SHRI GURU RAM RAI UNIVERSITY

[Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC u/s (2f) of UGC Act 1956]



SYLLABUS FOR

B. Sc. (Hons.)Biotechnology

(Three Year Course- Semester System) School of Basic and Applied Sciences

(Effective from Academic Session 2021-2022-Onward)

VISION AND MISSION- DEPARTMENT OF BIOTECHNOLOGY

Vision

- 1. To be producing technical manpower through excellence in research and development, teaching, learning and training, with concern for worldwide environment and human society.
- 2. To provide well and quality education in the field of Life Sciences and Applied Sciences with proper training and practical expertise responsive to the needs of present and future century so that students excel and enhance in their professional life.

Mission

- 1. Providing friendly learning ambience to develop competence in diversified areas to create excellence in industrial, educational, research and technical areas.
- 2. Provide an efficient educational environment where students and research scholars can realize their full potential in their chosen disciplinary subjects and attain quality education to face the challenges of the future.
- 3. Establish networks collaborations and linkages with industries and academic institutes to produce ethically and morally strong workforce contributing to the development of knowledge economy.
- 4. Harness the skills of the students and assist them to excel in their professional life by providing life long leaning skills, sound theoretical knowledge, practical experience and all-round development with the help of well qualified and experienced faculty. Inculcate moral and ethical values for character building.

CURRICULUM

B. Sc. (Hons.) BIOTECHNOLOGY GRADUATE DEGREE PROGRAMME (2021-22 Onward)

1. Nomenclature:

There will be full time Biotechnology honour's Degree Programme named as B. Sc. (Hons.) in Biotechnology which will be written as B. Sc. (Hons.) Biotechnology. The duration of this programme shall be of three years (three full academic years) which shall be divided into six semesters. Each semester will be of six. months. Actual teaching in each semester is required minimum of 90 days. The examination for the first, third and fifth semester will normally be held in the month of December and for the second, fourth and sixth semester in the month of May or as convenient to the University.

2. The Medium of Instruction:

The medium of Instruction will be English.

3. The Medium of Examination:

The medium of examination will be English.

4. Intake:

The intake to B. Sc. (Hons.) Biotechnology course is 60 students. It may increase or decrease as per provisions of the University.

5. Eligibility to apply for Admission:

No candidate shall be eligible for admission to three year Full Time B. Sc. (Hons.) Biotechnology unless he/she has successfully completed higher secondary or Intermediate (with any biological subject) with prescribed number of credits or percentage through the examinations conducted by a National/State Board. Such qualifications as recognized by the University. Any candidate who has passed the plus two of the higher secondary board of Examinations in any state recognized as equivalent to the plus two of the Higher Secondary Board in with not less than 45 % marks in aggregate is eligible for admission, However, SC/ST, OBC and other eligible communities shall be given relaxation as per University rules.

Duration of the Programme : 3 Years

6. Selection Procedure for Admission: A candidate willing to seek admission to B. Sc. (Hons.) Biotechnology will have to appear in written entrance Test conducted by the University or on behalf of the University and followed by the counseling as per University norms. The selection for admission will be made on merit basis or as per University norms.

7. Semesters:

(a) An academic year shall consist of two semesters :

Odd Semester (I, III and V Semester) : generally July to November/December

Even Semester (II, IV and VI Semester): generally January to May/ June

The academic calendar for each semester shall be notified well before the commencement of the semester by the Dean, School of Basic and Applied Sciences.

(b) A semester shall normally extend over a period of 15 weeks. Each week shall have 30 hours of instruction including lab/ field work as applicable.

8. Credits:

(a) Credit defines the quantum of contents/ syllabus prescribed for a course and determines the number of hours of instruction required per week. Thus credits shall be assigned on the basis of the number of lectures/ tutorials / laboratory work/ project work and other forms of learning required to complete the course contents in a 15 week schedule.

(b) 1 Credit = 1 hour of lecture for theory and 1 Credit = 2 hour of laboratory for practicals.

(c) Motivate students with industrial visit, educational trip, seminar/conference during semester (not mandatory).

9. Roll Numbers and Enrollment Numbers:

The University shall allot a Roll Number to the students after payment realization, thorough scrutiny/ verification of the required documents for the course. After the completion of the admission procedure the enrolment number for the students shall be allotted by the University at the entry point which shall remain same for the entire period of study in the University.

10. The Credit Based Course Structure: B. Sc. (Hons.) Biotechnology- Three Year Programme- Choice Based Credit System (CBCS)

B. Sc. (Hons.) Biotechnology program shall be based on the choice based credit system in which credit defines the quantum of content/ syllabus prescribed for a course system and determines the number of hours of instruction per week.

Total Credits: 84 (Core Course) +8 (AECC) +8 (SEC) +24 (GE) +24(DSE) =148

C= Core Course AECC= Ability Enhancement Compulsory Course

SEC= Skill Enhancement Course GE= Generic Elective

GE= Generic Elective

DSE= Discipline Specific Elective

11. Student Advisor:

Every student shall have a teacher of the Department as his/her student advisor. All teachers of the department shall function as student advisors and will have more or less equal number of students with them. The student advisor will advise the students in choosing elective courses and offer all possible student support services.

12. Attendance:

- a. The teacher handling a course shall be responsible for maintaining a record of attendance of students who have registered for the course.
- b. All teachers shall intimate the Head of the Department at least seven calendar days before the last instruction day in the semester, the particulars of all students who have less than 75% attendance in one or more courses.
- c. A candidate who has less than 75% attendance shall not be permitted to sit for the endsemester examination in the course in which the shortfall exists. However, it shall be open to the Dean/ HOD to grant exemption to a candidate who has failed to obtain the prescribed 75% attendance for valid reasons on payment of prescribed fee and such exemptions shall not under any circumstances be granted for attendance below 65%.
- d. A candidate who fails to put in least 75% attendance in I semester shall not be allowed to pursue the studies in next semester. Such candidates may apply to the Dean/HOD for reregistration in the II semester in the next academic session.

Note : Rest of the provisions will be as framed by the University.

13. Fee and Resource Generation

As per decision of the University.

14. Examination and Evaluation

- (a) Evaluation will be done on a continuous basis. Three times during each semester. For the purpose of uniformity, there will be a uniform procedure of examination to be adopted by all teachers. There will be two sessional tests (Three if any student are unable to attend any sessional test) and one end-semester examination.
- (b) Sessional tests (of one to two hours duration) may employ one or more assessment tools such as objective tests, assignments, paper presentation, laboratory work, etc suitable to the course. This requires an element of openness. The students are to be informed in advance about the nature of assessment. It will be obligatory for the Students to attend the both Sessional tests, failing which they will not be allowed to appear in the concerned semester examination. The sessional test as part of the continuous internal assessment shall be conducted and evaluated by the teacher offering the course. A Student cannot repeat sessional tests (without permission from HOD). However, if for any compulsive reason the student could not attend the test, the prerogative of arranging a special test lies with the teacher with the approval of the Head of the Department. In case of students who could not attend any of the sessional tests due to medical reason or under extraordinary circumstances, a separate test shall be conducted before the concerned semester

examinations by the concerned faculty member after the approval of the Head of the Department and the Dean concerned.

- (c) The sessional tests will carry 30% of total marks for the course. The marks of the two Sessional Tests shall be taken into account for the computation of Grades.
- (d) There shall be a written end semester examination which shall be of 2/3 hours duration carrying 70% of total marks assigned for the course, covering the entire syllabus prescribed for the course.
- (e) The end semester practical examinations (field tour report, project report and training report) shall normally be held before the theory examination/or as per convenience by the Department. The internal faculty shall associate themselves with the examination process.

OUTCOME BASED EDUCATION

Programme outcomes (POs) Students will be able to

	ts will be able to
PO 1	Knowledge of Biotechnology and Applied sciences: Students have the basic
	knowledge of Biotechnology, Biochemistry (Biomolecules), Microbiology, Plant
	Biotechnology, environmental science, chemistry, Common biology (Botany and
	Zoology) and understand its applicability or correlate these applied science to
	nature.
PO2	Problem analysis: Identify, express, analyze the problems related to Applied
	(Biotechnology), basic and natural sciences.
PO3	Design/development of solutions: Students will be able to design or generate solutions of
	common problems of Applied Sciences (Biotechnology) and its output is to improve public
DO 4	and environmental health.
PO4	Modern tool usage: Generate, select, and apply appropriate modern techniques and
	resources for understanding the concept of Biotechnology.
PO5	Environment and sustainability: Understand the impact of the Applied science and
	Biotechnology to improve the environmental health and aware about the knowledge and
PO6	need of sustainable development. Project management, lab culture and Communication : Acquired the skills in
	handling scientific instruments, planning and performing in laboratory
	experiments. Communicate effectively on complex Biotechnological activities with
	the other science community and with society at large, such as being able to
	comprehend and write effective reports and design documentation, make effective
	presentations and give and receive clear instructions.
PO7	
P0/	Future prospective, Individual and Team Work: After the completion of this course students have the option to go for higher studies i.e. M. Sc. and then do some research for
	the welfare of mankind or prepare for other competitive examination. Function effectively
	as an individual, and as a member or leader in diverse teams and in multi-disciplinary
	settings followed with the knowledge of Biotechnology.
PO8	Life-long and interdisciplinary approach of learning: Realized how developments in any
	Biotechnological subject helps in the development of other science subjects and vice-versa
	and how interdisciplinary approach helps in providing better solutions and new ideas for
	the sustainable developments. Recognize the need for and have the preparation and ability to Engage in independent and life- long learning in the broadest context of
	Biotechnological Change.
PO9	Effective Writing: Got Skill for Write up in scientific literature and other social
	media platform related to life science.
PO10	Effective Communication: Speak, read, write and listen clearly in person and
	through electronic media in English and in one Indian language, and make meaning
	of the world by connecting people, ideas, books, media and technology.
PO11	Social Interaction and Ethics: Elicit views of others, mediate disagreements and
-	help reach conclusions in group. Recognize different value systems including your
	own, understand the moral dimensions of your decisions, and accept responsibility for
	them settings conclusions in group settings.
DO12	Transferictions and read Descion 1.1.1.1.4.1.4.1.4.1.4.1.
PO12	Interdisciplinary approach and Practical learning: Analyse the relationships among animals plants microbes and Industry Perform procedures as per laboratory standards
	animals, plants, microbes and Industry. Perform procedures as per laboratory standards in the areas of Biochemistry, Bioinformatics, Genomics, industrial biotechnology and
	fermentation technology.

Progra	am Specific Outcomes (PSOs)
PSO 1	The students will understand the basic metabolic and molecular processes required
	for normal cellular functions.
PSO2	The students will learn about different tools and techniques required for genetic
	manipulation, microbial culture and biochemical analysis.
PSO3	The students will be able to execute basic experiments related to biochemistry,
	microbiology, cell biology, recombinant DNA technology, etc.
PSO4	The students will be able to pursue higher studies in diverse areas of biological
	sciences or take up jobs in various biotechnology sectors.

Eligibility for admission:

Any candidate who has passed Plus Two (10+2) of the Higher Secondary Board Board of Examinations in any state recognized as equivalent to the Plus Two of the Higher Secondary Board in with not less than 45 % marks in aggregate is eligible for admission, However, SC/ST, OBC and other eligible communities shall be given relaxation in marks as per University rules.

Duration of the Programme : 3 Years

STUDY & EVALUATION SCHEME Choice Based Credit System /ECS Bachelor of Science (Hons.) Biotechnology

S. No.	Course	Couse Code	Course Name	Per	iods			Evaluation s	cheme	Subject
	Category			L	Т	Р	C	Sessional (Internal)	External (ESE)	Total
Theory			1	1			1			
1	Core	HBTC 101	Biochemistry and Metabolism	4	0	0	4	30	70	100
2	Core	HBTC 102	Cell Biology	4	0	0	4	30	70	100
3	Generic Elective	HBTG 103	Developmental Biology	4	0	0	4	30	70	100
4	Ability Enhancement Compulsory Course	AECC 101	Environmental Science	4	0	0	4	30	70	100
Practica	ıl			1		1	1			
1	Core	HBTL 101	Lab course based on course HBTC 101	0	0	2	2	30	70	100
2	Core	HBTL 102	Lab course based on course HBTC 102	0	0	2	2	30	70	100
3	Generic Elective	HBTL 103	Lab course based on course HBTG 103	0	0	2	2	30	70	100
			Total	16	0	6	22	21) 490	70

 $L-Lecture,\,T-Tutorial,\,P-Practical,\,C-Credit$

S. No.	Second Semeste Course	r Couse Code	Course Name		Perio	ods		Evaluation	scheme	Subject
	Category			L	Т	P	С	Sessional	External	Total
								(Internal)	(ESE)	
	I	I						I	I	Theory
1	Core	HBTC 201	Mammalian Physiology	4	0	0	4	30	70	100
2	Core	HBTC 202	Plant Physiology	4	0	0	4	30	70	100
3	Generic Elective	HBTG 203	Entrepreneurship Development	4	0	0	4	30	70	10
4	Ability Enhancement Compulsory Course	AECC 201/ 202 /203	English Communication	4	0	0	4	30	70	10
	I	I								Practica
1	Core	HBTL 201	Lab course based on course HBTC 201	0	0	2	2	30	70	10
2	Core	HBTL 202	Lab course based on course HBTC 202	0	0	2	2	30	70	10
3	Generic Elective	HBTL 203	Lab course based on course HBTG 203	0	0	2	2	30	70	10
			Total	16	0	6	22	210	490	70

5. No.	Course	Couse Code	Course Name		Perio	ods		Evaluation	scheme	Subject
	Category			L	Т	Р	С	Sessional	External	Total
								(Internal)	(ESE)	
						1 1				Theory
1	Core	HBTC 301	Genetics	4	0	0	4	30	70	100
2	Core	HBTC 302	General Microbiology	4	0	0	4	30	70	100
3	Core	HBTC 302	Chemistry-I	4	0	0	4	30	70	100
4	Generic Elective	HBTG 304	Bioethics and Biosafety	4	0	0	4	30	70	100
5	Skill enhancement course (Any one)	HBTS 305/306/307/3 08	Industrial Fermentations/ Molecular Diagnostics/ Basics of Forensic Science/ Green Chemistry	4	0	0	4	30	70	100
										Practical
1	Core	HBTL 301	Lab course based on course HBTC 301	0	0	2	2	30	70	100
2	Core	HBTL 302	Lab course based on course HBTC 302	0	0	2	2	30	70	100
3	Core	HBTL 303	Lab course based on course HBTC 303	0	0	2	2	30	70	100
	Generic Elective	HBTL 304	Lab course based on course HBTG 304	0	0	2	2	30	70	100
		1	Total	20	0	8	28	270	630	900

5. No.	Course	Couse Code	Course Name		Perio	ods		Evaluation	scheme	Subject
	Category			L	Т	P	С	Sessional	External	Tota
								(Internal)	(ESE)	
				I.	L	1 1				Theory
1	Core	HBTC 401		4	0	0	4	30	70	100
			Molecular Biology							
2	Core	HBTC 402	Immunology	4	0	0	4	30	70	100
3	Core	HBTC 403	Chemistry-2	4	0	0	4	30	70	100
4	Generic	HBTG 404	Biotechnology and	4	0	0	4	30	70	100
	Elective		Human Welfare							
5	Skill	HBTS		4	0	0	4	30	70	10
	enhancement	405/406/407	Enzymology/ Drug Designing/							
	course (Any		Evolutionary							
			Biology							
	one)									
										Practica
1	Core	HBTL 401	Lab course based on	0	0	2	2	30	70	100
			course HBTC 401							
2	Core		Lab course based on	0	0	2	2	30	70	100
2	core	HBTL 402	course HBTC 402	U	0	2	2	50	70	100
3	Core	11D1L 402	Lab course based on	0	0	2	2	30	70	10
		HBTL 403	course HBTC 403					-		
	Generic	HBTL 404	Lab course based on	0	0	2	2	30	70	100
	Elective		course HBTG 404							
		l	Total	20	0	8	28	270	630	900

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1 Core HBTC 502 4 0 0 4 2 Core HBTC 502 Recombinant DNA Technology 4 0 0 4 3 Discipline Centric Subjects HBTD 503/504/505a/ 505b Animal Diversity-I/ Ecology 4 0 0 4 4 Discipline (Any one) HBTD 506/507/508a/ 508b Animal Diversity-I/ Ecology 4 0 0 4 4 Discipline Centric Subjects HBTD 506/507/508a/ 508b Plant Diversity I/Plant Biotechnology/ Bioinformatics/ Advance Forensic Science 4 0 0 4 1 Core HBTL 501 Lab course based on course HBTC 501 0 0 2 2 3 Discipline (Any one) HBTL 503/504/505a/ Subjects Lab course based on course HBTC 502 0 0 2 2 3 Discipline (Any one) HBTL 503/504/505a/ Subjects Lab course based on course HBTD 502 0 0 2 2	Sessional External	onal External	Tota
1 Core HBTC 502 4 0 0 4 2 Core HBTC 502 Recombinant DNA Technology 4 0 0 4 3 Discipline Centric Subjects HBTD 503/504/505a/ 505b Animal Diversity-I/ Ecology 4 0 0 4 4 Discipline (Any one) HBTD 506/507/508a/ 508b Animal Diversity-I/ Ecology 4 0 0 4 4 Discipline Centric Subjects HBTD 506/507/508a/ 508b Plant Diversity I/Plant Biotechnology/ Bioinformatics/ Advance Forensic Science 4 0 0 4 1 Core HBTL 501 Lab course based on course HBTC 501 0 0 2 2 3 Discipline (Any one) HBTL 503/504/505a/ Subjects Lab course based on course HBTC 502 0 0 2 2 3 Discipline (Any one) HBTL 503/504/505a/ Subjects Lab course based on course HBTD 503/504/505a/505b 0 0 0 2 2	(Internal) (ESE)	nal) (ESE)	
2CoreHBTC 50240042CoreHBTC 50240043Discipline Centric Subjects (Any one)HBTD 503/504/505a/ 505bAnimal Diversity-I/ Animal Biotechnology/ Ecology Ecology and Environment Management/ Intellectual Property Rights40044Discipline Centric Subjects (Any one)HBTD 506/507/508a/ 508bPlant Diversity I/Plant Biotechnology/ Bioinformatics/ Advance Forensic Science0041Core HBTL 501Lab course based on course HBTC 50100222Core HBTL 502Lab course based on course HBTC 50200223Discipline HBTL Subjects (Any one)HBTL HBTL S03/504/505a/Lab course based on course HBTC 50100223Discipline HBTL Subjects (Any one)HBTL S03/504/505a/Lab course based on course HBTC 50500022		,	Theory
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3Discipline Centric Subjects (Any one)HBTD 503/504/505a/ 505bAnimal Diversity-I/ Animal Biotechnology/ Ecology Ecology and Environment Management/ Intellectual Property Rights40044Discipline Centric Subjects (Any one)HBTD 506/507/508a/ 508bPlant Diversity Bioinformatics/ Advance Forensic Science40041Core HBTL 501Lab course based on course HBTC 50100222Core HBTL 502Lab course based on course HBTC 50200223Discipline HBTL Subjects (Any one)HBTL S05b100223Discipline HBTL Subjects (Any one)HBTL S03/504/505a/000223Discipline (Any one)HBTL S03/504/505a/Lab course based on course HBTC 50200223Discipline (Any one)HBTL S03/504/505a/Lab course based on course HBTD 5050022	30 70	30 70	100
Centric Subjects (Any one)506/507/508a/ 508bI/Plant Biotechnology/ Bioinformatics/ Advance Forensic ScienceIII1Core HBTL 501Lab course based on course HBTC 50100222Core HBTL 502Lab course based on course HBTC 50200223Discipline Subjects (Any one)HBTL 503/504/505a/Lab course based on course HBTC 50200223Discipline Subjects (Any one)HBTL 503/504/505a/Lab course based on course HBTD 503/504/505a/ 505b0011	30 70	30 70	100
HBTL 501 course HBTC 501 I I I Core Lab course based on HBTL 502 0 0 2 2 I Joiscipline HBTL course HBTC 502 I I I I I Centric 503/504/505a/ Lab course based on course HBTD 0 0 2 2 I Subjects 505b Lab course based on course HBTD I	30 70	30 70	100
Image: HBTL 501 Course HBTC 501 Image: HBTL 501 Image: HBTL 501 Image: HBTL 501 Image: HBTL 502 Image: HBT		Pı	ractica
2Core HBTL 502Lab course based on course HBTC 50200223Discipline CentricHBTL 503/504/505a/0022Subjects (Any one)505bLab course based on course0022	30 70	30 70	100
3Discipline CentricHBTL 503/504/505a/0022Subjects (Any one)505bLab course based on course0022	30 70	30 70	100
	30 70	30 70	100
DisciplineHBTL0022Centric506/507/508a/Lab course based on course6666Subjects508bcourseHBTD 506/507/508a/ 508b6666	30 70	30 70	100

S. No.	Course	Couse Code	Course Name		Perio	ods		Evaluation	scheme	Subject
	Category			L	T P C		С	Sessional	External	Total
								(Internal)	(ESE)	
I				I					I	Theory
1	Core	HBTC 601		4	0	0	4	30	70	100
			Bio Analytical Tools							
2	Core	HBTC 602	Genomics & Proteomics	4	0	0	4	30	70	100
3	Discipline	HBTD	Animal Diversity-II/	4	0	0	4	30	70	100
	Centric	603/604/605	Microbial							
	Subjects		Physiology/							
	5		Biostatistics							
4	Discipline	HBTD	Plant diversity-II/	4	0	0	4	30	70	100
	Centric	606/607/608	Medical							
	Subjects		Microbiology/							
	Budjeets		Environment							
			Biotechnology							
										Practica
1	Core	HBTL 601	Lab course based on	0	0	2	2	30	70	100
2			course HBTC 601	0	0			20		100
2	Core	HBTL 602	Lab course based on course HBTC 602	0	0	2	2	30	70	100
3	Discipline	HBTL	Lab course based on	0	0	2	2	30	70	100
	Centric	603/604/605	course HBTD							
	Subjects		603/604/605							
	Discipline	HBTL	Lab course based on	0	0	2	2	30	70	100
	Centric	606/607/608	course HBTD							
	Subjects		606/607/608							
			Total	16	0	8	24	240	560	800

 $L-Lecture,\,T-Tutorial,\,P-Practical,\,C-Credit$

Total Credits: 84 (C) +8 (AECC) +8 (SEC) +24 (GE) +24(DSE) =148

C= Core Course

AECC= Ability Enhancement Compulsory Course

SEC= Skill Enhancement Course

GE= Generic Elective

DSE= Discipline Specific Elective

List of Electives

S. No	Subject Code	Subject Name	Semester
GENE	RIC ELECTIVE	SUBJECTS	
1	HBTG 103	Developmental Biology	I
2	HBTG 203	Entrepreneurship Development	II
3	HBTG 304	Bioethics and Biosafety	III
4	HBTG 404	Biotechnology and Human Welfare	IV
KILL	ENHANCEME	NT COURSES	
1	HBTS 305	Industrial Fermentations	III
2	HBTS 306	Molecular Diagnostics	III
3	HBTS 307	Basics of Forensic Science	III
4	HBTS 308	Green Chemistry	III
5	HBTS 405	Enzymology	IV
6	HBTS 406	Drug Designing	IV
7	HBTS 407	Evolutionary Biology	IV
ISCI	PLINE CENTRI	C SUBJECTS	
		DISCIPLINE CENTRIC SUBJECTS -1	
1	HBTD 503	Animal Diversity-I	V
2	HBTD 504	Animal Biotechnology	V
3	HBTD 505a	Ecology and Environment	V
		Management	X7
4	HBTD 505b	Intellectual Property Rights	V
	L	DISCIPLINE CENTRIC SUBJECTS -2	
5	HBTD 506	Plant Diversity-I	V
6	HBTD 507	Plant Biotechnology	V
7	HBTD 508a	Bioinformatics	V
8	HBTD 508b	Advance Forensic Science	V
		DISCIPLINE CENTRIC SUBJECTS -3	
9	HBTD 603	Animal Diversity-II	VI
10	HBTD 604	Microbial Physiology	VI
11	HBTD 605	Biostatistics	VI
		DISCIPLINE CENTRIC SUBJECTS -4	
12	HBTD 606	Plant diversity-II	VI
13	HBTD 607	Medical Microbiology	VI
14	HBTD 608	Environmental Biotechnology	VI

Components	I st internal	II nd Internal	External (ESE)
Weightage (%)	Marks	Marks	Marks
Weightage (%) Theory	15	15	70
Practical	Marks	Marks	Marks
	15	15	70

Course code	: HBTC 101
Course Name	: Biochemistry and Metabolism
Semester	: I

L	Т	Р	С
4	4	0	4

Course objective: This course is aimed to introduce the knowledge of biomolecules and their role in metabolic pathways. Also, it deals with the structure and function of enzymes.

UNIT I: Introduction to Biochemistry (10 Periods)

A historical prospective. Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids. 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 Periods)

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.

UNIT III (20 Periods)

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.

UNIT IV (20 Periods)

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. β-oxidation of fatty acids.

SUGGESTED READING AND TEXT BOOKS

- 1. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
- 2. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
- 3. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
- 4. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.
- 5. Berg, JM, Tymoczko, JL and Stryer, L 2006. Biochemistry. 6th ed. WH Freeman and Co.

CO	Descriptin	Bloom's Taxonomy Level
CO1	Remember the define the terms and basic concepts of Biochemistry and Metabolism and their different roles in biological systems, Nucleic Acid Metabolism	
CO2	Understand and Remember the principle, mechanism of basic and advanced Biochemistry and Metabolism, Nucleic Acid Metabolism.	
CO3	Applying, understanding and remembering the detailed process of structure and function of biomolecules and enzymes, Nucleic Acid Metabolism.	
CO4	Analyzing, applying, remembering, understanding the coordinated regulation of carbohydrate, Protein and lipid metabolic pathway, nucleic acid metabolism.	Remembering, Understanding, Analyzing
CO5	Evaluating, analyzing, Applying, remembering, and understanding the principle, methods, properties and functions of Biochemical enzymes and molecules, nucleic acid metabolism.	Remembering, Understanding
CO6	Constructing (Creating), evaluating, analyzing, demonstrating, remembering, and understanding the Biomolecules and Enzymes, nucleic acid metabolism	Domonahomina

Mapping of COs with POs & PSOs

Course Outcomes		-			Pro	ograi	n O	utco	mes (l	POs)			Spec	gram cific comes	(PSO	s)
	PO1	P02	P03	P04	P05	P06	PO7	PO8	P09	P010	P011	P012	PS01	PSO2	PSO3	PSO4
C01	3	3	1	1	1	1	1	1	3	1	1	1	3	2	1	1
CO2	3	3	1	1	1	1	1	1	3	1	1	1	3	2	1	1
CO3	2	3	3	3	3	3	2	2	3	2	2	2	3	2	2	1
CO4	3	2	3	3	3	3	1	1	3	1	0	1	3	3	2	1
CO5	3	2	3	1	1	1	2	2	3	3	2	1	3	2	1	1
CO6	1	1	1	1	1	1	1	1	2	2	2	1	3	2	2	1

3: High, 2: Medium, 1: Low

Course code	: HBTL 101
Course Name	: Lab Course Based on HBTC 101
Semester	: I

L	Т	Р	С
0	0	2	2

Practicals

- 1. Preparation of solutions: percentage solution, Molar solution, Nornal solution. Preparation ofbuffers.
- 2. Qualitative tests for Carbohydrates like Molisch's test, Anthrone test, Iodine test, Seliwanoff'stest, and Fehling's test.
- 3. Principles of Colorimetry: Verification of Beer-Lambert Law; Study relation between absorbance and % transmission.
- 4. Estimation of blood glucose by glucose oxidase method.
- 5. Preparation of buffers.
- 6. Sugar estimation by Anthrone method.
- 7. Protein estimation by Bradford method.
- 8. Nucleic acid estimation by Diphenylamine reagent.
- 9. Study activity of any enzyme under optimum conditions.
- 10. Study the effect of pH, temperature on the activity of salivary amylase enzyme.
- 11. Separation of Amino acids by paper chromatography.
- 12. JMol via Spoken Tutorial: Visualization of geometrical structure of simple molecules likecarbohydrates, fatty acids, amino acids and proteins.

	B. Sc. (Hons.) Biotechnology				
Course code	: HBTC 102				
Course Name	: Cell Biology				
Semester	: I				

L	Т	Р	С
4	4	0	4

Course Objective: Cell is the structural and functional unit of life. It is often referred to as the building block of life as well. The course on cell biology aims to impart knowledge of cell structure and functions of diverse cellular organelles.

UNIT-I (10 Periods)

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 Periods)

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 Periods)

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 Periods)

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.

SUGGESTED READING AND TEXT BOOKS

- 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.

CO		Descriptin Bloom's Taxonom							omy							
				1.0	• .1			1.1	•		6		vel	1		
CO1		Remember the define the terms and basic concepts of cell biology and their different roles in biological systems									Remembering					
CO2	Unders											of	-			
02	cellula	re	actio	n lik	e cel	l mer	nbrai	ne fu	nction	s, me	mbran	e		nembe		
	vacuola extrace		•			cellula	ar c	campa	rtment	izatio	n an	d	Unc	lerstan	ding	
<u> </u>	Applyi					g and	l rer	nemb	ering	the d	letaile	d		1, 2,3	;	
CO3	process	0.				0			0					nember	-	
	cytopla	ısmi	c org	ganel	les an	d diff	erent	com	ponent	ts of c	ells.			erstand nonstra	0	
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CO4	detaile												Ren	nembe	ring,	
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	and dif Evalua							1 P O1	momh	oring	9 n 4	1		$\frac{1}{10000000000000000000000000000000000$		
CO5	unders												Ren	nembe	ring,	
	and is												Understanding, Analyzing,			
	organe	lles.											Ē	valuati	ng	
	_															
CO6	Consti	ruct	ing	(C	reati	ng),	Ev	aluat	ing,	Ana	lyzing	<u></u> ,	1,	2,3,4,5	5,6	
CO6	demon	stra	ating	, rer	nemb	pering	g, ai	nd u	inders	standi	i ng th	e	Ren	nembe	ring,	
CO6	demon cell b	iolog	ating gy a	, rer	nemh cance	bering r bio	g, ai	nd u	inders	standi	i ng th	e	Ren Und A	nembe lerstand nalyzii	ring, ding, ng,	
CO6	demon	iolog	ating gy a	, rer	nemh cance	bering r bio	g, ai	nd u	inders	standi	i ng th	e	Ren Und A Ev	nembe lerstane nalyzii /aluatii	ring, ding, ng, ng,	
CO6	demon cell bi differe	iolog nt ce	ating gy a ellula	, ren and o ar fun	nemb cance ction	r bio s.	g, a n logy	n d u . Cre	anders eate a	s tandi waren	i ng th	e	Ren Und A Ev	nembe lerstand nalyzii	ring, ding, ng, ng,	
CO6	demon cell bi differe	iolog nt ce	ating gy a ellula	, ren and o ar fun	nemb cance ction	r bio s.	g, a n logy	n d u . Cre	inders	s tandi waren	i ng th	e	Ren Und A Ev	nembe lerstand nalyzin valuatin Creatin	ring, ding, ng, ng,	
	demon cell bi differe	iolog nt ce	ating gy a ellula	, ren and o ar fun	nemb cance ction	ering r bio s. with	g, an logy POs	nd u . Cro s & 1	anders eate a	standi waren	i ng th	e	Ren Und A Ev (nembe lerstand nalyzin valuatin Creatin gram	ring, ding, ng, ng,	
Course	demon cell b: differe: Ma	iolog nt ce	ating gy a ellula	, ren and o ar fun	nemb cance ction	ering r bio s. with	g, an logy POs	nd u . Cro s & 1	unders eate a PSOs	standi waren	i ng th	e	Rem Und A Ev () Prog	nembe lerstand nalyzin valuatin Creatin gram	ring, ding, ng, ng, g	5)
Course Dutcome	demon cell bi differe Ma	iolog nt ce	ating gy a ellula	, ren and o ar fun	nemb cance ction	ering r bio s. with	g, an logy POs	nd u . Cro s & 1	unders eate a PSOs	standi waren	i ng th	e	Rem Und A Ev () Prog	nembe lerstand nalyzin valuatin Creatin gram	ring, ding, ng, ng,	5)
Course Dutcome	demon cell b differe Ma	astra iolog nt ce	ating gy a ellula ing	of C	nemb cance action COs Pro	oering r bio s. with gram	g, an elogy PO:	nd u . Cro s &] utcor	nders eate a PSOs nes (F	varen POs)	ing the ness t		Ren Und A Ev O Prog Spec Outo	nembe lerstand nalyzin valuatin Creatin gram cific comes	ring, ding, ng, g (PSO	
Course Dutcome	demon cell bi differe Ma	iolog nt ce	ating gy a ellula ing	, ren and o ar fun	nemb cance ction	ering r bio s. with	g, an logy POs	nd u . Cro s & 1	unders eate a PSOs	standi waren	i ng th	e	Rem Und A Ev () Prog	nembe lerstand nalyzin valuatin Creatin gram	ring, ding, ng, ng, g	
Course	demon cell b differe Ma	astra iolog nt ce	ating gy a ellula ing	of C	nemb cance action COs Pro	ering r bio s. with gram 904 2	g, an elogy PO:	nd u . Cro s &] utcor	nders eate a PSOs nes (F	varen POs)	ing the ness t		Ren Und A Ev O Prog Spec Outo	nembe lerstand nalyzin valuatin Creatin gram cific comes	ring, ding, ng, g (PSO	2
Course Outcome	demon cell bi differe Ma	app	ating gy a ellula ing	of C	nemb cance action COs v Pro	ering r bio s. with gram	g, and short provide the second secon	nd u . Cro s & 1 utcor	PSOs nes (F	POs)	IIOA	P012	Rem Und A Ev O Vrog Spec Outo	nembe lerstand nalyzin valuatin Creatin gram cific comes	ring, ding, ng, g (PSO: EOSA	2
Course Outcome	demon cell bi differe Ma e E E E E E E E E E E E E E E E E E E	astra iolog nt co app 204 2	ting gy a ellula ing EO4 2	tof C	nemb cance action COs v Pro	ering r bio s. with gram 904 2	g, an elogy PO: h Ou 64 2	nd u . Cro s & 1 ntcor	PSOs nes (F	POs)	IIOA 1	2004	Rem Und A Ev Outo Spec Outo IOSA	nembe lerstand nalyzin valuatin Creatin gram cific comes	ring, ding, ng, g (PSO: EOSA 1	2
Course Dutcome CO1 CO2	demon cell bi differe Ma e E E E E E E E E E E E E E E E E E E	astra iolog nt co app 2 2 2	ting gy a ellula ing 0 2 2	FOI 1	nemb cance action COs v Pro	904 2 2	g, and plogy PO: h Ou 2 1	nd u . Cro s & 1 ntcor 2 1	PSOs nes (F	POs)	IIOA 1	2104 1 1	Rem Und A Ev Outo Spece Outo IOSA 3 3	nembe lerstand nalyzin valuatin Creatin gram cific comes 2 2 2	ring, ding, ng, g (PSO: Cost 1 1	
Course Dutcome CO1 CO2 CO3	demon cell bi differe Ma e D 2 3 3 3	astra iolog nt co app 2 2 2 2	ting gy a ellula ing 0 2 2 3	FO4 1 2 3	nemb cance action Pro 2 2 3	904 2 3	p Os PO s D Os D	nd u . Cro s & 1 ntcor 2 1 2	PSOs nes (F	POs)	IIOA 1 1 2	2104 1 1 2	Rem Und A Ev Outo Spece Outo IOSA 3 3 3	nembe lerstand nalyzin valuatin Creatin gram cific comes 2 2 2 2	ring, ding, ng, g (PSO: Cost 1 1 1 2	2 2 2 2

3: High, 2: Medium, 1: Low

Course code	: HBTL 102
Course Name	: Lab Course Based on HBTC 102
Semester	: I

L	Т	Р	С
0	0	2	2

Practicals

- 1. Study the effect of temperature and organic solvents on semi permeable membrane.
- 2. Study the working and functioning of microscope.
- 3. Demonstration of dialysis.
- 4. Study of plasmolysis and de-plasmolysis.
- 5. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
- 6. Study of structure of any Prokaryotic and Eukaryotic cell.
- 7. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
- 8. Cell division in onion root tip/ insect gonads.
- 9. Preparation of permanent slides of transverse sections (TS) of stem, root and leaf.
- 10. Demonstrate the structure of biomolecule using Cell Designer via Spoken Tutorial.
- 11. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

Course code	: HBTG 103
Course Name	: Developmental Biology
Semester	: I

L	Т	Р	С
4	4	0	4

Course objectives: The course aims to teach the principles and molecular biology of eukaryotic development, from zygote to embryo development and differentiation. The specific objectives of the course are:

- 1. To understand the history and basic concepts of embryology
- 2. To become familiar with the process of fertilization, spermatogenesis and oogenesis
- 3. To understand the process of organogenesis.
- 4. To understand the molecular basis of development.

UNIT I: Gametogenesis and Fertilization (10 Periods)

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 (20 Periods)

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 (20 Periods)

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 (10 Periods)

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers

Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals.

SUGGESTED READING AND TEXT BOOKS

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.

CO	Descriptin	Bloom's Level	Taxonomy
CO1	Remember the define the terms and basic concepts of Developmental biology and their different roles in biological systems	Reme	1 mbering
CO2	Understand and Remember the principle, mechanism of cellular reaction like Gametogenesis and Fertilization, Early embryonic development, Embryonic Differentiation and organogenesis.	Remer	,2 nbering, standing
CO3	Applying, understanding and remembering the detailed processes of Gametogenesis and Fertilization, Early embryonic development, Embryonic Differentiation and organogenesis.	Remer Unders Demor	2,3 nbering, tanding, nstrating
CO4	Analyzing, Applying, remembering, Understanding the detailed processes of structure and function of Gametogenesis and Fertilization, Early embryonic development, Embryonic Differentiation and organogenesis.	Remer Unders Anal	2,3,4 nbering, tanding, lyzing
CO5	Evaluating, Analyzing, Applying, remembering, and understanding the principle, methods, properties and functions of developmental biology.	Remer Unders Anal	3,4,5 nbering, standing, yzing, uating
CO6	Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the developmental biology.	Remer Unders Anal Evalu	4,5,6 nbering, itanding, yzing, uating, ating

Course Outcome s	Program Outcomes (POs) Program Specific Outcomes (I						Program Outcomes (POs)										
5	P01	P02	PO3	P04	P05	P06	P07	PO8	P09	P010	P011	P012	PS01	PSO2	PSO3	PS04	
C01	3	3	1	2	2	2	2	2	3	1	1	1	3	2	1	2	
CO2	2	2	2	2	2	2	1	1	3	1	1	1	3	2	1	2	
CO3	2	2	3	3	3	3	2	2	2	2	2	2	2	2	2	2	
CO4	2	2	3	3	3	3	1	1	3	1	1	1	2	3	2	2	
CO5	2	2	3	1	1	1	2	2	3	3	2	1	2	2	2	2	
CO6	2	2	1	1	1	1	1	1	3	2	2	1	3	2	2	2	

3: High, 2: Medium, 1: Low

Course code	: HBTL 103
Course Name	: Lab Course Based on HBTG 103
Semester	: I

L	Т	Р	С
0	0	2	2

Practicals

- 1. Study of different types of eggs.
- 2. Development of fate maps in the early embryos.
- 3. Observation of frog embryos, different developmental stages and life cycle of frog.
- 4. Identification of developmental stages of chick embryo using permanent mounts.
- 5. Preparation of a temporary stained mount of chick embryo.
- 6. Study developmental stages of Anopheles.
- 7. Demonstration of developmental stages of Drosophila.
- 8. Study of different types of placenta.
- 9. Examine the sections of mammalian skin, salivary glands, cartilage and bones.
- 10. Stages of flower development in plants.

	B. Sc. (Hons.) Biotechnology
Course code	: AECC 101
Course Name	: Environmental Science
Semester	: I

L	Т	Р	С
4	4	0	4

Course Objective: The basic objective of the environmental studies is to enable the students for interdisciplinary approach to complex environmental problems using basic tools of the natural and social sciences including ecosystem, geosystems, biology, chemistry and global process. They will acquire an attitude of concern for the environment and will be able to critically evaluate the science and policy ramifications of diverse portfolios on air and water quality, natural resources etc.

Unit 1: Introduction to Environmental Sciences

Multidisciplinary nature of Environmental Sciences; Scope and importance; Concept of sustainability and sustainable development.

Unit 2: Ecosystems

What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the ecosystems; Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 3: Natural Resources: Renewable and Non-renewable Resources

Land resources and land use change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state). Energy resources: Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Unit 4: Biodiversity and Conservation

Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots, India as a mega-

biodiversity nation; Endangered and endemic species of India, Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological, invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic

and Informational value.

Unit 5: Environmental Pollution

Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution, Nuclear hazards and human health risks, Solid waste management: Control measures of urban and industrial waste.Pollution case studies.

Unit 6: Environmental Policies & Practices

Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Environment Laws: Environment Protection Act 1986; Air (Prevention & Control of Pollution) Act 1981; Water (Prevention and control of Pollution) Act 1974; Wildlife Protection Act 1972; Forest Conservation Act 1980. International agreements: Montreal protocol, Kyoto protocol and Convention on Biological Diversity (CBD). Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

Unit 7: Human Communities and the Environment

Human population growth: Impacts on environment, human health and welfare. Resettlement and rehabilitation of project affected persons; case studies. Disaster management: floods, earthquake, cyclones and landslides. Environmental movements:Chipko, Silent valley, Bishnois of Rajasthan.

Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.

Environmental communication and public awareness, case studies (e.g., CNG vehicles inDelhi).

SUGGESTED READING AND TEXT BOOKS

- 1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
- 2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad 380 013, India, Email:mapin@icenet.net (R).
- 3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p.
- 4. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB).
- 5. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p

CO	Descriptin	Bloom's Taxonomy Level
	Remember the define the terms and basic concepts of environmental biology and their different roles to inflence biological systems.	
co2 e	Jnderstand and Remember the principle, mechanism of cellular reaction like Gametogenesis and Fertilization, Early embryonic development, Embryonic Differentiation and organogenesis.	Remembering,
CO3 F	Applying, understanding and remembering the detailed processes of Gametogenesis and Fertilization, Early embryonic development, Embryonic Differentiation and prganogenesis.	Remembering, Understanding, Demonstrating
CO4 d	Analyzing, Applying, remembering, Understanding the letailed processes of structure and function of Gametogenesis and Fertilization, Early embryonic levelopment, Embryonic Differentiation and organogenesis.	Remembering, Understanding, Analyzing
UUU U	Evaluating, Analyzing, Applying, remembering, and inderstanding the principle, methods, properties and functions of developmental biology.	1,2,3,4,5 Remembering, Understanding, Analyzing, Evaluating
CO0 d	Constructing (Creating), Evaluating, Analyzing, lemonstrating, remembering, and understanding the levelopmental biology.	1,2,3,4,5,6 Remembering, Understanding, Analyzing, Evaluating, Creating
I	Mapping of COs with POs & PSOs	0
ourse	Program Outcomes (POs)	Program Specific

Course Outcomes											_	_	Spec Outc		(PSOs)	
	P01	P02	P03	P04	P05	P06	P07	P08	604	P010	P011	P012	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	2	2	2	2	3	1	1	1	3	2	1	2
CO2	2	2	2	2	2	2	1	1	3	1	1	1	3	2	1	2
CO3	2	2	3	3	3	3	2	2	2	2	2	2	2	2	2	2
CO4	2	2	3	3	3	3	1	1	3	1	1	1	2	3	2	2
CO5	2	2	3	1	1	1	2	2	3	3	2	1	2	2	2	2
CO6	2	2	1	1	1	1	1	1	3	2	2	1	3	2	2	2

3: High, 2: Medium, 1: Low

Course code	: HBTC 201
Course Name	: Mammalian Physiology
Semester	: II

L	Т	Р	С
4	4	0	4

Course objective: The objectives of the course are as follows:

- 1. To examine basic concepts of mammalian physiology
- 2. To understand mechanisms of digestion, respiration, circulation and endocrine function
- 3. To explore the physico-chemical basis and operation of each organ system.

UNIT I: Digestion and Respiration (15 Periods)

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 O2 and CO2, Oxygen dissociation curve, Chloride shift.

UNIT II: Circulation (15 Periods)

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 Periods)

Structure of cardiac, smooth & skeletal muscle, threshold stimulus. 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 Periods)

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction.

Different endocrine glands- Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid

and adrenals, hypo & hyper-secretions.

SUGGESTED READING AND TEXT BOOKS

- 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.

CO					D	escri	ptin					Blo	om's	•	Taxor	omy
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		app	ing		Pro	ogran	n Oı	ıtcon		Os)			Prog Spec Outc	ram ific omes (PSOs)	
		app	ing		Pro	ogran	n Oı	ıtcon	nes (P	Ds)	011	012	Prog Spec Outc	ram ific omes (PSOs)	
Jutcomes		P02	ing 603	P04	Pro SOd	ogran 90d	n Ou LOd	otcon 804	nes (Pe	D3)	POIL	P012	Prog Spec Outc IO SA	ram ific omes (0SA	PSOs) COSA	
Outcomes	Ma IO 3	P02	ing EO4	2 F04	Pro SOA 2	90 2	n Or 604 2	Non 2	604 3	01111111111111	1	1	Prog Spec Outc IO Sa 3	ram ific omes (OSA 2	PSOs) EOSA	2
Outcomes	Ma IO 3 2	b03 3 2	EO 1 2	2 2	Pro 504 2 2	900 2 2	n Ou 604 2 1	80 2 1	60 3 3	0 1 1	1	1	Prog Spec Outc IOSA 3 3	ram ific omes (2 2	PSOs) EOSA	2
Outcomes CO1 CO2 CO3	Ma IO IO IO IO IO IO IO IO	app CO4 3 2 2	ing EO4 1 2 3	FOd 2 2 3	Pro 504 2 2 3	900 2 2 3	60 2 1 2	2 1 2	60 3 3 2	0 100 1 2	1 1 2	1 1 2	Prog Spec Outc IOSA 3 3 2	ram ific omes (2 2 2 2	PSOs) E E E C	2 2 2 2
CO1 CO2 CO3 CO4	IO 3 2 2 2	200 3 2 2 2 2	EOG 1 2 3 3	Pod 2 3 3	Pro 504 2 2 3 3	900 2 2 3 3	LOG 2 1 2 1	80 2 1 2 1	60 3 3 2 3	0104 1 1 2 1	1 1 2 1	1 1 2 1	Prog Spec Outc IOS 3 3 2 2	ram ific omes (2 2 2 3	PSOs)	2 2 2 2 2 2
CO1 CO2 CO3	Ma IO IO IO IO IO IO IO IO	app CO4 3 2 2	ing EO4 1 2 3	FOd 2 2 3	Pro 504 2 2 3	900 2 2 3	60 2 1 2	2 1 2	60 3 3 2	0 100 1 2	1 1 2	1 1 2	Prog Spec Outc IOSA 3 3 2	ram ific omes (2 2 2 2	PSOs) E E E C	2 2 2 2

3: High, 2: Medium, 1: Low

Course code	: HBTL 201
Course Name	: Lab Course Based on HBTC 201
Semester	: II

L	Т	Р	С
0	0	2	2

Practicals

- **1.** Determination of Haemoglobin
- 2. Preparation of temporary slide of a mammalian tissue sample
- **3.** Estimation of bleeding time and clotting time of the human being
- 4. Identification of blood cells by differential staining
- 5. Perform differential leukocyte count (DLC) in the blood sample
- 6. Counting of mammalian RBCs
- 7. Estimation of blood glucose level by glucometer
- 8. Identification of blood group in humans
- 9. Demonstration of action of an enzyme (catalase enzyme)
- 10. Separation of plasma and serum from the whole blood
- 11. Study pulmonary function test via online video tutorial

Course code	: HBTC 201
Course Name	: Plant Physiology
Semester	: 11

L	Т	Р	С
4	4	0	4

Course Objective: The objectives of the course are as follows:

- 1. To provide detailed information about the basic principles of plant function
- 2. To teach the plant-water relationships
- 3. To teach principles of plant cell physiology and plant growth and development
- 4. To teach carbon and nitrogen metabolism
- 5. To provide information about plant secondary metabolites and their role in plant stressphysiology

UNIT I: Anatomy (10 Periods)

The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf)

UNIT II: Plant water relations and micro & macro nutrients (12 Periods)

Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing. Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport

UNIT III: Carbon and nitrogen metabolism (20 Periods)

Photosynthesis- Photosynthesis pigments, concept of two photo systems, photphosphorylation,

calvin cycle, CAM plants, photorespiration, compensation point

Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

UNIT IV: Growth and development (18 Periods)

Growth and development: Definitions, phases of growth, growth curve, growth hormones

(auxins, gibberlins, cytokinins, abscisic acid, ethylene) Physiological role and mode of

action, seed dormancy and seed germination, concept of photoperiodism

and vernalization

SUGGESTED READING AND TEXT BOOK

- 1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
- 2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
- 3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
- 4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
- 5. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.

CO					D	escri	ptio	n				Blo	om's	Taxo	nomy	Leve
CO1	Remember and define the terms and basic concepts of plant physiology and their different roles to influence biological plant body systems.												R	1 ememt	pering	
CO2	Understand and Remember the principle, mechanism o Anatomy, Plant water relations and micro & macro nutrients, Carbon and nitrogen metabolism and Growth and development.											: 0	1,2 Remembering, Understanding			
CO3	Applying, understanding and remembering the detailed processes of Anatomy, Plant water relations and micro & macro nutrients, Carbon and nitrogen metabolism and Growth and development.											&	Un	1,2, memb derstar monst	ering, nding,	
CO4	detaile micro	Analyzing, Applying, remembering, Understanding the detailed study related to Anatomy, Plant water relations and micro & macro nutrients, Carbon and nitrogen metabolism and Growth and development.										d	Un	1,2,3 memb derstar Analyz	ering, nding,	
CO5	under	Evaluating, Analyzing, Applying, remembering, and understanding the principle, methods, properties and functions of plant physiology.1, 2,3,4,5 Remembering, Understanding, Analyzing, Evaluating														
CO6	Constructing (Creating), Evaluating, Analyzing demonstrating, remembering, and understanding th plant physiology and the awareness and appreciation for plants in environment, and their diverse physiological functions.										ne Or	Re Un	,2,3,4 memb dersta Analyz Evalua Creati	ering, nding, ing, ting		
Course Outcomes		app	ing	of C					PSOs nes (P				Prog Spec Outc	ific	PSOs)	
	POI	P02	PO3	P04	P05	P06	P07	P08	604	P010	P011	P012	PS01	PSO2	PSO3	PSO4
CO1	2	3	1	2	3	3	3	2	3	1	1	1	3	2	1	2
CO2	3	2	2	2	2	2	1	1	3	3	3	3	3	2	1	2
CO3	3	3 3 3 3 3 2 2 3 2 2 2 2 2 2 2										2				
CO4	2	2	3	3	3	3	1	1	3	1	1	1	2	3	2	2
		2	3	1	1	1	2	2	3	3	2	1	2	2	2	2
CO5	2	2	5	1	-											

Course code	: HBTL 202
Course Name	: Lab Course Based on HBTC 202
Semester	: II

L	Т	Р	С
0	0	2	2

Practicals

- 1. Demonstration of plasmolysis in *Tradescantia* leaves.
- 2. Determination of water potential of plant tissue.
- 3. Study stomatal distribution on leaf surfaces and calculation of stomatal index.
- 4. Study of ascent of sap in plants.
- 5. Study aerobic respiration in germinating seeds.
- 6. Separation of photosynthetic pigments by paper chromatography.
- 7. Chlorophyll and carotenoid quantification via spectrophotometric analysis.
- 8. Demonstration of photosynthesis in aquatic plant.
- 9. Determine the presence of starch and sucrose in plants.
- 10. Determination of transpiration from foliar surface.

Course code	: HBTG 203
Course Name	: Enterpreneurship Development
Semester	: II

L	Т	Р	С
4	4	0	4

Course Learning Objectives:

- 1. To understand the meaning and importance of Entrepreneurship .
- 2. To understand the various forms of business organisation .
- 3. To analyze the importance of finance in an enterprise .
- 4. To analyze the importance of marketing management in an enterprise.
- 5. To understand the meaning of international business.

UNIT I

INTRODUCTION (10 Periods)

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

UNIT II

ESTABLISHING AN ENTERPRISE (12 Periods)

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

UNIT III

FINANCING THE ENTERPRISE (15 Periods)

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 (13 Periods)

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 (10 Periods)

Meaning of International business, Selection of a product, Selection of a market for international

business, Export financing, Institutional support for exports.

SUGGESTED READING AND TEXT BOOKS

- 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.

								-	ion of		ourse	- <u>r</u>				T
СО		Description Bloom's Ta						1 axo	nomy	Level						
CO1	entrep influe	Remember and define the terms and basic concepts of entrepreneurship development and their different roles to influencing entrepreneurship, features of a successful Entrepreneurship											R	l ememl	bering	
CO2	mecha enterp	J nderstand and Remember the introduction and principle, nechanism of entrepreneurship, features, financing the nterprise, marketing management and entrepreneurship and nternational business.												1,2 ememb ndersta	ering,	
CO3	Apply proces financ entrep	pplying, understanding and remembering the detailed rocesses of mechanism of entrepreneurship, features, nancing the enterprise, marketing management and ntrepreneurship and international business.											Un	1,2, ememb dersta emonst	ering, nding,	
CO4	detaile entrep	nalyzing, Applying, remembering, understanding the etailed and complete study related to Biotechnologica ntrepreneurship features for the growth or individua erson and society											Un	1,2,3 ememb idersta Analyz	ering, nding, zing	
CO5	unders entrep marke	valuating, analyzing, applying, remembering, and nderstanding the properties of mechanism of ntrepreneurship, features, financing the enterprise narketing management and entrepreneurship and international business.										of e,	Re Un	1, 2,3, ememb idersta Analyz Evalua	ering, nding, zing,	
CO6	Const demon entrep applic.	nstra rene abili	a ting urshi ty in	, rei ip ai envii	nd th ronme	Dering ne av ent, ar	g, and waren and the	ness, eir div	unders appro	standi eciatic functic	on an	ne	Re Un	2,2,3,4 ememb idersta Analyz Evalua Creati	bering, nding, ting, ting	
		app	ing	or C		witti	rU	sæ	1308	•			D			
Course Outcomes					Pr	ograr	n Oı	utcon	nes (P	Os)			Prog Spec Outc	ific	(PSO s)	
	P01	P02	P03	P04	P05	P06	P07	PO8	P09	P010	P011	P012	PS01	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	2	2	3	1	1	1	3	2	1	2
CO2	2	2	2	2	2	2	1	1	3	2	2	2	2	2	1	2
CO3	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO4	2	2	2	2	2	2	1	1	3	1	1	1	2	2	2	2
	2	2	3	1	1	1	2	2	3	2	2	1	2	2	2	2
CO5	2		_													

3: High, 2: Medium, 1: Low

Course code	: HBTL 203
Course Name	: Lab Course Based on HBTG 203
Semester	: II

L	Т	Р	С
0	0	2	2

Practical

- 1. Assessing entrepreneur potential
- 2. Assessment of problem solving ability
- 4. Conducting market survey to know the demands for different products
- 6. Preparing project proposals
- 7. Individual and group presentations and evaluation of presentation
- 9. Conducting meeting Purpose, procedure, participation, physical arrangements,

recording and writing of minutes of meeting

10. Seminar and conferences : Use of body language

- 11. Conducting mock interviews testing initiative, team spirit and leadership
- 12. Group discussion and debates on current topics
- 13. Visit to entrepreneurship institute/ case study of successful entrepreneurs
- 14. Presentations by the students

Course code	: AECC 202
Course Name	: English Communication
Semester	: II

L	Т	Р	С	
4	4	0	4	

Course Objectives:

1. To define and explain various techniques of word formation; and develop skills of sensiblewriting and vocabulary building.

2. To illustrate and elaborate fundamental techniques and features of writing skills.

3. To demonstrate and discuss various types of common errors committed by users of English and solve exercises to develop their understanding in use of grammatically correct sentences.

4. To organize language lab activities and workshops to develop oral communication skills

Unit 1: Theory of Communication, Types and Modes of Communication: (8 Periods)

Introduction, Definitions and Function of Communication, Needs for Effective Communication,

Process of Communication, Barrier to Communication, Kinds of Communication; Intrapersonal,

Personal, Group and Mass, Verbal and Non-verbal Communication.

Unit 2: Listening and Speaking Skills: (8 Periods)

Types of Listening, Developing Effective Listening Skills, Academic Listening (Lectures),

Listening to Talks and Presentation, Monologue, Dialogue, Group Discussion, Miscommunication,

Interview, Public Speech, Pronunciation, Accent and Intonation and Rhythm.

Unit 3: Reading Skills: (8 Periods)

Skimming, Scanning, Summary, Paraphrasing, Comprehension.

Unit 4: Introductory English Grammar: (8 Periods)

Parts of Speech, Tenses, Punctuation, Common Errors in English.

Unit 5: Writing Skills; Social and Official Correspondence: (8 Periods)

Enquiries, Complaints and Replies, Letters to the Editor, Social Appeals in the Form of

Letter/ Pamphlets, Standard Business Letter, Email Drafting and Etiquettes, Preparing Agenda and Writing Minutes for Meetings.

Unit 6: Career Skills: (8 Periods)

Job Application, Cover Letter, Bio-data, CV and Resume and Effective Profiling,

Mock Interviews, Group Discussions.

SUGGESTED READINGS AND TEXT BOOKS

1. Fluency in English- Part II, Oxford University Press, 2006.

2. Business English, Pearson, 2008.

3. Language, Literature and Creativity, Orient Blackswan, 2013.

4. Language through Literature (Forthcoming) ed. Dr. Gauri Mishra, Dr. RanjhanaKaul, Dr. Brati Biswas.

CO						éscri		-				·	student			Level
CO1		emo	nstra	te kr	fferen 10wle	it tecl dge o	- hniqı	ies o	f wor ms, a			n;		1	bering	
	Unders Comm effecti	skills of sensible writing. Understand and remember the principle, mechanism of Communication skills, essential techniques and features of effective writing and make use of them in written communication.									of		1,2 memb idersta	ering,		
CO3	proces writing	Applying, understanding and remembering the detailed rocesses of essential techniques and features of effective writing and make use of them in written communication. Knowledge of synonyms, antonyms and skills of sensible									ve n.	Un	monst	ering, nding, rating		
CO4	Anal detail exerc	yzin ed s ises of o	tudy base oral	relat ed on and v	ed co them	mmor n; app	n erro oly ac	ors in equire	Englis Englis ed kno on in p	sh and wledg	l solve ge and		Un	1,2,3 memb dersta Analyz	ering, nding,	
0.05	unders	valuating, analyzing, applying, remembering, and inderstanding the principle, methods, properties an inctions of plant physiology.										Remembering				
CO6	demo Take activi	nstra pa ties;	ating rt in and	, ren 1 ind dete	nembe lividu e rmin	ering, al an e and	anc dgr l inv	d un oup r ent 1	g, A derstar comm new fo situat	nding unicat orms	the tion		Re Un	,2,3,4 memb dersta Analyz Evalua Creati	ering, nding, ing, ting	
	Ma	app	ing	of C	COs	with	PO	s &]	PSOs	5			1			
Course Outcomes					Pr	ograr	n O	utcon	nes (P	Os)			Prog Spec Outc	ific	(PSOs)	ı
	POI	P02	P03	P04	P05	P06	P07	PO8	P09	P010	P011	P012	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	2	2	3	3	2	3	1	1	1	3	2	1	2
CO2	3	2	2	2	2	2	1	1	3	3	3	3	3	2	1	2
CO3	3	3 2 3 3 3 3 2 2 3 2 2 2									2	2	2	2	2	
CO4	2	2	3	3	2	3	1	1	3	1	1	1	2	3	2	2
CO5	2	2	3	1	1	1	2	2	3	3	2	1	2	2	2	2
CO6		2 2 2 2 2 2 2 2 2 2 2 2 2 2										2	2	2	2	2

3: High, 2: Medium, 1: Low

	B. Sc. (Hons.) Biotechnology
Course code	: HBTC 301
Course Name	: Genetics
Semester	: III

L	Т	Р	С
4	4	0	4

Course objectives: The objectives of the course are as follows:

- 1. To make the student understand the Mendelian and non-Mendelian genetics of inheritance.
- 2. To make the student understand the allele and gene interactions.
- 3. To make the student learn the fundamentals of chromosome and gene organization.
- 4. To impart the knowledge about sex determination among humans and animals.
- 5. To teach the concepts of extra-chromosomal inheritance

UNIT I (12 Periods)

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.

UNIT II (18 Periods)

Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA.

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 Periods)

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.

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 Periods)

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.

SUGGESTED READING AND TEXT BOOKS

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

			utco	mes				-	letioi	1 01		Juise	· 	student			
CO					Descriptio								Blo	om's	Taxo	nomy	Level
CO1	and and g	the different concept of genetics, Mendeliar non-Mendelian genetics of inheritance, Chromosome genomic organization, Chromosome and gene mutations Genetic linkage, crossing over and chromosome ping.									e Is	R	1 emem	bering			
CO2	Unde Menc Chron gene	erstand and remember the different concept of genetics delian and non-Mendelian genetics of inheritance pmosome and genomic organization, Chromosome and e mutations and Genetic linkage, crossing over and mosome mapping.								e, d		1,2 ememb ndersta	ering,				
CO3	Appl proce conce genet organ	plying, understanding and remembering the detailed occesses, essential techniques and features of effective neept of genetics, Mendelian and non-Mendelian netics of inheritance, Chromosome and genomi- ganization, Chromosome and gene mutations and Geneti- kage, crossing over and chromosome mapping.								n c	Un	1,2, ememb dersta emonst	ering, nding, rating				
CO4	the of Men Chro and	nalyzing, applying, remembering and understanding e detailed study related to different concept of genetics, endelian and non-Mendelian genetics of inheritance, promosome and genomic organization, Chromosome d gene mutations and Genetic linkage, crossing over d chromosome mapping.									Remembering, Understanding, Analyzing						
CO5	funct of in Chron	rstan ions herit mosc	ding gene ance, ome	the tics, Ch and	Mer Mer romo gen	incip Idelia osom e m	le, an ar an ar ue ar utatio	meth nd no nd g ons	ods, on-Me genon and	pro endel nic (ering, pertie lian g organi etic li	s an enetic zatior	d :s 1,	Re Un	1, 2,3 ememb idersta Analyz Evalua	ering, nding, zing,	
CO6	 crossing over and chromosome mapping. Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the Take part in individual and group to different concept of genetics, Mendelian and non-Mendelian genetics of inheritance, Chromosome and genomic organization, Chromosome and gene mutations and Genetic linkage, crossing over and chromosome mapping. 								Re Un	,2,3,4 ememb idersta Analyz Evalua Creati	ering, nding, ting, ting						
	11	lap	ung	UI		vv1	LII I	03	& PS	508				Prog	ram		
Course Outcomes						Pro	gran	n Oi	itcom	nes (l	POs)			Spec	ific	(PSO s)	
		PO1	P02	PO3	P04	P05	PO6	P07	P08	P09	P010	P011	P012	PS01	PSO2	PSO3	PSO4
0.01		3	2	3	2	2	3	3	2	3	1	1	1	3	2	1	2
CO1		5		2					-	3	1	-	-	5		1	4

CO2

CO3

CO4

CO5

CO6

Shri Guru Ram Rai University, Patel Nagar, Dehradun, Uttarakhand-248001

Course code	: HBTL 301
Course Name	: Lab Course Based on HBTC 301
Semester	: III

L	Т	Р	С
0	0	2	2

Practicals

- 1. Safety guidelines of genetics laboratory and good laboratory practices.
- 2. Bacterial conjugation for genetic recombination.
- 3. Isolation of *E. coli* mutants by UV irradiation.
- 4. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
- 5. Simulation of genetic drift in an isolated population.
- 6. Karyotyping with the help of photographs
- 7. Polyploidy in onion root tip cells by colchicine treatment.
- 8. Preparation of the pedigree chart of blood group.
- 9. Permanent and temporary mount of mitosis.
- 10. Permanent and temporary mount of meiosis.
- 11. Mendelian deviations in dihybrid crosses
- 12. Demonstration of Barr Body Rhoeo translocation.
- 13. Study of polyploidy in onion root tip by colchicine treatment.

Course code	: HBTC 302
Course Name	: General Microbiology
Semester	: III

L	Т	Р	С
4	4	0	4

Course objectives: This course is designed to be an introduction to microbiology that will familiarize students with the diversity within the microbial world, biology of bacteria, their metabolism and genetics, and their control. The specific objectives are:

1. To illustrate the criteria used for classification of microorganisms

2. To explain the structure of a prokaryotic cell

3. To give an overview of growth, nutrition and metabolism in bacteria

4. To illustrate the concepts of bacterial recombination

UNIT I (10 Periods)

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 Periods)

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms,

methods of isolation, Purification and preservation.

UNIT III (20 Periods)

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 Periods)

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.

SUGGESTED READING AND TEXT BOOKS

- 1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th 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. 12 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 th edition. Pearson
- 8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

СО]	Desc	ripti	ion					Blo	om's 🛛	Faxon	omy L	evel
CO1	Evolutio Mainter Metabo	nember the different concept of fundamentals, History and lution of Microbiology, microbial diversity, Cultivation and intenance of microorganisms, Microbial growth, Microbia abolism, Bacterial Reproduction, Control of Microorganism or microbiology and food microbiology.									ion an icrobia	d 1	R	1 ememt	bering		
CO2	and Ev growth, of Mici	erstand and remember the concept of fundamentals, Histo Evolution of Microbiology, microbial diversity, Microbi th, Microbial Metabolism, Bacterial Reproduction, Contr ficroorganisms, water microbiology, food microbiology and vation and Maintenance of microorganisms.								licrobia Contro	al ol		1,2 emembendersta	ering,			
CO3	genetic of mi	-									abolisi hogeni	7, n	r, Remembering, In Understanding,				
CO4	detaile genetie metabe	yzing, applying, remembering and understanding the led study related to different concept of microbiology, tic recombination in microbiology, diversity and bolism of microbiology along with Control of pathogenic porganisms, water microbiology and food microbiology.															
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CO3		3	3	2	2	3	3	2	2	3	2	2	2	2	2	2	2
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Course code	: HBTL 302
Course Name	: Lab Course Based on HBTC 302
Semester	: III

L	Т	Р	С
0	0	2	2

Practicals

- 1. Preparation and sterilization of media for bacterial culture.
- 2. Isolation of bacteria from the soil.
- 3. Preparation of pure culture of bacteria.
- 4. Streaking of bacterial culture.
- 5. Gram staining of bacteria.
- 6. Determination of bacterial cell size by micrometry.
- 7. Enumeration of microorganisms.
- 8. Preparation of bacterial growth curve.
- 9. Antimicrobial sensitivity test.
- 10. Demonstration of flagella staining.

Course code	: HBTC 303	
Course Name	: Chemistry- I	
Semester	: III	

L	Т	Р	С
4	4	0	4

Course objectives: The course aims to teach the principles of chemistry. The specific objectives of the course are:

- 1. To teach students the basic concepts of chemistry.
- 2. To make students understand the importance of chemistry in sustainable development.
- 3. To teach students the fundamental principles of biocatalysis,
- photochemistry and electrochemistry.

4. To teach students about chemistry in daily practice

UNIT I (18 Periods)

Stereochemistry: Writing of Fischer projection, Newmann and Sawhorse projection and Wedge formulae. Interconversion of one type of structural representation into another type. Conformation: Restricted rotation about single bonds, Various conformations of ethane, butane and cyclohexane. Relative stability of different conformations in terms of energy difference is to be discussed for all these compounds. Geometrical Isomerism: Requirements for a molecule to show geometrical isomerism, Cis-Trans and E/Z notation along with CIP rules for geometrical isomers. Optical and Isomerism: Optical activity, specific molar rotation, chirality, enantiomerism, diastereoisomerism, racemic mixtures and their resolution by salt formation method. Relative and absolute configuration: D / L nomenclature system for configuration of carbohydrates (difference between d/l and D/L notations). Threo and Erythro designation. R and Sconfiguration (upto two chiral centres).

UNIT II (10 periods)

Alkenes and Alkynes: Hydrogenation, addition of halogens, Hydrohalogenation (Markovnikov's and anti-Markovnikov's addition), hydration, hydroxylation (cis and trans), oxymercurationdemercuration, hydroboration-oxidation, ozonolysis. Reactivity of alkenes vs alkynes. Aldehydes and ketones: (formaldehyde, acetaldehyde, benzaldehyde, acetone) Addition of sodium bisulphite, hydrogen cyanide and alcohols. Addition- elimination reactions with ammonia and its derivatives Name reactions: Aldol, cross Aldol, Claisen, Knoevengel, Cannizzaro, cross Cannizzaro

UNIT III (15 Periods)

Free radical substitution reactions: Halogenation of alkanes, allylic compounds and alkylbenzenes. Nucleophilic substitution reactions: Alkyl, allyl and benzyl halides – substitution of halogen by some common nucleophiles. Mechanism of SN1 and SN2 reactions (stereochemistry, nature of substrate, nucleophile and leaving group) Benzene diazonium chloride: Replacement of diazo group Alcohols,

amines and phenols: Substitution of active hydrogen, replacement of hydroxyl group in alcohols (using PCl5, SOCl2 and HI) Carboxylic acid derivatives: Hydrolysis Ethers: Cleavage by HI Electrophilic Substitution Reactions (aromatic compounds): General mechanism of electrophilic substitution reactions (nitration, halogenation, sulphonation, Friedel Crafts alkylation and acylation), directive influence of substituents.

UNIT IV (17 Periods)

Elimination Reactions: Alkyl halides (dehydrohalogenation, Savtzeff's rule), vicinal dihalides

(dehalogenation), alcohols (dehydration), Quaternary ammonium salts (Hofmann's elimination). Mechanism of E1 and E2 reactions (nature of substrate and base), elimination vs substitution. Oxidation Aromatic side chain: Oxidation with potassium permanganate, potassium dichromate Alcohols: Oxidation with potassium permanganate, potassium dichromate, catalytic dehydrogenation and Oppenauer oxidation. Oxidation of 1,2–diols with periodic acid and lead tetraacetate. Aldehydes: Oxidation with potassium permanganate, chromic acid and Tollen's reagent Ketones: Oxidation with potassium permanganate, sodium hypoiodite (iodoform reaction) and Baeyer-Villiger oxidation Reductions Aldeydes and Ketones: Catalytic hydrogenation, reduction with sodium borohydride, lithium aluminium hydride, Clemmensen, Wolff-Kishner Carboxylic acids and their derivatives:

Lithium aluminium hydride, sodium-ethanol and Rosenmund reduction. Nitro compounds: Acidic, alkaline and neutral reducing agents, lithium aluminium hydride and electrolytic reduction.

SUGGESTED READING AND TEXT BOOKS

- 1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical OrganicChemistry, 5 Ed., Pearson (2012).
- 2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Longman, London & New York.
- 3. Ahluwalia, V.K.; Dhingra, S. & Gulati, A. College Practical Chemistry, Universities Press.
- 4. I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
- 5. R. T. Morrison & R. N. Boyd: Organic Chemistry, Pearson Education.
- 6. Arun Bahl and B. S. Bahl : Advanced Organic Chemistry, S. Chand
- 7. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
- 8. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.

10. T. W. Graham Solomon's Organic Chemistry, John Wiley and Sons.

11. P.S. Kalsi, Stereochemistry, Conformation and Mechanism, John Wiley and Sons. D. Nasipuri, Stereochemistry of Organic Compounds, New Age International Publishers.

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CO3	Applyin process chemistr ketones substitu													Remembering, Understanding, Demonstrating			
CO4	detaile alkene substit Electro	yzing, applying, remembering and understanding the ed study related to concepts of chemistry: stereochemistry, es and alkynes, Aldehydes and ketones, Free radical itution reactions, Nucleophilic substitution reactions, rophilic Substitution Reactions, Elimination Reactions												zing			
COS	chemistr ketones substitu	the different functional groups. Tating, analyzing, applying, remembering, and standing the principle, methods, properties and functions o stry: stereochemistry, alkenes and alkynes, Aldehydes and es, Free radical substitution reactions, Nucleophilic tution reactions, Electrophilic Substitution Reactions nation Reactions and the different functional groups.												f Remembering, Understanding, Analyzing, Evaluating			
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Course code	: HBTL 303
Course Name	: Lab Course Based on HBTC 303
Semester	: III

L	Т	Р	С
0	0	2	2

Practicals

- 1. Purification of organic compounds by crystallization using the following solvents: (a) Water (b) Alcohol
- 2. Determination of the melting points of organic compounds (by Kjeldahl method and electrically heated melting point apparatus).
- 3. Determination of optical- 1g of starting compound. Recrystallize the product and determine the melting point of activity by using polarimeter Organic preparations: Carry out the following preparations using 0.5 the recrystallized sample.
- 4. To prepare acetanilide by the acetylation of aniline.
- 5. To prepare p-bromoacetanilide.
- 6. Benzolyation of aniline or β -naphthol by Schotten-Baumann reaction
- 7. Hydrolysis of benzamide or ethyl bezoate.
- 8. Semicarbazone derivative of one the following compounds: acetone, ethyl methylketone, diethylketone, cyclohexanone, benzaldehyde.
- 9. Nitration of nitrobenzene.
- 10. Oxidation of benzaldehyde by using alkaline potassium permanganate.

Course code	: HBTG 304
Course Name	: Bioethics and Biosafety
Semester	: III

L	Т	Р	С
4	4	0	4

Course Objectives: The objectives of the course are as follows:

- 1. To understand importance of bioethics and biosafety.
- 2. To understand legal social and economic impacts of biotechnology.
- 3. To understand regulatory guidelines and their importance.
- 4. To understand importance of patent.
- 5. To understand procedure to apply for patent.
- 6. To understand procedure of assessment of biosafety for biotech foods.
- 7. To understand ethical implications of biotechnology.

UNIT-I (15 Periods)

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 (20 Periods)

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 (10 Periods)

Bioethics - Necessity of Bioethics, different paradigms of Bioethics - National & International.

Ethical issues against the molecular technologies.

UNIT IV (15 Periods)

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)

Practices (GMP).

SUGGESTED READING AND TEXT BOOKS

- 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.

CO						Desc	crip	tion					1		s will		Bloom's Taxonomy Level			
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CO4	the de Entre Bioet	yzing, applying, remembering and understanding etailed study related to concepts of Patent Law, IPR preneurship, the basic regulations of excise, thics and Biosafety, Good Laboratory Practices P) and Good Manufacturing Practices (GMP).																		
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3: High, 2: Medium, 1: Low

Course code	: HBTL 304
Course Name	: Lab Course Based on HBTG 304
Semester	: III

L	Т	Р	С
0	0	2	2

Practicals

- 1. Study of basic laboratories: Biosafety Levels (BSL) 1 and 2.
- 2. Case study on clinical trials of drugs in India with emphasis on ethical issues.
- 3. Study of containment laboratories: Biosafety Level (BSL) 3.
- 4. Case study on women health ethics.
- 5. Planning of establishing a hypothetical biotechnology industry in India.
- 6. Study the maximum containment laboratory: Biosafety Level (BSL) 4.
- 7. Case study on medical errors and negligence.
- 8. Case study on handling and disposal of radioactive waste.
- 9. Study laboratory hazards: Fire hazards, Electrical Hazards, Noise, Ionizing hazards.
- 10. Transgenic animals/plants: Their effects on environment and health of the consumer.

Course code	: HBTS 305
Course Name	: Industrial Fermentations
Semester	: III

L	Т	Р	С
4	4	0	4

Course objectives: The specific objectives of the course are as follows:

- 1. To familiarize students with the production of industrial chemicals.
- 2. To impart knowledge about metabolic engineering of secondary metabolism.
- 3. To teach students about the enzyme and cell immobilization techniques relevant to industrial processing.
- 4. To make students understand the different methods of experimental model for design offermentation systems.
- 5. To teach about the enzyme kinetics used in fermentation technology.

UNIT I (12 Periods)

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 (15 Periods)

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 (13 Periods)

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 (20 Periods)

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.

SUGGESTED READING AND TEXT BOOKS

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.

Outcomes Outcomes (PSOs) Image: Condensity of the stress of th	(Course	Dutco	omes	(CC) s):	On c	comp	oletio	n of	this c	ourse	, the s	student	s will	be:			
construction of industrial chemicals, biochemicals and pharmacological interest, Enzyme and cell immobilization techniques in industrial processing, purification of products of pharmacological interest, Enzyme and cell immobilization techniques in industrial chemicals, biochemicals and chemotherapeutic products, Microbial products of pharmacological interest, Enzyme and cell immobilization techniques in industrial processing, purification of products and enzymes, enzyme kinetics. I.2. CO2 Understanding and remembering the detailed processing, purification of products and enzymes, enzyme kinetics. I.2.3.4 CO3 Applying, understanding and remembering protects of industrial processing, purification of products and enzymes, enzyme kinetics. Remembering. CO4 Analyzing, applying, remembering and understanding the detailed study related to concepts of industrial chemicals, biochemicals and chemotherapeutic products. Microbial products and conzymes, enzyme kinetics. I.2.3.4.5 CO5 Vanlating, analyzing, applying, remembering, and understanding the principle, methods, properties and functions of industrial processing, purification of products of pharmacological interest. Enzyme and cell immobilization techniques in industrial processing, purification of products of pharmacological interest, Enzyme and cell immobilization techniques in industrial processing, purification of products and enzymes, enzyme kinetics. I.2.3.4.5 CO6 Constructing (Creating). Evaluating Analyzing, encipse in dustrial processing, purification of products and enzymes, enzyme kinetics. I.2.3.4.5 CO6 Constructing (Creating). Evalua	СО]	Desc	ripti	ion					Blo	om's [Гахоп	omy I	Level		
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CO3 Applying, understanding and remembering the detailed 1,2,3 CO3 processes, essential techniques and features of industrial products. Microbial products of pharmacological interest, Enzyme and cell immobilization techniques in industrial processing, purification of products and enzymes, enzyme kinetics. Remembering, Understanding, Demonstrating CO4 Analyzing, applying, remembering and understanding the detailed study related to concepts of industrial chemicals, biochemicals and chemotherapeutic products. Microbial products of pharmacological interest, Enzyme and cell immobilization techniques in industrial processing, purification of products and enzyme, knettcs. 1, 2, 3, 4, 5 CO5 Evaluating, analyzing, applying, remembering, and understanding the principle, methods, properties and functions of industrial processing, purification of products and enzymes, enzyme kinetics. 1, 2, 3, 4, 5 CO6 Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the Take part in essential techniques and features of industrial processing, purification of products and enzymes, enzyme and cell immobilization techniques of industrial processing, purification of products and enzymes, enzyme and cell immobilization techniques of pharmacological interest, Enzyme and cell immobilization techniques of industrial processing, understanding the Take part in essential techniques and chemotherapeutic products, Microbial products of pharmacological interest, Enzyme and cell immobilization techniques in industrial processing, purification of products and enzymes, enzyme kinetics. 1, 2, 3, 4, 5, 6 CO4 Cost for the principle of DoS with POS & POS <td>CO2</td> <td>Understa industrial products, Enzyme processin</td> <td>nd an che Mic and</td> <td>nd ren emica crobia cell</td> <td>memb ls, l l pro imm</td> <td>er th bioch bduct lobili</td> <td>emica s of zatio</td> <td>als f ph n te</td> <td>and arma chniq</td> <td>cher colog ues</td> <td>mother ical i in in</td> <td>rapeuti interes dustria</td> <td>.c t, al</td> <td></td> <td>ememb</td> <td>ering,</td> <td></td>	CO2	Understa industrial products, Enzyme processin	nd an che Mic and	nd ren emica crobia cell	memb ls, l l pro imm	er th bioch bduct lobili	emica s of zatio	als f ph n te	and arma chniq	cher colog ues	mother ical i in in	rapeuti interes dustria	.c t, al		ememb	ering,			
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CO6Constructing demonstrating, remembering, and understanding the Take part in essential techniques and features of industrial chemicals, biochemicals and chemotherapeutic products, microbial products of pharmacological interest, Enzyme and cell immobilization techniques in industrial processing, purification of products and enzymes, enzyme kinetics.1,2,3,4,5,6 Remembering, Analyzing, Evaluating CreatingCo06Mapping of COs with POs & PSOsProgram Outcomes (POs)Program Specific Outcomes (POs)Course Out comesCool3233322322Cool3223322332212Cool3223322333223333Cool322332233322333333Cool32233322333223333333223333333333333333223333333333333333333	05	understar industrial products, Enzyme processin	uating,analyzing,applying,remembering,andrstanding the principle,methods,properties and functions of1, 2,3,4,5trialchemicals,biochemicalsandchemotherapeuticacts,Microbialproductsofpharmacologicalinterest,meandcellimmobilizationtechniquesinindustrial											zing,					
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Course code	: HBTS 306
Course Name	: Molecular Diagnostics
Semester	: III

L	Т	Р	С
4	4	0	4

Course objectives: The course is designed to give an overview and applications of differentmolecular biology techniques used in disease diagnosis. The specific objectives of the course are:

- 1. To teach students different molecular techniques used for disease diagnosis.
- 2. To make students understand the utilization of these techniques in disease diagnosis.
- 3. To teach the use of different enzyme immunoassay based diagnostic methods.
- 4. To impart the knowledge about the molecular diagnostic of different human diseases.

UNIT I (15 Periods)

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 (15 Periods)

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 (18 Periods)**

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 (12 Periods)

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

SUGGESTED READING AND TEXT BOOKS

- 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 (edited by Paniker CKJ). University Press Publication.
- 5. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical

CO]	Desc	ripti	ion					Blo	om's 🛛	Faxon	omy I	Level
CO1	Enzyme microbio specific	biology, Susceptibility tests, standardization of antigen and fic antibodies, GLC, HPLC, Electron microscopy, sytometry and cell sorting. Transgenic animals.														
CO2	Enzyme microbio specific	rstand and remember the specific and basic concepts of ne Immunoassays, Molecular methods in clinical biology, Susceptibility tests, standardization of antigen and1,2 Remembering, Understanding														
CO3	Susceptil antibodie	ng, understanding and remembering the detailed 1,2,3														
CO4	detailed Enzyme microbi and spe	zing, applying, remembering and understanding the ed study related to concepts of immunological methods, ne Immunoassays, Molecular methods in clinical piology, Susceptibility tests, standardization of antigen pecific antibodies, GLC, HPLC, Electron microscopy, ytometry and cell sorting. Transgenic animals.1,2,3,4 Remembering, Understanding, Analyzing														
CO5	understan immunol methods standardi Electron animals.	rdization of antigen and specific antibodies, GLC, HPLC, on microscopy, flowcytometry and cell sorting. Transgenic										zing,				
CO6	Constr demons part in Molecu tests, s GLC, F sorting.	trating immu lar me andaro IPLC,	g, rem inolog thods dization Elect genic	gical in cl on of ron n anim	ring, meth inica ant nicros als.	and ods, il mic igen scopy	l und Enzy crobic and y, floy	vme l ology, speci wcyto	nding Immu , Susc fic a metry	noassa ceptibi ntibod y and	ake ays, llity lies,	U	Re Indersta	1,2,3,4 ememb anding, Evalua Creati	ering, Analy ting	zing,
		<u> </u>	,										Prog	ram		
Course Outcomes					rro	gran		iicon		POs)			Speci Outc	ific omes (PSOs)	
		F01	P03	P04	P05	P06	PO7	P08	P09	P010	P011	P012	PSO1	PSO2	PSO3	POSQ
C01	2	2	3	3	3	3	3	2	3	2	2	2	3	2	1	2
CO2	2	2 3 2 2 2 2 3 3 2 3 3						3	2	2	1	2				
CO3	2	2 3 2 2 2 2 2 2 3 2 2						2	2	2	2	3	2			
CO4	3	2	2	3	2	3	2	2	3	1	3	3	2	2	3	3
CO5	3	2	2	2	2	2	2	2	3	3	2	3	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Course code	: HBTS 307
Course Name	: Basics of Forensic Science
Semester	: III

L	Т	Р	С
4	4	0	4

Course objectives: This is an introductory course on forensic sciences with the following objectives:

- 1. To familiarize students with the fundamental principles of forensic sciences.
- 2. To impart knowledge about the injuries and deaths and how they are assessed.
- 3. To make students understand the process of documentation of crime scenes.
- 4. To impart the knowledge about the importance of cyber security in forensic sciences.

Unit I (15 Periods)

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 (15 Periods)

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 (15 Periods)

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 (15 Periods)

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.

SUGGESTED READING AND TEXT BOOKS

- 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).

CO	Description	Bloom's Taxonomy Leve
CO1	Remember the different basic concepts of introduction and principles of forensic science, forensic science laboratory and its organization and service, Classification of fire arms and explosives, Role of the toxicologist and findings, Principle of DNA fingerprinting, application of DNA profiling in forensic medicine and introduction to Cyber security.	1 Remembering
CO2	Understand and remember the specific and basic concepts of forensic science, forensic science laboratory and its organization and service, Classification of fire arms and explosives, Role of the toxicologist and findings, Principle of DNA fingerprinting, application of DNA profiling in forensic medicine and introduction to Cyber security.	Remembering, Understanding
CO3	Applying, understanding and remembering the detailed processes, essential techniques and features of forensic science, forensic science laboratory and its organization and service, Classification of fire arms and explosives, Role of the toxicologist and findings, Principle of DNA fingerprinting, application of DNA profiling in forensic medicine and introduction to Cyber security.	Remembering, Understanding, Demonstrating
CO4	Analyzing, applying, remembering and understanding the detailed study related to concepts of crime scene detection methods, forensic science, forensic science laboratory and its organization and service, Classification of fire arms and explosives, Role of the toxicologist and findings, Principle of DNA fingerprinting, application of DNA profiling in forensic medicine and introduction to Cyber security.	1,2,3,4 Remembering, Understanding, Analyzing
CO5	Evaluating, analyzing, applying, remembering, and understanding the principle, methods, properties and functions of forensic science, forensic science laboratory and its organization and service, Classification of fire arms and explosives, Role of the toxicologist and findings, Principle of DNA fingerprinting, application of DNA profiling in forensic medicine and introduction to Cyber security.	Remembering, Understanding, Analyzing, Evaluating
CO6	Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the take part in forensic science, forensic science laboratory and its organization and service, Classification of fire arms and explosives, Role of the toxicologist and findings, Principle of DNA fingerprinting, application of DNA profiling in forensic medicine and introduction to Cyber security.	1,2,3,4,5,6 Remembering, Understanding, Analyzing, Evaluating Creating

				000				itcon	nes (1	POs)			Progr	am Spe	ecific			
Course		Program Outcomes (POs) Outcomes (PSC													SOs)	s)		
Outcomes	P01	P02	P03	P04	P05	906	P07	PO8	604	P010	P011	P012	PS01	PSO2	PSO3	PSO4		
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CO2	3	3	2	2	2	2	3	3	2	3	3	3	2	2	3	2		
CO3	3	3	2	2	2	2	2	2	3	2	2	3	3	2	3	2		
CO4	3	2	2	3	2	3	2	2	3	1	3	3	2	2	3	3		
CO5	3	2	2	2	2	2	2	2	3	3	2	3	2	2	2	2		
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2		
3: High, 2	: Me	dium	n, 1:	Low														
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Course code	: HBTS 308
Course Name	: Green Chemistry
Semester	: III

L	Т	Р	С
4	4	0	4

Course objectives: The course aims to teach the principles of green chemistry. The specificobjectives of the course are:

- To teach students the basic concepts of green chemistry. 5.
- To make students understand the importance of green chemistry in sustainable development. 6.
- To teach students the fundamental principles of biocatalysis, 7. photochemistry and electrochemistry.
- 8. To teach students about green chemistry in daily practice

UNIT I: Introduction and principles

Introduction to green chemistry and its guiding principles; green chemistry and industry; waste minimization and atom economy; reduction of material use, reduction of energy requirement; energy efficiency improvements; alternative energy sources; alternative solvents.

UNIT II: Green chemistry and sustainable development [12 Hours]

The concept of sustainability; green chemistry and sustainability's parameters; sustainable use of chemical feedstock; sustainable use of water; sustainable use of energy; environmental resilience; life-cycle assessment: Identification of more sustainable products and processes.

UNIT III: Biocatalysis

Introduction to biocatalysis; chemical production by biocatalysis: bulk chemicals, pharmaceuticals, flavor and fragrance compounds, carbohydrates, enantiomerically pure synthons, polymers; green biocatalytic processes: biocatalysis in supercritical CO₂, biocatalysis in waste treatment, biodesulfurisation.

UNIT IV: Photochemistry, electrochemistry and fuel cells [14 Hours]

Impact of green process technology on the chemical industry; heterogeneous catalysis in practice; homogeneous catalysis in practice; renewables as chemical feedstock and biocatalysis use of renewable feedstock for the production of chemicals; bioproduction of chemicals in industry.

Photons as clean reagents; reduced usage of reagents; photochemical reactors; introduction to green electrochemistry; electrochemical cells; electrochemical waste minimization; recovery and recycling of metal ions; fuel cell electrochemistry; fuel cell applications.

SUGGESTED READIND AND TEXT BOOKS

- 1. Clark, J and Macquarrie, D 2002. Handbook of Green Chemistry and Technology, 1st ed.Blackwell Science Ltd.
- 2. Lancaster, M 2010. Green Chemistry: An Introductory Text, 1st ed. Royal Society of Chemistry.
- 3. Sharma, SK and Mudhoo, A 2010. Green Chemistry for Environmental Sustainability, 1st ed.CRC Press, Boca Raton.

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[12 Hours]

[10 Hours]

4. Torok, B and Dransfield, T 2017. Green Chemistry: An Inclusive Approach, 1st ed. Elsevier.

Course Outcomes (COs): On completion of this course, the students will be:

	Course Outcomes (COs): On completion of this course, the students will be:																		
СО]	Desc	eript	tion					Blo	om's	Taxo	nomy	Level		
CO1	Reme and devel electr	priı opm	nciple ent,	es	of Bie	gree ocata	en Iysis		Re	1 ememt	pering								
CO2	of gre	een o	rstand and remember the specific and basic concepts een chemistry, sustainable development, Biocatalysis, chemistry, electrochemistry and fuel cells.												1,2 memb idersta	ering,			
CO3	Appl proce chemi Photo	sses, stry,	ess	senti susta	al te ainabl	echni le	iques dev	an an velop	d n s,	Un	1,2,3 memb derstau monst	ering, nding,							
CO4	the of susta	detai inabl	led s	study devel	ving, rela opme d fuel	ted tent,	o con Biod	ncept		Re Un	1,2,3 memb derstar Analyz	,4 ering, nding, ting							
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CO6	dem take Bioc cells	onsti par ataly	rating t in sis,	g, re gree Photo	Creat mem n ch ochen	berin emist nistry	ng, a ry, s r, ele	n d sustai		Re Un A	,2,3,4 memb derstan Analyz Evaluat Creati	ering, nding, ing, ting							
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Course					P	rogi	am	Ou	tcor	nes	(POs	s)		Specific					
Outcome	es													Out	comes	5 (PS	Os)		
		P01	P02	PO3	P04	PO5	PO6	P07	PO8	P09	P010	P011	P012	PSO1	PSO2	PSO3	PSO4		
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CO3		2 3 2 2 2 2 2 3 2 2										2	3	2	2	2			
CO4		2	2	2	3	2	3	2	2	3	1	3	2	2	2	2	3		
CO5		2	2	2	2	2	2	2	2	3	2	2	3	2	2	2	2		
CO6		2	2	2	2	2	2	2	2	2	2	2	2	2 2 2 2 2					

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Course code	: HBTC 401
Course Name	: Molecular Biology
Semester	: IV

L	Т	Р	С
4	4	0	4

Course objectives: Molecular biology has witnessed a paradigm shift after the discovery of double helical structure of DNA. This course on molecular biology aims to teach the fundamental role of DNA molecule as a blueprint of life. The specific objectives of the course are as follows:

- 1. To familiarize students with the structure and function of biological system at the molecularlevel.
- 2. To impart knowledge about the key components participating in the replication of geneticmaterial.
- 3. To teach the processes and pathways which replicate, transcribe and translate DNA.
- 4. To make students understand the different methods of DNA damage, repair and recombination.
- 5. To teach the fundamental principles of gene expression regulation.

UNIT I: DNA structure and replication (15 Periods)

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.

UNIT II: DNA damage, repair and homologous recombination (10 Periods)

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 Periods)

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 Periods)

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.

SUGGESTED READING AND TEXT BOOKS

- 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.

COI Remember the different basic concepts of introduction to DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation. Remembering CO2 Understanding and remember the specific and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processes, essential techniques and features DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation. 1,2,3 CO3 Applying, understanding and remembering the detailed membering. Understanding, Transcription and RNA processing, Regulation of gene expression and translation. CO4 Analyzing, applying, remembering and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation. CO4 Analyzing, applying, remembering, and understanding the detailed study related to concepts of DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation. 1, 2, 3, 4, 5, 6 Conterst of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation.	CO					De	scri	ptio	n					Bloor	n's Ta	axono	my L	eve
CO2 of DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation. Remembering, Understanding and remembering the detailed processes, essential techniques and features DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation. I.2,3 CO4 Analyzing, applying, remembering and understanding the detailed to concepts of DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation. I.2,3,4 CO5 Evaluating, analyzing, applying, remembering, and understanding the principle, methods, properties and translation. I. 2,3,4,5 CO6 Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the principle, methods, properties and translation. I. 2,3,4,5,6 CO6 Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the take part in DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation. I. 2,3,4,5,6 CO6 Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the take part in DNA structure and replication, define the term	CO1	DNA str concepts homolog	uctu of l gous	re an Mole rec	nd rej cular omb	plica r Bio inatio	tion, ology on,	defin , DN Tran	ne th IA da Iscrip	e terr amag otion	ns ar e, rep and	nd bas bair an RN	nd A		Rem	1 nember	ring	
and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation. Understanding, Demonstrating CO4 Analyzing, applying, remembering and understanding the detailed study related to concepts of DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation. 1, 2, 3, 4, 5 CO5 Evaluating, analyzing, applying, remembering, and understanding the principle, methods, properties and functions of DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation. 1, 2, 3, 4, 5, 6 CO6 Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the take part in DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation. 1, 2, 3, 4, 5, 6 Mapping of COs with POs & PSOs Program Specific Outcomes (POs) Program Specific Outcomes (PSOs) Evaluating Evaluating Evaluating Transcription and RNA processing, Regulation of gene expression and translation. Program Specific Outcomes (PSOs)	CO2	Underst of DNA concepts homolog processin	and strue of gous ng, F	and cture Mole rec Regul	reme and ecula comb latior	embe repli ar Bio oinati n of g	er the catic ology on, gene	e spe on, de y, D Tra expr	cific efine NA nscri essio	and the to dama ption	basic erms ge, r an l tran	conc and b epair id R slatio	epts asic and NA n.			emberi		
CO4 the detailed study related to concepts of DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation. Remembering, Analyzing CO5 Evaluating, analyzing, applying, remembering, and understanding the principle, methods, properties and functions of DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation. 1, 2, 3, 4, 5 CO6 Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the take part in DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation. 1, 2, 3, 4, 5, 6 CO6 Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the take part in DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation. 1, 2, 3, 4, 5, 6 Mapping of COs with POs & PSOs Program Outcomes (POs) Program Specific Outcomes (PSOs) Course Outcomes I I I I I I I I I I I I I I	CO3	and repl Molecul recombin	ng, understanding and remembering the detailed es, essential techniques and features DNA structure plication, define the terms and basic concepts of lar Biology, DNA damage, repair and homologous ination, Transcription and RNA processing,												Reme Unde	emberi rstandi	ing,	
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3: High, 2: Medium, 1: Low

CO2

CO3

CO4

CO5

CO6

3 2

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Co	ours	e co	ode	: HBTL 401		
Co	ours	e N	: Lab Course Based on HBTC 401			
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Practicals

- 1. Preparation of solutions for Molecular Biology experiments.
- 2. Genomic DNA isolation from animal tissue.
- 3. Genomic DNA isolation from bacterial cells.
- 4. Isolation of DNA From coconut endosperm.
- 5. Characterization of DNA by spectrophotometric analysis.
- 6. Purification of DNA.
- 7. Melting point determination of DNA.
- 8. Isolation of Plasmid DNA by alkaline lysis method
- 9. Agarose gel electrophoresis of genomic DNA & plasmid DNA
- 10. Preparation of restriction enzyme digests of DNA samples
- 11. Demonstration of AMES test or reverse mutation for carcinogenicity

	B. Sc. (Hons.) Biotechnology
Course code	: HBTC 402
Course Name	: Immunology
Semester	: IV

L T P C 4 4 0 4

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Course objectives: The specific objectives of the course are as follows:

- 1. To familiarize students with the structure and function of the immune system.
- 2. To impart knowledge about the key components participating in fighting the disease.
- 3. To make students understand immunodiagnostic methods like RIA and ELISA.
- 4. To teach students about vaccines and modes of vaccination.

UNIT I (20 Periods)

Immune Response - An overview, components of mammalian immune system, molecular structure of Immund-

globulins or Antibodies, Humoral & Cellular immune responses, Tlymphocytes & 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 Periods)

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 Periods)

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 Periods)

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.

SUGGESTED READING AND TEXT BOOKS

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.

2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-

3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and

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.

СО					Des	scrip	otion	1					Bloom	's Tax	konom	y Lev	vel	
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	Vaccines																	
	ELISA.																	
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	Major H		-		•	-			•									
	Vaccines Applying								<u>stics –</u> ering		<u>, ELIS</u> deta				123			
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	 detailed study related to concepts of Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA. Immunity to different organisms. Evaluating, analyzing, applying, remembering, and understanding the principle, methods, properties and functions of Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, 										0							
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	or An	tibod	ies,	Reg	ulatio	on o	fir	nmur	oglob	ulin	gene	;					-	
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		3	2	2	2	2	3	3	3	3	2	2	3	2	2	2	2	
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3: High, 2: Medium, 1: Low

C	our	se c	ode	: HBTL 402			
C	our	se N	lame	: Lab Course Based on HBTC 402			
Se	Course Name: Lab Course Based on HBTC 402Semester: IV						
L	Т	Р	С				
0	0	2	2				

Practicals

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.

	B. Sc. (Hons.) Biotechnology
Course code	: HBTC 403
Course Name	: Chemistry- II
Semester	: IV
T P C	

4 4 0 4

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Course objective: This course is aimed to introduce the knowledge of biomolecules and their role in metabolic pathways. Also, it deals with the structure and function of enzymes.

UNIT I (10 Periods)

Carbohydrates: Classification of carbohydrates, reducing and non-reducing sugars, General properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose.

UNIT II (12 Periods)

Amino Acids, Peptides and Proteins: Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins.

UNIT III (20 Periods)

Enzymes and correlation with drug action: Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity), Enzyme inhibitors and their importance, phenomenon of inhibition (competitive and noncompetitive inhibition including allosteric inhibition).

UNIT IV (18 Periods)

Components of Nucleic acids: Adenine, guanine, thymine and cytosine (structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

SUGGESTED READING

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

- 2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- 3. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson
- 4. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman.
- 5. Berg, J. M., Tymoczko, J. L. & Stryer, L. Biochemistry 7th Ed., W. H. Freeman.
- 6. **Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. Vogel's** Textbook of Practical Organic Chemistry, ELBS.

CO	Description	Bloom's Taxonomy Level
CO1	Remember the different basic concepts of introduction to Carbohydrates, amino acids, peptides, proteins, Enzymes and correlation with drug action and Components of nucleic acids. Enzyme inhibitors and their importance.	1 Remembering
CO2	Understand and remember the specific and basic concepts of Carbohydrates, amino acids, peptides, proteins, Enzymes and correlation with drug action and Components of nucleic acids. Biological roles of DNA and RNA: Replication, Transcription and Translation.	1,2 Remembering, Understanding
CO3	Applying, understanding and remembering the detailed processes, essential techniques and features of Carbohydrates, amino acids, peptides, proteins, Enzymes and correlation with drug action and Components of nucleic acids. Biological roles of DNA and RNA: Replication, Transcription and Translation.	Remembering, Understanding, Demonstrating
CO4	Analyzing, applying, remembering and understanding the detailed study related to concepts of Carbohydrates, amino acids, peptides, proteins, Enzymes and correlation with drug action and Components of nucleic acids. Biological roles of DNA and RNA: Replication, Transcription and Translation. Enzyme inhibitors and their importance.	1,2,3,4 Remembering, Understanding, Analyzing
CO5	Evaluating, analyzing, applying, remembering, and understanding the principle, methods, properties and functions of Carbohydrates, amino acids, peptides, proteins, Enzymes and correlation with drug action and Components of nucleic acids. Biological roles of DNA and RNA: Replication, Transcription and Translation. Enzyme inhibitors and their importance.	1, 2,3,4,5 Remembering, Understanding, Analyzing, Evaluating
CO6	Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the take part in Carbohydrates, amino acids, peptides, proteins, Enzymes and correlation with drug action and Components of nucleic acids. Biological roles of DNA and RNA: Replication, Transcription and Translation. Enzyme inhibitors and their importance.	1,2,3,4,5,6 Remembering, Understanding, Analyzing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes				P	rogi	ram	Οι	itcor	nes	(POs	5)		Spe	gram cific comes	s (PS)	Os)
	P01	P02	P03	P04	PO5	P06	PO7	P08	P09	P010	P011	P012	PS01	PSO2	PSO3	PSO4
CO1	3	2	3	2	2	2	2	2	2	2	2	2	3	2	3	2
CO2	2	2	3	3	3	2	3	3	2	3	3	2	2	2	2	2
CO3	3	2	2	3	2	3	2	2	2	2	3	3	3	2	2	2
CO4	3	2	2	3	2	3	2	2	2	1	3	2	2	2	2	3
CO5	3	2	2	2	2	3	3	3	3	2	2	3	2	2	2	2
CO6	2	2	1	1	2	2	2	2	2	1	1	2	2	2	1	1

3: High, 2: Medium, 1: Low

				B. Sc. (Hons.) Biotechnology
Co	ours	se co	ode	: HBTL 403
Co	ours	se N	ame	: Lab Course Based on HBTC 403
Se	eme	ster		: IV
L	Т	Р	C	
0	0	2	2	

Practicals

- 1. Separation of amino acids by paper chromatography
- 2. To determine the concentration of glycine solution by formylation method.
- 3. Study of titration curve of glycine
- 4. Action of salivary amylase on starch
- 5. Effect of temperature on the action of salivary amylase on starch.
- 6. To determine the saponification value of an oil/fat.
- 7. To determine the iodine value of an oil/fat
- 8. Differentiate between a reducing/nonreducing sugar.
- 9. Extraction of DNA from onion/ cauliflower
- 10. To synthesize aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC.

0	Cour	rse o	code	: HBTG 404
0	Cour	rse l	Nam	e : Biotechnology and Human Welfare
S	Seme	este	r	: IV
L	Т	Р	C	
4	4	0	4	

Course Objective: The course introduces students to the fundamentals of biotechnology, current trends and careers in biotechnology, regulatory, and ethical aspects of biotechnology. The knowledge and skills gained in this course will provide students with a broad understanding of biotechnology and its impact on society.

UNIT I (10 Periods)

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

UNIT II (10 Periods)

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

UNIT III (15 Periods)

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 (12 Periods)

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 Periods)

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

SUGGESTED READING AND TEXT BOOKS

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

CO					De	scri	ptio	n					Bloon	n's Ta	axono	my L	eve
CO1	Remem Industry synthesi Forensic	, pro s, 2	tein Agric	engi cultu	neeri re,	ng, e N2	nzyn	ne ar	nd po	lysac	charie	de		Rem	1 ember	ing	
CO2	polysacc Environ	dustr hari ment	y, de s, Fo	pro synt orens	tein hesis ic sci	en s, A ience	ginee Agric and	ering ultur heal	, e re, th.	enzyr N2	ne fixat	and tion,			1,2 emberii rstandi		
CO3	Applyin processe protein Agricult and heal	ure,	inder ssent neeri N2	rstan tial t ng, e fixat	ding techn enzyr tion,	and iquea ne a Env	rem s and nd po ironn	emb d fea olysa nents	ering atures accha s, Fo	the s of ride rensi	deta Indus synthe c scie	iiled stry, esis, ence		Reme Under Demo	1,2,3 emberin rstandi onstrati	ng,	
CO4	the deta enginee Agricul and hea	Analyzing, applying, remembering and understanding the detailed study related to concepts of Industry, protein engineering, enzyme and polysaccharide synthesis, Agriculture, N2 fixation, Environments, Forensic science and health.1,2,3,4 Remembering, Understanding, AnalyzingValuating, analyzing, applying, remembering, and1, 2,3,4,5															
CO5	Evaluat understa function polysacc Environ	ndin s of chari	g tl Inc de	he lustr synt	princ y, pi hesis	and	d Remembering, d Understanding, d Analyzing, t, Evaluating										
CO6	Constr demons take pa polysac Enviror	strati rt in cchar nmer	ng, 1 Indu ride nts, F	reme istry synt foren	mber , pro hesis sic se	ring, tein (, A cienc	and engir gricu e and	l un neerin lture d hea	derstang, en , N2	andir nzym	ng the		1,2,3,4,5,6 Remembering, Understanding, Analyzing, Evaluating Creating				
Ma	apping	of C	COs	wit	h P()s 8	k PS	SOs						D			
Cours Outco					P	rogi	ram	Ou	itcoi	nes	(PO	5)		Spee	gram cific comes	5 (PS	Os)
		P01	PO2	PO3	P04	PO5	PO6	P07	PO8	P09	P010	P011	P012	PS01	PSO2	PSO3	
CC)1	2	2	3	2	2	2	2	2	2	2	2	2	3	2	3	2
CO)2	2	2	3	2	2	2	2	3	2	3	3	2	2	2	2	2
CC)3	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2
CO)4	2	2	2	2	2	2	2	2	2	1	3	2	2	2	2	2
CO)5	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
		2	2	1	1	2	2	2	2	2	1	1	2	2	2	1	1

3: High, 2: Medium, 1: Low

				B. Sc. (Hons.) Biotechnology
Course code				: HBTL 404
Course Name				: Lab Course Based on HBTG 404
Semester				: IV
L	Т	Р	С	
0	0	2	2	

Practicals

- 1. Perform ethanolic fermentaion using Baker's yeast
- 2. Study of a plant part infected with a microbe
- 3. Perform quantitative estimation of residual chlorine in water samples
- 4. Isolation and analysis of DNA from minimal available biological samples (and demonstrate food adulteration)
- 5. Case studies on Bioethics
- 6. Study the interaction of probiotics bacteria with food
- 7. Demonstration of biofuel production via Virtual Lab
- 8. Study protein denaturation
- 9. Study plant diversity of the University campus
- 10. Demonstration of antibiotic production by video tutorials

			B. Sc. (Hons.) Biotechnology
		Course code	: HBTS 405
		Course Name	: Enzymology
		Semester	: IV
L	Т	P C	
4	4		

4 4 0 4

Course objectives: The course aims to impart the knowledge about fundamental principles of enzyme reactions, and applications of enzyme engineering. The specific objectives of the course are:

- 1. To make students understand the mechanism of enzyme action.
- 2. To teach students Michaelis-Menten equation for enzyme kinetics.
- 3. To teach students the regulation of enzyme kinetics
- 4. To impart knowledge about enzyme engineering and its applications.

UNIT - I (20 Periods)

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.

UNIT – II (15 Periods)

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.

UNIT – III (13 Periods)

Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Qualitative description of concerted and sequential models. Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acid synthase

UNIT – IV (12 Periods)

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.

SUGGESTED READING AND TEXT BOOKS

- 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 and Sons, 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

CO	Description	Bloom's Taxonomy Level
CO1	Remember the different basic concepts of introduction to isolation, crystallization, purification classification and kinetics of enzymes, Two substrate reactions, Allosteric enzymes and Enzyme technology.	1 Remembering
CO2	Understand and remember the specific and basic concepts of isolation, crystallization, purification classification and kinetics of enzymes, Two substrate reactions, Allosteric enzymes and Enzyme technology.	Remembering,
CO3	Applying, understanding and remembering the detailed processes, essential techniques and features of isolation, crystallization, purification classification and kinetics of enzymes, Two substrate reactions, Allosteric enzymes and Enzyme technology.	Remembering,
CO4	Analyzing, applying, remembering and understanding the detailed study related to concepts of isolation, crystallization, purification classification and kinetics of enzymes, Two substrate reactions, Allosteric enzymes and Enzyme technology.	1,2,3,4 Remembering, Understanding, Analyzing
CO5	Evaluating, analyzing, applying, remembering, and understanding the principle, methods, properties and functions of isolation, crystallization, purification classification and kinetics of enzymes, Two substrate reactions, Allosteric enzymes and Enzyme technology.	Remembering, Understanding, Analyzing,
CO6	Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the take part in isolation, crystallization, purification classification and kinetics of enzymes, Two substrate reactions, Allosteric enzymes and Enzyme technology.	1,2,3,4,5,6 Remembering, Understanding, Analyzing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes		Program Outcomes (POs)											Program Specific Outcomes (PSOs)				
	P01	P02	P03	P04	P05	P06	PO7	PO8	P09	P010	P011	P012	PSO1	PSO2	PSO3	PSO4	
CO1	3	2	3	2	2	2	2	2	2	2	2	2	3	2	3	2	
CO2	3	2	3	3	3	3	2	2	2	3	3	2	3	3	3	2	
CO3	3	2	2	2	2	3	2	3	3	3	2	2	3	3	3	2	
CO4	2	2	2	2	2	2	2	2	2	1	3	2	2	2	2	2	
CO5	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	
CO6	2	2	1	1	2	2	2	2	2	1	1	2	2	2	1	1	

3: High, 2: Medium, 1: Low

				B. Sc. (Hons.) Biotechnology
		Cou	irse cod	e : HBTS 406
		Cou	irse Nai	ne : Drug Designing
		Sen	nester	: IV
L	Т	Р	С	
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4 4 0 4

Course objectives: The course is designed to give an overview of the process of drug design and development. The specific objectives of the course are as follows:

- 1. To teach the criteria used for drug development as a process involving target selection and lead discovery.
- 2. To impart the knowledge about computer aided drug design.
- 3. To give students an overview of drug delivery system, pre clinical and clinical testing.

UNIT I (12 Periods)

Delivery considerations of biotechnological products: Introduction, Stability profile, Barriers to proteins and peptide delivery, Delivery of protein & peptide drugs, Lymphatic transportation of proteins, Site specific protein modification (protein engineering), Toxicology profile characterization.

UNIT II (12 Periods)

Drug targeting and drug delivery systems: Introduction, Historical perspectives, Drug targeting, Cellular levels events in targeting. Ligands as means of targeting, Blood cell receptors for endogenous compounds, Carrier system for targeting, Vesicular systems for ligand mediated drug targeting, Specialized liposomes for cellular drug targeting.

UNIT III (12 Periods)

Vaccines: Introduction, Multivalent subunit vaccines, Purified macromolecules, Synthetic peptide vaccines, Immuno-adhesions, Recombinant antigen vaccines, Vector vaccines, Anti-idiotype vaccines, Targeted immune

stimulants, Miscellaneous approaches, New generation vaccines, Novel vaccine delivery systems.

UNIT IV (12 Periods)

Introduction to drug design cycle: Structure Activity Relationship (SAR), Rational Drug Design, Pharmacophoric patterns, Quantitative Structure-Activity Relationship. (Q SAR) & Hans equation.

UNIT V (12 Periods)

Introduction to molecular modeling: Quantum mechanical and molecular orbital methods, Introduction to semiempirical, molecular mechanics and ab initio techniques. Potential energy surface, Docking and modeling substrate – receptor interactions. Introduction to s/w tools for CADD.

Suggested Reading and Text Books

- 1. Hill, RG and Rang, HP 2012. Drug Discovery and Development: Technology in Transition. 2nd ed. Churchill Livingstone.
- 2. Kenakin, TP 2012. Pharmacology in Drug Discovery, 1st ed. Elsevier.
- 3. Gad, SC 2005. Drug Discovery Handbook, 1st ed. Wiley-Interscience.
- 4. Stromgaard, K,Krogsgaard-Larsen, P and Madsen, U 2016. Textbook of Drug Design and Discovery, 5th ed. CRC press.

CO					D	escr	iptio	on					Bloo	m's T	axono	omy I	Level
CO1	Remem delivery targetin	/ con g an	nside 1d dr	eratio ug d	erent ons o elive	basi f bio ry sy	c con techn	ncept	gical	prod	ucts,	Drug			1 nembe		
CO2	cycle ar Unders of deliv Drug ta design o substrate	tand very urget cycle	d and cor ing e and	l ren nside and l mol	nemb ration drug lecula	per the ns o delive ar mo	f bio very odelir	otecł syst	nnolog ems,	gical vacc	prod cines,	lucts, drug			1,2 ember erstanc		
05	process conside and dru molecul	ng, understanding and remembering the detailed1,2,3es, essential techniques and features of delivery rations of biotechnological products, Drug targeting g delivery systems, vaccines, drug design cycle and ar modeling, Docking and modeling substrate and s/w1,2,3range applying remembering and understanding1,2,3range applying remembering and understanding1,2,3															
CO4	Analyz the de consid targetiz design	yzing, applying, remembering and understanding1,2,3,4detailed study related to concepts of deliveryRemembering,iderations of biotechnological products, DrugUnderstanding,ting and drug delivery systems, vaccines, drugAnalyzinging substrate and s/w tools for CADD.Analyzing															
205	Evalua understa function product vaccine	ating, analyzing, applying, remembering, and tanding the principle, methods, properties and ons of delivery considerations of biotechnological ets, Drug targeting and drug delivery systems, es, drug design cycle and molecular modeling, ng and modeling substrate and CADD.1, 2,3,4,5 Remembering, Understanding, Analyzing, Evaluating															
CO6	Constr demon take p produc vaccin Dockir	istrat art cts, 2 es, 6	ting, deliv Drug drug	rem ery targ desi	embe consi geting ign c	ering idera g an cycle	, an tions d dru and	d un of ug d mol	nders biote eliver ecula	tandi chno ry sy	ing th logica /stems	e al s,	1,2,3,4,5,6 Remembering, Understanding, Analyzing, Evaluating Creating				
Μ	apping	g of	CO	s w	ith I	POs	& I	PSO	S								
Course Outcon					P	rogi	ram	Οι	itcor	nes	(PO :	s)		Spe	gram cific comes	s (PS)	Os)
		P01	P02	PO3	PO4	PO5	PO6	PO7	PO8	P09	P010	P011	P012	PSO1	PSO2	PSO3	
CO	1	2	2	3	2	2	2	2	2	3	2	2	2	3	2	3	2
CO	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
	3	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
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Course code	: HBTS 407
Course Name	: Evolutionary Biology
Semester	: IV

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4	4	0	4

Course objectives: The objectives of the course are as follows:

- 1. To make the student understand the population variation.
- 2. To make the student understand the evolutionary development.
- 3. To make the student learn the speciation.
- 4. To impart the knowledge about evolutionary changes.

UNIT I: Variation within populations [16 Hours]

Life's beginnings: chemogeny, RNA world, biogeny, origin of photosynthesis; evolution of eukaryotes mechanisms responsible for the maintenance and loss of genetic polymorphism within populations; Frequency dependent selection; neutral variation; finite populations; mutations. Micro evolutionary changes; inter-population variations; races, Species concept; Isolating mechanisms; modes of speciation-allopatric; sympatric adaptive radiation; macroevolution exemplified by Galapagos finches

UNIT II: Historical review of evolutionary concept [10 Hours]

Lamarckism; Darwinism; Neo-Darwinism; genetic differentiation among populations in time and space: Drift; effects of migration/dispersal; population structure.

UNIT III: Evidences of evolution [12 Hours]

Fossil record: types of fossils; transitional forms, geological time scale; evolution of horse; origin and evolution of the genetic code and protein synthesizing machinery; three domains of life; neutral theory of molecular evolution; molecular clock; evolution of globin gene family.

UNIT IV: Speciation and reproductive isolation [10 Hours]

Divergence mechanisms; evolution of new species; mate choice; role of time and geography; speciation processes), heritable variations and their role in evolution.

SUGGESTED READING AND TEXT BOOKS

- 1. Ridle, M 2004. Evolution 3rd ed. Blackwell publishing.
- 2. Hall, BK and Hallgrimson, B 2008. Evolution 4th ed. Jones and Barlett Publishers.
- 3. Campbell, NA and Reece JB 2011. Biology. 9th ed. Pearson, Benjamin, Cummings.
- 4. Pevsner, J 2009. Bioinformatics and Functional Genomics. 2nd ed. WileyBlackwell.
- 5. Campbell, NA and Reece JB 2011. Biology. 9th ed. Pearson, Benjamin, Cummings.

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3: High, 2: Medium, 1: Low

Course code	: HBTC 501
Course Name	: Bioprocess Technology
Semester	: V

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Course objectives: The specific objectives of the course are as follows:

- 1. To impart the knowledge of cultivation and growth kinetics of microorganisms.
- 2. To make students understand the basic concept of sterilization and different parts of a bioreactor.
- 3. To teach the application of bioprocess technology in industries.
- 4. To make students understand about thermal death kinetics of microorganisms.

UNIT I (10 Periods)

Introduction to bioprocess technology.

Basic principle components of fermentation technology. Types of microbial culture and its growth

kinetics- Batch, Fedbatch and Continuous culture.

UNIT II (20 Periods)

Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inoculation development and sterilization.

UNIT III (15 Periods)

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

UNIT IV (15 Periods)

Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

SUGGESTED READING AND TEXT BOOKS

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.

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3: High, 2: Medium, 1: Low

Course code	: HBTL 501
Course Name	: Lab Course Based on HBTC 501
Semester	: V

L	Т	Р	С
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Practicals

- 1. Bacterial growth curve.
- 2. Estimation of Biomass Production.
- 3. Determination of the specific growth rate and generation time of a bacterium during submergedfermentation.
- 4. Estimation of the effect of temperature and pH on the growth of microbes.
- 5. Estimation of the effect of substrate concentration on the growth of *E.coli*.
- 6. Estimation of Monod Parameters for microbial growth kinetics.
- 7. Calculation of thermal death point (TDP) of a microbial sample.
- 8. Isolation of industrially important microorganisms from natural resource.
- 9. Screening of microbes for the production of enzymes.
- 10. Optimization of production and analysis of ethanol.
- 11. Biological treatment of wastewater originating from an industrial source.

Course code	: HBTC 502
Course Name	: Recombinant DNA Technology
Semester	: V

L	Т	Р	С
4	4	0	4

Course objectives: The specific objectives of the course are as follows:

- 1. To impart knowledge about different components such as vectors, restriction enzymes, ligases, polymerases, alkaline phosphatases used for making recombinant DNA molecule.
- 2. To make students understand the different techniques such as PCR, transformation, site-directedmutagenesis, etc.
- 3. To teach the basics of gene transfer technique in plants.
- 4. To understand Agrobacterium Ti plasmid biology been utilized for making genetically-modifiedplants.

UNIT I (15 Periods)

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 Periods)

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 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 Periods)

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 Periods)

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.

SUGGESTED READING AND TEXT BOOKS

- 1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
- 2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
- 3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
- 4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7 edition. Blackwell Publishing, Oxford, U.K.

CO	Description	Bloom's Taxonomy Level
CO1	Remember the different basic concepts of introduction to Introduction to molecular tools used in RDT and applications, Restriction and modification system, hybridization techniques, Genetic engineering in animals, Random and site-directed mutagenesis and Genetic engineering in plants.	1 Remembering
CO2	Understand and remember the specific and basic concepts of basic principle components of molecular tools used in RDT and applications, Restriction and modification system, hybridization techniques, Genetic engineering in animals, Random and site-directed mutagenesis and Genetic engineering in plants.	
CO3	Applying, understanding and remembering the detailed processes, essential techniques and features of molecular tools used in RDT and applications, Restriction and modification system, hybridization techniques, Genetic engineering in animals, Random and site-directed mutagenesis and Genetic engineering in plants	Remembering,
CO4	Analyzing, applying, remembering and understanding the detailed study related to concepts of molecular tools used in RDT and applications, Restriction and modification system, hybridization techniques, Genetic engineering in animals, Random and site-directed mutagenesis and Genetic engineering in plants.	1,2,3,4 Remembering, Understanding, Analyzing
CO5	Evaluating, analyzing, applying, remembering, and understanding the principle, methods, properties and functions of molecular tools used in RDT and applications, Restriction and modification system, hybridization techniques, Genetic engineering in animals, Random and site-directed mutagenesis and Genetic engineering in plants.	Evaluating
CO6	Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the take part in molecular tools used in RDT and applications, Restriction and modification system, hybridization techniques, Genetic engineering in animals, Random and site-directed mutagenesis and Genetic engineering in plants	1,2,3,4,5,6 Remembering, Understanding, Analyzing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes		Program Outcomes (POs)									Spec	gram cific comes	(PSO	s)		
	P01	P02	PO3	P04	P05	PO6	P07	PO8	P09	P010	P011	P012	PS01	PSO2	PSO3	PSO4
CO1	2	2	3	2	2	2	2	2	3	2	2	2	3	2	3	2
CO2	3	2	2	2	3	3	3	2	3	2	2	3	3	3	2	2
CO3	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
CO4	2	2	2	2	2	2	2	2	2	1	3	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	3	3	2	2	2	3	3

3: High, 2: Medium, 1: Low

Course code	: HBTL 502
Course Name	: Lab Course Based on HBTC 502
Semester	: V

L	Т	Р	С
0	0	2	2

Practicals

- 1. Isolation of chromosomal DNA from plant cells
- 2. Isolation of chromosomal DNA from *E.coli*
- 3. Plasmid DNA isolation and electrophoresis of DNA from E. coli.
- 4. Restriction digestion of plasmid DNA.
- 5. Restriction mapping of DNA.
- 6. Ligation of DNA molecules.
- 7. Preparation of competent cells.
- 8. Transformation of competent cells.
- 9. Designing of primers for polymerase chain reaction (PCR).
- 10. Perform PCR to amplify a DNA fragment.
- 11. Isolation of recombinant protein from bacterial cells.

Course code	: HBTD 503
Course Name	: Animal Diversity- I
Semester	: V

L	Т	Р	С
4	4	0	4

Course objectives: This course presents an overview of invertebrates, ranging from protozoa to hemichordata. The specific objectives of the course are as follows:

- 1. To make the student understand the classification invertebrates of animal kingdom.
- 2. To make the student understand the characteristics of invertebrates.
- 3. To make the student learn the diversity of protozoa to hemichordata.
- 4. To impart the knowledge about parasitic adaptation of roundworms.

UNIT I (15 Periods)

- a) Outline of classification of Non- Chordates upto subclasses. Coelomata, Acoelomata, Symmetries, Deutrostomes, Protostomes.
- b) Protozoa: Locomotion, Reproduction, evolution of Sex, General features of *Paramoecium* and *Plasmodium*. Pathogenic protozoans
- c) Porifera: General characters, outline of Classification; skeleton, Canal System

UNIT II (15 Periods)

- a) Coelenterata: General Characters, Outline of classifications Polymorphism, Various types of stinging cells; Metagenesis, coral reefs and their formation.
- b) Platyhelminthes- General Characters; Outline of classification; Pathogenic flatworms: Parasitic adaptations.
- c) Aschelminthes: General features, Outline of classification, Pathogenic roundworms and their vectors in relation to man: Parasite adaptation.

UNIT III (15 Periods)

- a) Annelida: General features, Outline of classification, Coelom: Metameric segmentation, General features of Earthworm, Vermicomposting.
 - b) Arthropoda: General Features, Outline of Classification; Larval forms of crustacean, Respiration in Arthropoda; Metamorphosis in insects; Social insects; Insect vectors of diseases; Apiculture,

Sericulture.

UNIT IV (15 Periods)

- a) Mollusca : general features, Outline of classification, Shell Diversity; Torsion ingastropoda.
- b) Echinodermata: General features, Outline of Classification Larval forms
- c) Hemichordata: Phylogeny: Affinities of Balanoglossus

SUGGESTED READING AND TEXT BOOKS

- 1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. & J.I., Spicer (2002) TheInvertebrates: A New Synthesis. III Edition. Blackwell Science.
- 2. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
- 3. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
- 4. Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press.
- 5. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-HillCompanies.

CO		Description										Blo	om's	Taxo	nomy	Leve	
CO1	Outline Protozo	ember the different basic concepts of introduction to ne of classification of Non- Chordates upto subclasses, zoa, Porifera to Arthopoda, Mollusca, Echinodermata demichordata. Apiculture, sericulture.1Remembering 															
CO2	of Nor Arthop	stand and remember the specific and basic concepts1,2n- Chordates upto subclasses, Protozoa, Porifera to ooda, Mollusca, Echinodermata and Hemichordata.1,2Remembering, Understanding															
CO3	Applyi process of Nor Arthop	i ng , ses, n- (oda	ure, sericulture.ng, understanding and remembering the detailed1,2,3ng, understanding and remembering the detailed1,2,3es, essential techniques for identificatin and featuresRemembering,ure, Sericulture.Understanding,ure, sericulture.Demonstrating														
CO4	the c subcla	yzing, applying, remembering and understanding detailed study related to Non- Chordates upto asses, Protozoa, Porifera to Arthopoda, Mollusca, nodermata and Hemichordata. Apiculture,															
CO5	Evalua underst Protozo and He	atin tanc ba,	i g, ding Pori	the fera	e N to A	on- arthor	Cho poda,	ordat , Mo	es u llusca	upto	sub	classe	5,	Re Un	I, 2,3, memb derstar Analyz Evaluar	ering, nding, ing,	
CO6	demor take p Porife	structing (Creating), Evaluating, Analyzing, onstrating, remembering, and understanding the part in Non- Chordates upto subclasses, Protozoa, fera to Arthopoda, Mollusca, Echinodermata and ichordata. Apiculture, sericulture.1,2,3,4,5,6 Remembering, Understanding, Analyzing, Evaluating															
	Ma	pp	oing	g of	COs	s wi	th P	Os	& P	SOs					Creati	116	
ourse outcome	es				P	rogi	ram	Οι	itcoi	nes	(PO	s)		Spec	gram cific comes	5 (PS)	Os)
		P01	P02	PO3	P04	PO5	PO6	PO7	P08	P09	P010	P011	P012	PS01	PSO2	PSO3	
CO1		2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2
CO2		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3		2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2
CO4		2	2	2	2	2	2	2	2	2	1	3	2	2	2	2	2
CO5		3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
				1	1	1	1	1	1	1	1	1 .	1 1 1 1 1				

Course code	: HBTL 503
Course Name	: Lab Course Based on HBTD 503
Semester	: V

L	Т	Р	С
0	0	2	2

Practicals

- 1. Study of protozoa using permanent slides.
- 2. Identification and classification of porifera: Euspongia, Scypha.
- 3. Study of hydra by permanent slides.
- 4. Identification and classification of platyhelminthes: Taenia, Fasciola.
- 5. Ecological Note On any of the specimens in Exercise No 1 Models of dissection of

Earthworm, Cockroach Earthworm: Digestive, Nervous System, Cockroach: Digestive

Reproductive, Nervous System.

- 6. Study digestive system of earthworm using models.
- 7. Dissection of salivary glands of cockroach.
- 8. Glycerin preparation of hastate plate.
- 9. Permanent preparation of gill lamella.
- 10. Dissection of *Pila*.

Course code	: HBTD 504
Course Name	: Animal Biotechnology
Semester	: V

L	Т	Р	С
4	4	0	4

Course objectives: The course aims to make students gain knowledge in the current trends and techniques in animal biotechnology. The specific objectives of the course are as follows:

1. To develop an understanding about animal cell culture and gene delivery methods in animals.

2. To provide an overview of in-vitro fertilization, embryo transfer methods and other related techniques.

3. To gain knowledge about the stem cells and their various applications

4. To learn about the production of transgenic animal and gene therapy and their applications.

UNIT I (10 Periods)

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.

UNIT II (10 Periods)

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 Periods)

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

UNIT IV (20 Periods)

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

SUGGESTED READING AND TEXT BOOKS

- 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 DNAgenes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

CO		Description									Blo	om's	Taxo	nomy	Level		
	anima transg	nember the different basic concepts of introduction to nal biotechnology, gene transfer methods in animals, sgenesis, animal diseases need help of biotechnology, nal propagation and genetic modification in medicine.								s,	Re	1 ememt	pering				
CO2	Unde of ani transg anima	rsta mal enes	nd and biotestis, a	nd re echn nima	emen ology al dis	nber y, gei sease	the s ne tra es ne	specit ansfe ed h	fic an er me elp c	nd ba thods of bio	sic co s in an otechr	oncept nimals nology	s,		1,2 memb idersta	ering,	
CO3	Apply proces of ani transg anima	ving sses, mal enes	, un , esse biotesis, a	derst ential echn anima	andi l tech ology al di	ng a nniqu y, ge sease	nd r les fo ne tra s ne	remen or ide ansfe ed h	mberi entific er me elp c	ing catin thods of bio	the d and f s in an otechr	letaile eature nimals nology	d :s 3, 7,	Un	1,2,3 memb derstar monst	ering, nding,	
CO4	the c trans need	lyzing, applying, remembering and understanding letailed study related to animal biotechnology, gene fer methods in animals, transgenesis, animal diseases help of biotechnology, animal propagation and help of biotechnology, animal propagation and															
005	Evalu under metho	netic modification in medicine. luating, analyzing, applying, remembering, and erstanding the animal biotechnology, gene transfer hods in animals, transgenesis, animal diseases need help biotechnology, animal propagation and genetic							er p	Re Un	1, 2,3, memb derstar Analyz Evalua	ering, nding, ing,					
CO6	demo take meth help modi	nstructing (Creating), Evaluating, Analyzing, nonstrating, remembering, and understanding the e part in animal biotechnology, gene transfer thods in animals, transgenesis, animal diseases need p of biotechnology, animal propagation and genetic dification in medicine. Mapping of COs with POs & PSOs								Re Un H	,2,3,4 memb derstar Analyz Evaluar Creati	ering, nding, ing, ting					
course Outcome											(PO	s)		Spee	gram cific comes	5 (PS	Os)
		P01	P02	PO3	P04	P05	P06	P07	PO8	P09	P010	P011	P012	PS01	PSO2	PSO3	
CO1		3	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2
CO2		2	2	3	3	3	3	3	3	2	2	2	2	2	2	2	2
CO3		3	3	3	2	2	2	2	3	2	2	2	2	2	2	2	2
CO4		2	3	3	3	3	3	3	3	3	1	3	2	3	3	3	3
CO5		3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Course code	: HBTL 504
Course Name	: Lab Course Based on HBTD 504
Semester	: V

L	Т	Р	С
0	0	2	2

Practicals

- 1. Sources of contamination and decontamination measures.
- 2. Preparation of Hanks Balanced salt solution.
- 3. Preparation of Minimal Essential Growth medium.
- 4. Isolation of lymphocytes for culturing.
- 5. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization.
- 6. Preparation of animal cell culture media.
- 7. Inoculation of cells in animal cell culture media.
- 8. Trypsinizing and subculturing cells from a monolayer.
- 9. Perform animal cell counting.
- 10. Determine the percentage of viable cells by trypan blue exclusion test.
- 11. MTT cell proliferation assay.
- 12. Establishment of primary cell culture.
- 13. Giemsa staining of animal cells.
- 14. DPPH (2,2 Diphenyl-1-Picryl Hydrazyl) radical scavenging assay.
- 15. Preservation of animal cells.
- 15. DNA isolation from animal tissue.
- 16. Quantification of isolated DNA.
- 17. Resolving DNA on Agarose Gel.

Course code	: HBTD 505a
Course Name	: Ecology and Environment Management
Semester	: V

L	Т	Р	С
4	4	0	4

Course objectives: The specific objectives of the course are as follows:

- 1. To impart basic knowledge about the environment and its allied problems.
- 2. To teach students about different types of ecosystem.
- 3. To make students understand the flow of energy in an ecosystem.
- 4. To increase awareness amongst students about different environmental challenges.

UNIT-I (12 Periods)

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 (20 Periods)

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 (18 Periods)

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 (10 Periods)

Environmental biotechnologies, Biotechnologies in protection and preservation of environment.

Bioremediation, Waste disposal.

SUGGESTED READING AND TEXT BOOKS

- 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.

CO	Description	Bloom's Taxonomy Level
CO1	Remember the different basic concepts of introduction to our environment and ecosystem, energy transfer in an ecosystem, bio- geochemical cycles (N,C,P cycles), pollution & environmental health problems, bio-transformation, environmental biotechnologies, biotechnologies in protection and preservation of environment. Bioremediation, Waste disposal.	Remembering
CO2	Understand and remember the specific and basic concepts of environment and ecosystem, energy transfer in an ecosystem, bio- geochemical cycles (N,C,P cycles), pollution & environmental health problems, bio-transformation, environmental biotechnologies, biotechnologies in protection and preservation of environment.	Remembering, Understanding
CO3	Applying, understanding and remembering the detailed processes, essential techniques for identificatin and features of environment and ecosystem, energy transfer in an ecosystem, bio-geochemical cycles (N,C,P cycles), pollution & environmental health problems, bio-transformation, environmental biotechnologies, biotechnologies in protection and preservation of environment.	Remembering, Understanding, Demonstrating
CO4	Analyzing, applying, remembering and understanding the detailed study related to environment and ecosystem, energy transfer in an ecosystem, bio-geochemical cycles (N,C,P cycles), pollution & environmental health problems, bio-transformation, environmental biotechnologies, biotechnologies in protection and preservation of environment.	1,2,3,4 Remembering, Understanding, Analyzing
CO5	Evaluating, analyzing, applying, remembering, and understanding the environment and ecosystem, energy transfer in an ecosystem, bio-geochemical cycles (N,C,P cycles), pollution & environmental health problems, bio-transformation, environmental biotechnologies, biotechnologies in protection and preservation of environment.	Understanding, Analyzing,
CO6	Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the take part in environment and ecosystem, energy transfer in an ecosystem, bio-geochemical cycles (N,C,P cycles), pollution & environmental health problems, bio- transformation, environmental biotechnologies, biotechnologies in protection and preservation of environment.	1,2,3,4,5,6 Remembering, Understanding, Analyzing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes		Program Outcomes (POs)										Program Specific Outcomes (PSOs)				
	PO1	P02	PO3	P04	PO5	P06	P07	PO8	P09	P010	P011	P012	PS01	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2
CO2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3	3	3	3	2	2	2	2	3	2	2	2	2	2	2	2	2
CO4	2	3	3	3	2	2	2	2	2	1	3	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3: High, 2	3: High, 2: Medium, 1: Low]							

Course code	: HBTL 505a
Course Name	: Lab Course Based on HBTD 505a
Semester	: V

L	Т	Р	С
0	0	2	2

Practicals

- 1. Estimation of the biodiversity of a region.
- 2. Study the different components of an ecosystem.
- 3. Analysis of soil types by sieve method and pH method.
- 4. Determination of population density by quadrat sampling.
- 5. Study biogas production using plant waste by Spoken Tutorial.
- 6. Demonstration of Principle of GPS (Global Positioning System).
- 7. Study of the life table and fecundity table, plotting of the three types of survivorship curves from the hypothetical data.
- 8. Study of the types of soil, their texture by sieve method and rapid tests for pH, chlorides, nitrates, carbonates and organic carbon.
- 9. Study any five endangered/ threatened species.
- 10. Study of bioremediation of contaminated soil.

Course code	: HBTD 505b
Course Name	: Intellectual Property Rights
Semester	: V

L	Т	Р	С
4	4	0	4

Course objectives: The course aims to explain students about intellectual property rights and patents. The specific objectives of the course are as follows:

- 1. To make students aware of types of IPRs and their utility.
- 2. To make students understand the procedure of filing a patent.
- 3. To teach students about the bioethical and biosafety practices related to biotechnology.
- 4. To familiarize students with copyright, trademarks, designs and information technology act. **UNIT I: Introduction to IPR** [8 Hours]

Basic understanding of intellectual property rights; utility of IPRs; different types of IPRs; introduction to Indian patent law; world trade organization and its related intellectual property provisions world organizations: WIPO and TRIPS agreement, international treaties and conventions on intellectual property.

UNIT III: Protection of IPRs

Intellectual/industrial property and its legal protection in research, design and development. Forms of protection of IPRs: Introduction to copyrights and its applicability; fundamental concepts and importance of trademarks and trade secrets; geographical indications; design layout design of integrated circuits.

UNIT III: Patents

Methods of patenting and general concept of patent; patenting agencies; use of technical information in patent documents; revocation of patent; patenting of biological material like microorganisms, plant and animal, patenting in biotechnology, economic, ethical and depository considerations.

UNIT IV: Copyright

Nature of Copyright; subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings; registration, procedure, term of protection; ownership of copyright; assignment and licence of copyright.

UNIT V: Trademarks

Concept of Trademarks; different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks); non-registrable trademarks; registration of trademarks; rights of holder and assignment and licensing of marks.

SUGGESTED READINGS AND TEXT BOOKS

- 1. Pandey, N and Dharni, K 2014. Intellectual Property Rights, 1st ed. PHI Learning Pvt. Ltd.
- 2. Tomkowicz, R 2011. Intellectual Property Overlaps: Theory, Strategies and Solutions, 1st ed.Routledge.
- 3. Bouchoux, DE 2013. Intellectual property: The Law of Trademarks, Copyrights, Patents and Trade Secrets, 4th ed. Cenage Learning.

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[8 Hours]

[8 Hours]

[8 Hours]

[8 Hours]

CO	Description	Bloom's Taxonomy Level			
CO1	Remember the different basic concepts of introduction to IPR, Protection of IPRs, Patents, Copyright, assignment and licence of copyright, trademarks and rights of holder and assignment and licensing of marks.	1 Remembering			
CO2	Understand and remember the specific and basic concepts of IPR, Protection of IPRs, Patents, Copyright, assignment and licence of copyright, trademarks and rights of holder and assignment and licensing of marks. patenting in biotechnology, economic, ethical and depository considerations.	1,2 Remembering, Understanding			
CO3	Applying, understanding and remembering the detailed processes and features of IPR, Protection of IPRs, Patents, Copyright, assignment and licence of copyright, trademarks and rights of holder and assignment and licensing of marks. patenting in biotechnology, economic, ethical and depository considerations.	Understanding, Demonstrating			
CO4	Analyzing, applying, remembering and understanding the detailed study related to IPR, Protection of IPRs, Patents, Copyright, assignment and licence of copyright, trademarks and rights of holder and assignment and licensing of marks. patenting in biotechnology, economic, ethical and depository considerations.	1,2,3,4 Remembering, Understanding, Analyzing			
CO5	Evaluating, analyzing, applying, remembering, and understanding the IPR, Protection of IPRs, Patents, Copyright, assignment and licence of copyright, trademarks and rights of holder and assignment and licensing of marks. patenting in biotechnology, economic, ethical and depository considerations.	Remembering, Understanding, Analyzing, Evaluating			
CO6	Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the take part in IPR, Protection of IPRs, Patents, Copyright, assignment and licence of copyright, trademarks and rights of holder and assignment and licensing of marks. patenting in biotechnology, economic, ethical and depository considerations.	he Remembering, ht, Understanding, hd Analyzing, s. Evaluating			
	Mapping of COs with POs & PSOs				
Course utcome		Program Specific			
utcome	s Program Outcomes (POs)	Outcomes (PSOs)			

Course Outcomes		Program Outcomes (POs)							Program Specific Outcomes (PSOs)							
	P01	P02	P03	P04	P05	P06	P07	PO8	P09	P010	P011	P012	PS01	PSO2	PSO3	PSO4
C01	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	3	2	2	2	2	2	1	3	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Course code	: HBTL 505b
Course Name	: Lab Course Based on HBTD 505b
Semester	: V

L	Т	Р	С
0	0	2	2

Practicals

- 1. Introduction to IPR with Case Studies
- 2. Study on mechanism of handling infringement, piracy, and unauthorized use.
- 3. Case study and provides a pool of information to the general public since all forms of IP are published except in case of trade secrets.
- 4. Case Studies on Industrial designs relates to features of any shape, configuration, surface pattern, composition of lines and colors applied to an article whether 2-D, e.g., textile, or 3-D, e.g., toothbrush.
- 5. Brief introduction on trademarks relate to any mark, name, or logo under which trade is conducted for any product or service and by which the manufacturer or the service provider is identified.

Course code	: HBTD 506
Course Name	: Plant Diversity-I
Semester	: V

L	Т	Р	С
4	4	0	4

Course objectives: This course presents an overview of lower plants, ranging from algae to pteridophytes. The specific objectives of the course are as follows:

- 1. To make students understand the organization of plant kingdom.
- 2. To teach the characteristics of lower plant genera.
- 3. To make students learn the economic importance of lower plants.
- 4. To impart the knowledge about diseases caused by plant pathogens.

UNIT I

Algae: (20 Periods)

General character, classification and economic importance. Life histories of algae belonging to various classes:

Chlorophyceae – Volvox, Oedogonium

Xantho phyceae -Vaucheria

Phaeophyceae – *Ectocarpus*

Rhodophyceae-Polysiphonia

UNIT II

Fungi: (20 Periods)

General characters, classification & economic importance. Life histories of Fungi:

Mastigomycontina- Phytophthora

Zygomycotina-Mucor

Ascomycotina- Saccharomyces

Basidomycotina-Agaricus

Deutromycotina-Colletotrichum

UNIT III

Lichens : (10 Periods)

Classification, general structure, reproduction and economic importance. Plant diseases: 4 of 36 Casual organism, symptoms and control of following plant diseases.

Rust & Smut of Wheat.

White rust of Crucifers.

Late blight of Potato.

Red rot of Sugarcane.

Citrus Canker.

UNIT IV

Bryophytes: (10 Periods)

General characters, classification & economic impotence. Life histories of following:

Marchantia.

Funaria.

SUGGESTED READING AND TEXT BOOKS

- 1. Agrios, G.N. 1997 Plant Pathology, 4 th edition, Academic Press, U.K.
- 2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996 Introductory Mycology, 4 Th edition, John Wiley and Sons (Asia) Singapore.
- 3. Bold, H.C. & Wayne, M.J. 1996 (2 nd Ed.) Introduction to Algae.
- 4. Kumar, H.D. 1999. Introductory Phycology. Aff. East-West Press Pvt Ltd., Delhi.
- 5. Lee, R.E. 2008. Phycology, Fourth Edition, Cambridge University Press, USA.
- 6. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishers.
- 7. Shaw, A.J. and Goffinet, B. 2000 Bryophyte Biology. Cambridge University Press.

- 8. Van den Hoek, C.; Mann, D.J. & Jahns, H.M. 1995. Algae: An introduction to Phycology. Cambridge Univ. Press.
- 9. Vander-Poorteri 2009 Introduction to Bryophytes. COP.
- 10. Webster, J. and Weber, R. 2007 Introduction to Fungi. 3 Rd edition, Cambridge University Press, Cambridge.
- 11. Wickens, G.E. 2004 Economic Botany: Principles and Practices, Springer. Kuwer Publishers, Dordrecht, The Netherlands

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
g p c]	Remember the different basic concepts of introduction to eneral character, classification and economic importance of lants, fungi, plant diseases and general characters, lassification & economic impotence. Life histories of <i>Marchantia</i> and <i>Funaria</i> .	1 Remembering
	Understand and remember the specific and basic concepts f plants, fungi, plant diseases and general characters, lassification & economic impotence. Life histories of <i>Marchantia</i> and <i>Funaria</i> .	1,2 Remembering, Understanding
CO3 A p g L	pplying, understanding and remembering the detailed rocesses and features of plants, fungi, plant diseases and eneral characters, classification & economic impotence. ife histories of <i>Marchantia</i> and <i>Funaria</i> .	Demonstrating
	Analyzing, applying, remembering and understanding the detailed study related to plants, fungi, plant diseases and general characters, classification & economic impotence. Life histories of <i>Marchantia</i> and <i>Funaria</i> .	1,2,3,4 Remembering, Understanding, Analyzing
	Evaluating, analyzing, applying, remembering, and nderstanding the plants, fungi, plant diseases and general haracters, classification & economic impotence. Life istories of <i>Marchantia</i> and <i>Funaria</i> .	
1	Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the take part plants, fungi, plant diseases and general characters, classification & economic impotence. Life histories of <i>Marchantia</i> and <i>Funaria</i> .	1,2,3,4,5,6 Remembering, Understanding, Analyzing, Evaluating Creating
	Mapping of COs with POs & PSOs	

Course		Program Outcomes (POs)										Program Specific Outcomes (PSOs)				
Outcomes	P01	P02	PO3	P04	P05	PO6	PO7	PO8	P09	P010	P011	P012	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	3	2	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
C ,	3: High, 2: Medium, 1: Low Shri Guru Ram Rai University, Patel Nagar, Dehradun, Uttarakhand-248001									L						

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Course code	: HBTL 506
Course Name	: Lab Course Based on HBTD 506
Semester	: V

L	Т	Р	С
0	0	2	2

Practicals

- 1. Collection of algae, fungi, bryophytes and pteridophytes from nearby localities and the campus.
- 2. Slide preparation of *Volvox* and *Oedogonium* to study their vegetative and reproductivestructures.
- 3. Preparation of temporary mounts of fungi to study hyphae.
- 4. Prepare sections of the gills of *Agaricus*.
- 5. Preparation of temporary mount of Saccharomyces cerevisiae (Baker's yeast).
- 6. Section cutting and lectophenol mount of plant disease materials.
- 7. Section cutting of lichen to study the anatomy.
- 8. Study of growth forms of lichens (crustose, foliose and fruticose).
- 9. Comparative study of thalli of various bryophytes.
- 10. Section cutting of pteridophyte to study their anatomy and vascular system.

Course code	: HBTD 507
Course Name	: Plant Biotechnology
Semester	: V

L	Т	Р	С
4	4	0	4

Course objectives: This course presents an overview of the techniques and underlying theory of plant tissue culture, and plant genetic engineering, and their applications. The specific objectives of the course are as follows:

- 1. To enable students acquire knowledge of the fundamental principles of plant tissue culture.
- 2. To learn about different kinds of plant culture techniques.
- 3. To make students understand the principles of Agrobacterium tumefaciens biology and Ti-plasmid.
- 4. To impart knowledge about the diverse applications of plant biotechnology and genetically- modified crops.

UNIT I (15 Periods)

Introduction, Cryo and organogenic differentiation, Types of culture: Seed , Embryo, Callus, Organs,

Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip

culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

UNIT- II (20 Periods)

In vitro haploid production: Androgenic methods: Anther culture, Microspore culture andogenesis

Sgnificance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic

haploids, factors effecting gynogenesis, chromosome elimination

techniques for production of haploids in cereals.

UNIT - III (15 Periods)

Protoplast Isolation and fusion: Methods of protoplast isolation, Protoplast development, Somatic hybridization, identifiation and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation Nomenclautre, methods, applications basis and disadvantages. **UNIT – IV (10 Periods)**

Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria.

SUGGESTED READING AND TEXT BOOKS

- 1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
- 2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
- 3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
- 4. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
- 5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
- 6. Russell, P.J. 2009 Genetics A Molecular Approach. 3rdedition. Benjamin Co.
- 7. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)
- 8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

CO]	Desc	ripti	ion					Blo	om's 🛛	Faxon	omy I	Level
CO1	charac differe	ember the different basic concepts of introduction to general1cter of plant biotechnology, cryo and organogenicRememberingentiation, types of culture, In vitro haploid production,plast Isolation and fusion and Plant Growth Promotingria.1															
CO2	plant of cul fusion	biote ture, an on	stand and remember the specific and basic concepts of piotechnology, cryo and organogenic differentiation, types ure, In vitro haploid production, protoplast Isolation and and Plant Growth Promoting bacteria. Somaclonal on nomenclautre, methods, applications basis and antages1,2 Remembering, Understanding														
CO3	proces organo produo Promo	sses ogen ction oting	ng, understanding and remembering the detailed1,2,3es and features of plant biotechnology, cryo and genic differentiation, types of culture, In vitro haploidRemembering, Understanding, Demonstrating														
CO4	detai organ produ Prom	yzing, applying, remembering and understanding the led study related to plant biotechnology, cryo and nogenic differentiation, types of culture, In vitro haploid action, protoplast Isolation and fusion and Plant Growth noting bacteria. Somaclonal variation nomenclautre, ods, applications basis and disadvantages.										zing					
CO5	differe protop bacter	stand entiat olast ia.	standing the plant biotechnology, cryo and organogenic entiation, types of culture, In vitro haploid production, plast Isolation and fusion and Plant Growth Promoting ia. Somaclonal variation nomenclautre, methods,										ic n, U g	Re Jndersta	1, 2,3, ememb anding, Evalua	ering, Analy	zing,
CO6	demo part differ proto bacte appli	ations basis and disadvantages.1,2,3,4,5,6structing (Creating), Evaluating, Analyzing, onstrating, remembering, and understanding the take in plant biotechnology, cryo and organogenic rentiation, types of culture, In vitro haploid production, oplast Isolation and fusion and Plant Growth Promoting eria. Somaclonal variation nomenclautre, methods, cations basis and disadvantages.1,2,3,4,5,6 Remembering, Understanding, Analy Evaluating Creating											zing,				
	M	app	ing o	f CC)s wi	th P	Os &	z PS(Os					Prog	ram Sj	pecific	
Course						Pro	gran	ı Ot	itcon	nes (1	POs)				comes (
Dutcomes		P01	P02	PO3	P04	P05	P06	P07	PO8	P09	P010	P011	P012	PSO1	PSO2	PSO3	PSO4
C01		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO2		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3		2 2 2 3 2 2 2 2 2 1 3 2 2 2							2	2	2						
CO3 CO4		2											Z				
		2 2 2	2 2 2	2	2	2	2	2	2	3	2	2	2	2 2	2	2	2 2 2 2

Course code	: HBTL 507
Course Name	: Lab Course Based on HBTD 507
Semester	: V

L	Т	Р	С
0	0	2	2

Practicals

- 1. Sterilization of glassware, plasticware, and preparation of stock solutions.
- 2. Preparation of Murashige and Skoog (MS) medium.
- 3. Sterilization and inoculation of the explant on MS medium.
- 4. Induction of callus from the explant.
- 5. Isolation of DNA from plant tissue by CTAB method.
- 6. Isolation of RNA from plant tissue.
- 7. Isolation of protein from plant tissue.
- 8. Isolation of protoplasts by mechanical method.
- 9. Perform seed viability test by tetrazolium chloride test.
- 10. Isolation of plant embryos and their in vitro culture.

Course code	: HBTD 508a
Course Name	: Bioinformatics
Semester	: V

L	Т	Р	С
4	4	0	4

Course objectives: The aim of the course is to introduce students to the basic tenets of bioinformatics. The course provides a strong foundation for developing skills in using biological sequence databases, and tools for biological sequence analysis. The specific objectives of the course are as follows:

- 1. To teach students about biological sequence data storage.
- 2. To make students understand about various bioinformatics tools used for DNA, RNA and proteinsequence analysis.
- 3. To impart knowledge about biological sequence alignment.
- 4. To teach the fundamental principles of molecular phylogeny.

UNIT I (10 Periods)

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 (20 Periods)

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 (20 Periods)

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 (10 Periods)

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

SUGGESTED READING

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

	Course			mes				-			tins c	ouise	1				ovel
СО				11.00			ripti						_	om's 7	axon	omy I	Level
CO1	charact Inform data id	ember the different basic concepts of introduction to general acter of Bioinformatics, history of Bioinformatics, Sequence mation Sources, Protein Information Sources, techniques for identifications, Sequence and Phylogeny analysis, Searching bases and genome annotation.									e r	R	l ememb	bering			
CO2	Bioinfo Source identifi	erstand and remember the specific and basic concepts of formatics, history of Bioinformatics, Sequence Information ces, Protein Information Sources, techniques for data fications, Sequence and Phylogeny analysis, Searching pases and genome annotation.										formation Remembering, for data Understanding					
CO3	Apply process Bioinfo Inform Sequer	ing, ses orma ation nce	ing, understanding and remembering the detailed 1,2,3														
CO4	detail Bioin Inform Seque	yzing, applying, remembering and understanding the ed study related to Bioinformatics, history of formatics, Sequence Information Sources, Protein mation Sources, techniques for data identifications, ence and Phylogeny analysis, Searching Databases and me annotation.											zing				
CO5	unders Sequer technic	nating,analyzing,applying,remembering,and1, 2,3,4,5standing the Bioinformatics,ence Information Sources,iques for data identifications,Searching Databases and genome annotation.										zing,					
CO6	demo in E Inforr for d Searc	structing (Creating), Evaluating, Analyzing, onstrating, remembering, and understanding the take part											1,2,3,4,5,6 Remembering, Understanding, Analyzing, Evaluating Creating				
		<u>"PI</u>	<u>,,,,,</u>	, U I		, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		05		505				Prog	gram	Sneci	fic
Course					P	rogi	ram	Ou	itcoi	nes	(PO	s)			comes	-	
Dutcome	es	P01	PO2	PO3	P04	PO5	P06	PO7	PO8	P09	P010	P011	P012	PSO1	PSO2	PSO3	PCOS
CO1		3	2	2	2	2	2	2	3	3	3	3	3	3	3	2	2
CO2		3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2
CO3		3	3	3	3	3	3	3	2	2	2	3	3	3	3	3	3
CO4		2	2	2	3	2	2	2	2	2	1	3	2	2	2	2	2
CO5		2 2 3 3 2 2 3 3 3 2								3	2	2	2	2	2	2	2
			2 2 3 3 2 2 3 3 3 2														

3: High, 2: Medium, 1: Low

Course code	: HBTL 508a
Course Name	: Lab Course Based on HBTD 508a
Semester	: V

L	Т	Р	С
0	0	2	2

Practicals

- 1. Sequence information resource
- 2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
- 3. Retrieval of nucleotide and protein sequence of a gene from NCBI.
- 4. Use of BLAST for searching a gene sequence.
- 5. Understanding and using: PDB, Swissprot, TREMBL
- 6. Finding ORF in a given DNA sequence.
- 7. Protein 3D structure visualization using RasMol.
- 8. Retrieval of structural data of a protein from PDB database.
- 9. Finding motif information of a protein using Prosite.
- 10. Multiple sequence alignment using Clustal omega.
- 11. Protein sequence analysis using PeptideCutter.
- 12. Perform virtual cloning using Benchling.

Course code	: HBTD 508b
Course Name	: Advance Forensic Science
Semester	: V

L	Т	Р	С
4	4	0	4

Course objectives: This is an introductory course on forensic sciences with the following objectives:

- 5. To familiarize students with the fundamental principles of forensic sciences.
- 6. To impart knowledge about the injuries and deaths and how they are assessed.
- 7. To make students understand the process of documentation of crime scenes.
- 8. To impart the knowledge about the importance of cyber security in forensic sciences.

UNIT I: Principles of forensic sciences and Forensic biology (14 Hours)

Introduction and principles of forensic science; forensic science laboratory and its organization; tools and techniques in forensic science; branches of forensic science; causes of crime; role of *modus operandi* in criminal investigation. Nature and importance of biological evidence; significance of hair, semen and blood as biological evidences; types and identification of microbial organisms of forensic significance; identification of wood, leaves, pollens, diatoms and insects as forensic evidence.

UNIT II: Injuries and deaths (10 Hours)

Classification of injuries and their medico-legal aspects; method of assessing various types of deaths; general and individual characteristics of handwriting; examination and comparison of handwritings and analysis of ink from various samples.

UNIT III: Exposives and ballistics (12 Hours)

Classification of firearms and explosives; introduction to internal, external and terminal ballistics;chemical evidence for explosives; process of documentation of crime scene by photography, sketching and field notes.

UNIT IV: Fingerprints, DNA fingerprinting and toxicology (12 Hours)

Fundamental principles of fingerprinting; classification of fingerprints; development of fingerprints as science for identification; principle of DNA fingerprinting; application of DNA profiling in forensics; role of the toxicologist; significance of toxicological findings in forensics.

SUGGESTED READING AND TEXT BOOKS

- 1. Bhasin, MK and Nath, S 2002.Role of Forensic Science in the New Millennium, University of Delhi, Delhi.
- 2. James, SH and Nordby, JJ 2005. Forensic Science: An Introduction to Scientific andInvestigative Techniques, 2nd ed. CRC Press, Boca Raton.
- 3. Nanda, BB and Tiwari, RK 2001. Forensic Science in India: A Vision for the Twenty FirstCentury, Select Publishers, New Delhi.
- 4. Eckert, WG editor 1997.Introduction to Forensic Sciences, 2nd ed. CRC Press, Boca Raton.
- 5. Tilstone, WJ, Hastrup, ML and Hald, C 2012. Fisher's Techniques of Crime Scene Investigation, 1st International ed. CRC Press, Boca Raton.

CO					Description Bloom's Taxonomy Level												
	charac labora medic docun	ember the different basic concepts of introduction to general1cter of principles of forensic science; forensic scienceRememberingatory and its organization, Classification of injuries and theirco-legal aspects, Exposives and ballistics, process ofco-legal of crime scene by photography, sketching andco-legal															
CO2	Under forens Classi Expos by pho	r stan ic sc ficati ives otogr	otes and Fingerprints, DNA fingerprinting and toxicology.rstand and remember the specific and basic concepts of ic science; forensic science laboratory and its organization, fication of injuries and their medico-legal aspects, ives and ballistics, process of documentation of crime scene otography, sketching and field notes and Fingerprints, DNA printing and toxicology.1,2 Remembering, Understanding														
	labora medic docun	sses tory o-leg nenta	and and i gal a tion	featu ts org ispect of ci	ires ganiza ts, E rime	of f ation, Expos scen	orens , Clas ives e by	ic so sifica and phot	cience ation o balli tograp	; for of inju istics, hy, s	ensic uries a proc sketchi	nd the cess conning an	e ir of d	Ur	1,2, ememb nderstar emonst	ering, nding,	
CO4	detai labor their docu	led atory med ment not	otes and Fingerprints, DNA fingerprinting and toxicology.1,2,3,4yzing, applying, remembering and understanding the ed study related to forensic science; forensic science atory and its organization, Classification of injuries and medico-legal aspects, Exposives and ballistics, process of nentation of crime scene by photography, sketching and notes and Fingerprints, DNA fingerprinting and1,2,3,4 Remembering, Understanding, Analyzing									zing					
	Evalu unders and it legal a	Dating, analyzing, applying, remembering, and rstanding the forensic science; forensic science laboratory ts organization, Classification of injuries and their medico- aspects, Exposives and ballistics, process of documentation time scene by photography, sketching and field notes and1, 2,3,4,5 Remembering, Understanding, Analyzing Evaluating								zing,							
CO6	Cons remen scient Class Expo by ph finger	truct mberi ce; f ificat sives iotogi rprint	ing (ing, a forens ion and b raphy, ing ar	Creat and sic s of in pallisti , sketo nd tox	ing), unde cience njurie ics, pr ching icolog	Evaluerstan e lat s an cocess and f gy.	ating ding oorato d th of do ield n	, Ana the tory a eir to cume totes a	lyzing take p ind it medico entation and Fir	, dem part in s or p-legation n of c	onstrat n forer ganizat l aspe rime sc ints, D	nsic ion, ects, eene	R	emembe	1,2,3,4 ering, U Analyz Evaluat Creati	ndersta ing, ting	nding,
		appi	ing o	of CC	Js wi				<u>Os</u> utcon	nes (I	POs)				ram Sj comes (
Course Outcomes		P01	P02	P03	P04	P05	P06	P07	PO8	P09	P010	P011	P012	PSO1	PSO2	PSO3	PSO4
CO1		2	2	2	2	2	2	2	3	3	3	3	3	3	3	2	2
CO2		3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3		2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
		2	2	2	3	2	2	2	2	2	1	3	2	2	2	2	2
CO4	-	2	2	3	3	2	2	3	3	3	2	2	2	2	2	2	2
CO4 CO5 CO6			2 2 3 3 2 2 3 3 3 2														

	B. Sc. (Hons.) Biotechnology
Course code	: HBTL 508b
Course Name	: Lab Course Based on HBTD 508b
Semester	: V

L	Т	Р	С
0	0	2	2

Practicals

- 1. Study of Crime Scene Investigation: Safeguarding, Searching, Recognition, Documentation, Collection, Packaging, and Preservation of Physical Evidence
- 2. Study of Trace Evidence Collection and Sorting.
- 3. Study of Examination of Human Hair.
- 4. Study of Examination of Trace Quantities of Synthetic Fibers.
- 5. Case Studies

Course code	: HBTC 601
Course Name	: Bio-Analytical Tools
Semester	: VI

L	Т	Р	С
4	4	0	4

Course objectives: The broad objective of the course is to make students aware about the importance and significance of the diverse tools and techniques used to study and understand the biologicalworld. The specific objectives of the course are as follows:

- 1. To introduce the basic principle, types and application of microscopy.
- 2. To study concepts applications and types of centrifugation.
- 3. To acquaint students with chromatography and spectroscopy techniques.
- 4. To makes students understand the techniques of electrophoresis and blotting.

UNIT I (10 Periods)

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

UNIT II (15 Periods)

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

UNIT III (15 Periods)

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 Periods)

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.

SUGGESTED READING AND TEXT BOOKS

- 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. ASM Press & 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.7^u edition. Pearson Benjamin Cummings Publishing, San Francisco.

CO]	Desc	ripti	on					Blo	om's 🛛	Faxon	omy L	evel
CO1	charac of tec electro	ember the different basic concepts of introduction to general1cter of bio-analytical, Simple microscopy, Principle and law chniques, Introduction to the principle of chromatography, rophoresis, blotting techniques and Biosensors and technology and their applications.1															
02	Unde Biose analyt Introd	rstan nsors tical, luctio	stand and remember the specific and basic concepts of asors and Nanotechnology and their applications, bio- cal, Simple microscopy, Principle and law of techniques, action to the principle of chromatography, electrophoresis, g techniques and cell fractionation techniques.1,2 Remembering, Understanding														
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CO4	Anal detai micr the techi	lyzin iled oscoj princ nique	g, aj stud py, P ciple es, I	y ro rincij of Biose	elated ple an chron nsors	l to nd lav natog and	bio w of raphy d N	-anal tech , el anote	lytical nique ectrop	l too s, Int ohore logy	ols, S roduct	ng the Simple tion to lotting thein			1,2,3 emembe anding,		zing
05	Princi chrom and N techni Con	stand iple a natog Janot iques struc	ling and la raphy echno	the aw of , ele ology	tech ctrop and	inalyt nique hores their	es, Int is, bl appli	tools trodu otting catio Eval	s, Si ction g tech ns an luatin	to the inique d cell \overline{g} ,	micr e prin es, Bic l fracti Ana	osenso	y, of U rs on	Re Indersta	1, 2,3, emembo anding, Evaluat	ering, Analyz ting ,5,6	zing,
	in bi techn elect Nano techn	o-ana nique tropho otech nique	alytic es, In oresis nolog es.	al too trodu s, i gy ar	ols, Si action blottin ad the	mple to tl ng eir ap	micr he pr techi plica	oscoj incip nique tions	py, Pr le of s,	incip chro Biose cell	le and matog msors	law of graphy and onation	f U	Indersta		Analyz ing	zing,
ourse outcomes											(POs))		Spec		(PSOs	5)
		P01	P02	P03	P04	PO5	P06	P07	PO8	P09	P010	P011	P012	PS01	PSO2	PSO3	V OSA
CO1		2	2	2	2	2	2	2	3	3	3	3	3	3	3	2	2
CO2		3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3		2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
CO4		2	2	2	3	2	2	2	2	2	1	3	2	2	2	2	2
CO5		2	2	3	3	2	2	3	3	3	2	2	2	2	2	2	2
CO6		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
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	B. Sc. (Hons.) Biotechnology
Course code	: HBTL 601
Course Name	: Lab Course Based on HBTC 601

Course Name	
Semester	

	Lad	Course	Dase
:	VI		

L	Т	Р	С
0	0	2	2

- 1. Centrifugation principle and separation of precipitate by centrifugation.
- 2. Native gel electrophoresis of proteins.
- 3. Separation of protein sample by SDS-polyacrylamide gel electrophoresis.
- 4. Separation of amino acids by paper chromatography.
- 5. Verification of Beer's law and determine the molar extinction coefficient of NADH.
- 6. Brightfield microscopy of the onion membrane cells.
- 7. Identification of lipids in a given sample by TLC.
- 8. Study of DNA blotting.
- 9. Demonstration of preparation of the sub-cellular fractions of rat liver cells.
- 10. Study the applications of spectroscopy.

Course code	: HBTC 602
Course Name	: Genomics & Proteomics
Semester	: VI

L	Т	Р	С
4	4	0	4

Course objectives: The broad objective of the course is to make students aware about the importance of the modern methods of genome and proteome analysis and the significance of these on the changing paradigm in genetics, medicine and agriculture. The specific objectives of the course are as follows:

- 1. To introduce the basic concepts of genomics and next generation sequencing.
- 2. To acquaint students with various genome databases and their applications.
- 3. To make students aware about the applications of genomics in various industries.
- 4. To makes students understand the techniques of proteome analysis diverse applications and benefits of genome and proteome analysis.

UNIT I (15 Periods)

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 Periods)

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 Periods)

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 filtration, SDS-PAGE); Native PAGE, Determination of covalent structures - Edman

degradation.

UNIT IV (15 Periods)

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.

SUGGESTED READING AND TEXT BOOKS

- 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.
- 4. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
- 5. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
- 6. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
- 7. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
- 8. Russell, P. J. (2009). *i*Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
- 9. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
- 10. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

СО	Description	Bloom's Taxonomy Level					
char sequ prot anal	Remember the different basic concepts of introduction to general character of genomics and proteonomics, Computer tools for sequencing projects, Managing and Distributing Genome Data, protein structure, interactions, Determination of sizes (Sedimentation analysis), Analysis of proteomes and genome and protein sequencing.1Remembering sequencing.1						
genc genc proj	erstand and remember the specific and basic concepts mics and proteonomics, Computer tools for sequence cts, Managing and Distributing Genome Data, protein struct actions, Determination of sizes (Sedimentation analy ysis of proteomes and genome and protein sequencing.	ture, Understanding					
and iden and Dete	ying, understanding and remembering the detailed proce features of Mass spectrometry based methods for pro- ification, Computer tools for sequencing projects, Manag Distributing Genome Data, protein structure, interacti rmination of sizes (Sedimentation analysis), Analysis omes and genome and protein sequencing.	ontein Remembering, ging Understanding, ons, Demonstrating					
CO4 An det too Da (Se	alyzing, applying, remembering and understanding ailed study related to genomics and proteonomics, Compu- s for sequencing projects, Managing and Distributing Geno a, protein structure, interactions, Determination of siz- dimentation analysis), Analysis of proteomes and genome a rein sequencing.	tter Remembering, me Understanding, zes Analyzing					
CO5 the proj	uating, analyzing, applying, remembering, and understan- genomics and proteonomics, Computer tools for sequen cts, Managing and Distributing Genome Data, protein struct actions, Determination of sizes (Sedimentation analy ysis of proteomes and genome and protein sequencing.	cing Remembering, ture, Understanding,					
ren pro and De pro	Astructing (Creating), Evaluating, Analyzing, demonstrati embering, and understanding the take part in genomics a ceonomics, Computer tools for sequencing projects, Manag Distributing Genome Data, protein structure, interactio ermination of sizes (Sedimentation analysis), Analysis teomes and genome and protein sequencing. Mapping of COs with POs & PSOs	and Remembering, ing Understanding, ons, Analyzing,					
	Program Outcomes (POs)						

Course				Р	rogi	ram	Ot	itcor	nes	(PO:	s)		Out	come	s (PS	Os)
Outcomes	P01	P02	PO3	P04	PO5	P06	PO7	PO8	PO9	P010	P011	P012	PS01	PSO2	PSO3	PSO4
CO1	3	2	2	3	3	3	2	3	3	3	3	3	3	3	2	2
CO2	3	3	2	2	2	2	2	3	3	3	3	2	3	3	3	3
CO3	2	3	2	2	3	3	3	2	2	2	3	3	3	3	3	3
CO4	2	3	2	3	2	2	3	3	3	1	3	2	2	2	2	2
CO5	2	3	3	3	2	2	3	3	3	2	2	3	3	3	3	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

	B. Sc. (Hons.) Biotechnology
Course code	: HBTL 602
Course Name	: Lab Course Based on HBTC 602
Semester	: VI

L	Т	Р	С
0	0	2	2

- 1. Identification of unknown sequence by BLAST and its functional annotation.
- 2. SNP analysis using SNP database of NCBI.
- 3. Comparison of genomes of two organisms using SynMap of CoGe.
- 4. Demonstration of microarray applications and analysis of microarray data.
- 5. Computation of pI and molecular weight of a protein using ExPASy ProtParam tool.
- 6. Demonstration of 2D PAGE and data analysis.
- 7. Generation of protein interaction networks using STRING software.
- 8. Subcellular protein localization study using CELLO tool.
- 9. Protein motif identification using MEME software.
- 10. Conserved domain analysis using NCBI batch-CD research.

Course code	: HBTD 603
Course Name	: Animal Diversity-II
Semester	: VI

L	Т	Р	С
4	4	0	4

Course objectives: The objectives of the course are as follows:

- 1. To make the student understand the classification and characteristics of Protochordates and theOrigin of Chordates
- 2. To make the student understand the characteristics and classifications of Pisces and Ambhibia
- 3. To make the student learn the diversity of different classes of Reptilia and Aves and Mammalia
- 4. To impart the knowledge about the Comparative anatomy of vertebrates.

UNIT I: Proto-chordates, Pisces and Ambhibia (15 Periods)

Proto-chordates: Outline of classification, General features and important characters of *Herdmania*, *Branchiostoma*. Origin of Chordates. Pisces: Migration in Pisces, Outline of classification. Amphibia: Classification, Origin, Parental care, Paedogenesis

UNIT II: Reptilia, Aves and Mammalia (15 Periods)

Reptelia: Classification, Origin Aves: Classification, Origin, flight- adaptations, migration. Mammalia: Classification, Origin, dentition

UNIT III: Comparative anatomy of vertebrates I (15 Periods)

Comparative anatomy of various systems of vertebrates: Integumentary, digestive, respiratory systems.

UNIT IV: Comparative anatomy of vertebrates II (15 Periods)

Comparative Anatomy of vertebrates – Heart, Aortic arches, Kidney & urinogenital system, Brain, Eye, Ear. Autonomic Nervous system in Mammals.

SUGGESTED READING AND TEXT BOOKS

- **1. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and** Bartlett Publishers Inc.
- 2. Kardong, K.V. (2005) Vertebrates Comparative Anatomy, Function and evolution. IV Edition. McGraw-Hill Higher Education.
- 3. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
- 4. Weichert, C.K. (1970). Anatomy of Chordate. McGraw Hill.
- 5. Young, J.Z. (2004). The life of vertebrates. III Edition. Oxford university press.

CO		Description										Blo	ever				
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	process Reptilia vertebra	ying, understanding and remembering the detailed esses and features of Proto-chordates, Pisces and Ambhibia, lia, Aves and Mammalia, Comparative anatomy of brates, Comparative anatomy of vertebrates, Autonomic ous system in Mammals and Outline of classification.								a, of	Ur	1,2,3 emembe nderstar emonstr	ering, nding,				
CO4	detaile Reptil verteb	lyzing, applying, remembering and understanding the led study related to Proto-chordates, Pisces and Ambhibia, ilia, Aves and Mammalia, Comparative anatomy of brates, Comparative anatomy of vertebrates, Autonomic ous system in Mammals and Outline of classification.							- U	Re Indersta	1,2,3 emembe anding,	ering,	zing				
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CO6	in Pro Mamr anator Mamr	nstra oto-c nalia ny nals	ating, chord a, Co of and	reme ates, ompar verte Outli	Pisco rative brate ne of	ring, es an e anat s, A class	and ad Ar comy autone sificat	und nbhib of ve omic tion.	oia, R ertebra Ner	ding eptili ates, vous	the tal a, Ave Compa syste	lyzing, ke part es and arative em in	U	Re Indersta	1,2,3,4 emembe anding, Evaluat Creati	ering, Analy ing	zing,
	Ma	app	oing	of	COs	s wit	th P	Os d	& P\$	SOs				D		<u>a</u> •	
					P	rogi	ram	Ou	itcor		(PO	s)			gram	-	e
Course										nes				Out	comes	5 (PS	
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	s	د PO1	P02	EO4 2	²	PO5	bO6	LOd 2			د P010	P011	² P012				Os)
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Course code	: HBTL 603
Course Name	: Lab Course Based on HBTD 603
Semester	: VI

L	Т	Р	С
0	0	2	2

Practicals

- 1. Identification and classification upto order of the Proto-chordata: Salpa, Doliolum,
- 2. Herdmania, Branchiostoma.
- 3. Classification and identification upto order of the Cyclostomata: Myxine, Petromyzon.
- 4. Virtual dissection of frog (Rana tigrina).
- 5. Identification and classification upto order of the Reptiles: Hemidactylus, Calotes and Draco.
- 6. Classification upto order of the Aves: Columba, Alcedo and Passer.
- 7. Identification and classification upto order of the Mammalia: Ornithorhynchu and Macropus.
- 8. Slides of mammalian histology of liver, lung, intestine, kidney, ovary and testes.
- 9. Preparation of slides of spicules of Herdmania and tadpole of Frog.
- 10. Preparation of mount of tadpole larva of frog.
- 11. Identification of endoskeletons of frog and rabbit.

Course code	: HBTD 604
Course Name	: Microbial Physiology
Semester	: VI

L	Т	Р	С
4	4	0	4

Course objectives: The specific objectives of the course are as follows:

- 1. To make students understand the classification of microbes.
- 2. To teach students about the transport of metabolites in microbes.
- 3. To teach students about the effects of the environmental factors on microbial growth and metabolism.
- 4. To impart knowledge about nitrogen fixation by microbes.

UNIT I (12 Periods)

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 (13 Periods)

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 (15 Periods)

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 (20 Periods)

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.

SUGGESTED READING AND TEXT BOOKS

1. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag.

- 2. Madigan MT, Martinko JM and Parker J. (2003). Brock Biology of Microorganisms.10 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.

Cou	rse O	utco	mes	(CC) s): (On c	comp	letior	n of	this c	ourse	, the s	tudent	s will	be:	
СО				J	Desc	ripti	ion					Blo	om's [Faxon	omy I	Level
char mici Mici	acter oorgai robial	ember the different basic concepts of introduction to general1cter of microbial physiology, Nutritional classification of porganisms, metabolism transport through membrane, obial Growth and effect of environmental factors of obial growth and microbial physiology1														
CO2 mea Nuti trans envi	erstan sureme itional sport t ronme	bial growth and microbial physiology.1,2rstand and remember the specific and basic concepts of rement of cell numbers, cell mass and metabolic activity, tonal classification of microorganisms, metabolism ort through membrane, Microbial Growth and effect of nmental factors of microbial growth and microbial1,2Remembering, UnderstandingUnderstanding														
CO3 App proc and mici Mic	lying, esses a met coorgan robial	iology. lying, understanding and remembering the detailed esses and features of measurement of cell numbers, cell mass metabolic activity, Nutritional classification of oorganisms, metabolism transport through membrane, robial Growth and effect of environmental factors of obial growth and microbial physiology.									Remembering, of Understanding, e, Demonstrating					
det ma mic Mi	ailed ss an croorg crobia	lyzing, applying, remembering and understanding the 1								1,2,3 emembe anding,	ering,	zing				
CO5 Eva unde meta meta effe	luatin erstanc abolic abolisr	g , ling t activ n trar nviroi	analy he m ity, N nspor	yzing, neasur Nutriti t thro	a emer ional ugh	pplyi nt of class meml	ng, cell sifica brane	reme numbe tion o , Mice	f mio robia	ring, cell ma croorg l Grov and m	anism vth an	d s, U d	Re Indersta	1, 2,3, emembe anding, Evaluat	ering, Analy	zing,
CO6 Co der in act me and	nstruo nonstr measu ivity, tabolis	e ting ating, areme Nut sm tra et of	, rementer nt of trition anspo envir	f cell nal ort th onme	ring, nun class rougl	and nbers ificat n me	und , cel tion embra	l mas of .ne, N	ding s an mici licro	Anal the tak d met coorga: bial G growt	abolic nisms, rowth	U	Re Indersta	1,2,3,4 emembe anding, Evaluat Creati	ering, Analy ting	zing,
]	Map	ping	g of (COs	s wit	th P	Os	& PS	SOs							
Course		1	T	P	rogi	am	Ou	itcon	nes	(POs	5)	I		gram comes	-	
Outcomes	P01	P02	P03	P04	P05	P06	P07	PO8	P09	P010	P011	P012	PSO1	PSO2	PSO3	VUSd
CO1	3	2	2	3	3	3	2	3	3	3	3	3	3	3	2	2
CO2	3	3	3	3	3	3	3	3	3	2	3	2	3	3	3	3
CO3	2	3	2	2	3	3	3	2	3	2	3	3	3	3	3	3
CO4	2	3	2	3	2	2	2	2	3	1	3	2	2	2	2	2
	3	3	3	2	2	2	3	3	3	2	2	3	3	3	3	2
CO5																
CO5 CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

Course code	: HBTL 604
Course Name	: Lab Course Based on HBTD 604
Semester	: VI

L	Т	Р	С
0	0	2	2

- 1. Introduction to microbiological laboratory safety rules and laboratory instructions.
- 2. Calculation of specific growth rate and generation time in bacteria.
- 3. Determination of the effect of pH on bacterial growth.
- 4. Determination of the effect of temperature on the growth of *Aspergillus niger* by dry weightmethod.
- 5. To study and plot the growth curve of *Aspergillus niger* by radial growth measurements.
- 6. Demonstration of lactic acid fermentation.
- 7. Demonstration of the thermal death time and decimal reduction time of *E. coli*.
- 8. Effect of inhibitors on growth of bacteria.
- 9. Effect of carbon source on microbes growth.
- 10. Biofilm analysis.

Course code	: HBTD 605
Course Name	: Biostatistics
Semester	: VI

L	Т	Р	C		
4	4	0	4		

Course objectives: This is an introductory course on statistics. The specific objectives of the courseare as follows:

- 1. To teach students the basic principles of statistics, data types and collection of data.
- 2. To make students understand the various methods of data presentation and measures of centraltendency.
- 3. To make students understand the basic concepts of probability and Probability distribution
- 4. Understand the testing of the hypothesis and learn its applications.

UNIT I (12 Periods)

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 (18 Periods)

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

UNIT III (18 Periods)

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 (12 Periods)

Correlation and Regression. Emphasis on examples from Biological Sciences.

SUGGESTED READING

- 1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
- 2. Glaser AN (2001) High YieldTM 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.

CO	Description	Bloom's Taxonomy Leve
CO1	Remember the different basic concepts of introduction to general character and concepts of biostatistics, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences.	Remembering
CO2	Understand and remember the specific and basic concepts of measurement of biostatistics, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences.	1,2 Remembering, Understanding
CO3	Applying, understanding and remembering the detailed processes and features of biostatical analysis, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences.	Remembering, Understanding, Demonstrating
CO4	Analyzing, applying, remembering and understanding the detailed study related to measurement of biostatical analysis, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences.	1,2,3,4 Remembering, Understanding, Analyzing
CO5	Evaluating, analyzing, applying, remembering, and understanding the measurement of biostatical analysis, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences.	Remembering, Understanding, Analyzing, Evaluating
CO6	Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the take part in biostatical analysis, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences.	1,2,3,4,5,6 Remembering, Understanding, Analyzing, Evaluating Creating
	Mapping of COs with POs & PSOs	
	Program Outcomes (POs)	Program Specific Outcomes (PSOs)

	Dragnam Outcomag (D Og)												Outcomes (PSOs)			
P01	P02	P03	P04	P05	P06	P07	P08	909	P010	P011	P012	PS01	PSO2	PSO3	PSO4	
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	B. Sc. (Hons.) Biotechnology
Course code	: HBTL 605
Course Name	: Lab Course Based on HBTD 605
Semester	: VI

L	Т	Р	С
0	0	2	2

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.

Course code	: HBTD 606
Course Name	: Plant Diversity-II
Semester	: VI

L	Т	Р	С
4	4	0	4

Course objectives: The objectives of the course are as follows:

- 1. To make students understand the general features and clasification of pteridophytes.
- 2. To impart knowledge about the features of gymnosperms and process of fossil formation.
- 3. To make students learn about general characters of angiosperms.
- 4. To remember the origin, evolution of flowering plants and their economic importance.

UNIT I: (10 Periods)

Pteridophytes

General characters of pteridophytes, affinities with bryophytes & gymnosperms, classification, economic importance, study of life histories of fossil Pteridophytes – *Rhynia*.

UNIT II: (20Periods) Pteridophytes: Type studies

Life histories of *Selaginella*- (Heterospory and seed habit), *Equisetum, Pteris, Lycopodium.*

UNIT III: (20 Periods)

Gymnosperms

General characters, classification, geological time scale, theories of fossil formation, types of fossils, fossil gymnosperms- *Williamsonia & Glossopteris*, telome and stele concept.

UNIT IV: (10 Periods)

Gymnosperms: Type studies

Life histories of Cycas & Pinus, economic importance of gymnosperms.

SUGGESTED READING AND TEXT BOOKS

1. Bhatnager, S.P. and Moitra, A. 1996 Gymnosperms. New Age International (P) Ltd. Publishers,New Delhi.

2. Parihar, N.S. 1996. The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.

3. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishers.

4. Wickens, G.E. 2004 Economic Botany: Principles and Practices, Springer. Kuwer Publishers, Dordrecht, The Netherlands

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CO1	introc types Gymi	nember the different basic concepts and oduction to general character of Pteridophytes, s of Pteridophytes, Gymnosperms, types of mosperms, economic importance of nosperms and pteridophytes.											1 ememt	•										
CO2	Unde of Pt types	ersta erido of	stand and remember the specific and basic concepts1,2ridophytes, types of Pteridophytes, Gymnosperms, of Gymnosperms, economic importance of sperms and pteridophytes.1,2Remembering, Understanding																					
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CO4	the Pter	deta idop	yzing, applying, remembering and understanding detailed study related to Pteridophytes, types of dophytes, Gymnosperms, types of Gymnosperms, omic importance of gymnosperms and pteridophytes.1,2,3,4 Remembering, Understanding, Analyzing																					
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CO4						+	2								-	1 -	1	1		2 2 2 2 2 2 2 2 2 2 2				
CO4 CO5		2	2	2	2	2	2	3	3	3	2	2	2	2	2	2	2							

Course code	: HBTL 606
Course Name	: Lab Course Based on HBTD 606
Semester	: VI

L	Т	Р	С
0	0	2	2

1. Collection of plants pteridophytes, gymnosperms and angiosperms.

- 2. Sectioning to study anatomy of vegetative and reproductive parts of *Selaginella*.
- *3.* Sectioning to study anatomy of vegetative and reproductive parts of *Equisetum*.
- 4. Study anatomy of vegetative and reproductive parts of *Pteris*.
- 5. Examination of morphology and anatomy of vegetative and reproductive parts of *Cycas*.
- 6. Section cutting of *Pinus* needle.
- 7. Examination of morphology and anatomy of vegetative and reproductive parts of *Ephedra*.
- 8. Study morphology and anatomy of vegetative and reproductive parts of angiospermic flower.
- 9. Permanent slide of LS and TS of monocot root.
- 10. Permanent slide of LS and TS of dicot root.

Course code	: HBTD 607
Course Name	: Medical Microbiology
Semester	: VI

L	Т	Р	С
4	4	0	4

Course objectives: The objective of this course is:

- 1. To introduce basic principles and application relevance of microbiological diseases
- 2. To gain the knowledge about the bacterial agents responsible for infectious diseases.
- 3. To understand the pathology of the viruses and fungal diseases.
- 4. To gain the knowledge about laboratory diagnosis

UNIT I (18 Periods)

Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels. Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: *S.aureus, S.pyogenes, B.anthracis, C.perferinges, C.tetani, C.botulinum, C.diphtheriae M.tuberculosis, M. leprae.*

UNIT II (15 Periods)

Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: *E.coli, N. gonorrhoea, N. meningitidis, P. aeruginosa, S. typhi, S. dysenteriae, Y. pestis, B. abortus, H. influenzae, V. cholerae, M. pneumoniae, T. pallidum M. pneumoniae, Rickettsiaceae, Chlamydiae.*

UNIT III (12 Periods)

Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.

UNIT IV (15 Periods)

Fungal and Protozoan infections. Dermatophytoses (*Trichophyton, Microsporun and Epidermophyton*) Subcutaneous infection (*Sporothrix, Cryptococcus*), systemic infection (*Histoplasma, Coccidoides*) and opportunistic fungal infections (*Candidiasis, Aspergillosis*),

Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis,

Malaria)

SUGGESTED READINGS

- 1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
- **2.** Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier. .
- 3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

CO					1	Desc	ripti	on					Blog	om's]	[axond	omv T	evel
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CO4	detail nosoc patho Morp	lyzing, applying, remembering and understanding the led study related to Normal microflora of human body, comial infections, carriers, septic shock, septicemia, ogenicity, virulence factors, toxins, biosafety levels, phology, pathogeneis, symptoms, laboratory diagnosis, ases caused by viruses, Fungal and Protozoan infections.									zing						
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CO6	demo in No carrie factor sympt Funga	 Fungal and Protozoan infections. Instructing (Creating), Evaluating, Analyzing, onstrating, remembering, and understanding the take part Vormal microflora of human body, nosocomial infections, iers, septic shock, septicemia, pathogenicity, virulence pors, toxins, biosafety levels, Morphology, pathogeneis, ptoms, laboratory diagnosis, Diseases caused by viruses, gal and Protozoan infections. Intertions Inter									zing,						
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Course code	: HBTL 607
Course Name	: Lab Course Based on HBTD 607
Semester	: VI

L	Т	Р	С
0	0	2	2

- 1. Demonstration of safety and GLP in medical microbiology laboratory.
- 2. Identification of Gram-negative pathogenic bacteria (based on cultural, morphological andbiochemical characteristics.
- 3. Growth curve of pathogenic bacteria.
- 4. Identification of Gram-positive pathogenic bacteria (based on cultural, morphological andbiochemical characteristics.
- 5. To perform antibacterial testing by Kirby-Bauer method.
- 6. To prepare temporary mounts of *Aspergillus* and *Candida*.
- 7. Evaluating the growth potential of pathogenic bacteria in water.
- 8. Capsule staining and spore staining of pathogenic bacteria.
- 9. Culture of bacteria from the buccal swab.
- 10. Antifungal testing for Aspergillus sp.

Course code	: HBTD 608
Course Name	: Environmental Biotechnology
Semester	: VI

L	Т	Р	С
4	4	0	4

Course objectives: The course is aimed to introduce basics of environmental biotechnology and focuses on the utilization of different biotechnological methods to protect environment. The course is designed to meet the following specific objectives:

- 1. To impart the basic knowledge about environmental biotechnology.
- 2. To make students understand the concepts and applications of biofuels and bioremediation.
- 3. To make the student understand the process of formation of biofertilizers and leran its applications.
- 4. To give students an overview of various applications of biotechnology in pollution control and biotransformation of pollutants.

UNIT I (18 Periods)

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 (20 Periods)

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms. Treatment of municipal waste and Industrial effluents.

UNIT III (12 Periods)

Bio-fertilizers. Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil.

Algal and fungal biofertilizers VAM)

UNIT IV (10 Periods)

Bioleaching. Environmental significance of genetically modified microbes, plants and animals.

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

CO	Description	Bloom's Taxonomy Leve					
CO1	Remember the basic concepts of general character of environmental biotechnology, conventionala and modern fuels and their environmental impact, bioremediation, phytoremediation, biodegradation, Biofertilizers and Bioleaching. Environmental significance of genetically modified microbes, plants and animals.	1 Remembering					
CO2	Understand and remember the specific and basic concepts and applications environmental biotechnology, conventionala and modern fuels and their environmental impact, bioremediation, phytoremediation, biodegradation, Bio-fertilizers and Bioleaching.	1,2 Remembering, Understanding					
CO3	Applying, understanding and remembering the detailed processes and features of Environmental significance of genetically modified microbes, plants and animals, environmental biotechnology, conventionala and modern fuels and their environmental impact, bioremediation, phytoremediation, biodegradation, Bio-fertilizers and Bioleaching.	Remembering,					
CO4	Analyzing, applying, remembering and understanding the detailed study related to environmental biotechnology, conventionala and modern fuels and their environmental impact, bioremediation, phytoremediation, biodegradation, Bio-fertilizers and Bioleaching, Environmental significance of genetically modified microbes, plants and animals	1,2,3,4 Remembering, Understanding, Analyzing					
CO5	Evaluating, analyzing, applying, remembering, and understanding the environmental biotechnology, conventionala and modern fuels and their environmental impact, bioremediation, phytoremediation, biodegradation, Bio-fertilizers and Bioleaching, Environmental significance of genetically modified microbes, plants and animals.	Remembering, Understanding,					
CO6	Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the take part in environmental biotechnology, conventionala and modern fuels and their environmental impact, bioremediation, phytoremediation, biodegradation, Bio-fertilizers and Bioleaching, Environmental significance of genetically modified microbes, plants and animals	1,2,3,4,5,6 Remembering, Understanding, Analyzing, Evaluating Creating					

Course Outcomes (COs): On completion of this course, the students will be

Mapping of COs with POs & PSOs

Course		Program Outcomes (POs)										Program Specific Outcomes (PSOs)				
Outcomes	P01	P02	PO3	P04	PO5	904	P07	P08	P09	P010	P011	P012	PS01	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	2	3	2	2	2	2	2	3	2	2
CO2	2	2	2	2	2	2	2	2	3	2	3	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	3	2	3	2	2	2	2	3
CO4	2	3	2	3	3	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	2	2	2	3	3	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

Course code	: HBTL 608
Course Name	: Lab Course Based on HBTD 608
Semester	: VI

L	Т	Р	С		
0	0	2	2		

Practicals

- 1. Calculation of Total Dissolved Solids (TDS) of water sample.
- 2. Calculation of Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) of water sample.
- 3. Calculation of Total Solids (TS) of water sample.
- 4. Calculation of BOD of water sample.
- 5. Calculation of COD of water sample.
- 6. Bacterial Examination of Water by MPN Method.