NATIONALEDUCATIONPOLICY-2020

Common Minimum Syllabus for all Uttarakhand State Universities and Colleges

Syllabus Proposed
2023-24

Sri Dev Suman Uttarakhand University
Badshahithol, Tehri (Garhwal)

पाठ्यक्रम निर्माण समिति, उत्तराखण्ड
Curriculum Design Committee, Uttarakhand

क्र0 सं0	नाम एवं पद	
1	**प्रो0 एन0 के0 जोशी** कुलपति, श्रीदेव सुमन उत्तराखण्ड विश्वविद्यालय, टिहरी	**अध्यक्ष**
2	कुलपति, कुमाऊँ विश्वविद्यालय, नैनीताल	**सदस्य**
3	**प्रो0 जगत सिंह बिष्ट** कुलपति, सोबन सिंह जीना विश्वविद्यालय, अल्मोड़ा	**सदस्य**
4	**प्रो0 सुरेखा डंगवाल** कुलपति, दून विश्वविद्यालय, देहरादून	**सदस्य**
5	**प्रो0 ओ0 पी0 एस0 नेगी** कुलपति, उत्तराखण्ड मुक्त विश्वविद्यालय, हल्द्वानी	**सदस्य**
6	**प्रो. एम0 एस0 एम0 रावत** सलाहकार–रूसा, रूसा निदेशालय, देहरादून	**सदस्य**
7	**प्रो0 के0 डी0 पुरोहित** सलाहकार–रूसा, रूसा निदेशालय, देहरादून	**सदस्य**

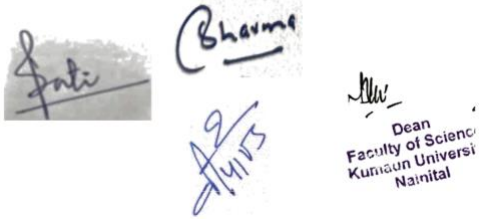
KUMAUN UNIVERSITY NAINITAL
Integrated B.Sc.-M.Sc.- Biotechnology

Common Minimum Syllabus for State Universities and Colleges of Uttarakhand

National Education Policy- 2020

Subject: Biotechnology

PROPOSED STRUCTURE OF INTEGRATED B.SC.-M.SC.-BIOTECHNOLOGY
SYLLABUS



National Education Policy-2020

Common Minimum Syllabus for all Uttarakhand State Universities/Colleges

SUBJECT: Biotechnology

Syllabus Developed by		
Name	**Designation**	**Affiliation**
Prof. Veena Pande	Professor & Head	Department of Biotechnology, Kumaun University Nainital-Uttarakhand
Dr. Tapan K. Nailwal	Associate Professor	Department of Biotechnology, Kumaun University Nainital-Uttarakhand
Dr. Rishendra Kumar	Assistant Professor	Department of Biotechnology, Kumaun University Nainital-Uttarakhand
Dr. Santosh K. Upadhyay	Assistant Professor	Department of Biotechnology, Kumaun University Nainital-Uttarakhand
Dr. Mayank Pandey	Assistant Professor (contractual)	Department of Biotechnology, Kumaun University Nainital-Uttarakhand
Dr. Praveen Dhyani	Assistant Professor (contractual)	Department of Biotechnology, Kumaun University Nainital-Uttarakhand

Moderated by:

Name	Designation	Affiliation
Prof. R. L. Singh	Vice Chancellor	N. P. University, Medininagar, Palamu, Jharkhand
Prof. B. D. Lakhchaura	Retired Professor	Department of Biochemistry, College of Veterinary Sciences, G. B. P. U. A. & T. Pantnagar
Prof. N. K. Singh	Professor	Department of Plant Breeding & Genetics, College of Agriculture, G. B. P. U. A. & T. Pantnagar
Dr. Anshulika Upadhyay	Assistant Professor (Contractual)	Dept. of Biotechnology, MBPG College, Haldwani, Kumaun University Nainital

Semester-wise Titles of the Papers in B.Sc. Biotechnology

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
Certificate in Basic Biotechnology					
1	I	UBT01- (T/P)	Chemical Science I	Theory + Practical	4+2
		UBT02- (T)	Biology of Plants	Theory	6
		UBT03-(T)	Biology of Animals	Theory	6
		-	Vocational		3
			Co-curricular		Qualifying
	II	UBT04- (T/P)	Elementary Molecular Biology	Theory + Practical	4+2
		UBT05-T	Basics of Genetics	Theory	6
		UBT06- (T/P)	Introductory Microbiology	Theory + Practical	4+2
		-	Elective (Either in Ist or 2nd semester)		4/5/6
		-	Vocational		3
			Co-curricular		Qualifying
				Total	**46/47/48**
Diploma in Biotechnology					
2	III	UBT07-T	Basic Cell Biology	Theory	6
		UBT08- (T/P)	Chemical Science II	Theory + Practical	4+2
		UBT09- (T/P)	Fundamental Biochemistry	Theory + Practical	4+2
		-	Vocational		3
			Co-Curricular		Qualifying
	IV	UBT10- (T/P)	Basic Genetic Engineering	Theory + Practical	4+2
		UBT11- (T)	Elementary Industrial Microbiology	Theory	6
		UBT12-T	Food Biotechnology	Theory	6
		-	Elective (Either in 3rd or 4th semester)		4/5/6
		-	Vocational		3
			Co-Curricular		Qualifying
				Total	**46/47/48**

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Degree in Bachelor of Science (Biotechnology)					
3	V	UBT13-(T/P)	Basics of Immunology	Theory + Practical	4+2
		UBT14-T	Introductory Animal Biotechnology	Theory	4
		UBT15-T	Environmental Biotechnology	Theory	4
		UBT16-(T)	Molecular Cancer Biology	Theory	4
			Co-Curricular		Qualifying
			Industrial Training/Survey/Research Project		4
	VI	UBT17-(T/P)	Introductory Plant Biotechnology	Theory + Practical	4+2
		UBT18-(T/P)	Bio-Analytical Techniques	Theory + Practical	4+2
		UBT19-T	Microbial Genetics	Theory	4
		UBT20-T	Medical Biotechnology	Theory	4
			Co-Curricular		Qualifying
			Industrial Training/Survey/Research Project		4
				Total	**46**

Elective papers offered

Course code	Paper title	Theory/Practical	Credits
UBT05-T	Basics of Genetics	Theory	6
UBT07-T	Basic Cell Biology	Theory	6
UBT12-T	Food Biotechnology	Theory	6
UBT16-(T)	Molecular Cancer Biology	Theory	4

Subject Prerequisite

The candidate should have passed (10+2) examination in science stream with PCB (Physics, Chemistry, Biology and/or Biotechnology) or PCM (Physics, Chemistry and Maths) or any other science subject.

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PROGRAM OBJECTIVES:

1. Students after completion of the program will be eligible for pursuing higher courses in biotechnology and related fields.

2. Graduates will get competency in the subject and would contribute to the growth of the country in different disciplines related to biotechnology

3. Students will pursue career paths in teaching or research at suitable levels.

PROGRAM SPECIFIC OUTCOMES (PSOs)	
CERTIFICATE IN BIOTECHNOLOGY	
First Year	This course introduces the knowledge of genetics, molecular biology and microbiology; along with achieving the basic foundation in Mathematics, Biology and Chemistry. **PSO1.** After completion of this certificate course, students will be able to demonstrate and apply their knowledge of genetics, molecular biology and microbiology related to the field of biotechnology **PSO2:** Understand the basic concepts of genetics and molecular biology such as inheritance pattern, DNA replication, transcription and translation **PSO3:** Understand how genetic information is transmitted in organism **PSO4.** Acquire knowledge about the application of various types of microscopes, staining techniques, culture techniques, sterilization, preservation etc. **PSO5:** Perform experiments of DNA isolation, agarose gel electrophoresis, spectroscopy, PCR etc **PSO6:** apply for job at technical positions in different research laboratories, diagnostic centers and industries.
Second Year	**DIPLOMA IN BIOTECHNOLOGY**
	After completion of diploma course, students will be able to- **PSO1:** Learn the chemistry, structure and functions of major bio-molecules and metabolism of carbohydrate, protein etc. **PSO2**: Understand the significance of Biochemistry and basics of enzymes. **PSO3:** Familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in Biochemistry. **PSO4:** Understand different biochemical tools and techniques such as chromatography, electrophoresis etc. **PSO 5.** Know the chemical structure of nucleotides including their components, describe primary, secondary structure of DNA and RNA **PSO 6:** Perform different experiments based on the techniques such as chromatography, electrophoresis, centrifugation etc. **PSO 7:** Would be able to understand Morphology and cell structure; Various subcellular bodies, their interaction and trafficking etc **PSO 8:** Understand the foundations of modern biotechnology and explain the principles that form the basis for recombinant technology & understand and perform various recent molecular and recombinant DNA technology techniques; perform experiments of DNA isolation, gene cloning, transformation etc.
Third Year	**DEGREE IN BACHELOR OF SCIENCE** **(Biotechnology)**

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	After completing the three years degree course in Biotechnology, the students will be able to: **PSO1:** Understand the principles, practices and applications of plant biotechnology, transgenic plant generation, plant tissue culture, plant genomics, and genetic transformation. **PSO2:** Performand analyze the results of experiments using basic laboratory techniques of immunology, animal and plant biotechnology, Bio-analytical techniques, medicalbiotechnology, Microbial genetics and Environmental biotechnology. **PSO3**: Learn different gene delivery methods to deliver foreign gene in plants and animals **PSO4:** Familiarize with the principles, practices and application of animal biotechnology in Transgenesis,Tissue Engineering, and biopharmaceuticals. **PSO5:** Develop an ability to properly understand the technical aspects of existing technologies that help in addressing the various challenges faced by humankind. **PSO6**. learn fundamentals of Environmental Biotechnology and understand the importance of clean (pollution free) environment **PSO7:** Understand biotechnological solutions to address environmental issues including pollution, mineral resource winning, renewable energy and water recycling **PSO8:** Understand and also able to perform different immunological techniques like agglutination reaction, ABO typing and ELISA. **PSO9:** Demonstrate principle and application of Chromatography (Column chromatography, Ion- exchange chromatography, Gel-permeation (molecular sieve, chromatography, Affinity chromatography, Paper chromatography, Thin-layer chromatography and HPLC *etc*) **PSO10:** Demonstrate knowledge for in-depth analytical and critical thinking to identify, formulate and solve the issues related to Biotechnology research, Biotechnology Industry, Pharma industry, Medical or hospital related organizations, and Academia. **PSO 11:** Exhibit ability to do research independently as well as in collaboration in the area of Biotechnology Industry, Pharma industry, Medical or hospital related organizations, and Academia**.**

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Subject: Biotechnology							
Year	**Semester**	**Theory Paper**	**Units**	**Practical Paper**	**Units**	**Research Project**	**Total Credits of the Year subject**
1	I	**CHEMICAL SCIENCE I**	4 Units	**CHEMICAL SCIENCE I**	1. Volumetric Analysis: Acid-Base, Oxd-Red, Iodometric Titration, Potassium dichromate. 2. Determination of surface tension/ viscosity 3. Calculation of parachor 4. Separation of the organic binary mixture and identification of the compounds.	NIL	4+2=6
		BIOLOGY OF PLANTS	5 Units	**BIOLOGY OF PLANTS**	NA	NIL	6
		BIOLOGY OF ANIMALS	5 Units	**BIOLOGY OF ANIMALS**	NA	NIL	6

	II	**ELEMENTARY MOLECULAR BIOLOGY**	5 Units	**ELEMENTARY MOLECULAR BIOLOGY**	1. Estimation of DNA content in thegivensample by diphenylamine method 2. Estimation of RNA content by the Orcinol method 3. Isolation of DNA from bacterial or plant or animal cell 4. Spectrophotometric Quantitation of DNA. 5. DNA Hyperchromacity.	NIL	4+2=6
		BASICS OF GENETICS	5 Units	**NONE**	NA	NIL	6
		INTRODUCTORY MICROBIOLOGY	5 Units	**INTRODUCTORY MICROBIOLOGY**	1. Preparation of nutrient agar slants, plates and nutrient broth and their sterilization 2. Inoculation of agar slants, agar plate and nutrient broth 3. Culture of micro-organism using various techniques 4. Simple and differential staining procedures, endospore staining, flagellar staining, cell wall staining, Capsular staining, negative staining 5. Bacterial colony counting 6. Microscopic Observation of different vegetative, capsular and spore forms of bacteria and fungus under 7. Isolation of microbes from soil samples and determination of the number of colony forming units 8. Study of growth curve of *E. coli*	NIL	4+2=6

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2	III	**BASIC CELL BIOLOGY**	4 Units	**NONE**	NA	NIL	6
		CHEMICAL SCIENCE II	5 Units	**CHEMICAL SCIENCE II**	1. Preparation of organic compound, Nitration, Bromination, Acetylation etc. 2. Preparation of Inorganic compound. 3. Paper, Thin layer and column chromatography of sugars, Amino acid, phenols etc. 4. Qualitative analysis of inorganic mixture containing not more than six ionic species. (excluding insoluble substances)	NIL	4+2=6
		FUNDAMENTAL BIOCHEMISTRY	6 Units	**FUNDAMENTAL BIOCHEMISTRY**	1. Estimation of Carbohydrates 2. Estimation of Proteins 3. Separation of Amino acids by Paper Chromatography 4. Thin layer Chromatography 5. Gel Electrophoresis 6. Assay of enzyme activity and Enzyme kinetics 7. Saponification of Fats	NIL	4+2=6
	IV	**BASIC GENETIC ENGINEERING**	5 Units	**BASIC GENETIC ENGINEERING**	1. Isolation of Plasmid DNA 2. Restriction digestion with EcoRI' HindIII or any other restriction enzyme available 3. Agarose gel electrophoresis of Restricted and Unrestricted DNA fragments.	NIL	4+2=6

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		Elementary Industrial microbiology	**8 units**	**NONE**	**NA**	**Nil**	**6**
		Food Biotechnology	8 Units	NONE	NA	NIL	6
3	V	**BASICS OF IMMUNOLOGY**	5 Units	**BASICS OF IMMUNOLOGY**	1. Demonstration of immunization techniques and bleeding of experimental animals. 2. Separation of serum. 3. Antibody and Antigen interaction- Agglutination, Precipitation, Ochterlony double diffusion 4. ELISA	NIL	4+2=6
		INTRODUCTORY ANIMAL BIOTECHNOLOGY	5 Units	**NONE**	NA	NIL	4
		ENVIRONMENTAL BIOTECHNOLOGY	5 Units	**NONE**	NA	NIL	4

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		MOLECULAR CANCER BIOLOGY	5 Units	**NONE**	NA	NIL	4
	VI	**INTRODUCTORY PLANT BIOTECHNOLOGY**	5 Units	**INTRODUCTORY PLANT BIOTECHNOLOGY**	1. Plant tissue culture, Media preparation 2. Ex plant selection and sterilization 3. Callus culture 4. Callus splitting and Regeneration 5. Rooting and Shooting of callus using Auxins and Cytokinins 6. Hardening of the tissue culture generated plantlets	NIL	4+2=6
		BIO-ANALYTICAL TECHNIQUES	5 Units	**BIO -ANALYTICAL TECHNIQUES**	1. Gravimetric estimation of barium, zinc, iron, copper, sulphate and chromium 2. Organic Mixture: Separation of two component organic mixtures (water soluble), systemic analysis of each component.	NIL	4+2=6
		MICROBIAL GENETICS	6 Units	**NONE**	NA	NIL	4
		MEDICAL BIOTECHNOLOGY	6 Units	**NONE**	NA	NIL	4

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Pattern of examination theory papers

A. Theory (External)

*Each theory paper shall consist two sections **A** and **B**.*
***Section A**: (Short answers type with reasoning); 45 marks, eight questions of nine marks each, any five have to be attempted.*
***Section B**: (Long answers type); 30 marks, two questions of fifteen marks each. Both the questions are compulsory with internal choice.*

B. Internal assessment

For each theory paper internal assessment shall be conducted periodically (in the form of class tests and/or assignments/ group discussion/ oral presentation/ overall performance) during the semester period. Total marks allotted to internal assessment shall be 25. The evaluated answer sheets/assignments have to be retained by the Professor In-Charge for the period of six months and can be shown to the students if students want to see the evaluated answer sheets. The marks obtained by the students shall be submitted to the Head of concerned department/ the Principal of the College for uploading onto the University examination portal.

C. Practical

*The laboratory work of the students has to be evaluated periodically. The breakup of marks for practical examination for **each semester** would be as follows:*

Practical exam: 20% marks
Viva voce: 20% marks
Lab record: 20% marks
Spotting: 30% marks
Attendance: 10% marks
Total: 50 marks (each semester)

Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, Kumaun University, Nainital.

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
Certificate in Basic Biotechnology					
1	I	UBT01-(T/P)	Chemical Science I	Theory + Practical	4+2
		UBT02- (T)	Biology of Plants	Theory	6
		UBT03-(T)	Biology of Animals	Theory	6
		-	Vocational		3
			Co-curricular		Qualifying
	2	UBT04-(T/P)	Elementary Molecular Biology	Theory + Practical	4+2
		UBT05-T	Basics of Genetics	Theory	6
		UBT06-(T/P)	Introductory Microbiology	Theory + Practical	4+2
		-	Elective (Either in Ist or 2nd semester)		4/5/6
		-	Vocational		3
			Co-curricular		Qualifying
				Total	**46/47/48**

Semester-I

Paper-I (Theory+ practical)

Course Title: CHEMICAL SCIENCE I

Course Objective: To understand the basic principles of atomic structure, nomenclature, reaction kinetics, electrochemistry, ionic strength and pH etc, for their application in biotechnology related disciplines.

Credits: 4+2		**Compulsory**
Max. Marks: 100+50 (Practical)		Min. Passing Marks:……
Total Number of Lectures = 60		
Units	**Content (Theory)**	**Number of Lectures**
1	• Atomic structure, chemical bonding, hybridization, valence shell electron pair repulsion (VSEPR) theory. To NH_3, H_3O^+, SF_4,ClF_3 and H_2O, Molecular orbital theory (MOT) , • Periodic properties: viz. ionization potential, electron affinity, electronegativity etc. study of s, p and d- block elements.	**15**
	• Coordination compound: Werners theory and IUPAC nomenclature of coordination compounds valence bond theory and discussion of inner and outer orbit complexes.	

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2	• Acids and bases: elementary ideas of Bronsted – Lowery and Lewis concept of acid and bases. SHAB (soft and hard acid and base), buffer solution, pH, pKa and pKb values, • Solution: Henrys law, Roults law, osmotic pressure and its measurement, effect of solute on B.P. and F.P. of solution. Vapour pressure, surface tension, viscosity, parachor, Rheochor and their applications	**15**
3	• Chemical kinetics: 1^{st} 2^{nd} and 3^{rd} order reactions, determination of order of reaction, molecularity and order of reaction, Energy of activation, Arhenus equation, half- life period, catalyst and composite reaction. • Electrochemistry: Galvanic cells, EMF, type of electrodes, reference electrodes, electroanalytical methods viz; potentiometry, conductometry, polarography, weak and strong electrolyte, degree of hydrolysis of salts.	**15**
4	• Ionic and Liquid crystals • Nuclear chemistry: concepts of nuclides, isotopes, isobars, isotones, radioactivity, nuclear reaction, • Colloidal solutions: properties of collides, Tyndel effect, flocculation, Hardy –Sultze rule.	**15**

Books Recommended:

- Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5^{th} edition.
- Madan, R.L., "Chemistry for Degree Students, B. Sc. First Year", S. Chand Publishing, New Delhi, India, 2011, 3^{rd} edition.
- Madan, R.D., Malik, U.M. and Tuli, G.D., "Selected topics in Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2010**.**
- Chandra, S., "Comprehensive Inorganic Chemistry" New Age International Publishers, India, 2018, 1^{st} edition.
- Prakash, S., Tuli, G.D., Basu, S.K. and Madan, R.D., "Advanced Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2000, Vol 1.
- Finar, I.L., "Organic Chemistry", Pearson Education India, 2002, 6^{th} edition.
- Eliel, E.L. and Wilen, S.H., "Stereochemistry of Organic Compounds", Willey, 1994,1^{st} edition.
- Bahl, A., Bahl, B.S. and Tuli, G.D., "Essential of Physical Chemistry", S. Chand Publishing, India, 2010.
- Bariyar, A., Singh, R.P. and Dwivedi, A., "Text Book for B. Sc. Chemistry I", Anu Books, 2019.

Suggested online links:

- https://ocw.mit.edu/courses/chemistry/5-111sc-principles-of-chemical-science-fall-2014/unit-ii-chemical-bonding-structure/lecture-14/
- https://onlinecourses.swayam2.ac.in/nce19_sc15/preview
- http://www.ocw.titech.ac.jp/index.php?module=General&action=T0300&GakubuCD=3&GakkaCD=332100&KeiCD=21&KougiCD=202102333&Nendo=2021&lang=EN&vid=03
- https://www.openlearning.com/courses/introduction-to-physical-chemistry/?cl=1
- https://www.careers360.com/university/indian-institute-of-technology-bombay/chemistry-of-main-group-elements-certification-course
- https://onlinecourses.swayam2.ac.in/cec20_lb01/preview

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- https://nptel.ac.in/courses/104/103/104103071/
- http://test.open.uci.edu/lectures/chem_1c_lec_20_general_chemistry_electrochemistry_pt_5.html

Semester-I Paper-I (Practical)

Course Title: CHEMICAL SCIENCE I

Total Number of Hrs = 60		
Units	**Content (Theory)**	**Number of Hrs**
1	Volumetric Analysis : Acid-Base, Oxidation-Reduction, Iodometric Titration, Potassium dichromate.	**15**
2	Determination of surface tension/ viscosity	**15**
3	Calculation of parachor	**15**
4	Separation of the organic binary mixture and identification of the compounds.	**15**

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Semester-I

Paper-II (Theory)

Course Title: Biology of Plants

Course objective: Students will learn basics of plant classification, anatomy, morphology and physiology etc. The background of plant science would enable the students to apply biotechnological tools in agricultural crops and other plants.

Credits: 6	**Compulsory**	
Max. Marks: 100	Min. Passing Marks:……	
Total Number of Lectures =90		
Units	**Content (Theory)**	**Number of Lectures**
1	• Plant Kingdom. The classification up to the level of genus and species, important characters of each class with suitable examples. • Mechanism of Photosynthesis, photophosphorylation. • Mechanisms and significance of respiration.	**20**
2	• Plant- water relations, absorption movement and transpiration of water. • Translocation of minerals and nutrients.	**15**
3	• Dicot and monocot root and stem, structure and function of different cells (Angiosperms and Gymnosperms) • Inflorescence and their types with example, fruit and their types with example. • Secondary growth of stem • Development of seed, Seed germination and dormancy	**20**
4	• Plant growth hormones- introduction and functions. • Major auxin & Cytokinin, their functions and application • Vernalization, Photoperiodism	**15**
5	• Apomixis • Parthenocarpy, Polyembryony • Ecobiology of the medicinally and aromatically important plants.	**20**

Books Recommended:

- Smith, A. M., Coupland, G., Dolan, L., Harberd, N., Jones, J., Martin, C., Amey, A. (2009). Plant Biology. Boca Raton, FL: CRC Press.
- Bowsher, C., Steer, M., & Tobin, A. (2008). Plant Biochemistry. London, England: Garland Science.
- Godwin, H. (2015). Plant biology: An outline of the principles underlying plant activity and structure. Cambridge, England: Cambridge University Press.
- Sharma, H. P. (2009). Plant embryology: Classical and experimental. Oxford, England: Alpha Science International.

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Suggested online links:

- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=1p0OY7YTBClr5D2KEqnvVg==
- https://onlinecourses.swayam2.ac.in/cec21_bt03/preview
- https://onlinecourses.swayam2.ac.in/cec19_bt01/preview
- https://onlinecourses.nptel.ac.in/noc19_bt17/preview
- https://onlinecourses.swayam2.ac.in/cec19_bt09/preview

Semester-I

Paper-III (Theory)

Course Title: BIOLOGY OF ANIMALS

Course Objective: This course will introduce students to Classification and nomenclature of animals, evolution, adaptation and animal physiology etc. This would help them in applying biotechnological principles to animal model systems.

Credits: 6	**Compulsory**	
Max. Marks: 100	Min. Passing Marks:……	
Total Number of Lectures = 90		
Units	**Content (Theory)**	**Number of Lectures**
1	• Basic concept of classification for the five kingdom approach, Linnaean hierarchy. • Principles of nomenclature, International code of zoological nomenclature. • Outline classification of Non-chordates and chordates including general characters and examples of major living groups.	**20**
2	• Organic evolution- Evidences. • Theory of evolution- Lamarckism & Neo- Lamarckism; Darwinism & Neo-Darwinism; Modern synthetic theory of evolution. • Population genetics- Hardy-Weinberg law.	**15**
3	• Digestion: Digestion & absorption of carbohydrates, proteins and lipids, role of enzymes and hormones, Respiratory pigments. • Respiration:, Respiratory pigments, Transport of oxygen and carbon dioxide; Control of breathing. • Circulation: Composition and function of blood & lymph, Heart beat & cardiac cycle. • Structure of muscles and mechanism of muscle contraction.	**20**

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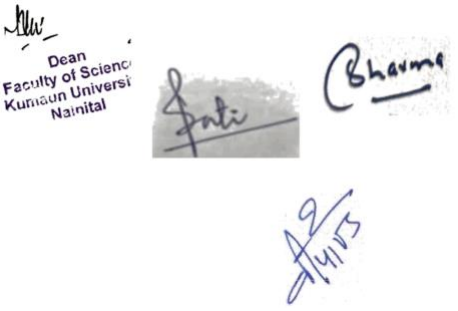
4	• Nervous system: CNS, PNS, Autonammic system, nerve impulse. • Excretion: Composition of Urine & its formation in mammals • Endocrines: A brief idea of structure and functions of Hypothalamus, Pituitary, Thyroid, Parathyroid, Adrenal, Pancreas, Testis & ovary.	**20**
5	• Aquatic adaptations of fish- Morphological, Anatomical and physiological. A brief idea of fish culture. • Outline of Sericulture, Apiculture & insects pest management.	**15**

Books Recommended:

- Shipley, A. E., & MacBride, E. W. (2014). *Zoology: An elementary text-book*. Cambridge, England: Cambridge University Press.
- Miller, S. A., Harley, J. P., & Molles, M. C. (2012). *Zoology* (9th ed.). Maidenhead, England: McGraw Hill Higher Education.
- Hill, R., Wyse, G. A., & Anderson, M. (2016). *Animal Physiology* (4th ed.). Sunderland, MA: Sinauer Associates.
- R. Jurd; Instant Notes Animal Biology; Bios Scientific Publishers

Suggested online links:

- https://nptel.ac.in/courses/102/104/102104058/
- https://www.digimat.in/nptel/courses/medical/anatomy/AN11.html
- https://nptel.ac.in/courses/102/104/102104042/
- https://ocw.mit.edu/courses/biology/7-016-introductory-biology-fall-2018
- https://www.digimat.in/nptel/courses/medical/anatomy/AN11.html
- https://onlinecourses.swayam2.ac.in/cec20_bt19/preview
- https://onlinecourses.nptel.ac.in/noc21_bt46/preview
- https://ocw.mit.edu/courses/brain-and-cognitive-sciences/9-04-sensory-systems-fall-2013



Semester-II

Paper-I (Theory + Practical)

Course Title: **ELEMENTARY MOLECULAR BIOLOGY**

Course Objective: Students will understand molecular logic of life; they will understand the organization and functions of DNA, RNA, and proteins. They would also learn the biochemical and molecular regulation of various biological processes

Credits: 4+2	**Compulsory**	
Max. Marks: 100+25 (Practical)	Min. Passing Marks:……	
Total Number of Lectures = 60		
Units	**Content (Theory)**	**Number of Lectures**
1	• Control Dogma of Molecular Biology • Recapitulation of Nucleic acid structure forms. Nucleic acid as genetic material (Avery *et al*'s experiment & Hershey &Chase's experiment) • DNA polymerases in Prokaryotes & Eukaryotes • Replication of DNA: Semi conservative replication of DNA (Messelsen & Stahl experiment), Uni–directional bi–directional replication of DNA &rolling circle DNA replication, DNA replication in prokaryotes (Initiation, elongation & termination), DNA replication in eukaryotes (Initiation, elongation & termination)	**12**
2	• Transcription: Transcription in prokaryotes (Promoter sites, initiation & elongation, termination), Transcription in Eukaryotes (Promoter, enhancer & silencer sites for initiation, transcription factors, elongation & termination), RNA polymerase in prokaryotes & Eukaryotes. • RNA processing- capping, tailing & splicing, ribozyme, RNA editing.	**12**
3	• Protein Synthesis: Translation in Prokaryotes & Eukarytoes (Formation of aminoacyl tRNA, Initiation, Elongation & Termination of polypeptide). Post translational Modification of proteins. • Genetic code: Properties of genetic code, chain initiation & chain termination codons, wobble hypothesis.	**12**
4	• Concept of gene and its organization • Regulation of gene expression: Positive & Negative regulation, The operon model for transcriptional regulation (*Lac* operon & *Trp* operon) control of lac operon, regulation of *Trp* operon.	**12**

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5	• Organization of genetic material: Chromosomal DNA content & C-Value paradox, Repetitive DNA, satellite DNA, (reassociation Kinetics, Chemical complexity & Kinetic complexity) • Homologous recombination, Holliday model	**12**

Books Recommended:

1. Nelson, David L., and Michael M. Cox. (2017). Lehninger Principles of Biochemistry. 7th ed. New York, NY: W.H. Freeman.
2. Howell, S. H. (Ed.). (2014). Molecular Biology (2014th ed.). New York, NY: Springer.
3. Verma, P. S., & Agarwal, V. K. (2010). Molecular Biology. New Delhi, India: S Chand.
4. Cox, M. M., & O'Donnell, M. (2015). Molecular biology: Principles and practice (1st ed.). New York, NY: W.H. Freeman.

Suggested online links:

- https://onlinecourses.swayam2.ac.in/cec20_ma13/preview
- https://ocw.mit.edu/courses/find-by-topic/#cat=science&subcat=biology&spec=molecularbiology
- https://ocw.mit.edu/courses/biology/7-28-molecular-biology-spring-2005/
- https://www.ncbi.nlm.nih.gov/books/NBK9855/

Semester-II
Paper-I (Practical)
Course Title: **ELEMENTARY MOLECULAR BIOLOGY**

Total Number of Hrs = 60		
Units	**Content (Theory)**	**Number of Hrs**
1	Estimation of DNA content in the given sample by diphenylamine method	12
2	Estimation of RNA content by the Orcinol method	12
3	Isolation of DNA from bacterial or plant or animal cell	12
4	Spectrophotometric Quantitation of DNA.	12
5	DNA Hyperchromacity.	12

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Semester-II

Paper-II (Theory)

Course Title: BASICS OF GENETICS

Course Objective: Students will learn basic concepts in genetics and microbial genetics. They will learn genetic inheritance through historical experiments and get knowledge of chromosome organization.

Credits: 6	**Compulsory**	
Max. Marks: 100	Min. Passing Marks:……	
Total Number of Lectures = 90		
Units	**Content (Theory)**	**Number of Lectures**
1	• Modern concept of gene & genome • Introduction of genetics, genotype, phenotype and other genetic terminology • Mendel's laws of inheritance and their molecular interpretation. • DNA as genetic material-experimental proof	**20**
2	• Chromosomes- structural organization of prokaryotic and eukaryotic chromosomes, Kinds of chromosomes based on chromosomal aberration- structural & numerical.	**15**
3	• Mutation: spontaneous and induced, chemical and physical mutagens, induced mutations in plants, animals and microbes for economic benefits, Replica plating techniques. • Hereditary defects- Kleinfelters syndrome, Down's syndrome, Turners syndrome	**20**
4	• Microbial genetics- Recombination in bacteria; Molecular mechanism of recombination, Transformation Transduction, Conjugation ,replica, plating.	**15**
5	• Concept in Monosomy, trisomy, nullisomy & others introduction • Introduction to Genetic & physical maps • Classical experiment of genetics in drosophila for establishing linkages and crossing over. • Biochemical genetics – *Neurospora crassa* experiments	**20**

Books Recommended:

1. Gardner EJ, Simmons MJ, Sunstad DP. **Principles of Genetics**. 8th Edition. John Wiley and Sons.
2. Hartl, D. L., & Jones, E. W. (1998). **Genetics: Principles and Analysis**. Sudbury, MA: Jones and Bartlett.
3. Pierce, B. A. (2005). **Genetics: a Conceptual Approach**. New York: W.H. Freeman.
4. Smith, J. M. (1998). **Evolutionary Genetics.** Oxford: Oxford University Press Genetics: Principles and Analysis – Hartl and Jones.
5. Snustand DP, Simmons MJ. **Principles of Genetics**. (2016) 7th Edition. John Wiley and Sons.

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6. Verma PS, Agarwal VK. **Cell Biology, Genetics, Molecular Biology, Evolution and Ecology**. (2004). S Chand and Company Ltd.

Suggested online links:

- https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-bt05/
- https://www.classcentral.com/course/swayam-principles-of-genetics-23082
- https://onlinecourses.nptel.ac.in/noc21_bt02/preview
- https://ocw.mit.edu/courses/find-by-topic/#cat=science&subcat=biology&spec=genetics
- https://nptel.ac.in/courses/102/103/102103012/
- https://nptel.ac.in/courses/102/106/102106025/
- https://nptel.ac.in/courses/102/103/102103015/

Semester-II

Paper-III (Theory + Practical)

Course Title: Introductory Microbiology

Course Objective: Students will get general idea of common microorganisms; they will also learn basics of laboratory safety. They will have idea of basic laboratory techniques and would be able to apply the knowledge gained towards research, diagnostic, and therapeutic purposes.

Credits:4+2	Compulsory
Max. Marks: 100 + 25 (practical)	Min. Passing Marks:……

Total Number of Lectures = 60

Unit	Content (Theory)	Number of lectures
1	• History of microbiology: Importance & scope of microbiology • Classification and nomenclature of Microbes • Importance & scope of microorganisms in human welfare	**10**
2	• Characteristics and examples of *Archaebacteria,* eubacteria, viruses, viroids and prions. • Size, shape and arrangement of bacterial cells, cell wall, cytoplasmic membrane (Protoplasts, spheroplasts), flagella, pili, spores and cysts. • Bacteriophage – lytic and lysogenic cycle; Staining techniques – simple (Monochrome and negative) and differential (Gram and acid fast).	**15**

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3	• Control of microorganisms – Methods of sterilization, disinfection, sanitation, pasteurization, physical and chemical methods of control. • Staining techniques – Simple (Monochrome and negative) and differential (Gram and acid fast).	**10**
4	• Bacterial nutrition – Nutritional classes of microorganisms. • Microbial media and its types. • Isolation of pure culture from natural sources and its maintenance	**10**
5	• Microbial growth – Growth curve, conditions affecting growth. • Batch and continuous culture; Measurement of bacterial growth. • Introduction to microbial pathogens & diseases (Cholera, tuberculosis, tetanus, measles & Mumps, influenza, rabies, Poliomyelitis, toxoplasmosis, HIV, Candidiasis etc.)	**15**

Books Recommended:

- Tortora, Gerard J., Berdell R. Funke, and Christine L. Case. 2004. Microbiology: an introduction: Pearson
- Pelczar, M. J., Jr, & etc. (1993). Microbiology: Concepts and Applications (6th ed.). London, England: McGraw-Hill Education (ISE Editions).
- Madigan, M. M., Martinko, J. M., Parker, J., Messley, K., & Norrell, S. (2003). *Brock biology of microorganisms: (international edition) with microbiology lab manual*. Upper Saddle River, NJ: Pearson.

Suggested online links:

- https://nptel.ac.in/courses/102/103/102103015/
- https://dth.ac.in/medical/courses/Microbiology/block-1/1/index.php
- https://onlinecourses.swayam2.ac.in/cec19_bt11/preview
- https://ocw.mit.edu/courses/find-by-topic/#cat=science&subcat=biology&spec=microbiology

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Semester-II Paper-III (Practical)

Course Title: Introductory Microbiology

Total Number of Hrs = 60

Unit	Content (Practical)	Number of Hrs.
1	Preparation of nutrient agar slants, plates and nutrient broth and their Sterilization	8
2	Inoculation of agar slants, agar plate and nutrient broth	7
3	Culture of micro-organism using various techniques	7
4	Simple and differential staining procedures, endospore staining, flagellar staining, cell wall staining, Capsular staining, negative staining	8
5	Bacterial colony counting	7
6	Microscopic Observation of different vegetative, capsular and spore forms of bacteria and fungus under	7
7	Isolation of microbes from soil samples and determination of the number of colony forming units	8
8	Study of growth curve of *E. coli*	8

Year	Semester	Course Code	Paper Title	Theory/Practical	Credits
DIPLOMA IN BIOTECHNOLOGY					
2	3	UBT07-T	Basic Cell Biology	Theory	6
		UBT08-(T/P)	Chemical Science II	Theory + Practical	4+2
		UBT09-(T/P)	Fundamental Biochemistry	Theory + Practical	4+2
		-	Vocational		3
			Co-Curricular		Qualifying
	4	UBT10-(T/P)	Basic Genetic Engineering	Theory + Practical	4+2
		UBT11-(T)	Elementary Industrial Microbiology	Theory	6
		UBT12-T	Food Biotechnology	Theory	6
		-	Elective (Either in 3rd or 4th semester)		4/5/6
		-	Vocational		3
			Co-Curricular		Qualifying
				Total	**46/47/48**

Semester-III Paper- I
(Theory)

Course Title: BASIC CELL BIOLOGY

Course objective: Students will understand basic cellular structure and function of cell-organelles. They will also get introduced to concepts of cell division and cell-death.

Credits: 6	**Compulsory**	
Max. Marks: 100	Min. Passing Marks:……	
Total Number of Lectures = 90		
Units	**Content (Theory)**	**Number of Lectures**
1	• Cell as a unit of living system. The cell theory; Precellular evolution; Eukaryotic and Prokaryotic cells. • Biochemical composition of cells (Protein, lipids, carbohydrates, nucleic acids).	**20**
2	• Structure and functions of various cell organelles; ultrastructure of plasma membrane; cell wall, endoplasmic reticulum, mitochondria, Golgi body, chloroplast, lysosomes, peroxisomes & glyoxisomes.	**30**
3	• Structure of nucleus, nucleolus and chromosomes; Giant chromosomes (lampbrush & polytene). • Cytoskeletal structures (actin, microtubules intermediate filament	**20**
4	• Cell division (Mitosis and Meiosis); Cell cycle; Difference between cancerous and normal cells. • Cell senescence, cell death and apoptosis.	**20**

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Books Recommended:

- Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular Biology of the Cell (6th Ed.). New York: Garland Science
- Cooper, G. M., and Hausman, R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM ; Sunderland.
- Karp, G. Cell and Molecular Biology. Concepts and experiments. John Harris, D., Wiley & sons, New York
- Iwasa J., Marshal W. Karp's Cell Biology(2018) (8th edition) Wiley & Sons, NY
- Iwasa J., Marshal W. Karp's Cell and Molecular Biology: Concepts and experiments. (2015) (8th edition) Wiley & sons, New York
- Watson, J. D. Baker TA, Bell, SP Gann, A. Levine, M. Losick R. (2008). Molecular Biology of the Gene (5th ed.). Pearson
- Lodish, H F. Berk, A. Kaiser, CA, Krieger, M. Bretscher, A. Ploegh, H. Aman, A. Martin, K. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman
- Gupta P.K. Cell and Molecular Biology 2018. 5th edition Rastogi Publication India.

Suggested online links:

- https://ocw.mit.edu/courses/biological-engineering/20-310j-molecular-cellular-and-tissue-biomechanics-spring- 2015/readings/MIT20_310JS15_Kamm2.2.pdf
- https://ocw.mit.edu/courses/find-bytopic/#cat=science&subcat=biology&spec=cellbiology
- https://onlinecourses.swayam2.ac.in/cec19_bt12/preview
- https://onlinecourses.nptel.ac.in/noc21_cy15/preview
- https://ocw.mit.edu/high-school/biology/exam-prep/cells/subcellular-organization/cytoskeleton/
- http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S001174BS/P001859/M030475/ET/1526877295P11_M14_ET.pdf
- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2rAs1Puvga4LW93zMe83aA==

Semester-III

Paper-II (Theory + Practical)

Course Title: Chemical science II

Course objective: Students would get basics of stereochemistry, isomerism, chemistry of organic compounds and that of various analgesics and other drugs.

Credits: 4+2	**Compulsory**	
Max. Marks: 100+25 (Practical)	Min. Passing Marks:……	
Total Number of Lectures = 60		
Units	**Content (Theory)**	**Number of Lectures**
1	• Basic stereochemistry: Geometrical isomerism, E, Z, nomenclature enantiomerism, distereoisomerism, D, L configuration,andabsoluteconfiguration(R,S nomenclature), conformational analysis, and IUPAC nomenclature. • Concepts of thermodynamics in chemical reaction.	**12**

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2	• Reaction mechanism: type of organic reactions, reaction intermediates, S_{N1}, S_{N2}, E_1 and E_2 reactions, hemolytic and heterolytic fission, nucleophile, electrophiles, mechanism of Aldol condensation, Cannizaro reaction, Friedal craft reaction, Beckmann reagent, Dield-Alder reaction, Hoffmann-reaction, electrophilic substitution reactions, orientation effect.	**12**
3	• Aliphatic and aromatic organic compounds: general method of preparation, properties, chemical reaction and application of both aliphatic and aromatic hydrocarbon, aldehydes, ketones, alcohols, ether, thioether, amines, amids, anhydrides, and carboxylic acids, phenols, organic chemistry of Sulphur compounds, chloramin-t, saccharin etc	**12**
4	• Heterocyclic aromatic compounds: pyridine, pyrol, quinoline, isoquinoline structure properties synthesis and applications. • Basic concepts about bioactive natural product viz, alkaloids, terpenoids, steroids.	**12**
5	• Basic concept about analgesics, antipyretics, preparation and uses of asperin, paracetamol, sulphadrug viz sulphanilamide, sulphaquanidine and sulphapyridine.	**12**

Books Recommended:

- Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5th edition.
- Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33rd edition.
- Mukerji, S.M., "Reaction mechanism in Organic Chemistry", Laxmi Publications, 2007, 3rd edition.
- Singh, Jagdamba and Yadav, L.D.S., "Undergraduate Organic Chemistry" Pragati Prakashan, India, 2011, Vol 1.
- Loudon, G. Marc, "Organic Chemistry", Oxford University Press, 2008, 4th edition.
- Atkins P.W., "Atkin's Physical Chemistry: International", Oxford University Press, 2018, 11th edition.
- Ball D.W., "Physical Chemistry", Cengage India Private Limited, 2017, 2nd edition.
- Puri, B.R., Pathania, M.S. and Sharma, L.R., "Principles of Physical Chemistry", Vishal Publishing, India, 2020, 47th edition.
- Madan, R.L., "Chemistry for Degree Students, B. Sc. First Year", S. Chand Publishing, New Delhi, India, 2011, 3rd edition.
- Madan, R.D., Malik, U.M. and Tuli, G.D., "Selected topics in Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2010.
- Chandra, S., "Comprehensive Inorganic Chemistry" New Age International Publishers, India, 2018, 1st edition.
- Prakash, S., Tuli, G.D., Basu, S.K. and Madan, R.D., "Advanced Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2000, Vol 1.
- Finar, I.L., "Organic Chemistry", Pearson Education India, 2002, 6th edition.

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- Eliel, E.L. and Wilen, S.H., "Stereochemistry of Organic Compounds", Willey, 1994,1st edition.
- Boyd, Morrison and Bhattacharjee, "Organic Chemistry", Pearson Education India, 2010, 7th edition.

Suggested online links:

- https://onlinecourses.nptel.ac.in/noc19_cy25/preview
- https://onlinecourses.swayam2.ac.in/nce19_sc15/preview
- https://nptel.ac.in/content/storage2/courses/104103022/download/module6.pdf
- https://www.openlearning.com/courses/introduction-to-physical-chemistry/?cl=1
- https://www.careers360.com/university/indian-institute-of-technology-bombay/chemistry-of-main-group-elements-certification-course
- https://onlinecourses.swayam2.ac.in/cec20_lb01/preview
- https://nptel.ac.in/courses/104/103/104103071/

Semester-III
Paper-II (Practical)
Course Title: **Chemical science II**

Total Number of Hrs = 60		
Units	**Content (Theory)**	**Number of Hrs**
1	Preparation of organic compound, Nitration, Bromination, Acetylation etc.	**15**
2	Preparation of Inorganic compound.	**15**
3	Paper, Thin layer and column chromatography of sugars, Amino acid, phenols etc.	**15**
4	Qualitative analysis of inorganic mixture containing not more than six ionic species. (excluding insoluble substances)	**15**


Semester-III

Paper-III (Theory + Practical)

Course Title: FUNDAMENTAL BIOCHEMISTRY

Course objective: Theoretical and practical knowledge of various topics, including, macromolecules, enzymes, hormones, vitamins and metabolic pathways.

Credits: 4+2	**Compulsory**
Max. Marks: 100+25 (Practical)	Min. Passing Marks:……

Total Number of Lectures = 60

Units	**Content (Theory)**	**Number of Lectures**
1	• Bio molecules-Their functions and biological significance • Thermodynamics of biochemical reactions, Energy rich biomolecules (ATP, NADP & Other phosphorylated compounds). • Carbohydrates: chemical structure, classification & properties, Importance in biological systems. Amino acids & peptides – classification, properties & structure; primary, secondary, tertiary & Quaternary structure of proteins. • Lipids: Structure, classification, properties & functions.	**15**
2	• Enzymes: classification, characteristics, factors affecting enzyme activity. Enzyme kinetics, Km, Enzyme inhibition. Coenzymes, isoenzymes & multienzyme complexes Apoenzyme, Allosteric enzymes.	**8**
3	• Nucleic acids: Base composition, nucleosides, nucleotides & polynucleotide structure. Forms and types of nucleic acids, Primary and secondary structure of nucleic acids	**7**
4	• Hormones: Structure, chemical classification, Mode of action at molecular level, functions in brief & regulation. • Vitamins: Structure & Functions.	**7**
5	• Coordinated control of Metabolism: Glycolysis, citric acid cycle, pentose phosphate pathway, Glycogen breakdown & synthesis, control of glycogen metabolism, Electron transport & Oxidative phosphorylation, Fatty acid oxidation & Fatty acid biosynthesis, Nitrogen fixation in plants & microorganisms, inborn errors of metabolism, glucogenic & Ketogenic amino acids, Urea cycle, Catabolism of Purine & pyrimidine nucleotides.	**15**
6	• Cell-cell interaction; cell adhesion to matrix, cell locomotion (muscle contraction, cell beading). • Membrane trans post	**8**

Books Recommended:

- Nelson DL. Cox MM. (2017) Lehninger Principles of Biochemistry (7th ed.). W H Freeman
- New York.

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- Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.
- Rodwell VW. Bender D. Botham KM. Kennelly PJ Weil PA.(2018). Harper's Illustrated Biochemistry. (31st edition) McGraw-Hill Education
- Berg, JM Tymoczko, JL. Gatto, GJ., Stryer, L. (2015). Biochemistry. (8th ed.) W H Freeman and Company New York.
- Hofmann A. Clokie S. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology. (2018) (8th edition) Cambridge University Press
- Boyer RF. (2012) Biochemistry laboratory: modern theory and techniques (2nd Edition). Pearson Education, Inc
- Jain JL. Jain S. Jain N. (2005). Fundamentals of Biochemistry. (6th edition). S Chand and
- Company Ltd.
- Satyanarayana U. Chakrapani U. (2013). Biochemistry (4th edition). Elsevier and Books and Allied (P) Ltd

Suggested online links:

- https://ocw.mit.edu/courses/find-by-topic/#cat=healthandmedicine&subcat=spectroscopy
- https://nptel.ac.in/courses/104/105/104105076/
- https://nptel.ac.in/courses/102/106/102106087/
- https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/module-i/session-4/
- https://www.youtube.com/channel/UCtiCUwgrWOPPz-qOu-QGRDg
- https://ocw.mit.edu/courses/biology/7-016-introductory-biology-fall-2018/lecturevideos/lecture-4-enzymes-and-metabolism/
- https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/module-i/session-3/
- https://onlinecourses.swayam2.ac.in/cec20_bt12/preview

Semester-III
Paper-III (Practical)
Course Title: **FUNDAMENTAL BIOCHEMISTRY**

Total Number of Hrs = 60		
Units	**Content (Theory)**	**Number of Hrs**
1	Estimation of Carbohydrates	**8**
2	Estimation of Proteins	**8**
3	Separation of Amino acids by Paper Chromatography	**12**
4	Thin layer Chromatography	**8**
5	Gel Electrophoresis	**8**
6	Assay of enzyme activity and Enzyme kinetics	**8**
7	Saponification of Fats	**8**

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Semester-IV

Paper-I (Theory + Practical)

Course Title: BASIC GENETIC ENGINEERING

- **Course Objectives:** Students will obtain knowledge of various topics as per the syllabus including hands on training on different rDNA techniques, Restriction digestion, gel-electrophoresis, plasmid isolation etc. They would also learn basic tools of bioinformatics.

Credits: 4+2		**Compulsory**
Max. Marks: 100+50 (Practical)		Min. Passing Marks:……
Total Number of Lectures = 60		
Units	**Content (Theory)**	**Number of Lectures**
1	• Scope & History of Genetic Engineering • Isolation & Purification of genomic & plasmid DNA from Bacteria, Plant & Animal cells. • Vectors: Nomenclature, properties, plasmids, cosmids, phages, yeast vector, plant & animal vectors, cassette vectors. • Restriction enzymes & other enzymes required in recombinant DNA technology.	**15**
2	• Introduction to techniques in Molecular Biology: Gene synthesis, cDNA synthesis & cloning, Gene sequencing (Maxma Gilbert method & Sanger's method), PCR (its forms & application). Northern, Southern & Western blotting. In situ hybridization, dot blots cDNA library construction & screening. • Genomic library construction & screening • Linkers, adaptors, Blunt end ligation, Homopolymer tailing	**15**
3	• Basic principle & introduction of antisense & ribozyme technology, post transcriptional gene silencing (RNAi technology), Gene therapy, Introduction to microarray technology	**10**
4	• Cloning & expression of foreign genes in Prokaryotes (E. coli) & Eukaryotes (*e.g.* yeast). Application of recombinant DNA technology.	**10**
5	Bioinformatics: History and scope, concepts of CD-ROM, e- mail, web sites, internet networking, database, collection & retrieval data of gene bank. Tools for sequence alignment (FASTA, BLAST, PSI-BLAST), primer designing, phylogenetic analysis, database searching for similar sequences.	**10**

Books Recommended:

- Brown, T. A. (2006). Gene Cloning and DNA Analysis: an Introduction. Oxford: Blackwell

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Pub.
- Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
- Slater, A., Scott, N. W., & Fowler, M. R. (2003). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press.
- Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: an Introduction to Genetic Engineering. Oxford: Oxford University Press

Suggested online links:

- https://onlinecourses.nptel.ac.in/noc19_bt15/preview
- https://nptel.ac.in/courses/102/103/102103013/
- https://www.classcentral.com/course/swayam-genetic-engineering-theory-and-application-14090
- https://onlinecourses.swayam2.ac.in/cec19_bt02/preview
- https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/recombinant-dna/
- https://ocw.mit.edu/courses/biology/7-16-experimental-molecular-biology-biotechnology-ii-spring-2005/

Semester-IV Paper-I
(Practical)

Course Title: **BASIC GENETIC ENGINEERING**

Total Number of Hrs = 60		
Units	**Content (Theory)**	**Number of Hrs**
1	Isolation of Plasmid DNA	**20**
2	Restriction digestion with EcoRI' HindIII or any other restriction enzyme available	**20**
3	Agarose gel electrophoresis of Restricted and Unrestricted DNA fragments.	**20**

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Semester-IV Paper-II
(Theory)

Course Title: **Elementary Industrial Microbiology**

Course Objective: This course introduces students to various aspects of industrial microbiology, including, Microbial isolation techniques, GRAS microbes, fermentation, downstream processing etc. It also provides idea of production of antibiotics, alcohol, vitamins, amino acids, biofuels and biofertilizers etc.

Credits: 6	**Compulsory**
Max. Marks: 100	-Min. Passing Marks:……

Total Number of Lectures = 90

Unit	**Topics**	**Total No. of Lectures/ Hours (90)**
I	History & Multidisciplinary nature of Industrial microbiology. A typical Bio process: Introduction, advantages & limitations. Patents and intellectual property rights.	**10**
II	Taxonomic diversity of industrially useful bacteria & fungi. Important characteristics of microbes used in Industrial Microbiology, Isolation techniques. Concept & examples of microorganisms classified as Generally Regarded as Safe (GRAS).	**20**
III	Exploitation of microorganism and their products, Screening, Strain development strategies, Immobilization methods.	**10**
IV	Fermentation: Media, Raw material, Antifoaming agents, Buffers. Equipments, Fermenter design. Types of fermentation – Single, Batch, Continuous.	**10**
V	Down-stream processing steps: Detection and assay of the product, Recovery (intercellular and extracellular product). Purification (solvent extraction & chromatography)	**10**
VI	Production of Alcohol (industrial alcohol, wine, beer, whiskey), Organic acid (Citric acid), Antibiotic (Penicillin)	**10**
VII	Production of Vitamin (B12), Enzyme (Amylase), Amino acid (Glutamic acid), Hormones (Insulin), Vaccine (Hepatitis B).	**10**
VIII	Biofuel (Methane), Production of Biofertilizers & Biopesticides, Biotransformation of steroids.	**10**

Recommended Books:

- Industrial Microbiology (2000) by AH Patel, Macmillan Publishers India
- Biology of Industrial microorganism (1981) by Arnold L. Domain, Bejamin/ cummings Pub. Co.
- Industrial Microbiology by Prescott & Dunns, AVI Publishing Company Inc.
- Industrial Microbiology by Casida LE, New age International (P) Ltd.

Suggested links:

- http://foodhaccp.com/foodsafetymicro/onlineindex.html
- http://www.cpe.rutgers.ed/courses/current/If0401wa.html

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Semester-IV Paper-
III (Theory)

Course Title: **Food Biotechnology**

Course objective: Students will understand the concepts of food biotechnology and would be able to relate the role of biotechnology in the food industry. They will get concepts regarding, food components, preservation, fermentation, spoilage and microbes involved in fermentation and spoilage.

Credits: 6	**Compulsory**
Max. Marks: 100	Min. Passing Marks:……

Total Number of Lectures = 90		
Unit	**Topic**	**No. of Lectures**
I	**Introduction to Food Biotechnology** • Historical Background of Food technology • Traditional fermented foods (meat, fish, bread, sauerkraut, soy bean, coffee, cocoa, tea) • Importance, global trends, codex guidelines, nutritional labelling in India, FSSAI guidelines • Improvements through Biotechnology (e.g. Golden Rice, Potato, Flavr Savr Tomato etc.)	**10**
II	**Enzymes in Food Industry:** • Carbohydrases • Proteasase • Lipases • Modification of food using enzymes: • Role of endogenous enzymes in food quality, • Enzymes use as processing aid and ingredients	**12**
III	**Food Fermentations:** • Common fermented foods - Cheese, Butter, Yoghurt, fermented/condensed milk and kefir. • Alcoholic beverages (Beer, Wine, Whisky), • Sauerkraut, Pickles, Soy products, Tea, coffee etc.	**12**
IV	**Food preservation:** • Food adulteration and prevailing food standards in India. • Source of microorganisms in milk and their types. • Microbiological examination of milk (standard plate count, direct microscopic count, reductase and phosphatase test). • Dehydration and pasteurization of milk.	**10**

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V	**Value addition products:** • Value addition products like High Fructose Syrup, Invert Sugars etc. SCPs (e.g. Spirulina, Yeast etc.) as food supplements, • Edible fungus: Mushrooms. Potential of Probiotics. • Flavor enhancers: Nucleosides, nucleotides and related compounds. Organic acids (Citric acid, Acetic acid) and their uses in foods/food products.	**12**
VI	**Vitamins and Minerals:** • Importance of Vitamins and their supplementation in foods and feedstock. • Food preservation and storage. Food Processing • Important minerals and their function in body and deficiency conditions • Requirements, allowances, enrichment, restorations, fortifications, losses of minerals, optimization and retention of minerals;	**12**
VII	**Growth of microorganisms in food:** • Intrinsic and extrinsic factors. • Food Spoilage (microbial and non-microbial) Control mechanisms of food spoilage: Physical and Chemical. • Microbial spoilage of food and factors affecting them: Spoilage of various kinds of foods: fish. meat, poultry, sea foods, bread and dairy products). • Food adulteration and prevailing food standards in India. • Indicator Microorganisms: As an indicator of good quality	**10**
VIII	**Food and water borne diseases:** • Gastroenteritis, Diarrhoea, Shigellosis, Salmonellosis, Typhoid, Cholera, Polio, Hepatitis, Dental Infections, etc. • Food borne intoxications: Staphylococcal, Bacillus, Clostridium etc. • Detection of food-borne pathogens.	**12**



Suggested Books

- Ray B and Bhunia A. 2008. Fundamental Food Microbiology, 4th Ed., CRC press, Taylor and Francis Group, USA.
- Martin RA and Maurice OM. 2008. Food Microbiology, 3rd Ed., The Royal Society of Chemistry, Cambridge, UK.
- James M J. 2000. Modern Food Microbiology, 6th Ed. Aspen Publishers, Inc., Gaithersburg, Maryland, USA.
- Frazier WC, and Westhoff DC. Food Microbiology. Fourth edition, MacGraw Hills publication
- Lopez GFG, Canaas G, Nathan EV. Food Sciences and Food biotechnology.
- Adams AR, and Moss MO. *Food Microbiology*. Third edition, Royal Society of Chemistry publishing.
- Hohn T and Leisinger KM. Biotechnology of Food Crops in Developing Countries.
- Doyle MP, Beuchat LR and Montville TJ. Food Microbiology Fundamentals and Frontiers. ASM Press.
- Schwartzberg HG, RaoMA. (Eds.) Biotechnology and Food Process Engineering.

Semester-V

Paper-I (Theory + Practical)

Course Title: BASICS OF IMMUNOLOGY

Course Objective: Students will learn various organs, cells and responses of Immune system. They would also learn responses generated by Lymphocytes, Antigen-Antibody interactions, various immunological techniques and immune disorders.

Credits: 4+2		**Compulsory**
Max. Marks: 100+50 (Practical)		Min. Passing Marks:……
Total Number of Lectures = 60		
Units	**Content (Theory)**	**Number of Lectures**
1	• Generation of Immune system organs and cells • Body defense mechanisms against infection- Innate & acquired.	**12**
2	• Body defence mechanisms against infection- Innate & acquired. • Active & Passive immunity, primary & secondary Immune response.	**12**
3	• Important attributes of antigens epitops, heptans & Carriers, Antibody structure, Immunoglobulin classes & antibody diversity.	**12**

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4	• Antigen & Antibody interaction in vivo & vitro. Agglutination & Precipitation reaction, Hemoagglutination, Immunofluorescence, ELISA, RIA etc.	**12**
5	• General idea about MHC in mouse, HLA system in humans, significance of MHC molecules & basic idea of complement system. • Monoclonal antibodies & their applications. • Immune disorders- Autoimmune diseases (Rheumatoid arthritis, Hashimoto's thyroiditis, & immunodeficiency (AIDS & SCID).	**12**

Books Recommended:

- Paul W E. (2012). Fundamental Immunology. New York: Raven Press.
- Punt J, Stranford S, Jones P., Owen JA, (2018). Kuby Immunology.(8th edition) New York: W.H. Freeman.
- Hay FC, Westwood OMR.(2008). Practical Immunology.(4th Edition). Wiley
- Delves P J, Martin SJ, Burton DR, and Roitt IM. (2017). Roitt's Essential Immunology.(13th edition). Wiley- Blackwell.
- Murphy K, and Weaver C, (2016). Janeway's Immunobiology. (9th edition) New York: Garland Science.
- Abbas AK, Lichtman AHH, Pillai S (2017) Cellular and Molecular Immunology (9th edition)
- Mohanty SK, Leela KS (2014) Textbook of Immunology. (2nd Edition). Jaypee Brothers Medical Publishers Pvt Ltd.
- Paul W E. (2012). Fundamental Immunology. New York: Raven Press.
- Parham, P. (2005). The Immune System. New York: Garland Science. Blackwell.

Suggested online links:

- https://onlinecourses.swayam2.ac.in/cec20_bt05/preview
- https://www.classcentral.com/course/swayam-immunology-14117
- http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000035ZO/P001308/M020592/ET/1519021131M14DiversityofimmunoglobulinQuad1.pdf
- https://ocw.mit.edu/courses/find-by-topic/#cat=healthandmedicine&subcat=immunology
- https://nptel.ac.in/courses/102/103/102103038/
- http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000035ZO/P001308/M020597/ET/1498640388PrinciplesandapplicationsSPRQuad1.pdf
- https://nptel.ac.in/courses/102/105/102105083/ https://nptel.ac.in/courses/102/103/102103015/
- https://nptel.ac.in/content/storage2/courses/102103013/pdf/mod7.pdf

Semester-V
Paper-I (Practical)
Course Title: **BASICS OF IMMUNOLOGY**

Total Number of Hrs = 60		
Units	**Content (Theory)**	**Number of Hrs**
1	Demonstration of immunization techniques and bleeding of experimental animals.	**15**
2	Separation of serum.	**15**
3	Antibody and Antigen interaction- Agglutination, Precipitation, Ochterlony double diffusion	**15**
4	ELISA	**15**

Semester-V

Paper-II (Theory)

Course Title: INTRODUCTORY ANIMAL BIOTECHNOLOGY

Course Objective: Students will learn theoretical and practical aspects of animal cell culture & its applications, vaccine technology, immunodiagnostics, embryo technology, animal transgenesis and gene therapy etc.

Credits: 4	**Compulsory**	
Max. Marks: 100	Min. Passing Marks:……	
Total Number of Lectures = 60		
Units	**Content (Theory)**	**Number of Lectures**
1	**Animal Cell Culture:** • History and development of cell culture • Layout and basic requirements for cell culture laboratory • Sterilization and preparation for cell culture • Culture media – Natural and synthetic; Importance of serum in cell culture • Growth factors- EGF, ECF, PDGE, IL –2, NGF & erythropoietin	**12**
2	**Application of Animal Cell Culture:** • Types of animal cell culture • Concept of transformation and neoplastic cells • Development of primary culture (chicken embryo fibroblast) • Commonly used cell lines- their organization and characteristics (Vero, BHK-21, MDBK, HeLa etc.) • Subculture and cryopreservation • Application of animal cell culture technology	**12**

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3	**Immunodiagnostics and Vaccine Technology** • Introduction to immunodiagnostics • Monoclonal antibodies • Introduction to vaccines • Types of vaccines • Killed V/s Attenuated vaccines • Modern generation vaccines	**12**
4	**Embryo Biotechnology and Animal Cloning** • Embryo Biotechnology: Introduction to embryo transfer technology • Brief Introduction to developmental Biology: oocyte, sperm, fertilization, embryogenesis • Methodology: Selection of donor; superovulation; selection of recipient; synchronization of estrous; embryo transfer; cryopreservation • Animal Cloning: Introduction to animal cloning • Importance and scope of animal cloning	**12**
5	**Fermentation Technology and Animal Transgenesis** • Introduction to fermentation Technology • Bioreactors for large scale production of animal cells • Production of hormones and special secondary metabolites- insulin, growth hormone and interferon • A brief introduction to animal transgenesis. • Various methods of animal transgenesis. • Gene Therapy: Introduction; Types of gene therapy, Applications. Socio ethical issues	**12**

Books Recommended:

- Animal Cell Culture Techniques. Ed. Martin Clynes, springer.
- Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, OXFORD.
- Culturing of animal cells by Ian Freshney, 6th edition
- Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Humana Press
- Singh B. Gautam SK (2013). Textbook of animal biotechnology. The Energy and Resources Institute, TERI
- Gupta PK (2018) Animal Biotechnology. Rastogi Publications
- Animal Cell Culture Methods In: Methods in Cell Biology, Vol. 57, Ed. Jenni P Mather and David Barnes, Academic Press.
- Biotechnology: Expanding Horizons by BD Singh, 3rd Edition, Kalyani Publishers.

Suggested online links:

- https://www.nptel.ac.in/content/storage2/courses/102103012/pdf/mod6.pdf
- https://nptel.ac.in/courses/102/104/102104042/
- https://nptel.ac.in/content/storage2/courses/102103038/download/module2.pdf
- https://www.nptel.ac.in/noc/courses/noc20/SEM1/noc20-me04/
- https://ocw.mit.edu/courses/find-by-topic/#cat=science&subcat=biology&spec=stemcells
- https://ocw.mit.edu/courses/materials-science-and-engineering/3-051j-materials-forbiomedical-

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- applications-spring-2006/lecture-notes/lecture13.pdf
- https://ocw.mit.edu/courses/biological-engineering/20-109-laboratory-fundamentals-inbiological-engineering-fall-2007/lecture-notes/
- https://ocw.mit.edu/courses/health-sciences-and-technology/hst-535-principles-andpractice-of-tissue-engineering-fall-2004/

Semester-V
Paper-III (Theory)
Course Title: ENVIRONMENTAL BIOTECHNOLOGY

Course objective: Theoretical knowledge of various topics as per the syllabus including ecosystem, conservation of biodiversity and resources, conventional and alternative fuels, and waste management. They will also study of role of biotechnological techniques in environment protection.

Credits: 4	**Compulsory**	
Max. Marks: 100	Min. Passing Marks:……	
Total Number of Lectures = 60		
Units	**Content (Theory)**	**Number of Lectures**
1	• Basic concept of Ecosystem- types, structure and functions. • Renewable and non- renewable resources • Conservation of Biodiversity, in situ, ex situ, Gene bank. • An idea of biosensors, biopolymers, bio plastic and biochips.	**12**
2	• Wastewater management- Treatment of municipal waste and industrial effluents. • Solid waste and soil pollution management- Management of non-hazardous solid waste and medical solid waste. • Management of hazardous waste • Air pollution and its control • Reclamation of wasteland	**12**
3	• Conventional fuels (Firewood, coal, gas, animal oils) and their environmental impact. • Modern fuels- Methanogenic bacteria & biogas, microbial hydrogen production, solar energy. • Plant based petroleum industry • Biopesticides- Bacterial & Fungal • Biofertilizers- Nitrogen fixers, PSB, Mycorrhiza & VAM; vermicomposting.	**12**

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4	• Bioabsorption of metals- microorganisms and metal absorption; bacterial metal resistance; mechanism of bioabsorption; Phytoremediation • Bioremediation- microorganisms in bioremediation; bioremediation technologies. • Biorecovery of petroleum- MEOR	**12**
5	• Concept of biosafety in relation to: • Organism pathogenicity • Biological active biotechnology product • Release of GMOs to the environment • Genetic modification and food uses • Biosafety and recombinant DNA guidelines • Concept of GMP(Good manufacturing practices) & GLP (Good Laboratory practices)	**12**

Books Recommended:

- Ritmann R and McCarty P L (2000). Environmental Biotechnology: Principle & Applications. 2nd Ed., McGraw Hill Science.
- Thakur IS. (2011) Environmental Biotechnology basic concepts and applications. I.K. International Publishing House Pvt. Limited
- Srinivas TR (2008). Environmental Biotechnology. New Age International Pvt. Ltd.
- Evans GM and J. C. Furlong (2003). Environmental Biotechnology: Theory and Applications. Wiley Publishers.
- Scragg A., (2005) Environmental Biotechnology. Pearson Education Limited.
- Chapman JL Ecology: Principal & Application. Cambridge Univ. Press.
- Odum E and Barret G. (2004) Fundamentals of Ecology. Nataraj Publication.

Suggested online links:

- https://nptel.ac.in/courses/127/106/127106004/
- https://nptel.ac.in/courses/102/105/102105088/
- https://onlinecourses.swayam2.ac.in/ugc19_bt18/preview
- https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-34-waste-containmentand-remediation-technology-spring-2004/lecture-notes/
- https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-018j-ecology-i-theearth-system-fall-2009/
- https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-018j-ecology-i-theearth-system-fall-2009/lecture-notes/MIT1_018JF09_Lec07.pdf
- https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-89-environmentalmicrobiology-fall-2004/

Semester-V
Paper-IV (Theory)
Course Title: Molecular Cancer Biology

Credits: 4	**Compulsory**	
Max. Marks: 100	Min. Passing Marks:……	
Total Number of Lectures = 60		
Unit	**Topics**	**Total No. of Lectures/ Hours (90)**
I	Introduction, growth characteristics of cancers cells; Morphological and ultrastructural properties of cancer cells. Differences between benign and malignant tumors. Types of growth: hyperplasia, dysplasia, anaplasia and neoplasia. Nomenclature of neoplasms. Epidemiology of cancer	**12**
II	Cancer biology and biochemistry- Aberrant metabolism during cancer development; Paraneoplastic syndromes; cellular protooncogenes- oncogene activation. Growth factors-EGF, TNF- and TGF- and growth factor receptors. Signal transduction in cancer. Role of transcription factors, Tumor markers.	**12**
III	Radiation and chemical carcinogenesis- stages in chemical carcinogenesis- Initiation, promotion and progression. Free radicals, antioxidants in cancer; Viral carcinogenesis -DNA and RNA Viruses. Hormone mediated carcinogenesis in humans	**12**
IV	Cell Cycle Regulation-Tumor suppressor genes p53, p21, Rb, BRACA1 and BRACA2. Telomeres, Telomerase, and Immortality; cell- cell interactions, cell adhesion-invasion and metastasis - VEGF signaling, angiogenesis; Epigenetics-Role of DNA methylation in gene silencing- epigenetic silencing of tumor-suppressor genes; Apoptosis in cancer-Cell death by apoptosis, role of caspases; Death signaling pathways-mitochondrial and death receptor pathways.	**12**
V	Detection of Cancers, Prediction of aggressiveness of Cancer, Different forms of therapy, Chemotherapy, radiation Therapy, and Immunotherapy: advantages and limitations. Epigenetics of cancer, Identification of targets for drug development.	**12**

Recommended Books:

- The Molecular Biology of Cancer: S. Pelengaris, M. Khan. Blackwell Publication.
- Cancer Associated Viruses (2012), Erle S. Robertson (Editor); Springer Science & Business Media
- The Biological Basis of Cancer: R. G. McKinnell, et al 2nd Ed, Cambridge University Press, 2006.
- The Biology of Cancer: R. A. Weinberg. Garland Science. 2006.
- Virology a practical approach, Maly B.W.J. IRL Press, Oxford, 1987.

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- Introduction to modern Virology, Dunmock N.J and Primrose.S.B., Blackwel Scientific Publications. Oxford, 1988.
- An Introduction to Cellular & Molecular Biology of Cancer, Oxford Medical publications, 1991
- Gene expression systems. Joseph M. Fernandez & James P. Hoeffler. Academic Press, 1999.
- Cancer Biology IV Ed Volume2 Raymond W Ruddon M.D.(2007)
- Cancer Biology (3rd_Edition) Roger J.B. et al (2006)
- Advances in Cancer Stem Cell Biology, Roberto Scatena, Alvaro Mordente & Bruno Giardina (Ed) Springer(2012).

Suggested links:

- https://nptel.ac.in/content/storage2/courses/104103068/pdf/M4.pdf
- https://onlinecourses.swayam2.ac.in/aic20_ge02/preview
- https://dth.ac.in/medical/courses/pathology/2/3/index.php
- https://ocw.mit.edu/courses/biology/7-016-introductory-biology-fall-2018/lecture-videos/lecture-25- cancer-1/
- https://ocw.mit.edu/courses/biology/7-342-cancer-biology-from-basic-research-to-the-clinic-fall-2004/

Semester-VI

Paper-I (Theory + Practical)

Course Title: INTRODUCTORY PLANT BIOTECHNOLOGY

Course objective: The course introduces students to basics of plant biotechnology: Media preparation and sterilization, cryopreservation, growth hormones, in-vitro micropropagation of plant tissue, anther, pollens etc. Marker assisted selection, genetic fidelity markers, plant transgenesis etc would also be taught.

Credits: 4+2		**Compulsory**
Max. Marks: 100+25 (Practical)		Min. Passing Marks:……
Total Number of Lectures = 60		
Units	**Content (Theory)**	**Number of Lectures**
1	• Introduction and history of plant tissue culture • Applications • Selection & sterilization of explant • Media used for sterlization & culture • Growth regulators	**12**
2	• Cytopreservation • Synthetic seeds and its application • Micropropogation • Somatic Embryogenesis & organogenesis • Protoplast culture & fusion	**12**

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3	• Anther and Ovary culture • Di haploids and their applications • In Vitro pollination & fertilization • Their applications in plant breeding	**12**
4	• DNA Markers • Types of markers • Applications of DNA markers in plant science • Diversity analysis, mapping and tagging, evolutionary studies and marker assisted selection.	**12**
5	• Plant transformation & methods: Agrobacterium-mediated, biolistic, transfection etc. successful examples of transgenic plants, advantage of transgenic plants. • Recent developments in transformation methods.	**12**

Recommended Books:

- Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science
- Chawla, H. S. (2000). Introduction to Plant Biotechnology. Enfield, NH: Science.
- Smith R. (2012). Plant Tissue Culture (3rd Edition) Academic Press.
- Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: an Introduction to Genetic Engineering. Oxford: Oxford University Press.

Suggested online links:

- https://nptel.ac.in/courses/102/103/102103016/
- https://www.bhu.ac.in/science/biotechnology/syllabi/M.Sc%20(BioTechnology)%20including%20SWAYAM.pdf
- https://onlinecourses.swayam2.ac.in/cec19_bt01/preview
- https://onlinecourses.swayam2.ac.in/cec21_bt02/preview
- https://onlinecourses.swayam2.ac.in/cec21_bt03/preview
- https://nptel.ac.in/content/storage2/courses/102103013/pdf/mod6.pdf



Semester-VI Paper-I
(Practical)

Course Title: **INTRODUCTORY PLANT BIOTECHNOLOGY**

Total Number of Hrs = 60		
Units	**Content (Theory)**	**Number of Hrs**
1	Plant tissue culture, Media preparation	**10**
2	Ex plant selection and sterilization	**10**
3	Callus culture	**10**
4	Callus splitting and Regeneration	**10**
5	Rooting and Shooting of callus using Auxins and Cytokinins	**10**
6	Hardening of the tissue culture generated plantlets	**10**

Semester-VI

Paper-II (Theory + Practical)
Course Title: Bio-analytical Techniques

Course objective: Students will learn principle and applications of Microscopy, chromatography, centrifugation, electrophoresis, blotting techniques, spectroscopy and autoradiography etc

Credits: 4+2	**Compulsory**
Max. Marks: 100+25 (Practical)	Min. Passing Marks:……
Total Number of Lectures = 60	

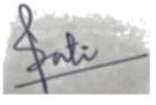
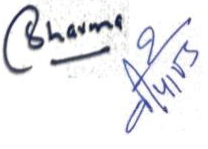
Units	**Content (Theory)**	**Number of Lectures**
1	• Balances (Electrical & Electronics) • Microscopy- (Compound, Phase contrast, Electron- TEM & SEM), Fluorescence microscopy • pH meter	**12**
2	• Chromatography: Paper chromatography, Thin layer chromatography, Column chromatography, Gas chromatography	**12**
3	• Colorimetry and Spectrophotometry (UV-VIS): Lambert Beer's law, Concept of IR, NMR and mass spectrometry, Radio-immune assay; ELISA; Western blotting	**12**
4	• Centrifugation: Zonal, Density gradient, Differential centrifugation; Tracer techniques & Autoradiography	**12**
5	• Electrophoresis: PAGE, Agarose gel Electrophoresis • Autoclave**,** Laminar air flow	**12**

Books Recommended:

- Berg, JM Tymoczko, JL. Gatto, GJ., Stryer, L. (2015). **Biochemistry.** (8th ed.) W H Freeman and Company New York.
- Nelson DL. Cox MM. (2017) **Lehninger Principles of Biochemistry** (7th ed.). W H Freeman New York.
- Voet, D., & Voet, J. G. (2016). **Biochemistry** (5th ed.). Hoboken, NJ: J. Wiley & Sons.
- Rodwell VW. Bender D. Botham KM. Kennelly PJ Weil PA.(2018). **Harper's Illustrated Biochemistry**.(31st edition) McGraw-Hill Education
- Hofmann A. Clokie S. **Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology**. (2018) (8th edition) Cambridge University Press
- Boyer RF. (2012) **Biochemistry laboratory : modern theory and techniques**(2nd Edition). Pearson Education, Inc

Suggested online links:

- https://ocw.mit.edu/courses/find-by-topic/#cat=healthandmedicine&subcat=spectroscopy
- https://nptel.ac.in/content/storage2/courses/102103044/pdf/mod5.pdf
- https://nptel.ac.in/courses/102/103/102103044/
- https://nptel.ac.in/content/storage2/courses/103105060/Sde_pdf/Module-7.pdf

- https://nptel.ac.in/content/storage2/courses/102103047/PDF/mod3.pdf
- https://nptel.ac.in/courses/102/101/102101049/
- https://nptel.ac.in/content/storage2/courses/104103069/module6/lec1/1.html

Semester-VI

Paper-II (Practical)

Course Title: **Bio-Analytical Techniques**

Total Number of Hrs = 60		
Units	**Content (Theory)**	**Number of Hrs**
1	Gravimetric estimation of barium, zinc, iron, copper, sulphate and Chromium	**30**
2	Organic Mixture: Separation of two component organic mixtures (water soluble), systemic analysis of each component.	**30**

Semester-VI

Paper-III (Theory)

Course Title: Microbial Genetics

Course objective: In this course students will get introduced to prokaryotic genome organization, genetic exchange and its mechanisms, gene mapping, gene regulation in prokaryotes and bacteriophage genetics etc.

Credits:4	**Compulsory**	
Max. Marks: 100	Min. Passing Marks:……	
Total Number of Lectures = 60		
Units	**Content (Theory)**	**Number of Lectures**
1	**Prokaryotic Genomes** Physical organization of bacterial genomes (Structure of the bacterial nucleoid, Replication and partitioning of the bacterial genome and Genome of Archaea).	**10**

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2	**Mechanism of genetic exchange** : Plasmid and bacterial sex, Types of plasmids (F Plasmid: a Conjugate plasmid', Mobilization of Non-conjugative plasmid, R plasmid, Col plasmid Copy number and incompatibility), Episomes. Transposable elements (Insertion sequence and transposons,	**10**	
3	**Integrons and Antibiotic** Resistance cassettes, Multiple Antibiotic Resistant bacteria, Mu–virus); Bacterial Genetics (Mutant phenotype, DNA mediated Transformation; Conjugation (Cointegrate Formation and Hfr Cells, Time–of–Entry Mapping, F' Plasmid); Transduction (Generalized transduction, Specialized Transduction)- gene mapping	**10**	
4	**Molecular Mechanism of gene regulation in prokaryotes** Transcriptional regulation in prokaryotes (inducible and repressible system, positive regulation and negative regulation); Operon concept – lac, trp, Ara operons.	**10**	
5	**Bacteriophages:** Stages in the Lytic Life Cycle of a typical phage, Properties of a phage infected bacterial culture, Specificity in phage infection, E. coli PhageT4, *E. coli* Phage T7, *E. coli* phage lambda, Immunity to infection, Prophage integration, Induction of prophage, Induction & Prophage excision, Repressor, Structure of the operator and binding of the repressor and the Cro product, Decision between the lytic and lysogenic Cycles, Transducing phages, *E. coli* phage phiX174, filamentous DNA phages, Single stranded RNA phages, The lysogenic Cycle.	**10**	
6	**Bacteriophage Genetics** Benzer's fine structure of gene in bacteriophage T4: Plaque Formation and Phage Mutants, Genetic recombination in the lytic cycle, (concept of recon, muton, cistron).	**10**	

Books Recommended:

- Cronan J. and Freifelder D., Microbial Genetics; Second Edition
- Khalifa AE; Fundamentals of Microbial Genetics; Lamber Academic Pub.
- Sundara R.S. Microbial Genetics; Amol Publications Pvt Ltd
- Modern Microbial Genetics, Second Edition; Editor(s): Uldis N. Streips, Ronald E. Yasbin; Wiley- Liss, Inc.

Suggested online links:

- https://nptel.ac.in/content/storage2/courses/102103013/pdf/mod7.pdf
- https://nptel.ac.in/content/storage2/courses/102103013/module1/lec1/5.html
- https://ocw.mit.edu/courses/biology/7-03-genetics-fall-2004/lecture-notes/
- https://nptel.ac.in/content/storage2/courses/102103013/pdf/mod1.pdf

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Semester-VI Paper-IV
(Theory)

Course Title: **Medical Biotechnology**

Course objective: The course will help the students to develop understanding in the field of medical biotechnology. They will be taught basics and applications of gene therapy, gene delivery methods, xenotransplantation and drug-delivery etc.

Credits: 4	**Compulsory**	
Max. Marks: 100	Min. Passing Marks:……	
Total Number of Hrs = 60		
Units	**Content (Theory)**	**Number of Lectures**
1	**Gene therapy** Background, types of gene therapy (ex vivo & in vivo), choosing targets for gene therapy, vectors in gene therapy, retroviruses, adenoviruses, adeno-associated viruses, types of gene delivery, Weismann barrier (soma-to-germ line barrier), epigenetic inheritance, problems & ethics.	**12**
2	**Gene Delivery methods** Viral delivery (through Retroviral vectors, through Adenoviral vectors), Non-viral delivery, Antibody engineering	**12**
3	**Vaccines** & **Synthetic therapy** Vaccine vectors, nucleic acid vaccines, immune-enhancing technology. Synthetic DNAs, therapeutic Ribozymes, synthetic drugs.	**12**
4	**Xenotransplantation** Terminology, technology behind it, organ donors, social & ethical issues.	**12**
5	**Cell Adhesion-based therapy** and **Drug delivery** Integrin's, inflammation, cancer & metastasis. Conventional & new approaches to drug delivery.	**12**

Books Recommended:

- Blick BR, Delovitch TL et al. Medical Biotechnology (2ndEdition). ASM Press
- Nallari P., Rao V. Medical Biotechnology. Oxford Higher Education
- Glick BR & Patten CL (Ed); Medical Biotechnology: Principles and Applications of Recombinant DNA; ASM Press

Suggested online links:

- http://www.ocw.titech.ac.jp/index.php?module=General&action=T0300&GakubuCD=2&GakkaCD=321503&KeiCD=15&course=3&KougiCD=202103160&Nendo=2021&lang=E

N &vid=03

- https://ocw.mit.edu/courses/find-by-topic/#cat=healthandmedicine
- https://ocw.mit.edu/courses/biology/7-349-stem-cells-a-cure-or-disease-spring-2011/
- https://ocw.mit.edu/courses/health-sciences-and-technology/hst-151-principles-of- pharmacology-spring-2005/
- https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-bt24/

Semester-wise Titles of the Papers in M.Sc. Biotechnology

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
Bachelor (Research) in Biotechnology					
4	VII	PBT01-(T/P)	Biochemistry	Theory + practical	4+1
		PBT02-(T/P)	Molecular Biology	Theory + practical	4+1
		PBT03-(T/P)	Microbiology and industrial applications	Theory + practical	4+1
		PBT04-(T)	Biostatistics and Computer Applications	Theory	5
		PBT05-(T)	Environmental Biochemistry & Biotechnology	Theory	5
					Total : 25
	VIII	PBT06-(T/P)	Genetic Engineering	Theory + practical	4+1
		PBT07-(T/P)	Analytical Techniques	Theory + practical	4+1
		PBT08-(T)	Molecular Virology	Theory	5
		PBT09-(T)	Cell and Developmental Biology	Theory	5
		PBT10-(T/P)	Plant Biochemistry and Biotechnology	Theory + practical	4+1
		PBT-E	Elective		4
					Total: 29
Master in Biotechnology					
5	IX	PBT11-(T)	Genomics and Proteomics	Theory	5
		PBT12-(T)	Bioprocess Engineering and technology	Theory	5

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		PBT13-(T)	Animal Biotechnology	Theory	5
		PBT14-(T)	Molecular Genetics	Theory	5
		PBT15-(T/P)	Immunology and Immuno-technology	Theory + practical	4+1
					Total : 25
	X	PBT16-(P)	Research		25
					Total: 25

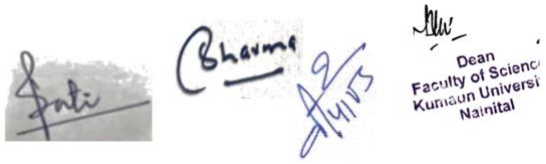
Elective papers offered			
Course Code	**Paper Title**	**Theory/Practical**	**Credits**
PBT01- (T/P)	Biochemistry	Theory + practical	4+1
PBT02-(T/P)	Molecular Biology	Theory + practical	4+1
PBT03- (T/P)	Plant Biochemistry and Biotechnology	Theory + practical	4+1

Purpose of the Program

Biotechnology uses living cells and cellular material to create different range of products which improve overall quality of life. The purpose of the postgraduate Biotechnology program at the university and college level is critical to develop the understanding of different aspects of Biotechnology in the students so that they are prepared for various job roles as in various industries and research institutions.

Program objectives

To produce high-potential biotechnologists with interdisciplinary knowledge to innovate, plan, and analyze problems related to biotic and abiotic systems. The program further envisages biotech professionals with strong sense of developing innovative strategies for various sustainable goals and objectives related to wellness of different organisms on earth. The professionals will be creative and ethically strong biologists who will serve the nation for its holistic growth.



Program's Outcomes

PO 1. Develop professional skills through scientific attitude and values. Students will have foundation in the fundamentals and applications of the Biotechnology required for different job roles.

PO 2. Demonstrate knowledge for in-depth research to formulate and solve the issues related to Biotechnology research

PO 3. Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.

PO 4. Demonstrate skills to use modern analytical tools/ software/ equipment and analyse and solve problems in various courses of biotechnology.

PO 5. Execute their professional roles in society as biotechnology professionals, employers and employees in various industries, researchers and educators.

PO 6. Acquire knowledge and understanding of norms and ethics in the field of biotechnology.

PROGRAM SPECIFIC OUTCOMES (PSOS)	
BACHELOR (RESEARCH) IN BIOTECHNOLOGY	
Fourth Year	This course introduces the foundation of viz., (i) Biochemistry, (ii) Molecular Biology, (iii) Microbiology & Industrial Applications, (iv) Environmental Biochemistry&Biotechnology,(v)geneticengineering,(vi)Analyticaltechniques, (vii) Molecular Virology, (viii) cell &developmental biology, (ix) Plant Biochemistry and Biotechnology along with basics of (x) Biostatistics and Computers. <u>After completion of the course:</u> **PSO1.** Understand the basic concepts of genetics and molecular biology such as Inheritance pattern, DNA replication, transcription and translation. **PSO2.** Understand the basic concepts of Biomolecules such as Carbohydrates, Lipids, Enzymes, Nucleic acid, hormones and Vitamins. The students also develop understanding of coordinated control of metabolism. **PSO3.** Understand the basic concepts of Microbial diversity & systematics, Microbial growth & physiology, microbial interactions & infection and Microbes & environment. **PSO4.** Understand the basic concepts of Biostatistics tools for recording and analyzing experimental data. **PSO5.** Understand the basic concepts of Genetic engineering such as cloning vectors,cloningmethodologiesandthereapplicationsinIndustryastherapeutics tools.

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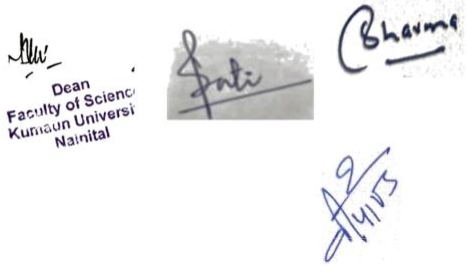
	PSO6. Understand the basic concepts of analytical techniques such as spectroscopic techniques, Chromatographic techniques, centrifugation techniques for analysis of different samples in different manner for their accurate assessment. **PSO7.** Understand the basic concepts of cell structure, cell organelles, types of cells,
	cell communication, differential and specialized cell like stem cells for better understanding of the basic unit of life i.e. cell. **PSO8.** Perform experiments on Estimation of amino acids, enzymes etc. by using spectroscopic and chromatographic techniques. **PSO9.** Perform experiments on sterilization techniques, media preparation and Characterization of Microorganisms **PSO10.** Perform experiments of Protein purification & estimation, preparation of plasmid DNA and construct formation, DNA isolation, electrophoresis, spectroscopy, PCRetc. **PSO11.** Apply at technical positions in different research laboratories, diagnostic centers and industries. **PSO12.** Understand the basic concepts of Plant Tissue Culture, Protoplast Culture and Somatic Hybridization, Agrobiology, Genetic Transformation, Strategies for Introducing Biotic and Abiotic Stress Resistance, Somaclonal variations, Plants as Biofactories, Principals and applications of cryopreservation, Secondary product formation by cell suspension cultures, and Biosafety and containment practices **PSO13.** Understand the basic concepts of Environmental Biochemistry and Biotechnology such as Environmental pollution, Control, remediation and management, Bioaugmentation, Alternate source of energy, Environment and health in respect to genetics, and Human biomonitoring. **PSO14.** Understand the basic concepts of Molecular Virology, Structure of animal viruses and plant viruses, General Genomic organization of animal viruses, General Genomic organization of plant viruses, Methods to diagnose animal virus infections, and Methods to study plant viruses. **PSO15.** Perform experiments on Plant Tissue Culture such as Preparation of media, Surface sterilization of explants, Micropropagation of plants, Green house and hardening practices.
Fifth Year	**MASTER IN BIOTECHNOLOGY**



	This course introduces the foundation of following courses viz., (i) Genomics and proteomics, (ii) Bioprocess engineering & technology, (iii) Animal Biotechnology, (iv) Molecular genetics, and (v) Immunology &Immunotechnology <u>After completion of the course:</u> **PSO1.** Understand the basic concepts of Structural organization of genome, genome sequencing projects, protein analysis methods, Pharmacogenomics and functional genomics. **PSO2.** Understand the basic concepts of Bioprocess engineering such as large scale
	culture as fermentation and protein generation, upstream processing and downstream processing, analysis & application of food processing enzymes and microorganisms. **PSO3.** Understand the basic concepts of Animal cell culture, animal health biotechnology, animal reproductive biotechnology & genomics and DNA forensics. **PSO4.** Understand the basic concepts of Bacterial Mutants and mutations, Gene transfer in bacteria, Biology of Bacteriophages and Plasmids, Mendelian Genetics, Gene mapping and human genome project, and Population genetics and evolution. **PSO5.** Understand the basic concepts of Immunology- fundamental concepts and anatomy of the immune system, Immune responses generated by B and T lymphocytes, Antigen-antibody interactions, Vaccine Technology, and Clinical Immunology. **PSO6.** Perform experiments on Immunology such as Preparation of human blood smear and identification of cells, Determination of blood groups and Rh antigen, Estimation of antiserum, Antiserum titer determination by ELISA, Immunization, Collection of Serum, Immunoelectrophoresis and Immunodiagnostics.

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Year	Semester	Theory Paper	Units	Practical Paper	Units	Elective credit	Research Project	Total Credits of the semester
4	VII	Biochemistry	1. Chemical Basis of life 2. Proteins 3.Enzymes 4.Carbohydrates 5. Lipids 6. Nucleic acids 7.Bioenergetics	Biochemistry	1. Titration of Amino Acids. 2. Colorimetric determination ofpKa. 3. Quantitative estimation of Proteins andSugars. 4. Separation techniques-Centrifugation, Chromatography (Gel Permeation, Ion exchange, TLC,etc.)	-	-	5

		Molecular Biology	1. Genomic Organization 2. DNA Structure, Replication, Repair & Recombination 3. Prokaryotic &Eukaryotic Transcription 4. Post Transcriptional Modification 5. Mutaions, Oncogenes and Tumor suppressor gene	Molecular biology	1. Plasmid DNA isolation and DNA quantitation 2. Restriction digestion 3. Preparation of competent cells 4. Agarose gel electrophoresis 5. Restriction Enzyme digestion of DNA 6. Purification of DNA from an agarose gel 7. DNA Ligation 8. Transformation of *E. coli* with standard plasmids, Calculation of transformation efficiency 9. Restriction mapping of recombinant plasmid. 10. Polymerase Chain reaction 11. RFLP analysis of the PCR product	-	-	5

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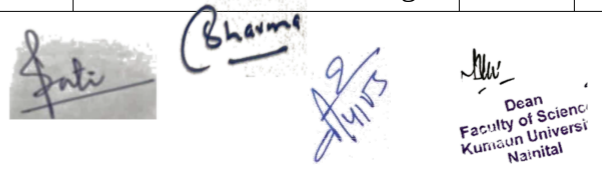
		Microbiology & Industrial application	1. Microbial Diversity &Systematics 2. Microbial Growth & Physiology 3. Microbial Interactions and Infection 4. Microbes and Environment 5. Industrial Applications	Microbiology	1. Sterilization, disinfection, safety in microbiological laboratory. 2. Preparation of media for growth of various microorganisms. 3. Isolation and maintenance of organisms by plating, Streaking and Serial dilution methods- slants and stab cultures, Storage of microorganisms. 4. Gram Staining and enumeration of microorganisms. 5. Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen. 6. Assay of antibiotics production and demonstration of antibiotic resistance. 7. Isolation and screening			5



					of industrially important microorganisms. 8. Determination of thermal death point and thermal death time of microorganisms			
		Biostatics & Computers	10. Units					5
		Environmental Biochemistry and Biotechnology	1. Introduction 2. Pollution Control, remediation and management 3. Alternate source of energy 4. Environment and health in respect to genetics					5
								Total (VII semester): 25
	VIII	Genetic Engineering	1. Basics Concepts 2. Cloning vectors 3. Cloning methodologies 4. PCR and its applications 5. Sequencing and	Genetic Engineering	*1.* Isolation of genomic DNA from *E. coli* 2. PCR amplification of bacterial/plant/animal-cell genomic region and analysis by agarose gel electrophoresis. 3. Preparation of plasmid			**5**

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		Gene therapy	DNA from *E. coli* DH5α and gel analysis. 4. Restriction digestion of vector (gel analysis) with Restriction endonucleases 5. a. Vector and Insert ligation Transformation in *E. coli* DH5α. 6. Plasmid isolation and confirming recombinant by PCR and RE digestion. 7. Transformation of recombinant plasmid in *E.coli* Laboratory strain. 8. Induction of recombinant protein with IPTG and analysis on SDS-PAGE. 9. Purification of protein on Ni-NTA/Glutathione/Mannose column and analysis of purified protein by SDS-PAGE.		
	Analytical Techniques	1. Basic Techniques 2. Spectroscopy	Analytical Techniques	1. Paper Chromatography of amino acids. 2. T.L.C of lipids.	5

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			Techniques 3.Chromatography Techniques 4. Centrifugation 5.Radioactivity 6.Advanced Techniques		*3.* Isolation of plasmid DNA from *E.coli.* 4. Agarose gel electrophoresis of isolated plasmid DNA. 5. Extraction and purification of protein from plant and animals. 6. SDS PAGE of BSA and extracted proteins			
		Molecular Virology	1. Structure of animal viruses and plant viruses 2. General Genomic organization of animal viruses 3. General Genomic organization of plant viruses 4. Methods to diagnose animal virus infections 5. Methods to study plant viruses	-	-	-	-	5

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Cell and Developmental Biology	1. Cell Theory and Methods of Study 2. Membrane Structure and Function 3. Organelles 4.Endo-membrane System and Cellular Motility 5.Cell Communication 6. Differentiation of specialized cells 7. PlantMeristem Organization and Differentiation			5
Plant Biochemistry and Biotechnology	1. Plant Tissue Culture 2. Agrobiology 3.Strategies for Introducing Biotic and Abiotic Stress Resistance/Tolerance 4.Somaclonal variations, Plants	Plant Biochemistry and Biotechnology	1. SOPs of Plant Tissue Culture laboratory 2. Preparation of media. 3. Surface sterilization of explants 4. Micro propagation of plants 5. Green house and hardening practices 6. Clonal fidelity	5

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			as Biofactories 5.Principals and applications of cryopreservation, 6. Secondary product formation by cell suspension cultures		regenerated plants.			
		Total (VIII Semester): 25+4 (elective)=29						
5	IX	Genomics and Proteomics	1. Introduction: Structural organization of genome 2. Genome sequencing projects 3. Proteomics 4. Pharmacogenomics 5.Functional genomics and proteomics					5
		Bioprocess Engineering and Technology	1. Basic principle of Biochemical engineering					5

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			2. Concepts of basic mode of fermentation processes 3. Downstrea m processing 4. Applications of enzymes in food processing 5. Applications of Microbes in food process operations and production					
		Animal Biotechnology	1. Animal cell culture 2. Animal health Biotechnology 3. Animal Reproductive Biotechnology 4. Animal genomics 5. DNA Forensics	-	-	-	-	5

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		Molecular Genetics	1. Bacterial Mutants and mutations 2. Bacteriophages and Plasmids 3. Mendelian Genetics 4. Molecular Genetics of Lambda 5. Gene mapping and human genome project	-	-	-	-	5

		Immunology and immunotechnology	1. Immunology-fundamental concepts and anatomy of the immune system 2. Immune responses generated by B and T lymphocytes 3. Antigen-antibody interactions 4. Vaccine Technology 5. Clinical Immunology	Immunology and immunotechnology	1. Preparation of human blood smear and identification of cells. 2. Determination of blood groups. 3. Determination of Rh antigen. 4. Estimation of antiserum by Mancini method. 5. Estimation of antiserum by Ouchterlony method. 6. Antiserum titer determination by ELISA. 7. DOT ELISA for the presence of specific antigen. 8. Immunization, Collection of Serum. 9. Immuno electrophoresis. 10.Immuno diagnostics (Demonstration using commercial kits).	-	-	5
								Total (IX Semester): 25
	X	Research Project						**Total (X Semester):** 25

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Pattern of examination theory papers

A. Theory

*Each theory paper shall consist two sections **A** and **B**.*

***Section A**: (Short answers type with reasoning); 25 marks, eight questions of five marks each, any five have to be attempted).*

***Section B**: (Long answers type); 50 marks, one question of ten marks each. Five questions are compulsory (each question from each unit) with internal choice.*

B. Internal assessment

For each theory paper internal assessment shall be conducted periodically (in the form of class tests and/or assignments/ group discussion/ oral presentation/ overall performance) during the semester period. Total marks allotted to internal assessment shall be 25. The evaluated answer sheets/assignments have to be retained by the Professor In-Charge for the period of six months and can be shown to the students if students want to see the evaluated answer sheets. The marks obtained by the students shall be submitted to the Head of concerned department/ the Principal of the College for uploading onto the University examination portal.

C. Practical

The laboratory work of the students has to be evaluated periodically. The breakup of marks for practical examination for each semester would be as follows:

Practical exam: 20% marks

Viva voce: 20% marks

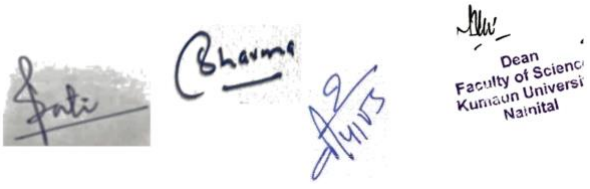
Lab record: 20% marks

Spotting: 30% marks

Attendance: 10%

Total: 150 marks (each semester)

Marks obtained in the practical examination have to be submitted to the Head of the department / Principal of the college. The Head of the Department / Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, Kumaun University, Nainital.



Semester-VII

Paper-1 (Theory)

Course Title: Biochemistry

Program/Class: Bachelor (Research) in Biotechnology	**Year:** Fourth	**Semester:** Seven
Paper-1 Theory Subject: Biotechnology		
Course Code: PBT01- (T/P)	**Course Title:** Biochemistry	

Credits:4	Compulsory
Max. Marks: 100	Min. Passing Marks:

Total Number of Lectures = 60

Course Objectives: To develop a clear understanding of the concepts related to structures and functions of biomolecules for better understanding of energetics and regulation of metabolic pathways. To develop hands-on-ability in young minds to plan and execute different biochemical experiments in the laboratory.

Unit	**Content**	**Number of lectures**
1	**Chemical basis of life:** Composition of living matter; Water- properties, pH, pKa,Titration curves of weak acids, Buffers, Handerson-Hasselbach equations, ionization and hydrophobicity; Emergent properties of biomolecules in water; Water as a reactant.	8
2	**Proteins:** Amino acids as building blocks of proteins and their chemical properties,pI and pKa values, Primary, Secondary, Tertiary and Higher order structure of Proteins, Protein Sequencing, Ramchandran Plot, Conjugated proteins- Glycoproteins, Lipoproteins, Heamproteins.	9
3	**Enzymes**: General principles of catalysis, Quantitation of enzyme activity and efficiency, Enzyme characterization and Michaelis- Menten kinetics, Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; Single substrate enzymes	9
4	**Carbohydrates:** Mono- Di- and Polysaccharides, Optical isomerism, Structure of Carbohydrates, Glycolysis, Gluconeogenesis, Pentose phosphate pathways, Citric acid cycle.	8
5	**Lipids:** Classification and structural analysis of fatty acids, Glycerols, Waxes, Glycolipids, Phospholipids, Sphingolipids, Sterols, Lipoproteins, β-oxidation, Biosynthesis of Cholesterol and Fatty acids	9

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6	**Nucleic acids:** Biosynthetic pathways of purines and pyrimidines, degradation pathways	**8**
7	**Bioenergetics-** Basic principles; Equilibria and concept of free energy; Group transfer, concept of Entropy, Enthalpy and free energy , Oxidation and Reduction reactions, Electron Transport Chain, Oxidative phosphorylation;photosynthesis.	9

Books Recommended:

1. Lehninger: Principles of Biochemistry, 3rd edition, by David L. Nelson and M.M. Cox (2000) Maxmillan/ Worthpublishers.
2. Fundamentals of Biochemistry by Donald Voet and Judith G Voet (1999). John Wiley & Sons, NY
3. Biochemistry, 2nd edition, by R.H. Garrett and C.M. Grisham (1999). Saunders College Publishing,NY.
4. Outlines of Biochemistry by E.E.Conn, P.K.Stumpf, G. Bruenimg and Ray H.Doi (1987). John Wiley & Sons,NY
5. Biochemistry,2ndedition,byLaurenceA.Moran,K.G.Scrimgeour,H.R.Horton, R.S. Ochs and J. David Rawn (1994), Neil Patterson Publishers Prentice Hall.
6. Berg, JM Tymoczko, JL. Gatto, GJ., Stryer, L. (2015). **Biochemistry.** (8th ed.) W H Freeman and Company NewYork.
7. Satyanarayana U. Chakrapani U. (2013). **Biochemistry**. (4th edition). Elsevier and Books and Allied (P)Ltd

Suggested online links:

1. https://nptel.ac.in/courses/104/105/104105076/
2. https://nptel.ac.in/courses/102/106/102106087/
3. https://ocw.mit.edu/courses/find-by-topic/#cat=healthandmedicine&subcat=spectroscopy
4. https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/module-i/session4/
5. https://ocw.mit.edu/courses/biology/7-016-introductory-biology-fall-2018/lecturevideos/lecture-4enzymes-and-metabolism/
6. https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/module-i/session3/

Semester-VII

Practical

Course Title: Biochemistry

Program/Class: Bachelor (Research) in Biotechnology	**Year:** Fourth	**Semester:** Seven
Practical Subject: Biotechnology		
Course Code: PBT01- (T/P)	**Course Title:** Biochemistry-Practical	

Credits:1	Compulsory
Max. Marks: 50	Min. Passing Marks

Total Number of hours = 60

Unit	**Contents**	**Number of hours**
1	Titration of Amino Acids.	**15**
2	Colorimetric determination of pKa.	**15**
3	Quantitative estimation of Proteins and Sugars.	**15**
4	Separation techniques- Centrifugation, Chromatography (Gel Permeation, Ion exchange, TLC, etc.)	**15**

Semester-VII

Paper-2 (Theory)

Course Title: Molecular Biology

Program/Class: Bachelor (Research) in Biotechnology	**Year:** Fourth	**Semester:** Seven
		Paper-2 Theory Subject: Biotechnology
Course Code: PBT02- (T/P)		**Course Title:** Molecular Biology

Credits:4	Compulsory
Max. Marks: 100	Min. Passing Marks:……

Total Number of Lectures = 60

Course Objectives: To illustrate the molecular concepts of life, through learning the organization and functions of DNA, RNA, and proteins, that can describe and demonstrate the regulation of various biological processes. To develop clear understanding of established concepts and perceive recent scientific developments in the field of molecular biology.

Unit	**Contents**	**Number of Lectures**
1	**Genome Organization** Organization of bacterial genome; Structure of eukaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; DNA reassociation kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleosome phasing; DNase I hypersensitive region; DNA methylation &Imprinting	12
2	**DNA Structure; Replication; Repair & Recombination** Structure of DNA-A-,B-, Z- and triplex DNA; Measurement of properties-Spectrophotometric, CD, AFM and Electron microscope analysis of DNA structure; Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single stranded circular DNA; Gene stability and DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes; Gene disruption; FLP/FRT and Cre/Lox recombination.	12

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3	**Prokaryotic & Eukaryotic Transcription** Prokaryotic Transcription; Transcription unit; Promoters- Constitutive and Inducible; Operators; Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and independent; Anti- termination; Transcriptional regulation-Positive and negative;Operon concept-lac,trp,ara,his,andgaloperons;Transcriptionalcontrolin lambda phage; Transcript processing; Processing of tRNA and rRNA Eukaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase I, II, III; Eukaryotic promoters and enhancers; General Transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF); Activators and repressors; Transcriptional and post-transcriptional gene silencing	12
4	**Post Transcriptional Modification** Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA. **Translation & Transport** Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; Isoaccepting tRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co-and post-translational modifications; Genetic code in mitochondria; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation	12
5	**Unit-V Mutation; Oncogenes and Tumor suppressor gene** Nonsense, missense and point mutations; Intragenic and Intergenic suppression; Frameshift mutations; Physical, chemical and biological mutagens; Transposition- Transposable genetic elements in prokaryotes and eukaryotes; Mechanisms of transposition; Role of transposons in mutation; Viral and cellular oncogenes; Tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Activation of oncogenes and dominant negative effect; Suppression of tumor suppressor genes; Oncogenes as transcriptional activators.	12

Books Recommended:

1. Watson, J. D. Baker TA, Bell, SP Gann, A. Levine, M. Losick R. (2008). **Molecular Biology of the Gene** (5th ed.). Pearson
2. Lodish, H F. Berk, A. Kaiser, CA, Krieger, M. Bretscher, A. Ploegh, H. Aman, A. Martin, K. (2016). **Molecular Cell Biology** (8th Ed.). New York: W.H.Freeman
3. Karp, G. **Cell and Molecular Biology. Concepts and experiments**. John Harris, D., Wiley & sons, NewYork
4. Old, R. W., Primrose, S. B., & Twyman, R. M. (2006). **Principles of Gene Manipulation and Genomics**, 7th Edition: BlackwellPublishing.

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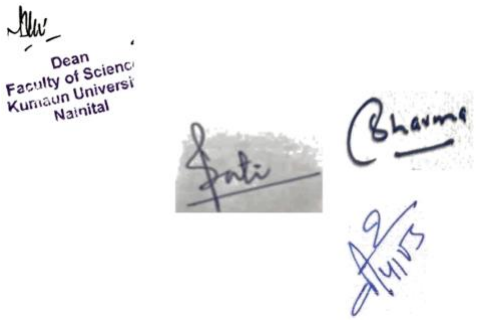
5. Brown, T. A. (2018). **Genomes** 4. (4 edition) New York: Garland SciencePub.

Suggested online links:

1. https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/molecularbiology/
2. https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/molecularbiology/transcription-translation/
3. https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/molecularbiology/gene-regulation-and-the-lac-operon/
4. https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/recombinantdna/
5. https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/recombinantdna/agarose-gel-electrophoresis-dna-sequencing-pcr/
6. https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/recombinantdna/basic-mechanics-of-cloning/
7. https://ocw.mit.edu/courses/biological-engineering/20-109-laboratory-fundamentals-inbiological-engineering-fall-2007/labs/mod1_3/

8.https://nptel.ac.in/courses/102/103/102103045/#



Semester-VII

Practical

Course Title: Molecular Biology

Program/Class: Bachelor (Research) in Biotechnology	**Year:** Fourth	**Semester:** Seven
Practical Subject: Biotechnology		
Course Code: PBT02- (T/P)	**Course Title:** Molecular Biology-Practical	

Credits:1	Compulsory
Max. Marks: 50	Min. Passing Marks:

Total Number of Hours = 60

Unit	**Contents**	**Number of Hours**
1	Plasmid DNA isolation and DNA quantitation	**5**
2	Restriction digestion	**5**
3	Preparation of competent cells	**5**
4	Agarose gel electrophoresis	**5**
5	Restriction Enzyme digestion of DNA	**5**
6	Purification of DNA from an agarose gel	**5**
7	DNA Ligation	**5**
8	Transformation of *E.coli* with standard plasmids, Calculation of transformation efficiency	**10**
9	Restriction mapping of recombinant plasmid.	**5**
10	Polymerase Chain reaction	**5**
11	RFLP analysis of the PCR product	**5**

Semester-VII

Paper-3 (Theory)

Course Title: Microbiology and Industrial Applications

Program/Class: Bachelor (Research) in Biotechnology	**Year:** Fourth	**Semester:** Seven
Paper-3 Theory Subject: Biotechnology		
Course Code: PBT03- (T/P)	**Course Title:** Microbiology and Industrial Applications	

Credits:4	Compulsory
Max. Marks: 100	Min. Passing Marks:……

Total Number of Lectures = 60

Course Objectives: To develop understanding of the basic concepts on Microbial growth and physiology, Microbial diversity and systematics. To develop understanding on the microbes and their relations to environment.

Unit	**Contents**	**Number of Lectures**
1	**Microbial Diversity & Systematics.** The Milestones in Microbiology: The discovery of microbial world by Antony van Leeuwenhocek, The controversy over spontaneous generation, Golden age of Microbiology. Criteria for classification of microorganism; Classification of Bacteria according to Bergey's manual; Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.	12

2	**Microbial Growth & Physiology** Cell Structure and Functions: Prokaryote cell, size, shape and arrangement of bacterial cells, Cell wall, External and Internal structures to the cell wall of Eubacteria. Ultrastructure of Archaea (Methanococcus); Unicellular Eukaryotes (Yeast). Microbial growth: Batch, fed-batch, continuous kinetics, synchronous growth, methods of growth estimation, stringent response, thermal death of a bacterial cell. Methods in Microbiology: Pure culture techniques, The theory and practice of sterilization, Principles of microbial nutrition, Construction of culture media, Enrichment of culture techniques, Pure culture and its maintenance	12
3	**Microbial Interactions and Infection** Host-pathogen interactions; Microbes infecting animals and plants; Disease reservoirs, epidemiological terminologies, infectious diseases transmission, pathogenicity islands and their role in bacterial virulence	12
4	**Microbes and Environment** Salient features of extremophiles (halophiles, thermophiles, psychrophiles) archaeabacteria. aerobic and anaerobic bacteria, phototrophic and gliding bacteria, prosthecate and budding bacteria. Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing	12
5	**Industrial Applications** Role of microorganisms in natural system and artificial system. Scope and importance of Microbiology in Biotechnology. Microbial fuel cells; Prebiotics and Probiotics; Vaccines. Microbial processes-production, optimization, screening, strain improvement, for the production of ethanol, organic acids, antibiotics etc. Basic principles in bioprocess technology; Media Formulation; Sterilization; Batch and continuous sterilization systems; Bioprocess control and monitoring variables such as temperature, agitation, pressure, pH.	12

Books Recommended:

1. Madigan, M. T., Martinko, J. M., & Parker, J. (2003). Brock biology of microorganisms. Upper Saddle River, NJ: Prentice Hall/PearsonEducation.
2. Prescott, and Joanne M. Willey. Prescott's Microbiology. New York: McGraw-Hill, 2011.
3. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (1993). Microbiology: Concepts and applications. New York:McGraw-Hill.
4. Tortora, Gerard J, Berdell R. Funke, and Christine L. Case. Microbiology: An Introduction. , 2004.
5. Mattha, W, Berg C Y, and Black JG. (2005). **Microbiology, Principles and**

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Explorations. Boston, MA: John Wiley & Sons.

6. Ananthanarayana R, PanickerCKJ(2020). **Ananthanarayana and Panicker's Textbook of Microbiology**(11edition) Universities Press (India) Pvt.Ltd

Suggested online links:

1. **https://microbeonline.com**
2. **https://ocw.mit.edu/courses/find-by topic/#cat=science&subcat=biology&spec=microbiology**
3. **https://nptel.ac.in/courses/102/103/102103015/**

Semester-VII

Practical

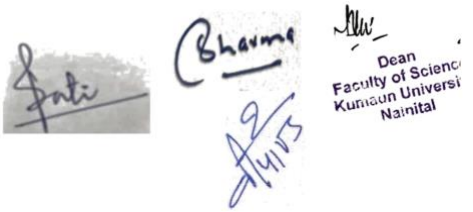
Course Title: Microbiology and Industrial Applications

Program/Class: Bachelor (Research) in Biotechnology	**Year:** Fourth	**Semester:** Seven
		Practical Subject: Biotechnology
Course Code: PBT03- (T/P)		**Course Title:** Microbiology and Industrial Applications -Practical

Credits:1	Compulsory
Max. Marks: 50	Min. Passing Marks:……

Total Number of Hours = 60

Unit	**Contents**	**Number of Hours**
1	Sterilization, disinfection, safety in microbiological laboratory.	**7**
2	Preparation of media for growth of various microorganisms.	**7**
3	Isolation and maintenance of organisms by plating, Streaking and Serial dilution methods- slants and stab cultures, Storage of microorganisms.	**8**
4	Gram Staining and enumeration of microorganisms.	**7**
5	Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen.	**7**
6	Assay of antibiotics production and demonstration of antibiotic resistance.	**7**
7	Isolation and screening of industrially important microorganisms.	**9**
8	Determination of thermal death point and thermal death time of microorganisms.	**8**



Semester-VII

Paper-4 (Theory)

Course Title: Biostatistics and Computer Applications

Program/Class: Bachelor (Research) in Biotechnology	**Year:** Fourth	**Semester:** Seven
Paper-4 Theory Subject: Biotechnology		
Course Code: PBT04- (T)	**Course Title:** Biostatistics and Computer Applications	

Credits:5	Compulsory
Max. Marks: 100	Min. Passing Marks:……

Total Number of Lectures = 60

Course Objectives: To gain understanding on fundamentals of computers and biostatistics for managing and analyzing the scientific data generated.

Unit	**Contents**	**Number of Lectures**
1	Brief description and Tabulation of data and its graphical representation.	6
2	Measure of central tendency and description: Mean, Mode, Median, Range, Standard deviation, Variance, Idea of two types of errors and level of significance, Tests of significance (F and T test), Chi-Square tests.	8
3	Simple linear regression and Correlation.	4
4	Introduction of digital computers: Organizations, Low-level and High-level languages, Binary systems.	6
5	Flow charts and Programming techniques.	4
6	Introduction to data structures and data base concepts, Introduction to internet and its applications.	6
7	Introduction to MS-office software covering word processing, spread sheets and presentation software.	6
8	Introduction to Harvard graphics/Sigma plotter.	4
9	Computer oriented statistical techniques: Frequency table of single discrete variable. Bubble sort, Computation of mean, Variance and standard deviations, T-test, Correlation coefficient.	8
10	Bio-informatics- Internet access and using web search engines to access biological databases, sequence, structure and strain database, Secondary and sequence analysis of DNA, RNA and proteins.	8

Books Recommended:

1. Rosner, B. (2000). **Fundamentals of Biostatistics**. Boston, MA: DuxburyPress.
2. Daniel, W. W. (1987). **Biostatistics, a Foundation for Analysis in the Health Sciences**. New York: Wiley
3. Mariappan P. (2013) **Biostatistics**.Pearson
4. Rastogi VB.(2015). **Biostatistics** (3rd Edition).MedTec
5. Lesk, A. M. (2002). **Introduction to Bioinformatics**. Oxford: Oxford University Press
6. Baxevanis, A. D., & Ouellette, B. F. (2001). **Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins**. New York:Wiley-Interscience

Suggested online links:

1. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-092bioinformatics-and-proteomics-january-iap-2005/lecture-notes/
2. https://ocw.mit.edu/courses/biology/7-91j-foundations-of-computational-and-systems-biologyspring-2014/
3. https://ocw.mit.edu/courses/biology/7-91j-foundations-of-computational-and-systems-biologyspring-2014/lecture-slides/
4. https://ocw.mit.edu/courses/mathematics/18-650-statistics-for-applications-fall-2016/
5. https://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring-2014/
6. https://ocw.mit.edu/courses/mathematics/18-443-statistics-for-applications-fall-2003/lecture-notes/

Semester-VII

Paper-5 (Theory)

Course Title: Environmental Biochemistry and Biotechnology

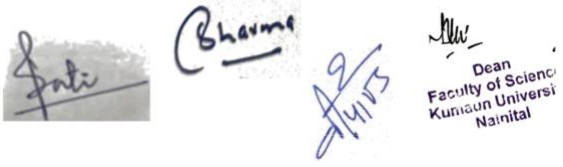
Program/Class: Bachelor (Research) in Biotechnology	**Year:** Fourth	**Semester:** Seventh
Paper-5 Theory Subject: Biotechnology		
Course Code: PBT05- (T)	**Course Title:** Environmental Biochemistry and Biotechnology	

Credits:5	Compulsory
Max. Marks: 100	Min. Passing Marks:……

Total Number of Lectures = 60

Course Objectives: The course is aimed at to make students understand and appreciate the importance of environmental biotechnology so as to develop remediation techniques for environmental degradation. To inspire the students to find ways to contribute personally and professionally for sustainable development of environment friendly societal development.

Unit	**Contents**	**Number of Lectures**
1	**Introduction** Environment; Basic concepts; Resources; Eco system: plants, animals, microbes; Ecosystem management; Renewable resources; Sustainability; Microbiology of degradation and decay; Role of Biotech in environmental protection; Control and management of biological processes.	12
2	**Pollution** Environmental pollution; Source of pollution; Air, water as a source of natural resource; Hydrocarbons, substituted hydro carbons; Oil pollution; Surfactants; Pesticides; Measurement of pollution; Water pollution; Biofilm; Soil pollution; Radioactive pollution; Radiation; Ozone depletion; Green house effect; Impact of pollutants; Measurement techniques; Pollution of milk and aquatic animals.	12



3	**Control, remediation and management** Waste water collection; control and management; Waste water treatment; Sewage treatment through chemical, microbial and biotech techniques; Anaerobic processes; Anaerobic filters; Anaerobic sludge blanket reactors; Bioremediation of organic pollutants and odorous compounds; Use of bacteria, fungi, plants, enzymes, and GE organisms; Plasmid borne metabolic treatment; Bioaugmentation; Bioremediation of contaminated soils and waste land; Bioremediation of contaminated ground water; Macrophytes in water treatment; Phytoremediation of soil metals; Treatment for waste water from dairy, distillery, tannery, sugar and antibiotic industries.	12
4	**Alternate source of energy** Biomass as source of energy; Bioreactors; Rural biotechnology; Biocomposting; Biofertilizers; Vermiculture; Organic farming; Bio-mineralization; Biofuels; Bioethanol and biohydrogen; Solid waste management.	12
5	**Environment and health in respect to genetics** Gene and environment; Effect of carbon and other nanoparticles upon health; Gene mutation; Genetic testing; Genetic sensors; Environmental pollution and children; Human biomonitoring.	12

Books Recommended:

1. Thakur IS. (2011)Environmental Biotechnology basic concepts and applications. I. K. International Publishing House Pvt. Limited
2. Evans GM and J. C. Furlong (2003). Environmental Biotechnology: Theory and Applications. Wiley Publishers.
3. Ritmann R and McCarty P L (2000). Environmental Biotechnology: Principle & Applications. 2nd Ed., McGraw Hill Science.
4. Scragg A., (2005) Environmental Biotechnology. Pearson Education Limited.
5. Srinivas TR (2008). Environmental Biotechnology. New Age International Pvt. Ltd.

Suggested online links:

1. https://nptel.ac.in/courses/104/103/104103020/
2. https://nptel.ac.in/courses/102/105/102105088/

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SEMESTER VIII

Paper 1 (Theory)

Course Title: Genetic Engineering

Program/Class: Bachelor (Research) in Biotechnology	**Year:** Fourth	**Semester:** Eighth
		Paper-1 Theory Subject: Biotechnology
Course Code: PBT06- (T/P)		**Course Title:** Genetic Engineering

Credits:4	Compulsory
Max. Marks: 100	Min. Passing Marks:……

Total Number of Lectures = 60

Course Objectives: The objectives of course include development of theoretical and practical knowledge on concepts of genetic engineering such as cloning vectors, PCR, restriction enzymes and DNA sequencing.

Unit	**Contents**	**Number of Lectures**
1	**Basics Concepts** DNA structure and properties; Restriction enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphate, cohesive and blunt end ligation; Linkers; Adaptors; Homopolymer tailing, Labeling of DNA, Hybridization technique: Northern, southern and colony hybridization, fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA Protein Interactions; electrophoretic shift assay.	**12**
2	**Cloning Vectors** Plasmids; M13 mp vector; PUC19 and Bluescript vectors, Phagemids, Lambda vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Mammalian expression vectors & retroviral vectors; Prokaryotic Expression vectors with GST-, His- and MBP- tags; Affinity purification of recombinant fusion proteins; Inclusion bodies; Methodologies to reduce formation of inclusion bodies.	**12**
3	**Cloning Methodologies** Bacterial Transformation; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Phagedisplay	**12**

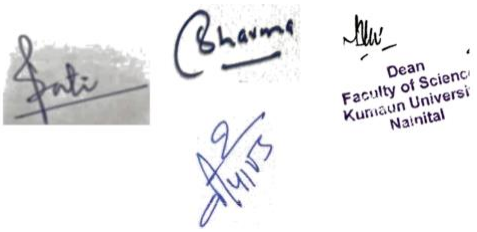
4	**PCR and its Applications** Primer design; Fidelity of thermo stable enzymes; DNA polymerases; Types of PCR- reverse transcriptase, real time PCR, hot start PCR, colony PCR, cloning of PCR products; T-vectors; Proof reading enzymes; PCR in site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection.	**12**
5	**DNA Sequencing and Silencing** Enzymatic DNA sequencing; Automated DNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; RNA interference and siRNA Gene knockouts and Gene Therapy	**12**

Books Recommended:

1. Principles of Gene Manipulation by R.W.Old and S.B.Primrose Third Edition Blackwell ScientificPublication
2. Genes VI by B. Lewin
3. From Genes to Clones by E. L.Winnecker.
4. Brown, T. A. (2006). **Gene Cloning and DNA Analysis: an Introduction.** Oxford: Blackwell Pub.
5. Slater, A., Scott, N. W., & Fowler, M. R. (2003). **Plant Biotechnology: The Genetic Manipulation of Plants**. Oxford: Oxford University Press

Suggested online links:

1. https://ocw.mit.edu/courses/find-by-topic/#cat=science&subcat=biology&spec=stemcells
2. https://ocw.mit.edu/courses/materials-science-and-engineering/3-051j-materials-for-biomedical-applications-spring-2006/lecture-notes/lecture13.pdf
3. https://ocw.mit.edu/courses/biological-engineering/20-109-laboratory-fundamentals-in-biological-engineering-fall-2007/lecture-notes/
4. https://ocw.mit.edu/courses/health-sciences-and-technology/hst-535-principles-and-practice-of-tissue-engineering-fall-2004/
5. https://ocw.mit.edu/courses/biological-engineering/20-109-laboratory-fundamentals-in-biological-engineering-fall-2007/labs/mod1_3/



Semester-VIII

(Practical)

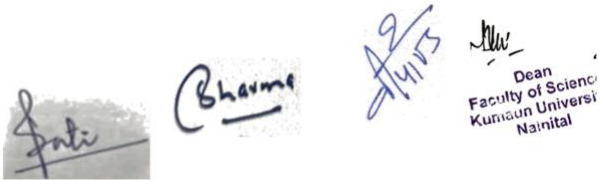
Course Title: Genetic Engineering

Program/Class: Bachelor (Research) in Biotechnology	**Year:** Fourth	**Semester:** Eighth
		Practical Subject: Biotechnology
Course Code: PBT06- (T/P)	**Course Title:** Genetic Engineering-practical	

Credits: 1	Compulsory
Max. Marks: 50	Min. Passing Marks:……

Total Number of Hours:60

Unit	**Contents**	**Number of Hours**
1	Isolation of genomic DNA from *E. coli*	**6**
2	PCR amplification of bacterial/plant/animal-cell genomic region and analysis by agarose gel electrophoresis.	**6**
3	Preparation of plasmid DNA from *E.coli* DH5α and gel analysis.	**6**
4	Restriction digestion of vector (gel analysis) with Restriction endonucleases	**6**
5	Vector and Insert ligation	**6**
6	Transformation in *E.coli* DH5α.	**6**
7	Plasmid isolation and confirming recombinant by PCR and RE digestion.	**6**
8	Transformation of recombinant plasmid in *E.coli* Laboratory strain.	**6**
9	Induction of recombinant protein with IPTG and analysis on SDS-PAGE	**6**
10	Purification of protein on Ni-NTA/Glutathione/Mannose column and analysis of purified protein by SDS- PAGE.	**6**



SEMESTER VIII

Paper-2 (Theory)

Course Title: Analytical Techniques

Program/Class: Bachelor (Research) in Biotechnology	**Year: Fourth**	**Semester:** Eighth
Paper-2 Theory Subject: Biotechnology		
Course Code: PBT07- (T/P)	**Course Title:** Analytical Techniques	

Credits:4	Compulsory
Max. Marks: 100	Min. Passing Marks:……

Total Number of Lectures = 60

Course Objectives: The course envisages conceptual and hands on learning of various analytical techniques. This course will enable students to perform spectroscopy techniques, enzyme assays, chromatography techniques etc.

Unit	**Contents**	**Number of Lectures**
1	**Basic Techniques** Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques. **Spectroscopy Techniques** Basic Principle, Instrumentation and Biological applications of: UV and Visible light absorption spectroscopy, Spectro fluorometry, CD and ORD, Atomic spectroscopy (Absorption and emission). Infrared spectroscopy, Raman Scattering, Application of FT-IR in the study of biomolecules, Nuclear Magnetic Resonance (NMR) spectroscopy, and EPR; Mass spectroscopy and mass analyzers like ion trap, quadrupole, magnetic sector, time of flight (ToF).	**12**

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2	**Chromatography Techniques** TLC and Paper Chromatography; Column chromatography Chromatographic methods for macromolecule separation-Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC. **Electrophoretic Techniques** Theory and application of Polyacrylamide and Agarose gel electrophoresis; Native and SDS-PAGE electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis	**12**
3	**Centrifugation** Basic principles; Mathematics & theory (RCF, Sedimentation Coefficient etc); Types of centrifuge- Micro centrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Application (Isolation of cell components); Analytical centrifugation.	**12**
4	**Radioactivity** Radioactive & stable isotopes; Radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Autoradiography; Applications of isotopes in biochemistry, Clinical application; Radioimmunoassay	**12**
5	**Advanced Techniques** Protein crystallization; Enzyme and cell immobilization techniques	**12**

Books Recommended:

1. Olaniyan, F. M., (2017) V Edition, Laboratory Instrumentation and Techniques, Create space independent publishing platform
2. Wilson, K., Walker, J. (eds.); Cambridge University Press, Cambridge, 2000, V Edition.
3. Willard, M. H., (2004), VII Edition, Instrumental Methods of Analysis, CBS Publisher and distributor Private Limited.

Suggested online links:

https://nptel.ac.in/courses/102/103/102103044/

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Semester-VIII

(Practical)

Course Title: Analytical techniques

Program/Class: Bachelor (Research) in Biotechnology	**Year:** Fourth	**Semester:** Eighth
		Practical Subject: Biotechnology
Course Code: PBT07- (T/P)	**Course Title:** Analytical techniques-Practical	

Credits: 1	Compulsory
Max. Marks: 50	Min. Passing Marks:……

Total Number of Hours:60

Unit	**Contents**	**Number of Hours**
1	Paper chromatography of amino acids	**10**
2	TLC of lipids	**10**
3	Isolation of plasmid DNA from Ecoli	**10**
4	Agarose gel electrophoresis of plasmid DNA from Ecoli	**10**
5	Extraction and purification of proteins from plant and animal	**10**
6	SDS PAGE of BSA and extracted proteins	**10**

Semester- VIII

Paper-3 (Theory)

Course Title: Molecular Virology

Program/Class: Bachelor (Research) in Biotechnology	**Year:** Fourth	**Semester:** Eighth
		Paper-3 Theory Subject: Biotechnology
Course Code: PBT08- (T)		**Course Title: Molecular Virology**

Credits:5	Compulsory
Max. Marks: 100	Min. Passing Marks…

Total Number of Lectures = 60

Course Objectives: The course objectives include learning of structural and genomic organization of different animal and plant viruses. The learning will enable students to take up research in challenging and evolving areas of virology, such as effective diagnostic and treatment of viral infections in plants and animals.

Unit	**Contents** -	**Number of Lectures**
1	Structure of animal viruses and plant viruses; Classification of animal and plant viruses; Satellite viruses; Viroids; Virusoids, Prions etc.; Transmission of Viruses; Vectors for Virus transmission, Cell to cell and systemic movement of viruses. Impact of Viruses on Health and Economy: (Diseases causes by animal viruses and plant viruses; Economic loss due to important viruses); Bacterial Viruses: Lysogenic and Lytic Phages, Bacteriophage Typing.	12
2	General Genomic organization of animal viruses; Replication and Life cycle of: Poliovirus, Human Immunodeficiency virus (HIV), Influenza Virus, Rabies Virus, Poxvirus, Herpesvirus and Hepatitis viruses; Introduction to Cancer causing viruses and their mechanism of host- cell transformation.	12
3	General Genomic organization of plant viruses; Replication and Life cycle of plant viruses: Cauliflower Mosaic Virus (CMV), Tobacco Mosaic Virus (TMV), Rice Dwarf Virus, Citrus triesteza Virus.	12
4	Methods to diagnose animal virus infections: Electron microscopy, Tissue culture growth of viruses and Cytopathic effects, Virus quantitation assays, Viral serology: ELISA, neutralization assays; Molecular methods: hybridization, Real-time PCR, antiviral assays.	12

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5	Methods to study plant viruses; Infectivity assays – Sap transmission, insect vector transmission, agro infection (using Agrobacterium); serological methods, immune electrophoresis in gels, direct double-antibody sandwich method, Dot ELISA, Immuno sorbent electron microscopy(ISEM),Polymerase chain reaction; Gene silencing, and viral suppressors of gene silencing.	12

Books Recommended:

1. Acheson, N. H. (2011). Fundamentals of molecular virology (No. Ed. 2). John Wiley & Sons, Inc.

Suggested online links:

https://nptel.ac.in/courses/102/103/102103039/

SEMESTER VIII

Paper-4 (Theory)

Course Title: Cell and Developmental Biology

Program/Class: Bachelor (Research) in Biotechnology	**Year:** Fourth	**Semester:** Eighth
		Paper-4 Theory Subject: Biotechnology
Course Code: PBT09- (T)	**Course Title:** Cell and Developmental Biology	

Credits:5	Compulsory
Max. Marks: 100	Min. Passing Marks:……

Total Number of Lectures = 60

Course Objectives: Produce a basic understanding of the unit of life i.e., cell by theoretical and pictorial learning of the organization and function of different cell organelles and developmental biology. Learning critical concepts, facts, and theories relevant to cellular mechanisms also understand the functions of different organelles of the cell and their interrelationships. Perceive recent developments in the field.

Unit	**Contents**	**Number of Lectures**
1	**Cell Theory and Methods of Study** Microscope and its modifications- Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM), Electron tunneling and Atomic Force Microscopy, etc. **Membrane Structure and Function** Structural models; Composition and dynamics; Transport of ions and macromolecules; Pumps, carriers and channels; Endo- and Exocytosis; Membrane carbohydrates and their significance in cellular recognition; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata	**12**
2	**Cellular compartments and intracellular sorting of proteins** ER & Lysosomes, peroxisomes, synthesis and sorting of proteins (lysosomal proteins, membrane proteins, secretory proteins). Nuclear transport.	**12**
3	**Endo-membrane System and Cellular Motility** Organization of nucleus and nuclear membrane, structure and organization of chromatin. Cytoskeleton: Actin filaments and cell cortex, cilliary movements and cytoplasmic microtubules and intermediate filaments.	**12**

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4	**Cell Communication** General principle, Signal Molecules, Signaling through GPCRs, Second Messengers, Molecular Switches, Cells Sensitivity to a signal, IP3, Jak-STAT pathways, Cam Kinase-II, Receptor Tyrosine Kinase, Signaling in Plants	**12**
5	**Differentiation of specialized cells** Stem cell differentiation. Differentiation of cancerous cells and role of proto-oncogenes **Plant Meristem Organization and Differentiation** Organization of shoot Apical Meristem (SAM); Organization of Root Apical Meristem (RAM); Pollen germination and pollen tube guidance; Phloem differentiation; Self-incompatibility and its genetic control; Embryo and endosperm development; Heterosis and apomixes.	**12**

Books Recommended:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P.(2014). **Molecular Biology of the Cell** (6th Ed.). New York: Garland Science
2. Cooper, G. M., and Hausman, R. E. (2013). **The Cell: a Molecular Approach** (6th Ed.). Washington: ASM ; Sunderland.
3. Karp, G. **Cell and Molecular Biology. Concepts and experiments**. John Harris, D., Wiley & sons, NewYork

Suggested online links:

1. https://nptel.ac.in/courses/102/103/102103012/
2. https://nptel.ac.in/courses/102/106/102106084/
3. https://nptel.ac.in/courses/102/107/102107075/

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Semester-VIII

Paper-5 (Theory)

Course Title: Plant Biochemistry and Biotechnology

Program/Class: : Bachelor (Research) in Biotechnology	**Year:** Fourth	**Semester:** Eighth
Paper-5 Theory Subject **Biotechnology**		
Course Code: PBT10- (T/P)	**Course Title:** Plant Biochemistry and Biotechnology	

Credits:4	Compulsory
Max. Marks:100	Min. Passing Marks:……

Total Number of Lectures = 60

Course Objectives: Describe the developmental processes operating in plants, hands on training of plant tissue culture & micropropagation methods. Evaluate and perform biotechnological tools for genetically modified plants generation in agriculture and industry. Understands the basics of sterilization and culture preparation methods and highlights the importance and fundamentals of plant tissue culture. To develop basic understanding of need of vectors for plant transformation. Create awareness for the suitability of transgenics,in the society, industrialists, and environment. To emphasize the interest in young mind for startup through biotechnology-based industry.

Unit	**Contents**	**Number of Lectures**
1	**Plant Tissue Culture** Historical perspective; Totipotency; Organogenesis; Somatic embryogenesis; Regulation and applications; Artificial seed production; Micropropagation; Somaclonal variation; Androgenesis and its applications in genetics and plant breeding; Germplasm conservation and cryopreservation. **Protoplast Culture and Somatic Hybridization** Protoplast isolation; Culture and usage; Somatic hybridization – methods and applications; Cybrids and somatic cell genetics.	12

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2	**Genetic Transformation** Agrobacterium-plant interaction; Virulence; Ti and Ri plasmids; Opines and their significance; T-DNA transfer; Disarming the Ti plasmid. Agrobacterium-mediated gene delivery; Co integrate and binary vectors and their utility; Direct gene transfer- PEG-mediated, electroporation, particle bombardment and alternative methods; Screenable and selectable markers; Characterization of transgenics; Chloroplast transformation; Marker-free methodologies; Gene targeting.	12
3	**Strategies for Introducing Biotic and Abiotic Stress Resistance/Tolerance** Bacterial resistance; Viral resistance; Fungal resistance; Insects and pathogens resistance; Herbicide resistance; Drought, salinity, thermal stress, flooding and submergence tolerance	12
4	**Somaclonal variations** **Plants as Bio factories** Concept of bio factories; Fermentation and production of industrial enzymes, vitamins and antibiotics and other biomolecules; Cell cultures for secondary metabolite production; Production of pharmaceutically important compounds; Bioenergy generation.	12
5	**Principals and applications of cryopreservation** Secondary product formation by cell suspension cultures, Culture media and environmental conditions supporting secondary product formation, Biotransformation of terpenoids, alkaloids and steroids by suspension and immobilized plant cell cultures, Biosafety and containment practices	12

Books Recommended:

1. Berg, JM Tymoczko, JL. Gatto, GJ., Stryer, L. (2015). Biochemistry. (8th ed.) W H Freeman and Company NewYork.
2. Nelson DL. Cox MM. (2017) Lehninger Principles of Biochemistry (7th ed.). W H Freeman New York.
3. Boyer RF. (2012) Biochemistry laboratory: modern theory and techniques(2nd Edition). Pearson Education, Inc
4. Jain JL. Jain S. Jain N. (2005). Fundamentals of Biochemistry. (6th edition). S Chand and Company Ltd.
5. Satyanarayana U. Chakrapani U. (2013). Biochemistry (4th edition). Elsevier and Books and Allied (P)Ltd
6. Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science
7. Chawla, H. S. (2000). Introduction to Plant Biotechnology. Enfield, NH: Science.

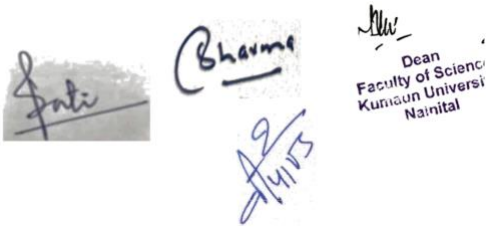
8. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
9. Dubey RC. (2014) A Textbook of Biotechnology (5th edition) S Chand and Company Ltd
10. Singh BD. (2015). Biotechnology: Expanding Horizons (4th edition). Kalyani Publishers

Suggested online links:

1.https://nptel.ac.in/courses/102/106/102106080/

2. https://nptel.ac.in/courses/102/103/102103016/

3. https://nptel.ac.in/courses/102/107/102107075/



Semester-VIII

Practical

Course Title: Plant Biochemistry and Biotechnology

Program/Class: : Bachelor (Research) in Biotechnology	**Year:** Fourth	**Semester:** Eighth
		Practical Subject: Biotechnology
Course Code: PBT10- (T/P)	**Course Title:** Plant Biochemistry and Biotechnology-practical	

Credits:1	Compulsory
Max. Marks: 50	Min. Passing Marks:

Total Number of Hours = 60

Unit	**Contents**	**Number of Hours**
1	SOPs of Plant Tissue Culture laboratory	**10**
2	Preparation of media.	**10**
3	Surface sterilization of explants	**10**
4	Micropropagation of plants	**10**
5	Green house and hardening practices	**10**
6	Clonal fidality of regenerated plants.	**10**

Semester-IX

Paper-1 (Theory)

Course Title: Genomics and Proteomics

Program/Class: Master of Biotechnology	**Year:** Fifth	**Semester:** Ninth
Paper-1 Theory Subject: Biotechnology		
Course Code: PBT11-(T)	**Course Title:** Genomics and Proteomics	

Credits:5	Compulsory
Max. Marks: 100	Min. Passing Marks:

Total Number of Lectures = 60

Course Objectives: To develop a foundation in the fundamental principles of genomics and Proteomics with the biological importance of protein-protein interaction, modeling and protein database, and their clinical relevance by apply different methods available to study DNA and RNA sequence analyses and to evaluate available genomic data to provide new insights in the fields of functional genomics. Study various available data relating to Human Genome Project towards ELSI, with GWAS, SNP and miRNA techniques using specific databases and bioinformatics tools.

Unit	**Content**	**Number of lectures**
1	**Introduction** Structural organization of genome in prokaryotes and eukaryotes; organelle DNA –mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RELP, DNA fingerprinting, RAPD, PCR, physical and genetic mapping.	12
2	**Genome sequencing projects** Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics (Comparing related sequences retrieved from database(s)), Identification and classification of organisms using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs. -	12

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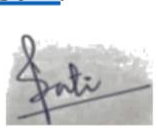
3	**Proteomics** Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Micro scale isoelectric focusing in solution, Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; Differential display proteomics, Methods of studying Protein-protein interactions: GST Pull-down assay, Co- immune precipitation, Yeast two-hybrid system.	12
4	**Pharmacogenomics:** High throughput screening in genome for drug discovery; Identification of Drug- targets, Pharmacogenomics and drug development; Gene-therapy.	**12**
5	**Functional genomics and proteomics** Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays; Structural proteomics	**12**

Suggested books:

1. Sangeetha, J. (2015). Genomics and Proteomics: Principles, Technologies, and Applications.
2. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher,2006.
3. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing,1987.
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten,2010.
5. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
6. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science,2001.
7. 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. BenjaminCummings.
8. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press,Washington.
9. Pevsner, J. (2009). Bioinformatics and Functional Genomics.IIEdition.John Wiley & Sons.

Suggested online links:

1. **https://nptel.ac.in/courses/102/101/102101076/**
2. **https://nptel.ac.in/courses/102/101/102101072/**
3. **https://nptel.ac.in/courses/102/104/102104056/**
4. **https://nptel.ac.in/courses/102/103/102103017/**




Semester-IX

Paper-2 (Theory)

Course Title: Bioprocess Engineering and Technology

Program/Class: Master in Biotechnology	**Year:** Fifth	**Semester:** Ninth
		Paper-2 Theory Subject: **Biotechnology**
Course Code: PBT12-(T)	**Course Title: Bioprocess Engineering and Technology**	

Credits: 5	**Compulsory**
Max. Marks: 100	Min. Passing Marks:

Total No. of Lectures- = 60

Course Objectives: To learn the basics of different types of fermentors and its accessories. Learning sterilization procedures, practical aspects of microbial growth kinetics, production kinetics, and inhibition models, types of bioreactor, its configurations and operation modes based upon the nature of natural products. To solve problems and seek practical solutions for large scale implementation.

Unit	**Contents**	**Number of Lectures**
1	**Basic principle of Biochemical engineering** Isolation, screening and maintenance of industrially important microbes; Microbial growth (an example from each group, particularly with reference to industrially useful microorganisms); Strain improvement for increased yield and other desirable characteristics.	12
2	**Concepts of basic mode of fermentation processes** Bioreactor designs; Types of fermentation and fermenters; Concepts of basic modes of fermentation – Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermentation media; Measurement and control of bioprocess parameters; Scale up and scale down process.	12
3	**Downstream processing** Bioseparation- filtration, centrifugation, sedimentation, flocculation; Cell disruption; Storage and packaging; Treatment of effluent and its disposal.	12

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4	**Applications of enzymes in food processing** Mechanism of enzyme function and reactions in process techniques; Enzymic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Production, recovery and scaling up of enzymes and their role in food and other industries; Immobilization of enzymes and their industrial applications	12
5	**Applications of Microbes in food process operations and production** Fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; Microbes and their use in pickling, producing colors and flavors, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins from lactic acid bacteria – Production and applications in food preservation.	12

Books recommended:

1. Stanbury P F and Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: PergamonPress
2. Shuler M L and Kargi F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: PrenticeHall.
3. Glazier AN and Nikaido H (2007).Microbial Biotechnology – Fundamental & Applied Microbiology – Second Edition. Cambridge UniversityPress.
4. Casida LE (2019) Industrial Microbiology. Second Edition, New Age International Publisher.
5. Bailey J E and Ollis D F. (1986). Biochemical Engineering Fundamentals. New York:McGraw-Hill.

Suggested online links:

1. https://ocw.mit.edu/high-school/biology/exam-prep/cellular-energetics/fermentationcellular-respiration/fermentation/
2. **https://nptel.ac.in/courses/102/106/102106080/**
3. **https://nptel.ac.in/courses/102/106/102106048/**
4. **https://nptel.ac.in/courses/102/106/102106022/**

Semester-IX

Paper-3 (Theory)

Course Title: Animal Biotechnology

Program/Class: Master in Biotechnology	**Year: Fifth**	**Semester:** Ninth
Paper-3 Theory Subject: **Biotechnology**		
Course Code: PBT13-(T)	**Course Title: Animal Biotechnology**	

Credit: 5	**Compulsory**
Max. Marks: 100	**Min. Passing Marks:**
Total No. of Lectures- = 60	

Course Objectives: Learning methods of gene manipulations in animal cells and embryonic stem cells for development of breeding and conservation approaches in animals. Lawfully consideration of the legal and ethical issues related to animal maintenance and experimental uses, that can generate best practices followed during maintenance of cell lines. Apply different recombinant DNA techniques to manipulate the genome of animal cells that can surely formulate ideas for the production of genetically modified organisms. Key understanding of different approaches in reproduction technology which also utilize the concept of molecular techniques involved in animal conservation.

Unit	**Contents**	**Number of Lectures**
1	**Animal cell culture** History of animal cell culture; Basic requirements for animal cell culture; Cell culture media and reagents; Animal cell, tissue and organ cultures; Primary culture, secondary culture; Continuous cell lines; Suspension cultures; Transfection and transformation of cells; Stem cells and their application; Induced Pluripotency, Application of animal cell culture for in vitro testing of drugs; Application of cell culture technology in production of pharmaceuticalproteins.	**12**
2	**Animal health Biotechnology** Recombinant approaches to vaccine production; Hybridoma technology; Phage display technology for production of antibodies; Antigen-antibody based diagnostic assays including radioimmunoassay and ELISA; Immunoblotting; Nucleic acid based diagnostic methods including nucleic acid probe hybridization; PCR, Real time PCR; Branched DNA technology, Nucleic acid sequencing; Animal disease diagnostic kits;Probiotics.	**12**

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3	**Animal Reproductive Biotechnology** Cryopreservation of sperms and ova of livestock; Artificial insemination; Super ovulation; in vitro fertilization; Culture of embryos; Cryopreservation of embryos; Embryo transfer; Micromanipulation of animal embryos; Transgenic animal technology and its different applications; Different methods of Transgenic animal production; Targeted gene transfer, Detection of Transgene and transgene function; Animal cloning-basic concepts; Cloning from embryonic cells and adult cells; Ethical, social and moral issues related to cloning; in situ and ex situ preservation of germplasm, Pregnancy diagnostic kits.	**12**
4	**Animal genomics** Introduction to animal genomics; Different methods for characterization of animal genomes, SNP, STR, RFLP, RAPD, proteomics, metobolomics; Genetic basis for disease resistance; Gene knock out technology and animal models for human genetic disorders.	**12**
5	**DNA Forensics** Immunological and nucleic acid based methods for identification of animal species; DNA Barcoding; Detection of adulteration in meat using DNA based methods; Detection of food/feed adulteration with animal protein; Identification of wild animal species using DNA based methods; Microbial forensics; Bioterror agents; Biocrimes and Bioterrorism.	**12**

Books suggested:

1. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: HumanaPress
2. Singh B. Gautam SK (2013). Textbook of animal biotechnology. The Energy and Resources Institute,TERI
3. Gupta PK. (2018) Animal Biotechnology. Rastogi Publications

Suggested online links:

1. https://ocw.mit.edu/courses/find-by-topic/#cat=science&subcat=biology&spec=stemcells
2. https://ocw.mit.edu/courses/materials-science-and-engineering/3-051j-materials-for-biomedical-applications-spring-2006/lecture-notes/lecture13.pdf
3. https://ocw.mit.edu/courses/biological-engineering/20-109-laboratory-fundamentals-in-biological-engineering-fall-2007/lecture-notes/
4. https://ocw.mit.edu/courses/health-sciences-and-technology/hst-535-principles-and-practice-of-tissue-engineering-fall-2004/
5. https://ocw.mit.edu/courses/biological-engineering/20-109-laboratory-fundamentals-in-biological-engineering-fall-2007/labs/mod1_3/

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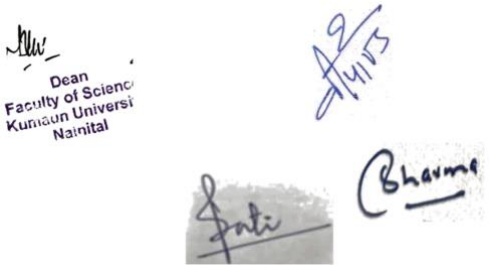
6. **https://nptel.ac.in/courses/102/104/102104058/**
7. **https://nptel.ac.in/courses/102/104/102104042/**



Semester-IX

Paper-4 (Theory)

Course Title: Molecular Genetics

Program/Class: Master in Biotechnology	**Year:** Fifth	**Semester:** Ninth
Paper-4 Theory Subject: Biotechnology		
Course Code: PBT14-(T)	**Course Title:** Molecular Genetics	

Credit: 5	**Compulsory**
Max. Marks: 100	**Min. Passing Marks:**
Total No. of Lectures- = 60	

Course Objectives: To learn basic concepts in molecular genetics. Explain genetic inheritance, discuss chromosome organization and sex determination so that students are able to relate genetic makeup of different organisms. Understanding the relationship between mutation and evolution. .

Unit	**Contents**	**Number of Lectures**
1	**Bacterial Mutants and mutations** Isolation; Useful phenotypes (auxotrophic, conditional, lethal, resistant); Mutation rate; Types of mutations (base pair changes; frameshift; insertions; deletion; tandem duplication); Reversion vs. suppression; Mutagenic agents; Molecular Mechanisms of mutagenesis; Assay of mutagenic agents (Ames test) **Gene transfer in bacteria** History; Transduction- generalized and specialized; Conjugation- F, F', HFr; F transfer; Hfr- mediated chromosome transfer; Transformation- natural and artificial transformation; Merodiploid generation; Gene mapping; Transposable genetic elements; Insertion sequences; Composite and Complex transposons; Replicative and non-replicative transposition; Genetic analysis using transposons.	12
2	**Bacteriophages and Plasmids** Bacteriophage-structure; Assay; Lambda phage – genetic map,lysogenic and lytic cycles; Gene regulation; Filamentous phages such as M13; Plasmids – natural plasmids; their properties and phenotypes; Plasmid biology – copy number and its control; Incompatibility; Plasmid survival strategies; Antibiotic resistance markers on plasmids (mechanism of action and resistance); Genetic analysis using phage and plasmid	12

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3	**Mendelian Genetics** Introduction to human genetics; Background and history; Types of genetic diseases; Role of genetics in medicine; Human pedigrees; Patterns of single gene inheritance-autosomal recessive; Autosomal dominant; X linked inheritance; Complicating factors – incomplete penetrance; variable expression; Multiple alleles; Co dominance; Sex influenced expression; Hemoglobinopathies – Genetic disorders of hemoglobin and their diseases. **Non Mendelian inheritance patterns** Mitochondrial inheritance; Genomic imprinting; Lyon hypothesis; iso disomy; Complex inheritance-genetic and environmental variation; Heritability; Twin studies; Behavioral traits; Analysis of quantitative and qualitative traits.	12
4	**Molecular Genetics of Lambda** The genome packaging, replication and recombination, Regulation of Lytic and Lysogenic Cycles	12
5	**Gene mapping and human genome project** Physical mapping; linkage and association **Population genetics and evolution** Phenotype; Genotype; Gene frequency; Hardy Weinberg law; Factors distinguishing; Hardy Weinberg equilibrium; Mutation selection; Migration; Gene flow; Genetic drift;	12

Books Recommended:

1. Brown, T. A. (2012). Introduction to genetics: a molecular approach. Garland Science.
2. Lodish, H F. Berk, A. Kaiser, CA, Krieger, M. Bretscher, A. Ploegh, H. Aman,A.
3. Martin, K. (2016). **Molecular Cell Biology** (8th Ed.). New York: W.H.Freeman
4. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). VIII editon Principles of Genetics.WileyIndia.
5. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. XI Edition.BenjaminCummings.
6. Russell, P. J. (2009). iGenetics A Molecular Approach. III Edition. Benjamin Cummings.
7. Pierce, B. A. (2008). Genetics A Conceptual Approach. W. H. Freeman& co.NY

Suggested online link:

https://nptel.ac.in/courses/102/104/102104052/

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Semester-IX

Paper-5 (Theory)

Course Title: IMMUNOLOGY AND IMMUNOTECHNOLOGY

Program/Class: Master in Biotechnology	**Year:** Fifth	**Semester:** Ninth
		Paper-5 Theory Subject: Biotechnology
Course Code: PBT15-(T/P)	**Course Title: Immunology and Immunotechnology**	

Credits:4	Compulsory
Max. Marks: 100	Min. Passing Marks:……

Total Number of Lectures = 60

Course Objectives: To understand the basics of immunology and facilitate the application of core immunology for healthy and diseases free nation. Evaluation of molecular and cellular basis of the development and function of the immune system in states of health and diseases. Correlate the theoretical immunology with clinical decision-making cancer diagnosis and treatment. Understanding the mechanisms of disease and therapeutic implications of vaccines and its development.

Unit	**Contents**	**Number of Lectures**
1	**Immunology- fundamental concepts and anatomy of the immune system** Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; haematopoesis; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue. (MALT & CALT); Mucosal Immunity; Antigens and antigenicity – immunogens and immunogenicity, Immune modulators: Adjuvants, hapten- carrier system; Toxins and Toxoids. Major Histocompatibility Complex – MHC genes, MHC and immune responsiveness and disease susceptibility.	12

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2	**Immune responses generated by B and T lymphocytes** Immunoglobulins- basic structure, classes & subclasses of immunoglobulins, antigenic determinants (Epitopes); Antigen-Antibody interaction, affinity, cross reactivity, specificity, Multigene organizationofimmunoglobulingenes;B-cellreceptor; Immunoglobulin superfamily; Basis of self –non-self-discrimination; Generation of antibody diversity; T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cytokines-properties, receptors and therapeuticuses.	12
3	**Antigen-antibody interactions** Precipitation, agglutination and complement mediated immune reactions; Antibodies as in-vitro and in-vivo probes; Advanced immunological techniques – RIA, ELISA, Western blotting, ELISPOT assay, Flow cytometry: Instrumentation and Applications; Identification of Immune Cells; Surface Plasmon resonance, Biosenor assays for assessing ligand–receptor interaction, CMI techniques-lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays,Apoptosis.	12
4	**Vaccine Technology** Principles of Immunization, Techniques for analysis of immune response. General Idea of Active and passive immunization; Live, killed, attenuated, sub unit vaccines; recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Hybridoma, antibody engineering - chimeric and hybrid monoclonal antibodies; Transfusion of Immuno-competent cells; stem cell therapy; Cell based vaccines.	12
5	**Clinical Immunology** Immunity to Infection : Bacteria, viral, fungal and parasitic infections (with examples from each group); Hypersensitivity – Type I-IV; Autoimmunity; Types of autoimmune diseases; Treatment of autoimmune diseases; Transplantation – Immunological basis of graft rejection; General Idea of Tumor immunology, Cancer immunotherapy; Immunodeficiency-Primary immunodeficiencies, Acquired or secondary immunodeficiencies	12

Books Recommended:

1. Punt J, Stranford S, Jones P., Owen JA, (2018). Kuby Immunology.(8th edition) New York: W.H.Freeman.
2. Hay FC, Westwood OMR.(2008). Practical Immunology.(4th Edition). Wiley Blackwell
3. Delves P J, Martin SJ, Burton DR, and Roitt IM. (2017). Roitt's Essential

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Immunology.(13th edition). Wiley-Blackwell.

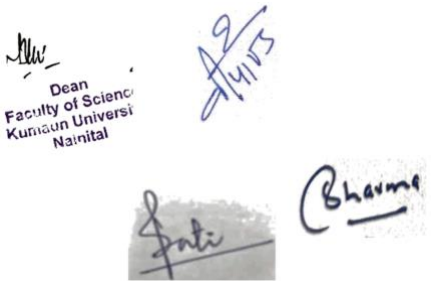
4. Hay FC, Westwood OMR.(2008). Practical Immunology.(4th Edition). Wiley Blackwell.
5. Murphy K, and Weaver C, (2016). Janeway's Immunobiology. (9th edition) New York: GarlandScience.

Suggested online links:

1. https://ocw.mit.edu/courses/find-by-topic/#cat=healthandmedicine&subcat=immunology

2.https://nptel.ac.in/courses/102/105/102105083/

3.https://nptel.ac.in/courses/102/103/102103038/



Semester-IX

(Practical)

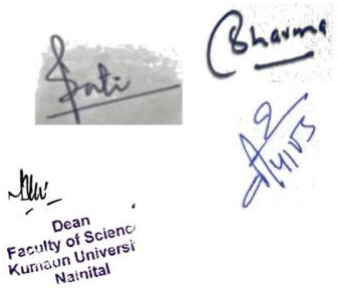
Course Title: Immunology and Immuno technology

Program/Class: Master of Biotechnology	**Year:** Fifth	**Semester:** Ninth
		Practical Subject: Biotechnology
Course Code: PBT15-(T/P)	**Course Title:** Immunology and Immuno technology-practical	

Credits:1	Compulsory
Max. Marks: 150	Min. Passing Marks:……

Total Number of Hours = 60

Unit	**Contents**	**Number of Hours**
1	Preparation of human blood smear and identification of cells.	**6**
2	Determination of blood groups	**6**
3	Determination of Rh antigen.	**6**
4	Estimation of antiserum by Mancini method	**6**
5	Estimation of antiserum by Ouchterlony method	**6**
6	Antiserum titer determination by ELISA.	**6**
7	DOT ELISA for the presence of specific antigen	**6**
8	Immunization, Collection of Serum	**6**
9	Immuno electrophoresis.	**6**
10	Immunodiagnostics (Demonstration using commercial kits).	**6**



Semester-X

Research Project

Course Objective: To provide sufficient hands-on learning experience related to the area of specialization with a focus on research orientation. To take up specific research problem statements with reasonable assumptions and constraints. Perform a literature search and/or patent search in the area of interest. Design and Conduct experiments. Synthesize the results and arrive at scientific conclusions. Document the results in the form of technical report/presentation

Program/Class: Master of Biotechnology	**Year:** Fifth	**Semester:** Tenth
		Subject: Biotechnology
Course Code: PBT16-(T)		**Course Title:** Research project

Credits: 25	Compulsory
	Min. Passing Marks:……