- Medical Microbiology
- Ecology and Environment
- Environmental Biotechnology
- Evolutionary Biology
- Intellectual Property Rights
- Microbial Physiology

Semester- I				
Course Code	**Course Type**	**Course Name**	**Credits**	**Hrs**
BBT 1.1	CC 1	Fundamentals of Chemistry	4	60
BBT 1.1P	CC 1P	Fundamentals of Chemistry	2	60
BBT 1.2	CC 2	Cell Biology	4	60
BBT 1.2P	CC 2 P	Cell Biology	2	60
BBT 1.3	AECC 1	English/EVS/MIL communication	4	60
BBT 1.4	GE 1 / GE 1P (any one for I semester)	Entrepreneurship Development	4	60
BBT 1.4P		Entrepreneurship Development	2	60
BBT 1.5		Bioethics and Biosafety		60
BBT 1.5P		Bioethics and Biosafety		60
BBT 1.6		Community health and Human Welfare		60
BBT 1.6P		Community health and Human Welfare		60
BBT 1.7		Developmental Biology		60
BBT 1.7P		Developmental Biology		60

Total Credit: 22

Semester -II				
Course Code	**Course Type**	**Course Name**	**Credits**	**Hrs**
BBT 2.1	CC 3	Biophysics	4	60
BBT 2.1P	CC 3P	Biophysics	2	60
BBT 2.2	CC 4	Biochemistry & Metabolism	4	60
BBT 2.2P	CC 4 P	Biochemistry & Metabolism	2	60
BBT 2.3	AECC 2	English/EVS/MIL communication	4	60
BBT 2.5	GE 2 / GE 2P (any one for II semester)	Entrepreneurship Development		60
BBT 2.5P		Entrepreneurship Development		60
BBT 2.6		Bioethics and Biosafety	4	60
BBT 2.6P		Bioethics and Biosafety	2	60
BBT 2.7		Community health and Human Welfare		60
BBT 2.7P		Community health and Human Welfare		60
BBT 2.8		Developmental Biology		60
BBT 2.8P		Developmental Biology		60
		Total	22	

Semester- III				
Course Code	**Course Type**	**Course Name**	**Credits**	**Hrs**
BBT 3.1	CC 5	Bioanalytical Tools	4	60
BBT 3.1P	CC 5P	Bioanalytical Tools	2	60
BBT 3.2	CC 6	General Microbiology	4	60
BBT 3.2P	CC 6P	General Microbiology	2	60
BBT 3.3	CC 7	Mammalian Physiology	4	60
BBT 3.3P	CC 7P	Mammalian Physiology	2	60
BBT 3.4	SEC 1	Molecular Diagnostics	4	60
		Molecular Diagnostics		
BBT 3.5		Industrial Fermentations		
		Industrial Fermentations		
BBT 3.6		Enzymology		
		Enzymology		
BBT 3.7		Drug Designing		
		Drug Designing		
BBT 3.8		Basics of Forensic Science		
		Basics of Forensic Science		
BBT 3.9	GE 3 / GE 3P (any one for III semester)	Entrepreneurship Development		60
BBT 3.9P		Entrepreneurship Development		60
BBT 3.10		Bioethics and Biosafety	4	60
BBT 3.10P		Bioethics and Biosafety	2	60
BBT 3.11		Community health and Human Welfare		60
BBT 3.11P		Community health and Human Welfare		60
BBT 3.12		Developmental Biology		60
BBT 3.12P		Developmental Biology		60

Total credit 28

Semester- IV				
Course Code	**Course Type**	**Course Name**	**Credits**	**Hrs**
BBT 4.1	CC 8	Molecular Biology	4	60
BBT 4.1P	CC 8P	Molecular Biology	2	60
BBT 4.2	CC 9	Immunology	4	60
BBT 4.2P	CC 9P	Immunology	2	60
BBT 4.3	CC 10	Genetics	4	60
BBT 4.3P	CC 10P	Genetics	2	60
BBT 4.4	SEC 2 / (any one for IV semester)	Molecular Diagnostics	4	60
		Molecular Diagnostics		
BBT 4.5		Industrial Fermentations		
		Industrial Fermentations		
BBT 4.6		Enzymology		
		Enzymology		
BBT 4.7		Drug Designing		
		Drug Designing		
BBT 4.8		Basics of Forensic Science		
		Basics of Forensic Science		
BBT 4.9	GE 4 / GE 4P (any one for IV semester)	Entrepreneurship Development		60
BBT 4.9P		Entrepreneurship Development		60
BBT 4.10		Bioethics and Biosafety	4	60
BBT 4.10P		Bioethics and Biosafety	2	60
BBT 4.11		Community health and Human Welfare		60
BBT 4.11P		Community health and Human Welfare		60
BBT 4.12		Developmental Biology		60
BBT 4.12P		Developmental Biology		60
		Total	28	

Semester -V				
Course Code	**Course Type**	**Course Name**	**Credits**	**Hrs**
BBT 5.1	CC 11	Fermentation Technology	4	60
BBT 5.1P	CC 11P	Fermentation Technology	2	60
BBT 5.2	CC 12	Recombinant DNA Technology	4	60
BBT 5.2P	CC 12P	Recombinant DNA Technology	2	60
BBT 5.3	DSE 1 & DSE 1P / DSE 2 & DSE 2P (any two for V semester)	Bioinformatics		60
BBT 5.3P		Bioinformatics		
BBT 5.4		Biostatistics		60
BBT 5.4P		Biostatistics		
BBT 5.5		Medical Microbiology	4	60
BBT 5.5P		Medical Microbiology	2	
BBT 5.6		Ecology and Environment	4	60
BBT 5.6P		Ecology and Environment	2	
BBT 5.7		Environmental Biotechnology		60
BBT 5.7P		Environmental Biotechnology		
BBT 5.8		Evolutionary Biology		60
BBT 5.8P		Evolutionary Biology		
BBT 5.9		Intellectual Property Rights		60
BBT 5.9P		Intellectual Property Rights		
BBT 5.10		Microbial Physiology		60
BBT 5.10P		Microbial Physiology		

Total credits: 24

Semester -VI				
Course Code	**Course Type**	**Course Name**	**Credits**	**Hrs**
BBT 6.1	CC 13	Animal Biotechnology	4	60
BBT 6.1P	CC 13P	Animal Biotechnology	2	60
BBT 6.2	CC 14	Genomics and Proteomics	4	60
BBT 6.2P	CC 14P	Genomics and Proteomics	2	60
BBT 6.3	DSE 3 & DSE 3P / DSE 4 & DSE 4P (any two for VI semester)	Bioinformatics		60
BBT 6.3P		Bioinformatics		60
BBT 6.4		Biostatistics		60
BBT 6.4P		Biostatistics		60
BBT 6.5		Medical Microbiology	4	60
BBT 6.5P		Medical Microbiology	2	60
BBT 6.6		Ecology and Environment	4	60
BBT 6.6P		Ecology and Environment	2	60
BBT 6.7		Environmental Biotechnology		60
BBT 6.7P		Environmental Biotechnology		60
BBT 6.8		Evolutionary Biology		60
BBT 6.8P		Evolutionary Biology		60
BBT 6.9		Intellectual Property Rights		60
BBT 6.9P		Intellectual Property Rights		60
BBT 6.10		Microbial Physiology		60
BBT 6.10P		Microbial Physiology		60
		Total	**24**	
		Total	**148**	

Total Credits: 148
Sem I: 22, Sem II: 22, Sem III: 28, Sem IV: 28, Sem V:24, Sem VI: 24.

Details of courses under B.Sc.

Course	*Credits	
	Theory+ Practical	Theory + Tutorial
I. Core Course (6 Credits)		
(14 Papers)	14X4= 56	14X5=70
Core Course Practical / Tutorial*		
(14 Papers)	14X2=28	14X1=14
II. Elective Course (6Credits)		
(8 Papers)		
A.1. Discipline Specific Elective	4X4=16	4X5=20
(4 Papers)		
A.2. Discipline Specific Elective Practical/ Tutorial*	4 X 2=8	4X1=4
(4 Papers)		
B.1. Generic Elective/ Interdisciplinary	4X4=16	4X5=20
(4 Papers)		
B.2. Generic Elective Practical/ Tutorial*	4 X 2=8	4X1=4
(4 Papers)		
III. Ability Enhancement Courses		
1. Ability Enhancement Compulsory Courses (AECC) (2 Papers of 4 credit each)		
Environmental Science	2 X 4=8	2 X 4=8
English/Hindi/MIL Communication		
2. Skill Enhancement Courses (SEC) (2 Papers of 4 credit each)		
(Minimum 2)	2 X 4=8	2 X 4=8
Total credit	**148**	**148**

Institute should evolve a system/policyabout ECA /General Interest/Hobby/Sports/NCC/NSS/related courses on its own.

*** Wherever there is a practical there will be no tutorial and vice-versa**

SEMESTER-I
BBT 1.1 Fundamentals of Chemistry

Learning Outcomes

- Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories.
- Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
- Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
- Students will be able to function as a member of an interdisciplinary problem solving team.

Unit-1 **(3 Lecture)**

Gaseous State: Kinetic theory of gases, and deviation of kinetic gas equation, Deduction of gas laws such as Boyl's law, Charle's law, Graham's law of diffusion. Avogadro's principle, velocity of gas molecules, kinetic energy of translational motion. Dalton's law of partial pressure.

Unit 2 **(Lecture 3)**

Chemical Kinetics – Order-molecularity. First and second order-nth order rate equation, temp dependence of rate of reactions, collision theory.

Unit 3 **(Lecture 4)**

Collgative properties-lowering of vapour pressure of solvent, elevation of boiling point, freezing point lowering of solutions, Osmosis and osmotic pressure, relation of osmotic and vapour pressure, Van't Hoff equation for osmotic pressure. Electrolytes, Arrhenius theory for dissociation of electrolytes.

Unit 5 **(Lecture 12)**

Ionic equilibrium: Electrolytic conductance, Faraday's Law of electrolysis, transference and transference numbers, variation of conductance with concentration, effect on infinite dilution and other factors on conductance, inter- ionic attraction theory of conductance, conductometric titration, activity coefficients and their determination, Debye-Huckel theory of activity coefficients, ionization constants of weak acids and bases, pH, buffers, solubility products, salt effects and solubility.

Unit 6 **(Lecture 6)**

Chemical bonding-various theories, covalent, hydrogen bonding and other weak interactions Atomic chemistry-electromagnetism. Principles of oxidation- reduction.

Unit 7 **(Lecture 18)**

Principles of electrochemistry: EMF and its measurements, single electrode potentials, calculation of single electrode potentials, thermodynamics of electrode potentials, classification of electrodes, amalgam, gas, metal/insoluble salt and oxidation- reduction electrodes, electrochemical cells, the junction potentials, solubility product and EMF potentiometric determination of pH, potentiometric titrations.

Unit 8

Basics in organic chemistry-Nomenclature, Hydrocarbons, alcohols, amines, alkyl indices Conformation of alkanes; alkyl halides, alcohols, ethers, amines Cycloalkanes. Oxidations, reductions, eliminations, addition and substitution reactions Synthesis of small molecules Quantitative structure-activity relationships (QSAR)

BBT 1.2 CELL BIOLOGY

Learning Outcome

- This course introduces the students to the basics of cell and its components.
- This gives them a strong foundation on the basic unit of life.
- At the end of the course, the student has a strong foundation on the functions of the cell.

Unit I **(10 Lecture)**

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation. Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

Unit II **(15 Lecture)**

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

Unit III **(20 Lecture)**

Lysosomes: Vacuoles and micro bodies: Structure and functions

Ribosomes: Structures and function including role in protein synthesis. **Mitochondria**: Structure and function, Genomes, biogenesis.

Chloroplasts: Structure and function, genomes, biogenesis

Nucleus: Structure and function, chromosomes and their structure.

Unit IV **(15 Lecture)**

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction.

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

BBT 1.2P PRACTICALS

1. Study the effect of temperature and organic solvents on semi permeable membrane.
2. Demonstration of dialysis.
3. Study of plasmolysis and de-plasmolysis.
4. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
5. Study of structure of any Prokaryotic and Eukaryotic cell.
6. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
7. Cell division in onion root tip/ insect gonads.
8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

SUGGESTED READING

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

SEMESTER II

BBT 2.1 FUNDAMENTALS OF PHYSICS

Learning outcome

- Differentiate the terms heat and temperature and measure temperature using thermometer and convert one scale of temperature to another scale.
- Understand specific heat capacity of gas and the different theories on specific heat capacity
- Differentiate between principles and methods to produce low temperature, liquefy air, helium and hydrogen
- Define postulates of kinetic theory of gases and arrive at theorem of equipartition of energy and derive Van der Waal‟s equation.
- Define different thermal processes and understand laws of thermodynamics and identify its outcome.

Unit 1 **(Lecture 1)**

Interrelationship between Physics and Life sciences.

Unit 2 Measurements: **(Lecture 6)**

Physical quantities, standards and units: Length: radius of proton to size to astronomical distances. Mass: atomic mass unit to mass of earth. Time: time for fast elementary particle to pass through nucleus to age of earth. Electric current. Thermodynamic temperature. Amount of substance. Luminous intensity. International systems and units: Units for measuring physical quantities and their inter-conversion.

Unit 3 Elasticity: Membrane biophysics, Heamodynamics, **(Lecture 3)**

Stress and strain in solids, Hook’s law, Stress-strain curves, Limit of elasticity. Relevance of elasticity to life science

Unit 4 Fluid Statics: **(Lecture 6)**

Fluids: Definition, Pressure and Density. The variation of pressure in a fluid at rest. Pascal’s Principle. Measurement of pressure. Various units of pressure and their inter-conversion.

Unit 5 Body Fluid Dynamics (Viscosity): (Lecture 10)

Streamline and turbulent flow (definition and explanation). Equation of continuity. Flow of liquids through capillaries. Poiseulles equation: Derivations and physical significance. Reynolds number: Physical significance. Concept of pressure energy. Bernoulli's theorem and its applications- Venturi meter and Pitot's tube. Viscosity estimation by Oswald's viscometer. Relevance to life sciences.

Unit 6 Surface tension: (Lecture 6)

Surface tension and surface energy: Definition, concept and derivation. Capillary action. Angle of contact. Wettability. Temperature dependence of surface tension. Relevance to life sciences and applications.

Unit 7 Heat: Quantum theory, radioisotopes in therapy (Lecture 5)

A form of energy. Quantity of heat and specific heat. Molar heat capacity of solid. Concept of temperature. Thermal equilibrium – zeroth law of thermodynamics. Measuring temperature. International practical temperature scale.

Unit 8 Thermodynamics and real gases Homostastics (Lecture 10)

Mechanical equivalent of heat. Heat and work. First law of thermodynamics: Mathematical form and limitations, applications. Indicator diagram and concept of cyclic process. Second law of thermodynamics. Concept of entropy with examples. Carnot cycle and its efficiency: Four steps involved, Efficiency. Van der Waals equation of state, Critical constants. Liquification of gases: Concepts used in refrigerator.

BBT 2.1P Practical

BBT 2.2 BIOCHEMISTRY AND METABOLISM

Learning Outcome

- Through this course the students are exposed to importance of biological macromolecules
- They acquire knowledge in the quantitative and qualitative estimation of biomolecules
- They study the influence and role of structure in reactivity of biomolecules
- At the end of the course, the students have a thorough understanding on the role of biomolecules and their functions

Unit I: Introduction to Biochemistry: **(10 Lecture)**

A historical prospective.

Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions

Unit II **(10 Lecture)**

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA.

Unit III **(20 Lecture)**

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: NAD^+, $NADP^+$, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate,lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions

Unit IV **(20 Lecture)**

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids.

BBT 2.2P PRACTICALS

1. To study activity of any enzyme under optimum conditions.
2. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
3. Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.
4. Estimation of blood glucose by glucose oxidase method.
5. Principles of Colorimetry**:**
   - **(i)** Verification of Beer's law, estimation of protein.
   - **(ii)** To study relation between absorbance and % transmission.
6. Preparation of buffers.
7. Separation of Amino acids by paper chromatography.
8. Qualitative tests for Carbohydrates, lipids and proteins

SUGGESTED READING

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

SECOND YEAR III SEMESTER

BBT 3.1 BIO-ANALYTICAL TOOLS

Learning Outcome

- This skill based course will teach the students the various instrumentations that are used in the analytical laboratories.
- This course covers both fundamental and applications of the instruments that are routinely used for the characterization of biomolecules
- At the end of the course, the student has the basic knowledge on the theory, operation and function of analytical instruments

Unit I **(10 Lecture)**

Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

Unit II **(15 Lecture)**

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infra- red), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

Unit III **(15 Lecture)**

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

Unit IV **(20 Lecture)**

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications**.**

BBT 3.1P PRACTICAL

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub-cellular fractions of rat liver cells.
4. Preparation of protoplasts from leaves.
5. Separation of amino acids by paper chromatography.
6. To identify lipids in a given sample by TLC.
7. To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.

SUGGESTED READING

2. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley& Sons. Inc.
3. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco

BBT 3.2 GENERAL MICROBIOLOGY

Learning Outcome

- This fundamental paper discusses the importance of microorganisms
- The course throws light on types of microorganisms in and around humans
- At the end of the course, the student has understanding on the metabolism and mechanism of microbial life

Unit I **(10 Lecture)**

Fundamentals, History and Evolution of Microbiology.

Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.

Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

Unit II **(10 Lecture)**

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

Unit III **(20 Lecture)**

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

Unit IV **(20 Lecture)**

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents

Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.

Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.

BBT 3.2P PRACTICALS

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.

SUGGESTED READING

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4th edition. John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA. (2005). *Modern Food Microbiology*. 7thedition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 thedition. Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

BBT 3.3 MAMMALIAN PHYSIOLOGY

UNIT I: Digestion and Respiration (15 Lecture) Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice

Respiration: Exchange of gases, Transport of O_2 and CO_2, Oxygen dissociation curve, Chloride shift.

UNIT II: Circulation (15 Lecture)

Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism of coagulation of blood.

Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

UNIT III: Muscle physiology and osmoregulation (15 Lecture)

Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction.

Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

UNIT IV: Nervous and endocrine coordination (15 Lecture)

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters. Mechanism of action of hormones (insulin and steroids). Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

BBT 3.3P PRACTICALS

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Counting of mammalian RBCs
4. Determination of TLC and DLC
5. Demonstration of action of an enzyme
6. Determination of Haemoglobin

SUGGESTED READING

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley & sons,Inc.

SEMESTER- IV
BBT 4.1 MOLECULAR BIOLOGY

Learning Outcome

- It deals with understanding the molecular aspects of the biology.
- It majorly emphasizes the concepts of central dogma of molecular biology spanning from DNA Replication till Protein Synthesis and Reverse transcription.
- It also helps in understanding the concepts of cellular function.

Unit I: DNA structure and replication (15 Lecture)

DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

Unit II: DNA damage, repair and homologous recombination (10 Lecture)

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.

Unit III: Transcription and RNA processing (17 Lecture)

RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5’ cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

Unit IV: Regulation of gene expression and translation (18 Lecture)

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation, Posttranslational modifications of proteins.

BBT 4.1P PRACTICAL

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA
5. Preparation of restriction enzyme digests of DNA samples
6. Demonstration of AMES test or reverse mutation for carcinogenicity

SUGGESTED READING

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

BBT 4.2 IMMUNOLOGY

Learning Outcome

- This course provides you with knowledge and understanding of immunology and the way it is applied in diagnostic and therapeutic techniques and research.
- It trains the students with essentiality of molecules, cells, tissues, and organs involved in the defense mechanism.
- It's a paper which accomplishes the learning of techniques involved in understanding the immunological aspects of physiology and biological samples

Unit I **(20 Lecture)**

Immune Response: An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T-lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

Unit II **(15 Lecture)**

Regulation of immunoglobulin gene expression: clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity.

Unit III **(13 Lecture)**

Major Histocompatibility complexes: class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.

Unit IV **(12 Lecture)**

Vaccines & Vaccination: adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA.

BBT 4.2P PRACTICAL

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Double immunodiffusion test using specific antibody and antigen.
8. ELISA.

SUGGESTED READING

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

BBT 4.3 GENETICS

Learning Outcome

- The paper helps in highlighting the scope and significance of genetics by imbibing the principles of hereditary genetic transmission and interactions of gene with environment.
- It also helps students to learn the molecular aspects of genetics disorders and mutations.
- It helps the students to appreciate the concepts of gene and relationship between genotype and phenotype

Unit I **(12 Lecture)**

Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance.

Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms.

Mendelian genetics : Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.

Unit II **(18 Lecture)**

Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.

Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences- SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA.

Genetic organization of prokaryotic and viral genome.

Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

Unit III **(15 Lecture)**

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abonormalities– Aneuploidy and Euploidy.

Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

Unit IV **(15 Lecture)**

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping.

Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting.

Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.

BBT 4.3P PRACTICALS

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Mendelian deviations in dihybrid crosses
4. Demonstration of - Barr Body -*Rhoeo* translocation.
5. Karyotyping with the help of photographs
6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
7. Study of polyploidy in onion root tip by colchicine treatment.

SUGGESTED READING

2. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
3. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
4. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
5. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
6. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

SEMESTER-V
BBT 5.1 INDUSTRIAL FERMENTATION

Unit I

Production of industrial chemicals, 37teroid37cal and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, microbial electricity, starch conversion processes; Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti cancer agents, amino acids.

Unit II

Microbial products of pharmacological interest, 37teroid fermentations and transformations. Over production of microbial metabolite, Secondary metabolism – its significance and products. Metabolic engineering of secondary metabolism for highest productivity. Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

Unit III

Purification & characterization of proteins, Upstream and downstream processing, solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra centrifugation, liquid extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems, Anaerobic fermentations.

Unit IV

Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of Ph and temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination, factors depending on scale up principle and different methods of scaling up. Metabolic engineering of antibiotic biosynthetic pathways.

BBT 5.1P PRACTICALS

1. Comparative analysis of design of a batch and continuous fermenter.
2. Calculation of Mathematical derivation of growth kinetics.
3. Solvent extraction & analysis of a metabolite from a bacterial culture.
4. Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/glucosidase etc.)

BBT 5.2 RECOMBINANT DNA TECHNOLOGY

Learning Outcome

- This course teaches RDNA technology techniques and their application in the field of genetic engineering
- They learn about plasmids, vectors and gain knowledge on the construction of Cdna libraries
- Student of this course have knowledge on gene manipulation, gene expression, etc which prepares them for further studies in the area of genetic engineering

Unit I **(15 Lecture)**

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.

Unit II **(20 Lecture)**

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and Cdna library, screening of recombinants, reverse transcription,. Genome mapping, DNA fingerprinting, Applications of Genetic Engineering Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

Unit III **(10 Lecture)**

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

Unit IV **(15 Lecture)**

Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and A. rhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

BBT 5.2P PRACTICALS

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E.coli*
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Making competent cells
7. Transformation of competent cells.
8. Demonstration of PCR

SUGGESTED READING

2. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K
3. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
4. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
5. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
6. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

SEMESTER- VI

BBT 6.1 ANIMAL BIOTECHNOLOGY

Learning Outcome

- This course teaches organization and expression of animal genome and animal tissue culture
- Students learn about transgenic animal, their application in pharmaceutical industry, cloning and its importance.
- This course prepares the students in appreciating the its benefits and applications in biotechnological, pharmaceutical, medical

UNIT I **(10 Lecture)**

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer. **(10 Lecture)**

UNIT II

Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.

UNIT III **(20 Lecture)**

Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.

UNIT IV **(20 Lecture)**

Genetic modification in Medicine – gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

BBT 6.1P PRACTICALS

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures.
3. Preparation of Hanks Balanced salt solution
4. Preparation of Minimal Essential Growth medium
5. Isolation of lymphocytes for culturing
6. DNA isolation from animal tissue
7. Quantification of isolated DNA.
8. Resolving DNA on Agarose Gel.

SUGGESTED READING

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA.
2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.
3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.
4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA- genes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

BBT 6.2 GENOMICS & PROTEOMICS

Learning Outcome

- This course aims to provide the knowledge and practical skills of functional genomics and proteomics.
- The course also teaches the techniques used in functional genemics such as microarrays, NGST, mRNA expression and miRNA expression.
- By the end of the course, students will have the necessary learning to radically advance our understanding of life and transform medicine

Unit I **(15 Lecture)**

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

Unit II **(10 Lecture)**

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

Unit III **(20 Lecture)**

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filteration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.

Unit IV **(15 Lecture)**

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution.

Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification.

De novo sequencing using mass spectrometric data.

BBT 6.2P PRACTICALS

1. Use of SNP databases at NCBI and other sites
2. Use of OMIM database
3. Detection of Open Reading Frames using ORF Finder
4. Proteomics 2D PAGE database
5. Softwares for Protein localization.
6. Hydropathy plots
7. Native PAGE
8. SDS-PAGE

SUGGESTED READING

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
5. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
6. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
7. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). *i*Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applicationsof recombinant DNA. ASM Press, Washington.
6. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

DISCIPLINE CENTRIC SUBJECTS

BBT 5.3/ BBT 6.3 BIOINFORMATICS

Learning Outcome

- This allied paper introduces the students to concepts in bioinformatics
- The student will be able to apply basic principles of biology, computer science and mathematics to address complex biological problems

Unit I **(Lecture 15)**

History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web

Unit II **(Lecture 15)**

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

Unit III **(Lecture 10)**

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

Unit IV **(Lecture 10)**

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission.Genome Annotation: Pattern and repeat finding, Gene identification tools.

BBT 5.3P/BBT 6.3P PRACTICALS

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.

SUGGESTED READING

2. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
3. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
4. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

I.P.R. ENTREPRENEURSHIP BIOETIHCS & BIOSAFETY

UNIT-I **(Lecture 10)**

Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.

UNIT II **(Lecture 20)**

Entrepreneurship: Selection of a product, line, design and development processes, economics on material and energy requirement, stock the product and release the same for making etc. The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.

UNIT III **(Lecture 15)**

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies.

UNIT IV **(Lecture 20)**

Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

PRACTICALS

1. Proxy filing of Indian Product patent
2. Proxy filing of Indian Process patent
3. Planning of establishing a hypothetical biotechnology industry in India
4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Case study on women health ethics.
6. Case study on medical errors and negligence.
7. Case study on handling and disposal of radioactive waste

SUGGESTED READING

1. Entrepreneurship: New Venture Creation : David H. Holt
2. Patterns of Entrepreneurship : Jack M. Kaplan
3. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
4. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
5. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

BBT 5.7/BBT 6.7 ENVIRONMENTAL BIOTECHNOLOGY

Learning Outcome

- The students in the course are exposed to the diversity, function, ecological adaptation of microorganisms within the environment
- This course gives the importance of microbial life to key ecosystem process and teaches the role of biotechnology to address environmental issues
- At the end of the course, students are able to analyze case studies representatives of key areas of environmental biotechnology

UNIT I **(Lecture 5)**

Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol

UNIT II **(Lecture 15)**

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products.

UNIT III **(Lecture 15)**

Treatment of municipal waste and Industrial effluents. Bio-fertilizers

Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)

UNIT IV **(Lecture 10)**

Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

Unit V: Environment Health Science **(Lecture 15)**

Environment pollution, Heavy metal poison, drinking and health,waste water disposal and health, biomganeticfeild and health.

BBT 5.7P/BBT 6.7P PRACTICALS

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of BOD of water sample.
3. Calculation of COD of water sample.
4. Bacterial Examination of Water by MPN Method

SUGGESTED READING

1. Environmental Science, S.C. Santra
2. Environmental Biotechnology, Pradipta Kumar Mohapatra
3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter
4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
5. Agricultural Biotechnology, S.S. Purohit
6. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer
7. Introduction to Environmental Biotechnology, Milton Wainwright
8. Principles of Environmental Engineering, Gilbert Masters
9. Wastewater Engineering – Metcalf & Eddy

BBT 5.10/BBT 6.10 MICROBIAL PHYSIOLOGY

Learning outcome:

Its an advanced course where students get to know about the microbes in extreme environment, their mode of functioning under stress. Besides this, they are acquainted with prokaryotic photosynthetic machinery in detail and the knowledge gained can be applied for enhancing the efficiency of plants.

UNIT I **(Lecture 12)**

Nutritional classification of microorganisms based on carbon, energy and electron sources, Metabolite Transport, Diffusion: Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron.

UNIT II **(Lecture 13)**

Microbial Growth. Definition of growth, balanced and unbalanced growth, growth curve, the mathematics of growth-generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxie growth curve. Measurement of microbial growth. Measurement of cell numbers, cell mass and metabolic activity

UNIT III **(Lecture 15)**

Effect of the environment on microbial growth

Temperature- temperature ranges for microbial growth, classification based on temperature ranges and adaptations, pH-classification based on pH ranges and adaptations, solutes and water activity, oxygen concentration, radiation and pressure. Chemolithotrophic metabolism, Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogenoxidizing bacteria and methanogens.

UNIT IV **(Lecture 20)**

Phototrophic metabolism. Historical account of photosynthesis, diversity of phototrophic bacteria, anoxygenic and oxygenic photosynthesis, photosynthetic pigments: action and absorption spectrum, type, structure and location, physiology of bacterial photosynthesis: light reactions, cyclic and non-cyclic photophosphorylation. Carbon dioxide fixation, Calvin cycle and reductive TCA cycle.

BBT 5.10P/BBT 6.10P PRACTICALS

1. To study and plot the growth curve of *E coli* using turbidometric method and to calculate specific growth rate and generation time.
2. To study and plot the growth curve of *Aspergillus niger* by radial growth measurements.
3. To study the effect of pH on the growth of *E. coli*
4. To study the effect of temperature of *Aspergillus niger* by dry weight method.
5. Demonstration of the thermal death time and decimal reduction time of *E. coli*.

SUGGESTED READING

1. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
2. Madigan MT, Martinko JM and Parker J. (2003). Brock Biology of Microorganisms.10th edition. Pearson/ Benjamin Cummings.
3. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons.
4. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India.
5. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

BBT 5.4/BBT 6.4 BIOSTATISTICS

Learning Outcome

- This course imparts the knowledge of basic statistical methods to solve problems
- Students are taught to operate various statistical software packages
- By the end of the course, the students are able to appreciate the importance of statistics in research and prepares them for a career in research.

UNIT I **(Lecture 12)**

Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

UNIT II **(Lecture 18)**

Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT III **(Lecture 18)**

Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)

UNIT IV **(Lecture 12)**

Correlation and Regression. Emphasis on examples from Biological Sciences.

BBT 5.4P/BBT 6.4P PRACTICALS

1. Based on graphical Representation
2. Based on measures of Central Tendency & Dispersion
3. Based on Distributions Binomial Poisson Normal
4. Based on t, f, z and Chi-square

SUGGESTED READING

1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High Yield^{TM} Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

BBT 5.6/BBT 6.6 ECOLOGY AND ENVIRONMENT MANAGEMENT

Learning Outcome

- The main objective of this paper is to create an awareness among the students about the environment
- By the end of the course, the students will have a better appreciation for the environment and become responsible citizens

UNIT-I **(Lecture 12)**

Our Environment: Geological consideration of Atmosphere, Hydrosphere, Lithosphere Scope of Ecology. Development & Evolution of Ecosystem. Principles & Concepts of Ecosystem. Structure of ecosystem. Strata of an ecosystem. Types of ecosystem including habitats. Cybernetics & Homeostasis. Biological control of chemical environment.

UNIT II **(Lecture 20)**

Energy transfer in an Ecosystem. Food chain, food web, Energy budget, Production & decomposition in a system. Ecological efficiencies, Trophic structure & energy pyramids, Ecological energetic, principles pertaining to limiting factors, Bio-geochemical cycles (N,C,P cycles).

UNIT-III **(Lecture 18)**

Pollution & environmental Health related to Soil, Water, Air, Food, Pesticides, Metals, Solvents, Radiations ,Carcinogen, Poisons. Detection of Environmental pollutant. Indicators & detection systems. Bio-transformation, Plastic, Aromatics, Hazardous wastes Environmental cleanup : Case studies

UNIT-IV **(Lecture 10)**

Environmental biotechnologies, Biotechnologies in protection and preservation of environment. Bioremediation, Waste disposal.

BBT 5.6P/BBT 6.6P PRACTICALS

1. Study of all the biotic and abiotic components of any simple ecosystem- natural pond or terrestrial ecosystem or human modified ecosystem.
2. Determination of population density in a terrestrial community or hypothetical community by quad rate method and calculation of the Simpson's and Shannon-Weiner diversity index for the same community.
3. Principle of GPS (Global Positioning System).
4. Study of the life table and fecundity table, plotting of the three types of survivorship curves from the hypothetical data.
5. Study of the types of soil, their texture by sieve method and rapid tests for –pH, chlorides, nitrates, carbonates and organic carbon
6. Study any five endangered/ threatened species- one from each class.

SUGGESTED READING

1. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2nd edition) Cambridge University Press.
2. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication.
3. Ghosh, S.K., Singh, R. 2003. Social forestry and forest management. Global Vision Publishing House
4. Joseph, B., Environmental studies, Tata Mc Graw Hill.
5. Michael Allabay, Basics of environmental science, Routledge Press.
6. Miller, G.T. 2002. Sustaining the earth, an integrated approach. (5thedition) Books/Cole, Thompson Learning, Inc.
7. Mohapatra Textbook of environmental biotechnology IK publication.
8. Rana SVS, Environmenta lpollution – health and toxicology, Narosa Publication
9. Sinha, S. 2010. Handbook on Wildlife Law Enforsement in India. TRAFFIC, India.
10. Thakur, I S, Environmental Biotechnology, I K Publication.

GENERIC SUBJECTS

BBT 1.4/BBT 2.4/BBT 3.9/BBT 4.9 ENTERPRENEURSHIP DEVELOPMENT

Learning outcome

- Develop idea generation, creative and innovative skills
- Aware of different opportunities and successful growth stories
- Learn how to start an enterprise and design business plans those are suitable for funding by considering all dimensions of business.
- Understand entrepreneurial process by way of studying different case studies and find exceptions to the process model of entrepreneurship.
- Run a small enterprise with small capital for a short period and experience the science and art of doing business.

UNIT I INTRODUCTION (Lecture 10)

Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.

UNIT II ESTABLISHING AN ENTERPRISE (Lecture 12)

Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility.

UNIT III FINANCING THE ENTERPRISE (Lecture 15)

Importance of finance / loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management.

UNIT IV MARKETING MANAGEMENT (Lecture 13)

Meaning and Importance, Marketing-mix, product management – Product line, Product mix, stages of product like cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.

UNIT V ENTREPRENEURSHIP AND INTERNATIONAL BUSINESS (Lecture **10)**

Meaning of International business, Selection of a product, Selection of a market for international business, Export financing, Institutional support for exports.

BBT 1.4P/BBT 2.4P/BBT 3.9P/BBT 4.9P Project Report on a selected product should be prepared and submitted.

SUGGESTED READING

1. Holt DH. Entrepreneurship: New Venture Creation.
2. Kaplan JM Patterns of Entrepreneurship.
3. Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand & Sons.

BBT 1.5/BBT 2.5/BBT 3.10/BBT 4.10 BIOETHICS AND BIOSAFETY BIOTECHNOLOGY AND HUMAN WELFARE

Learning Outcome

- This course is an introduction to the students on the ethical aspects of conducting research and safety aspects to be adhered in a research setting.
- This course also introduces the students to effective management of available resources and footprint of research activities.
- At the end of the course, the student would have gained sufficient knowledge to act as a responsible scientist and environmentally conscious.

UNIT I **(Lecture 10)**

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

UNIT II **(Lecture 10)**

Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT III **(Lecture 15)**

Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.

UNIT IV **(Lecture 12)**

Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

UNIT V **(13 Lecture)**

Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E.coli*, human genome project.

BBT 1.5P/BBT 2.5P/BBT 3.10P/BBT 4.10P PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Perform of ethanolic fermentaion using Baker's yeast
2. Study of a plant part infected with a microbe
3. To perform quantitative estimation of residual chlorine in water samples
4. Isolation and analysis of DNA from minimal available biological samples
5. Case studies on Bioethics (any two)

SUGGESTED READING

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

BBT 1.7/BBT 2.7/BBT 3.12/BBT 4.12 DEVELOPMENTAL BIOLOGY

Learning Outcomes

Students who successfully complete the course will be able to:

- Name, describe and order the main stages of development common to most multicellular organisms.
- Describe the main anatomical changes that occur during development.
- Identify the cellular behaviors that lead to morphological change during development.
- Describe the hierarchy of gene activation that occurs in early Drosophila development.
- Understand how gene activation plays a role in differentiation and development.
- Describe the unique characteristics of the *Hox* genes and explain how they act as master regulators of development in multicellular organisms.
- Describe the main signaling pathways that play important roles in development.
- Explain how embryonic stem cells and their alternatives can be used in medical treatments.
- Understand how errors in development lead to congenital defects and spontaneous abortion.

UNIT I: Gametogenesis and Fertilization (Lecture 10) Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

UNIT II: Early embryonic development (Lecture 20) Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.

UNIT III: Embryonic Differentiation (Lecture 20) Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT IV: Organogenesis (Lecture 10) Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals**.**

BBT 1.7P/BBT 2.7P/BBT 3.12P/BBT 4.12P PRACTICALS

1. Identification of developmental stages of chick and frog embryo using permanent mounts
2. Preparation of a temporary stained mount of chick embryo
3. Study of developmental stages of *Anopheles*.
4. Study of the developmental stages of *Drosophila* from stock culture/photographs..
5. Study of different types of placenta.

SUGGESTED READING

1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

SKILL ENHANCEMENT COURSE

BBT 3.4/BBT4.4 MOLECULAR DIAGNOSTICS

Learning Outcome

- Compare and contrast DNA and RNA, including their structure, function, duplication, regulation, extraction, resolution and detection.
- Define the term 'nucleic acid amplification.'
- Explain the process of DNA sequencing.
- Describe chromosomal structure.
- List methods used to detect chromosomal mutations.
- Explain how genetic principles apply to the transmission ofdisease.
- Describe the laboratory techniques used to detect: microorganisms, inherited disease, DNA polymorphisms, neoplastic processes, DNA based tissue typing.
- Outline the quality assurance process required in a molecular diagnostic laboratory.

UNIT I **(Lecture 15)**

Enzyme Immunoassays:

Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays.Applications of enzyme immunoassays in diagnostic microbiology

UNIT II **(Lecture 15)**

Molecular methods in clinical microbiology:

Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology

Laboratory tests in chemotherapy:

Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests:Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

UNIT III **(Lecture 18)**

Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Antiidiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.

UNIT IV **(Lecture 12)**

GLC, HPLC, Electron microscopy, flowcytometry and cell sorting.Transgenic animals.

BBT 3.4P/BBT4.4P PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Perform/demonstrate RFLP and its analysis
2. Kirby-Bauyer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture
3. A kit-basd detection of a microbial infection (Widal test)
4. Study of Electron micrographs (any four).
5. Perform any one immuno diagnostic test (Typhoid, Malaria, Dengue)

SUGGESTED READING

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
2. Bioinstrumentation, Webster
3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic
4. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (editedby Paniker CKJ). University Press Publication.
5. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
6. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.
7. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. Appleton- Centuary-Crofts publication.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
9. Microscopic Techniques in Biotechnology, Michael Hoppert

BBT 3.5/BBT4.5 INDUSTRIAL FERMENTATIONS

Learning Outcome

- The course aims to provide fundamental insights to exploit microbes for manufacturing of products which have huge industrial significance.
- The course blends science and engineering with various biochemical processes to obtain products such as food, chemicals, vaccines, medicine
- At the end of the course, the student will have a better appreciation for the role of microbes in industry using technology

UNIT I **(Lecture 12)**

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, microbial electricity, starch conversion processes; Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti cancer agents, amino acids.

UNIT II **(Lecture 15)**

Microbial products of pharmacological interest, steriod fermentations and transformations. Over production of microbial metabolite, Secondary metabolism – its significance and products.

Metabolic engineering of secondary metabolism for highest productivity.

Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

UNIT III **(Lecture 13)**

Purification & characterization of proteins, Upstream and downstream processing, solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra centrifugation, liquid extraction, ion-exchange recovery of biological products.

Experimental model for design of fermentation systems, Anaerobic fermentations.

UNIT IV **(Lecture 20)**

Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass

transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination, factors depending on scale up principle and different methods of scaling up. Metabolic engineering of antibiotic biosynthetic pathways.

BBT 3.5P/BBT4.5P PRACTICALS

1. Comparative analysis of design of a batch and continuous fermenter.
2. Calculation of Mathematical derivation of growth kinetics.
3. Solvent extraction & analysis of a metabolite from a bacterial culture.
4. Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/glucosidase etc.)

SUGGESTED READING

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
5. Salisbury, Whitaker and Hall. Principles of fermentation Technology.

BBT 3.6/BBT4.6 ENZYMOLOGY

Learning Outcome

- It helps the students to learn the significant features of the biochemical catalysts.
- It helps the students to learn the methodology involved in assessing the enzyme activity and mechanism of enzyme action.
- It illustrates the enzyme catalysis, kinetics and regulatory aspects.

UNIT - I **(Lecture 20)**

Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis.

Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin).

Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation,

Different plots for the determination of Km and Vmax and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories, Significance of activation energy and free energy.

UNIT – II **(Lecture 15)**

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki, suicide inhibitor.

Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. Techniques for studying mechanisms of action, chemical modification of active site groups, specific examples-: chymotrypsin, Iysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase.

Enzyme regulation: Product inhibition, feed backcontrol, covalent modification.

UNIT – III **(Lecture 13)**

Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Qualitative description of concerted and sequential models. Negative co- operativity and half site reactivity. Enzyme - Enzyme interaction, Protein ligand binding, measurements analysis of binding isotherm, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes. Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acid synthase.

UNIT – IV **(Lecture 12)**

Enzyme Technology: Methods for large scale production of enzymes.

Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry. Enzyme electrodes.

Thermal stability and catalytic efficiency of enzyme, site directed mutagenesis and enzyme engineering– selected examples, Delivery system for protein pharmaceuticals, structure function relationship in enzymes, structural motifs and enzyme evolution.

Methods for protein sequencing. Methods for analysis of secondary and tertiary structures of enzymes. Protein folding *invitro* & i*nvivo*.

BBT 3.6P/BBT4.6P PRACTICALS

1. Purification of an enzyme from any natural resource
2. Quantitative estimation of proteins by Bradford/Lowry's method.
3. Perform assay for the purified enzyme.
4. Calculation of kinetic parameters such as Km, Vmax, Kcat

SUGGESTED READING

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M.Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGrawHill, 2009.
3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley andSons, 1995.
4. Biochemistry by Mary K.Campbell & Shawn O.Farrell, 5th Edition, Cenage Learning,2005.
5. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999
6. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2004
7. Practical Enzymology Hans Bisswanger Wiley–VCH 2004
8. The Organic Chemistry of Enzyme-catalyzed Reactions Richard B. Silverman Academic Press 2002

BBT 3.8/BBT4.8 BASICS OF FORENSIC SCIENCE

Learning Outcome

- On completion of the programme students will
  Apply the Laboratory skills to participate in the career needs of Forensic community.
- Become trained in the laboratory skills of different division of Forensic Science.
  Be able to work with different R&D organizations

Unit I **(Lecture 15)**

Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

Unit II **(Lecture 15)**

Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.

Unit III **(Lecture 15)**

Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification,

Unit IV **(Lecture 15)**

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

BBT 3.8P/BBT4.8P PRACTICALS

1. Documentation of crime scene by photography, sketching and field notes.
2. a. Simulation of a crime scene for training.

   b. To lift footprints from crime scene.
3. Case studies to depict different types of injuries and death.
4. Separation of nitro compounds (explosives)/ ink samples by thin layer chromatography.
5. Investigate method for developing fingerprints by Iodine crystals.
6. PCR amplification on target DNA and DNA profiling,
7. E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Recovering deleted evidences, Password Cracking

SUGGESTED READING

1. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
2. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001).
3. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002).
4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).
5. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).
6. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
7. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).

SCHEME OF EXAMINATION / ASSESSMENT UNDER CBCS

The evaluation of each course shall contain two parts :Internal or In Semester Assessment (IA) and External or End-Semester Assessment (EA).The internal grade awarded to the students in each course in a semester shall be published on the notice board at least one week before the commencement of end semester examination. The responsibility of evaluating the internal assessment is vested on the teacher(s) who teaches the course. There will be University Examinations at the end of each semester for both Theory and Practical. Semester End Examinations for all theorypapers shall be got set/prepared by the Controller of Examinations as per existing norms and evaluation of all theory papers courses shall be done by eligible faculty members of a cluster of colleges to be formed by all the colleges of a district, under the supervision and coordination of the Controller of Examination. When there is a single college in a district it has the liberty either to join the nearest cluster or form a new cluster with a similarly placed college of an adjacent district. Principal of the college where an evaluation centre shall be established shall prepare the panel of Evaluators and Head Examiners. 5-10% of the answer scripts evaluated by each evaluator may be got revised at random through the Head Examiners, in case of all courses. 20% of the marks allotted to each theory paper and 50% of the marks allotted to each practical paper including field work/ project work/ dissertation, wherever prescribed, shall be reserved for internal assessment. The evaluation of a candidate shall be awarded and record thereof maintained in accordance with the Regulations prescribed for the purpose under the CBCS as per the following:

THEORY	Syllabus to be covered in the Examination	Time allotted	% Weightage (Marks)
Internal Assessment Test (Pattern:One Long answer type question of 10 marks and Five Short answer type questions of 2 marks each)	Upto 50% (after 45 days)	1 Hour	20
External End Semester University Exam (Pattern: As proposed by the concerned BOS and approved by Academic Council or (*)	Upto 100% (after 90 days)	**3 Hours**	**80**
Total			**100**
Daily Evaluation of Practical			50 (including 20% for attendance, 20% for

records/Viva voce/attendance etc.		Viva-voce and 60% for internal test and day to day performance)
Final Practical Performance + Viva voce (External Examination)	100% Syllabus	50 [40(Paper) +10(Viva-voce)]
Total		**100**

In case of failure/re-appear category the Internal Assessment earned by the candidate as a regular student shall be carried forward to the subsequent examination.

Component	**4 Credit Courses (Theory Paper of a Lab. Oriented Course) 80 Marks**	**6 Credit Courses (Theory Paper of a Non-Laboratory Course) 120Marks**	**2 Credit Courses (Theory) 40 Marks**
05 Short Answer type	5x2= 10 Marks	5x2= 10Marks	5x1=5
03 Medium Answer type	3x10=30 Marks	3x18 =54 Marks	3x5=15
02 Long Answer type	2x20=40 Marks	2x28=56Marks	2x10=20
Total Semester End Examination Marks in each course	80	120	40

MINIMUM ELIGIBILITY FOR APPEARANCE IN EXAMINATION

A semester end external examination for B.A. /B.Sc course, under CBCS, shall be open to the following categories of students :

1. A Regular student i.e. a student who has undergone a regular course of study in a college for the period specified for that course of study by having been on the rolls of the college immediately preceding the examination and has his/her name submitted to the Controller of Examinations by the college Principal where he/she has pursued the course for the examination and has fulfilled the following conditions to be certified by the college Principal concerned:
   - He/she has been a student of good conduct.
   - He/she has attended not less than 75% of the lecture delivered including seminars, tutorials etc. in each course opted by him/her in that semester.
   - He/she has passed in internal assessment.

ω In the case of laboratory course/practicals, he/she has attended not less than 75% of the practical classes conducted (practicals include field studies, workshop practice, map work, surveying etc.).

ω He/she has paid the prescribed fee.

2. Ex-students i.e. students who after having undergone a regular course of study and having completed all conditions of eligibility for appearance in a course(s) in a semester examination including minimum attendance requirement and having passed in Internal Assessment and having either failed to pass the semester examination in that subject/paper(s) or been unable to appear in the examination in that subject/paper(s) will be eligible to appear as a private candidate in the examination by submitting his/her 15 application on the prescribed form along with prescribed fees to reach the Controller of Examinations within the dates fixed for this purpose.

PROMOTION TO NEXT SEMESTER

i. A student will be eligible for promotion from Semester-I to II, Semester-III to IV if he/she has:
   - Secured pass marks in Internal Assessment of all the subjects/papers of the Semester I/III as the case maybe.
   - Has appeared in atleast one of the papers of Semester End examination of Semester I/III as the case maybe.

ii. A student will be eligible for promotion from Semester-II to III and Semester- IV to V provided he/she has earned atleast 50% of the total credits for the subjects/papers of theory/practicals of Semester-I/III as the case may be and passed in Internal Assessment of all subjects/papers of Semester–II/IV as the case maybe.

iii. A student will be eligible for promotion from Semester-V to VI provided he/she has passed in all subjects/papers of Semester-I and Semester-IIII. Provided that a student who does not fulfill the promotion criteria (i), (ii) & (iii) above shall be declared fail in the semester concerned. However, he/she shall have the option to retain the marks in the papers in which he/she has secured Pass marks.

iv. A student who has to reappear in a subject / paper prescribed for Semester-I to IV shall appear in the subsequent Semester end examination to be held as per the dates prescribed by the University.

v. A student who has to reappear in a subject(s)/paper(s) prescribed for Semester- V & VI shall appear in the supplementary examination.

CONDONATION OF LECTURES

1. The Principal of College concerned may condone shortage of a student in attendance in a semester for special reasons, to be recorded in writing upto 6% of the lectures deli Any candidate, who falls short of attendance beyond condonable limits or whose shortage in attendance is not condoned by the competent authorities and wants to pursue the programme, shall be required to rejoin the course along with the next batch of students of the same class to make up the deficiency by attending the required number of lectures by which he/she had fallen short. This provision shall however, be applicable only in respect of such of the candidates who have attended at least 50% classes in the said course/s. Candidates having attended less than 50% of the lectures in a particular course/s shall be considered for re- admission after depositing afresh the prescribed admission fee for the Semester

/ Course. However, such candidate/s shall appear in the examination along with the candidates of the semester,with which he/she has been re-admitted, in regular capacity.

Provided further also that in case such a student again falls short of lectures he/she shall not be allowed to seek admission to that course in any affiliated college in any subsequent year.

A student who has been on the rolls of a college in the Semester-I, II,III, IV & V of B.A./B.Sc./B.Com./BBA/BCA/Honours course and earns eligibility to join the Semester-II or III or IV or V of the programme as the case may be, but fails to join the semester when he/she was due to join it or discontinues his/her studies for any reason whatsoever may be considered for admission to the semester concerned in a subsequent year if he/she submits application to this effect before the commencement of the semester concerned provided a seat and other facilities for the courses offered by the student are available in the college concerned in the semester he/she wishes to join and the student seeks admission within a period of one year from the date he/she discontinue his/her studies.

INTERNAL ASSESSMENT FOR B.A/ B.Sc./BCA RUNNING

UNDER OLD SEMESTER SYSTEM

B. SC (BACHELOR OF SCIENCES)

- Theory = 100 Marks
- Practical = 50 Marks

2. vered or practicals conducted in each course separately.

Each Theory paper in Science shall be of 100 Marks. In which 20 Marks are reserved for Internal Assessment and 80 Marks for External Examination as per the following breakup:

- One Written Test = 10 Marks
- Home Assignment = 10 Marks

Practicals in Sciences shall be of 50 Marks. In which 50 Marks are reserved for Internal Practical assessment and 25 for External Practicals.

Distribution of Internal Practical 25 Marks

- Day to Day Performance 12 Marks
- One Practical Test 08 Marks
- Marks for Attendance 05 Marks Breakup

of Attendance of Practicals Above 75% to 80%
02 Marks
Above 80% to 85% 03 Marks
Above 85% to 90% 04 Marks
Above 90% to 100% 05 Marks

Note: The student who fails to secure 75% attendance shall not be eligible to appear in the Internal as well as in External Tests.

PASSING CRITERION

The minimum Grade /Grade Point required to pass each paper in a semester examination under CBCS shall be Grade D / Grade Point 4 in each theory paper/ Practical/Project (wherever applicable) in External Examination and Internal Assessment separately.

DETERMINATION OF GRADES

Absolute grading would be used where the marks obtained are converted to grades based on pre-determined class intervals. To implement the following grading system, the colleges /campuses shall use the following UGC recommended 10 point grading system:

Marks (%)	Letter Grades	Grade Points (G)
90-100	O (Outstanding)	10
80 to < 90	A^+ (Excellent)	9
70 to < 80	A (Very Good)	8
60 to < 70	B^+ (Good)	7
50 to < 60	B (Above Average)	6
40 to < 50	C (Average)	5
36 to < 40	D (Pass)	4
0 to < 36	F (Fail)	0
	AB (Absent)	0

1. A student obtaining Grade F shall be considered failed and will be required to reappear in the examination as per existing rules of the university under Semester System for Under Graduate Courses.
2. Grade (D) or Percentage of marks (36%) is required to pass in a course, Semester Grade Point Average (SGPA) of 4 to qualify a semester and a minimum Cumulative Grade Point Average (CGPA) of 4 to qualify for a UG degree.

Computation of SGPA and CGPA

The following procedure shall be used to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

- The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e. SGPA (Si) = $\Sigma(Ci \times Gi) / \Sigma Ci$,where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.
- The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e. CGPA = $\Sigma(Ci \times Si) / \Sigma Ci$ where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.
- The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

- Re-evaluation of answer scripts of semester end external examination shall be permissible in each course of a Semester examination of B.A./B.Sc./B.Com./BBA/BCA/Honours as per the University statutes.
- Re-evaluation shall not be permitted in the practical, internal assessment, project report, dissertation, thesis & viva-voce etc.
- Re-evaluation shall not be permissible for candidates connected with improvement of Grades.

REGISTRAR
BLDE (Deemed to be University)
Vijayapura-586103. Karnataka