National Education Policy- 2020

Sri Dev Suman Uttarakhand University, Badshahithaul, Tehri Garhwal

Common Minimum Syllabus for State Universities and Colleges of Uttarakhand

Subject: Biotechnology

PROPOSED STRUCTURE OF UG BIOTECHNOLOGY SYLLABUS

Proposed By:

Department of Zoology

Pt. L.M.S. Campus Rishikesh, Sri Dev Suman Uttarakhand University

BoS in Zoology (Biotechnology) Held on 11 July 2023

Board of Studies (BoS) Member
Department of Zoology
Pt. Lalit Mohan Sharma Campus, Rishikesh
Sri Dev Suman Uttarakhand University

S. No.	Name	Designation & Address	Sign.
1.	Prof. G.K. Dhingra	Dean, Faculty of Sciences	

S. No.	Name	Designation	Sign.
1.	Prof. D. M. Tripathi	Professor & Head	
2.	Prof. Surman Arya	Professor	
3.	Prof. Ahmad Pervez	Professor	
4.	Prof. Smita Badola	Professor	

Director from Research Institute

S. No.	Name	Designation & Address	Sign.
1.	Prof. Anita Rawat	Director, USERC, Dehradun	

Subject Experts

S. No.	Name	Designation & Address	Sign.
1.	Dr. K. P. Singh	Head &Assistant Professor, Dept. of Biotechnology, D.B.S.(P.G.) College, Dehradun	
2.	Dr. Narotam Sharma	Scientist & Head, DNA Labs, A center for Applied sciences, Dehradun	

Invited Principal from Govt. Post Graduates College

S. No.	Name	Designation & Address	Sign.
1.	Prof. Pushpa Negi	Principal, Govt. P.G. College, Tehri	
2.	Prof. Pankaj Pant	Principal, Govt. P.G. College, Nagnath Pokhari	
3.	Prof. Kuldeep Negi	Principal, Govt. P.G. College, Khanpur, Haridwar	

Theory and Practical Examination Pattern

Theory (External) each theory paper carrying maximum marks 75 and shell consists two sections A and B. Examination duration shall be 03 hours.

a) **Section A: (short answers type, 200 words).**
   Section A will consist of 08 questions, each of 6 marks in which 5 have to be answered.
   Total: 6×5 = 30

b) **Section B: (long answers type, 500 words).**
   Section B will consist of 05 questions, each of 15 marks in which 3 have to be answered.
   Total: 3×15 = 45

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(assignment 10 marks, written test / viva 10 marks and regularity 5, marks). The evaluated answer sheets/ assignment 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 the concerned department/ the Principal of the college for uploading on to the University examination portal.

Practical: The laboratory work of the students has to be evaluated periodically.
The internal assessment (in the form of lab test, lab record, internal evaluation, assignment/ home assignment and attendance) of total 10 marks per each semester shall be conducted during the semester.
All kinds of exercises have to be conducted during a semester. Maximum 5 marks of attendance can be given to the students.
In each semester practical examination of 75 marks has to be conducted by two examiners (external and internal) having duration of 4 hours. The total number of the students to be examined per batch should not be more than sixty. Marks obtained in the practical examination have to be submitted to head of the concerned department/ the Principal of the college. The Head of the department/ the Principal of the college will make necessary arrangement for uploading the marks on to the University examination portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, Sri Dev Suman Uttarakhand University, Badshahithaul, New Tehri.

The breakup of marks for practical examination for each semester would be as follows:

Practical exam:	50 Marks (Exercises)
Lab Record and Collection:	15 Marks
Viva voce:	10 Marks
Sessional (Internal):	25 Marks
Total:	**100 Marks (each semester)**

National Education Policy-2020
Common Minimum Syllabus for all Uttarakhand State Universities/Colleges

Subject: Biotechnology
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**
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.

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)
	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:** Perform and analyze the results of experiments using basic laboratory techniques of immunology, animal and plant biotechnology, Bio-analytical techniques,medical biotechnology, 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 inTransgenesis, 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**.**

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**	1. Introduction to plant kingdom. 2. Mechanism of photosynthesis, photophosphorylation and respiration. 3. Mechanism and significance of respiration. 4. Introduction to Dicot and Monocot root and stem, structure and function of different cells (Angiosperms and Gymnosperms) 5. Plant growth hormones-introduction and function.	NIL	6
		BIOLOGY OF ANIMALS	5 Units	**BIOLOGY OF ANIMALS**	1. Introduction to animal kingdom classification. 2. Organic evolution. 3. Population genetics. 4. Introduction to various Animal system. 5. Introduction to commercial implementation of different Animal culture.	NIL	6

	II	**ELEMENTARY MOLECULAR BIOLOGY**	5 Units	**ELEMENTARY MOLECULAR BIOLOGY**	1. Estimation of DNA content in the given sample 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	**BASICS OF GENETICS**	1. Introduction of genetics, genotype, phenotype and other genetics terminology. 2. Mendel law and their inheritance. 3. Chromosome- structural organization and disorder. 4. Chromosomal aberration. 5. Introduction to mutations and mutagens. 6. Introduction to microbial genetic recombination. 7. Introduction to classical genetic experiments.	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

2	III	**BASIC CELL BIOLOGY**	4 Units	**BASIC CELL BIOLOGY**	1. Cell as a unit of living system. 2. Structure and functions of various cell organelles. 3. Structure of nucleus and chromosomes: Giant chromosomes (lampbrush & polytene). 4. Cytoskeletal structures. 5. Cell division. 6. Cell senescence, cell death and apoptosis.	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' Hind III or any other restriction enzyme available 3. Agarose gel electrophoresis of Restricted and Unrestricted DNA fragments.	NIL	4+2=6

		Elementary Industrial microbiology	**8 units**	**Elementary Industrial microbiology**	1. Perspectives and introduction to industrial microbiology. 2. Basic microbial taxonomy. 3. Harnessing of introduction to fermentation technology. 4. Downstream processing. 5. Microbes in industries and agriculture.	**Nil**	**6**
		Food Biotechnology	8 Units	**Food Biotechnology**	1. Introduction to Food technology. 2. Enzymes in food industry. 3. Food fermentations 4. Food preservation. 5. Value addition products. 6. Vitamins and minerals. 7. Growth of microorganisms in food. 8. Food and water borne diseases.	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	**INTRODUCTORY ANIMAL BIOTECHNOLOGY**	1. Animal cell culture. 2. Application of Animal cell culture. 3. Immunodiagnostics and vaccine technology. 4. Embryo biotechnology and animal cloning 5. Fermentation technology and animal transgenesis.	NIL	4
		ENVIRONMENTAL BIOTECHNOLOGY	5 Units	**ENVIRONMENTAL BIOTECHNOLOGY**	1. Basic concept of ecosystem. 2. Waste water management. 3. Conventional fuels 4. Bio absorption and bioremediation. 5. Concept of biosafety.	NIL	4

		MOLECULAR CANCER BIOLOGY	5 Units	**MOLECULAR CANCER BIOLOGY**	1. introduction, growth characteristics of cancers cells. 2. Cancer biology biochemistry. 3. Radiation and chemical carcinogenesis. 4. Cell cycle regulation. 5. Cancer diagnosis and treatment.	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	**MICROBIAL GENETICS**	1. Prokaryotic genomes 2. Mechanism of genetics exchange. 3. Integrons and antibiotics. 4. Molecular mechanism of gene regulation in prokaryotes. 5. Bacteriophages. 6. Bacteriophage genetics.	NIL	4

		MEDICAL BIOTECHNOLOGY	6 Units	**MEDICAL BIOTECHNOLOGY**	1. Gene therapy. 2. Gene delivery methods. 3. Vaccines and synthetic therapy. 4. Xenotransplantation 5. Cell adhesion- based therapy and drug delivery.	NIL	4

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		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 1^{st} or 2^{nd} 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.	

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

- 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**

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.

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 oxygenand 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**

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, Anatomicaland 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**

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

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 chromosomeorganization.

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 and disorders of prokaryotic and eukaryotic chromosomes, Kinds of chromosomes based on chromosomal aberration- structural & numerical. • Hereditary defects- Kleinfelters syndrome, Down's syndrome, • Turners syndrome. • Concept in Monosomy, trisomy, nullisomy & others introduction.	**15**
3	• Introduction to mutations and mutagens. • Mutation: spontaneous and induced, chemical and physical mutagens, induced mutations in plants, animals and microbes for economic benefits.	**20**
4	• Introduction to Microbial genetics recombination. • Microbial genetics- Recombination in bacteria; Molecular mechanism of recombination, Transformation Transduction, Conjugation, replica plating.	**15**
5	• Introduction to classical genetics experiments. • 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.
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**

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

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**

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, and absolute configuration (R, S nomenclature), conformational analysis, and IUPAC nomenclature. • Concepts of thermodynamics in chemical reaction.	**12**

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.

- 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 phosphorylatedcompounds). • 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.

- 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**

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

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**

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 asSafe (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

Semester-IV
Paper-III (Theory)
Course Title: **Food Biotechnology**

Course objective: Students will understand the concepts of food biotechnology and would beable 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**

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**

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**

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-

- 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**

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, Differentforms 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.

- 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**

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 thebacterial nucleoid, Replication and partitioning of the bacterial genome and Genome of Archaea).	**10**

2	**Mechanism of genetic exchange** : Plasmid and bacterial sex, Types of plasmids (F Plasmid: a Conjugate plasmid', Mobilization of Non-conjugative plasmid, Rplasmid, 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

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 ofRecombinant 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=EN&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/