KARPAGAM ACADEMY OF HIGHER EDUCATION
Department of Biotechnology
(Scheme of examination for 2019-2020 onwards)
B.Sc., Biotechnology Curriculum

Course code	Name of the course	Objectives and Outcomes		Instruction Hrs / week			Credit	Marks		
		PEO´s	PO´s	L	T	P		CIA	ESE	Total
SEMESTER I										
19LSU101	Language -I	I	a	04	00	00	4	40	60	100
19ENU101	English	I	a	04	00	00	4	40	60	100
19BTU101	Biochemistry and Metabolism	I	a, b	04	00	00	4	40	60	100
19BTU102	Cell Biology	I	a, b	04	00	00	4	40	60	100
19BTU103	Chemistry -I	I	a	04	00	00	4	40	60	100
19BTU111	Biochemistry and Metabolism Practical	I	a, b	00	00	04	2	40	60	100
19BTU112	Cell Biology Practical	I	a, b	00	00	03	2	40	60	100
19BTU113	Chemistry Practical - I	I	a	00	00	03	2	40	60	100
	Semester total			**20**	**00**	**10**	**26**	**320**	**480**	**800**
SEMESTER II										
19LSU201	Language - II	-	-	04	00	00	4	40	60	100
19BTU201	Genetics	I	c, d	04	00	00	4	40	60	100
19BTU202	Chemistry - II	-	-	04	00	00	4	40	60	100
19BTU203	General Microbiology	I	c, d	04	00	00	4	40	60	100
19BTU211	Genetics Practical	I	c, d	00	00	03	2	40	60	100
19BTU212	Chemistry Practical - II	I	a	00	00	03	2	40	60	100
19BTU213	General Microbiology Practical	I	c, d	00	00	04	2	40	60	100
19AEC201	Environmental Studies	I	c, d	00	00	04	4	40	60	100
	Semester total			**20**	**00**	**10**	**26**	**320**	**480**	**800**
SEMESTER III										
19BTU301	Plant Physiology	II	e, f	04	00	00	4	40	60	100
19BTU302	Molecular Biology	II	e, f	04	00	00	4	40	60	100
19BTU303	Immunology	II	e, f	04	00	000	4	40	60	100
19BTU304A	I.P.R., Entrepreneurship, Bioethics and Biosafety	II	e, f	03	00	00	3	40	60	100
19BTU304B	Bio - Analytical Tool	II	e, f							
19BTU311	Plant Physiology Practical	II	e, f	00	00	04	2	40	60	100
19BTU312	Molecular Biology Practical	II	e, f	00	00	04	2	40	60	100
19BTU313	Immunology Practical	II	e, f	00	00	04	2	40	60	100
19BTU314A	I.P.R., Entrepreneurship, Bioethics and Biosafety Practical	II	e, f	00	00	03	1	40	60	100
19BTU314B	Bio - Analytical Tool Practical	II	e, f							
	Semester total			**15**	**00**	**15**	**22**	**320**	**480**	**800**

SEMESTER IV										
19BTU401	Bioprocess Technology	II,IV	e,f,g, h	04	00	00	4	40	60	100
19BTU402	Recombinant DNA Technology	II,IV	e,f,g, h	04	00	00	4	40	60	100
19BTU403	Genomics and Proteomics	II,IV	e,f,g, h	04	00	00	4	40	60	100
19BTU404A	Industrial Fermentation	II,IV	e,f,g, h	03	00	00	3	40	60	100
19BTU404B	Enzymology	II,IV	e,f,g, h							
19BTU411	Bioprocess Technology Practical	II,IV	e,f,g, h	00	00	04	2	40	60	100
19BTU412	Recombinant DNA Technology Practical	II,IV	e,f,g, h	00	00	04	2	40	60	100
19BTU413	Genomics and Proteomics Practical	II,IV	e,f,g, h	00	00	04	2	40	60	100
19BTU414A	Industrial Fermentation Practical	II,IV	e,f,g, h	00	00	03	1	40	60	100
19BTU414B	Enzymology Practical	II,IV	e,f,g, h							
	Semester total			**15**	**00**	**15**	**22**	**320**	**480**	**800**
SEMESTER V										
19BTU501A	Plant Diversity - I	III, IV	i, j	03	00	00	3	40	60	100
19BTU501B	Basics of Forensic Science	III, IV	i, j							
19BTU502A	Bioinformatics	III, IV	i, j	04	00	00	4	40	60	100
19BTU502B	Plant Diversity - II	III, IV	i, j							
19BTU503A	Plant Biotechnology	III, IV	i, j	04	00	00	4	40	60	100
19BTU503B	Evolutionary Biology	III, IV	i, j							
19BTU504A	Animal Biotechnology	III, IV	i, j	04	00	00	4	40	60	100
19BTU504B	Animal Diversity - I	III, IV	i, j							
19BTU511A	Plant Diversity Practical - I	III, IV	i, j	00	00	03	1	40	60	100
19BTU511B	Basics of Forensic Science Practical	III, IV	i, j							
19BTU512A	Bioinformatics Practical	III, IV	i, j	00	00	04	2	40	60	100
19BTU512B	Plant Diversity Practical – II	III, IV	i, j							
19BTU513A	Plant Biotechnology Practical	III, IV	i, j	00	00	04	2	40	60	100
19BTU513B	Evolutionary Biology Practical	III, IV	i, j							
19BTU514A	Animal Biotechnology Practical	III, IV	i, j	00	00	04	2	40	60	100
19BTU514B	Animal Diversity Practical - I	III, IV	i, j							
	Semester total			**15**	**00**	**15**	**22**	**320**	**480**	**800**

SEMESTER VI										
19BTU601A	Molecular Diagnostics	III, IV	k, l	03	00	00	3	40	60	100
19BTU601B	Biotechnology and Human Welfare	III, IV	k, l							
19BTU602A	Medical Microbiology	III, IV	k, l	04	00	00	4	40	60	100
19BTU602B	Environmental Biotechnology	III, IV	k, l							
19BTU603A	Biostatistics	III, IV	k, l	04	00	00	4	40	60	100
19BTU603B	Environment Management	III, IV	k, l							
19BTU611A	Molecular Diagnostics Practical	III, IV	k, l	00	00	03	1	40	60	100
19BTU611B	Biotechnology and Human Welfare Practical	III, IV	k, l							
19BTU612A	Medical Microbiology Practical	III, IV	k, l	00	00	04	2	40	60	100
19BTU612B	Environmental Biotechnology Practical	III, IV	k, l							
19BTU613A	Biostatistics Practical	III, IV	k, l	00	00	04	2	40	60	100
19BTU613B	Environment Management Practical	III, IV	k, l							
19BTU691	Project – *Viva Voce*	III, IV	k, l	00	00	08	6	40	60	100
ECA / NCC / NSS / Sports / General interest etc.,										Good
Semester total				**11**	**00**	**19**	**22**	**280**	**420**	**700**
Grand Total				**90**	**00**	**90**	**140**	**1880**	**2820**	**4700**

LS: Language course; EN: English course ; ECA: Extra Curricular Activities; NCC: National Cadet Corps; NSS: National Social Service DSE : Discipline Specific Elective

Blue – Employability **Green – Entrepreneurship** **Red- Skill Development**

Ability Enhancement Courses (AEC)		
Semester	**Course Code**	**Name of the Course**
I	19LSU101	Language – I
	19ENU101	English
II	19LSU201	Language – II
	19AEC201	Environmental Studies

Generic Elective Course (GE)/ Allied Course		
Semester	**Course Code**	**Name of the Course**
I	19BTU103	Chemistry - I
	19BTU113	Chemistry Practical - I
II	19BTU202	Chemistry – II
	19BTU212	Chemistry Practical - II

Core Courses (CC)		
Semester	**Course Code**	**Name of the Course**
I	19BTU101	Biochemistry and Metabolism
	19BTU102	Cell Biology
	19BTU111	Biochemistry and Metabolism Practical
	19BTU112	Cell Biology Practical
II	19BTU201	Genetics
	19BTU203	General Microbiology
	19BTU211	Genetics Practical
	19BTU213	General Microbiology Practical
III	19BTU301	Plant Physiology
	19BTU302	Molecular Biology
	19BTU303	Immunology
	19BTU311	Plant Physiology Practical
	19BTU312	Molecular Biology Practical
	19BTU313	Immunology Practical
IV	19BTU401	Bioprocess Technology
	19BTU402	Recombinant DNA Technology
	19BTU403	Genomics and Proteomics
	19BTU411	Bioprocess Technology Practical
	19BTU412	Recombinant DNA Technology Practical
	19BTU413	Genomics and Proteomics Practical
VI	19BTU691	Project – *Viva Voce*

Skill Enhancement Elective Courses (SEC)		
Semester	**Course Code**	**Name of the Course**
III	19BTU304A	I.P.R., Entrepreneurship, Bioethics and Biosafety
	19BTU304B	Bio - Analytical Tool
	19BTU314A	I.P.R., Entrepreneurship, Bioethics and Biosafety Practical
	19BTU314B	Bio - Analytical Tool Practical
IV	19BTU404A	Industrial Fermentation
	19BTU404B	Enzymology
	19BTU414A	Industrial Fermentation Practical
	19BTU414B	Enzymology Practical

V	19BTU501A	Plant Diversity - I
	19BTU501B	Basics of Forensic Science
	19BTU511A	Plant Diversity Practical - I
	19BTU511B	Basics of Forensic Science Practical
VI	19BTU601A	Molecular Diagnostics
	19BTU601B	Biotechnology and Human Welfare
	19BTU611A	Molecular Diagnostics Practical
	19BTU611B	Biotechnology and Human Welfare Practical

Discipline Specific Elective Courses (DSE)		
Semester	**Course Code**	**Name of the Course**
V	19BTU502A	Bioinformatics
	19BTU502B	Plant Diversity - II
	19BTU503A	Plant Biotechnology
	19BTU503B	Evolutionary Biology
	19BTU504A	Animal Biotechnology
	19BTU504B	Animal Diversity - I
	19BTU512A	Bioinformatics Practical
	19BTU512B	Plant Diversity Practical – II
	19BTU513A	Plant Biotechnology Practical
	19BTU513B	Evolutionary Biology Practical
	19BTU514A	Animal Biotechnology Practical
	19BTU514B	Animal Diversity Practical - I
VI	19BTU602A	Medical Microbiology
	19BTU602B	Environmental Biotechnology
	19BTU603A	Biostatistics
	19BTU603B	Environment Management
	19BTU612A	Medical Microbiology Practical
	19BTU612B	Environmental Biotechnology Practical
	19BTU613A	Biostatistics Practical
	19BTU613B	Environment Management Practical

PROGRAMME OUTCOMES (POs)

a) Graduates will acquire in-depth understanding of basic concept, knowledge about biochemistry and cell organelles, their functions for applied field, allied subject and life skills.

b) The students will be able to discuss the metabolic aspects of biomolecules.

c) The Graduates will gain the technical capability of handling, isolating and identifying various organisms from different sources.

d) Understanding and better knowledge of the causes, types and control methods for environmental pollution by the students.

e) The student will be able to discuss the mechanisms associated with gene expression system in prokaryotes and eukaryotes.

f) Understand the role of different types of cells, effectors and effectors mechanisms in immune-technology by the students.

g) Develop skills associated with screening of industrially important strains, various aspects of bioprocess technology and rDNA technology by the graduates.

h) The student will be able to understand the production of enzymes from different sources and enzyme characterization and kinetic actions in living organisms.

i) The student will be able to understand the production of transgenic plants and animals for human and environmental welfare.

j) Understand the basic concepts and modern knowledge of bioinformatics by graduates.

k) Apply the knowledge and skills gained from molecular aspects should be useful in developing new innovations in different life forms by the graduates.

l) The student will be able design, solve the application-oriented problem in biotechnological field through project-based learning.

PROGRAMME SPECIFIC OUTCOMEs (PSOs)

To enable the student to emerge as:

m) Proficiency to work on biotechnological concepts and interdisciplinary areas of science and technology towards product and process development for industrial and academic research applications.

n) An expert in Biotechnology and allied fields (medical, microbial, agricultural, environmental, plant and animal) for utilizing the practical skills to address biotechnological challenges.

o) Proficiency to demonstrate entrepreneurial and leadership skills with life-long learning

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

To impart the following PEOs to the students of Under-graduates in Biotechnology:

PEO I : To obtain detailed information about the fundamentals of Biotechnology, allied subjects and life skills.

PEO II : To provide information about the molecular methods which involved in cellular processes of living systems such as microbes to higher order organisms for applied aspects. To address the emerging need for skilled scientific manpower with research ethics involving organisms.

PEO III : To impart the basics and current molecular tools in the areas of Molecular Diagnostics, Fermentation Technology, Plant, Animal & Environmental Biotechnology are included to train the students for man power development and also sensitize them to scope for research. The practical subjects will provide information about the careers in the industry and applied research where biological system is employed.

PEO IV : To make the graduates of Biotechnology to learn and to adopt in a competitive world of technology update and contribute to all forms of life.

MAPPING OF PEOs AND POs

PEOs	Programme Outcome (s)														
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
PEO I	×	×	×	×											
PEO II					×	×	×	×							
PEO III									×	×	×	×			
PSO IV											×	×	×	×	×

கற்பகம் உயர்கல்வி கலைக்கழகம்
தமிழ்த்துறை
பகுதி - I தமிழ்ப் பாடத்திட்டம் (2019 - 2020)
முதல்பருவம்
(இளநிலை அறிவியல் பட்ட வகுப்புகளுக்குரியது)
(For I-UG Science Degree Classes) 19LSU101

பாடத்திட்டப் பொதுநோக்கம்

- கற்றல் வழி சிந்தனைத் திறனையும், கருத்து வெளிப்பாட்டுத் திறனையும், மேம்படுத்துதல்.
- ஆய்வுநோக்கை மேம்படுத்துதல்.
- இலக்கியங்கள் உணர்த்தும் வாழ்வின் நுட்பமான பகுதிகளை உணர்த்துதல்.
- மனித மனத்தினைப் பக்குவப்படுத்துதலில் இலக்கியம் தரும் பங்கினை உணர்த்துதல்.
- வளர்ந்து வரும் சமூகத்தில் அறஉணர்வு, பண்பாடு போன்றவை குறித்து அறிவூட்டல்.
- அரசுத் தேர்வுகளுக்கு மாணவர்களை ஆயத்தமாக்குதல்.

பாடத்திட்டப் பயன் விளைவு

- இந்திய குடியுரிமைப் பணி முதலான போட்டித் தேர்வுகளில், விருப்பப் பாடமாக இடம்பெறுகின்ற, 'தமிழ் இலக்கிய வரலாறு' குறித்த முழுமையான அறிமுகம் பெற்றிருத்தல்.
- கல்வெட்டியல், ஓலைச்சுவடியியல் மற்றும் தொல்லியல் சார்ந்த ஆவணத் தேடலுக்குரிய ஆய்வுமனப்பான்மையுடன், இலக்கியங்களை அணுகுதல்.
- தமிழின் வளர்ச்சித் துறையாகிய, 'அறிவியல் தமிழ்' ; 'இணைய தமிழ்' குறித்த பன்நோக்கு அணுகுமுறையிலான ஆய்வுச் சிந்தனை மேம்பாடு.
- வேலைவாய்ப்புக்குரிய சுயதிறன் மேம்பாட்டுடன், படைப்பாக்கத்திறன் மேம்பாடும் பெற்றிருத்தல் .
- சமுதாய மற்றும் வாழ்வியல் மதிப்புகளைப் பேணுவதற்குக் கருவியாக இலக்கியங்களை நாடுகின்ற மனப்பான்மை வளர்ச்சி.
- மொழிபெயப்புத் துறைசார்ந்த வேலைவாய்புத் திறன் பெற்றிருத்தல்

தாள்கள் வரிசையும் தேர்வுச் செயல்திட்டமும் பகுதி-I தமிழ்

பருவம்	தாள்	கற்பிக்கும் நேரம்/வாரம்	தேர்வு மணிகள்	மதிப்பெண் அக/எழுத்து	மொத்தம்	மதிப்பீடு
ஒன்று	I	4	3	40 / 60	100	4

அலகு – I : இக்கால இலக்கியம்: (10 மணிநேரம்)

கல்வி : மகாகவி பாரதியார் – சுயசரிதை - ஆங்கிலக் கல்வி.

இன்றைய நிலை : கவிமணி தேசிக விநாயகம் பிள்ளை – ஒற்றுமையே உயிர்நிலை.

மனிதநேயம் : கவிஞர் சிற்பி பாலசுப்பிரமணியன் –மலையாளக் காற்று.

சூழலியல் : கவிஞர். வைதீஸ்வரன் - விரல் மீட்டிய மழை.

பெண்ணியம்: கவிஞர். சுகந்தி சுப்பிரமணியம் – புதையுண்ட வாழ்க்கை.

அலகு – II : அற இலக்கியம்: (10 மணிநேரம்)

கொன்றை வேந்தன்: 1-50 பாடல்கள்

திருக்குறள்: பண்புடைமை, வினைத்திட்பம் – 20 குறள்கள்

பழமொழி நானூறு: 5 பாடல்கள்

அலகு - III : சிற்றிலக்கியம்: (10 மணிநேரம்)

மூவருலா: 1-26 கண்ணிகள்

திருச்செந்தூர் முருகன் பிள்ளைத்தமிழ்: 2 பாடல்கள்

கலிங்கத்துப் பரணி: போர்பாடியது - 9 பாடல்கள்

அலகு – IV : கட்டுரை: (10 மணிநேரம்)

1. **உயர்தனிச் செம்மொழி - பரிதிமாற்கலைஞர்**
2. **கட்டிடக்கலை** - அ. இராசமாணிக்கனார்
3. **வாழ்க்கை** - இளவழகனார்
4. ஆளுமைத்திறன் அறிவோம் - ஸ்ரீகண்ணன்
5. மணற்கேணி - நெ.து.சுந்தரவடிவேலு

அலகு- V : மொழிப்பயிற்சி: (8 மணிநேரம்)

1. பொருத்தமான தமிழ்ச் சொற்களைப் பயன்படுத்துதல்
2. செய்யுள் பொருளுணர் திறன்
3. **மொழிபெயர்ப்பு**ப் பயிற்சிகள்
4. கடிதங்கள் மற்றும் விண்ணப்பங்கள் எழுதுதல்

பாட நூல்: கற்பகச்சோலை – தமிழ் ஏடு. கற்பகம் பல்கலைக்கழகத் தமிழ்த் துறை வெளியீடு.

SEMESTER I

19ENU101 **ENGLISH** **4H - 4C**

Instruction Hours/week: **L:4 T:0 P:0** Marks: Internal:**40** External: **60** Total:**100**

End Semester Exam: 3

Course Objectives

- To train students to acquire proficiency in English.
- To explore different genres of literature and learning grammar.
- To provide aesthetic pleasure through literature.
- To inculcate moral values through literature.
- To develop ethical values.
- To give basic grammar knowledge.

Course Outcome

1. Develop the knowledge of interpersonal skills.
2. Establish and maintain social relationships.
3. Genres of literature will give moral values of life.
4. Develop communication skills in business environment
5. Communication skills will get developed.
6. Develop to have language competence.

UNIT - I : PROSE

1. Morals in the Indian Context - Francis Nicholas Chelliah
2. How Comic Books help us to relive our Childhood - Benoit Peeters
3. Let's Do What India Needs From Us -Dr.A.P.J. Abdul Kalam

UNIT - II : POEM

1. The Stolen Boat - William Wordsworth
2. Telephone Conversation- Wole Soyinka
3. A River - A.K. Ramanujan

UNIT - III : SHORT STORIES

1. Rapunzel - Brothers Grimm
2. The Ant and The Grasshopper- W. Somerset Maugham
3. The Nightingale and the Rose - Oscar Wilde.

UNIT - IV: Drama

1. The Merchant of Venice- Act 4-Scence 1
2. The Death Trap- Saki

UNIT - V: Grammar and Composition

GRAMMAR :

1. Tenses
2. Articles
3. Auxiliaries (Primary and Modal)
4. Tag Questions

Composition:

1. Reading to Comprehend
2. Letter Writing
3. Resume Writing
4. General Essay

Prescribed Text:

Reminisce, Published by the Department of English, Karpagam Academy of Higher Education.

Suggested Reading:

Hewings Martin,1999 Advanced English Grammar, Cambridge
University Press

19BTU101 BIOCHEMISTRY AND METABOLISM 4H - 4C

Instruction Hours/week: **L:4 T:0 P:0** Marks: Internal:**40** External: **60** Total:**100**

End Semester Exam: 3

Course Objectives

The main objectives of the course are,

- To provide clear understanding on the underlying principles, structures and functions of bio molecules.
- To acquire fundamental knowledge about the anabolism and catabolism in living organisms.
- To obtain the facts of metabolism and its disorders in the living system.
- To implement experimental protocols, and adapt them to plan and carry out simple investigations.
- To expose the students to a wide range of careers that combine biology, plants and medicine.
- To understand the principles that govern the structures of macromolecules and their participation in molecular recognition.

Course Outcomes

The learners will be able to,

1. To acquire knowledge on the structure, functional relationship of proteins, nucleic acid, carbohydrates and their roll in various biological processes.
2. To know about the role of various enzymes in metabolic process.
3. To quench the in-depth concepts of metabolism related disorders.
4. To know how genes are transmitted between generations, and how and when errors can arise.
5. To plan and safely perform fundamental techniques in molecular and cellular biology.
6. To get awareness of the ethical aspects of molecular science

UNIT- I

Introduction to macromolecules: Amino acids & Proteins**:** Structure, properties and function of Amino acids and Protein, Amino acid and protein classification. Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.

UNIT-II

Carbohydrates and Metabolism: Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions; Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle.

UNIT-III

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, Role of: NAD+, NADP+, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate, lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions. Photosynthesis – Photosystem I and II.

UNIT-IV

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

UNIT-V

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

References

1. Buchanan, B., Gruissem, W., & Jones, R. (2015). *Biochemistry and Molecular Biology of Plants* (2nd ed.). American Society of Plant Biologists.
2. Nelson, D.L., & Cox, M.M. (2013). *Lehninger: Principles of Biochemistry* (6th ed.). New York: W.H. Freeman and Company.
3. Murray, R.K., Bender, D.A., Botham, K.M. & Kennelly, P.J., (2012). *Harper's illustrated Biochemistry* (29th ed.). London: McGraw-Hill Medical.
4. Berg, J. M., Tymoczko, J. L., & Stryer, L. (2006). *Biochemistry* (6th ed.). Newyork : W.H. Freeman &Company.
5. Hopkins, W.G., & Huner, P.A. (2008). *Introduction to Plant Physiology* (2nd ed.). John Wiley & Sons.

Instruction Hours/week: **L:4 T:0 P:0** Marks: Internal:**40** External: **60** Total:**100**
End Semester Exam: 3

Course Objectives
The main objectives of the course are,

- To provide the fundamental knowledge on structures and role of basic components in prokaryotic and eukaryotic cells.
- To understand the structures and role of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
- To understand the mechanism of cellular components underlying mitotic cell division.
- To understand how energy is used and generated in cells.
- To understand that evolution entails changes in the genetic composition of cells.
- To understand the gene expression regulation during embryogenesis and mis-regulation in carcinogenesis.

Course Outcomes
The learners will be able to,

1. Understand the composition of prokaryotic and eukaryotic cells and its function.
2. Acquire information about intracellular and extracellular organelles and their functions.
3. Gain their knowledge to prevent cellular abnormalities and associated disorders.
4. Test and deepen their mastery of genetics by applying this knowledge in a variety of problem-solving situations.
5. Apply their knowledge of cell biology to selected examples of changes or losses in cell function.
6. Apply their knowledge of causal relationships between molecule/cell level phenomena ("modern" genetics) and organism-level patterns of heredity ("classical" genetics).

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

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

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

UNIT-IV
Cell organelles: Lysosomes, Vacuoles and micro bodies: Structure and functions Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis Nucleus: Structure and function, chromosomes and their structure.

UNIT-V

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

References

1. Karp, G. (2013). *Cell and Molecular Biology: Concepts and Experiments* (7th ed.). Hoboken, US: John Wiley & Sons. Inc.
2. Cooper, G.M., & Hausman, R.E. (2013). *The Cell: A Molecular Approach* (6th ed.). Washington, USA: ASM Press & Sunderland, D.C., Sinauer Associates.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J., & Bertoni, G. P. (2009). *The World of the Cell* (7th ed.). San Francisco: Pearson Benjamin Cummings Publishing.
4. De Robertis, E.D.P., & De Robertis, E.M.F. (2006). *Cell and Molecular Biology* (8th ed.). Lippincott Williams and Wilkins, Philadelphia.

19BTU103 **CHEMISTRY-1** **4H - 4C**

Instruction Hours/week: **L:4 T:0 P:0** Marks: Internal:**40** External: **60** Total:**100**

End Semester Exam: 3

Course Objectives

The student should know

- The molecular orbital theory, preparation and properties of inorganic compounds.
- Theory of covalent bond, polar effects and stereochemistry of organic compounds.
- About important industrial chemicals like silicones, fuel gases and fertilizers and their impact on environment.
- Elements of photochemistry, chemical kinetics and chromatography.
- About the dyes, chemotherapy and vitamins.
- About the Column, Paper and Thin Layer Chromatography.

Course Outcomes

The student understands

1. The molecular orbital theory, preparation and properties of inorganic compounds.
2. Theory of covalent bond, polar effects and stereochemistry of organic compounds.
3. About important industrial chemicals like silicones, fuel gases and fertilizers and their impact on environment.
4. Elements of photochemistry, chemical kinetics and chromatography.
5. About the dyes, chemotherapy and vitamins.
6. Principles and applications of Column, Paper and Thin Layer Chromatography.

UNIT-I

Chemical Bonding: Molecular orbital theory-linear combination of atomic orbitals-bonding and antibonding molecular orbitals-energy level diagram-bond order- M.O. configuration of H_2, N_2 and F_2 molecules. Diborane: Preparation, properties and structure. $NaBH_4$: Preparation and uses. Borazole: Preparation and properties. Interhalogen compounds: ICl, BrF_3, IF_5 - preparation, properties, uses and structure. Basic properties of iodine. Compounds of sulphur: Sodium hydrosulphite- preparation, properties, uses and structure. Per acids of sulphur: Preparation, properties, uses and structure.

UNIT- II

Covalent Bond: Orbital overlap, hybridization and geometry of CH_4, C_2H_4 and C_2H_2. Polar effects: Inductive effect-electromeric effect- mesomeric effect- steric effect- hyperconjugation.

Stereoisomerism: Elements of symmetry-polarised light and optical activity-isomerism in tartaric acid-racemisation- resolution- geometrical isomerism of maleic and fumaric acids-keto-enol tautomerism of acetoacetic esters.

UNIT-III

Industrial Chemistry: Silicones: Synthesis, properties and uses. Fuels gases: Natural gas-water gas-semi water gas-carbureted water gas-producer gas- oil gas (Manufacturing details not required) Fertilizers: NPK fertilizer-ammonium sulphate-urea-superphosphate of lime-triple superphosphate-potassium nitrate-ammonium nitrate. Pollution: Water, air and soil pollution-sources and remedies-acid rain-ozone hole-greenhouse effect.

UNIT-IV

Elements of Photochemistry, Chemical Kinetics and Chromatography: Elements of Photochemistry: Photochemical laws-Beer Lambert's law-Grotthuss-Draper law-Stark-Einstein law (statement only).

Chemical Kinetics: Rate-order-molecularity-pseudo first order reactions-zero order reactions-determination of order of reaction-measurement of order and rates of reactions-effect of temperature on reaction rate-energy of activation.
Chromatography: Principles and applications of Column, Paper and Thin Layer Chromatography.

UNIT- V
Dyes, Chemotherapy and Vitamins: Dyes: Terms used chromophore, auxochrome, bathachromic shift and hypochromic shift- classification of dyes – based on chemical structure and application-one example each for azo, triphenylmethane, vat and mordant dyes- preparation. **Chemotherapy:** Preparation, uses and mechanism of action sulpha drugs- preparation and uses of prontosil, sulphadiazine and sulphafurazole-structure and uses of penicillin and chloromycetin. **Vitamins:** Diseases caused by the deficiency of vitamins A, B_1, B_2, C and D-sources of these vitamins.

References

1. Veeraiyan, V., & Vasudevan, A.N.S. (2005). *Text Book of Allied Chemistry* (2nd ed.). Chennai: Highmount Publishing House.
2. Puri, B.R., & Sharma L.R. (2002). *Principles of Inorganic Chemistry*. Jalandar: Shoban lal & Company Ltd.
3. Bahl, B.S., & Arun Bahl, (2005). *Advanced Organic Chemistry.* New Delhi: S.Chand & Company Ltd.
4. Puri, Sharma & Pathania, (2003). *Physical Chemistry.* Jalandhar: Vishal Publishing Company Ltd.
5. Gopalan, R. & Sundaram, S. (2003). *Allied Chemistry* (3rd ed.). New Delhi: Sultan Chand & Sons.

19BTU111 BIOCHEMISTRY & METABOLISM PRACTICAL 4H - 2C

Instruction Hours/week: **L:4 T:0 P:0** Marks: Internal:**40** External: **60** Total:**100**

End Semester Exam: 3

Course Objectives

The main objectives of the course are,

- To acquire skill on various experimental methods and techniques on order to analyze the given biological samples.
- To know the standard procedures for handling the biochemical assays and instruments.
- To know the threshold levels of primary biochemical markers.
- To analyze common organic reagents and compounds based on their properties.
- To analyze biological compounds from unknown mixture/origin.
- To Understand Good laboratory practices in a laboratory.

Course Outcomes

The learners will be able to,

1. Gain skills on quantitative estimation methods for various biomolecules from natural sources.
2. Acquire handling skills to handle the spectroscopy instrumentations.
3. Obtain skills on primary screening of biochemical markers in samples.
4. Develop skills to prepare useful reagents in the laboratory.
5. Use of handling of glass wares, minor equipment for conducting experiments.
6. Learn safety and precautionary measures for working in a laboratory.

Practical

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

References

1. Buchanan, B., Gruissem, W., & Jones, R. (2015). *Biochemistry and Molecular Biology of Plants* (2nd ed.). American Society of Plant Biologists.
2. Nelson, D.L., & Cox, M.M. (2013). *Lehninger: Principles of Biochemistry* (6th ed.). New York: W.H. Freeman and Company.
3. Murray, R.K., Bender, D.A., Botham, K.M., & Kennelly, P.J., (2012). *Harper's illustrated Biochemistry* (29th ed.). London : McGraw-Hill Medical.
4. Berg, J. M., Tymoczko, J. L., & Stryer, L. (2006). *Biochemistry* (6th ed.). Newyork : W.H. Freeman &Company.
5. Hopkins, W.G., & Huner, P.A. (2008). *Introduction to Plant Physiology* (2nd ed.). John Wiley & Sons.

19BTU112 CELL BIOLOGY PRACTICAL 3H - 2C

Instruction Hours/week: **L:4 T:0 P:0** Marks: Internal:**40** External: **60** Total:**100**

End Semester Exam: 3

Course Objectives

The main objectives of the course are,

- To enable students to learn the basics of prokaryotic and eukaryotic cells
- To develop practical biological skills such as staining, sterilization, dialysis etc.
- To prepare students for subsequent biological courses that require an understanding of the physiology of organisms such as cell division, enzyme activity etc.
- To understand the basics of techniques to study cells.
- To prepare students to handle the equipment available and identify the suitable and appropriate experiments for their experiments.
- To learn aseptic techniques and microbial culture methods.

Course Outcomes

The learners will be able to,

1. Understand the unique features of plant and animal cells.
2. Gain the practical skills on tissue mounting techniques to visualize the cell morphology.
3. Acquire knowledge about cell's response to various environmental conditions.
4. Able to differentiate the cells of various living organisms and get awareness of physiological processes of cell.
5. Able to observe and correctly identify different cell types, cellular structures using different microscopic techniques.
6. Able to handle the equipment available and identify the suitable and appropriate experiments for their experiments.

Practical

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

References

1. Karp, G. (2013). *Cell and Molecular Biology: Concepts and Experiments* (7th ed.). Hoboken, US: John Wiley & Sons. Inc.
2. De Robertis, E.D.P., & De Robertis, E.M.F. (2006). *Cell and Molecular Biology* (8th ed.). Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M., & Hausman, R.E. (2013). *The Cell: A Molecular Approach* (6th ed.). Washington, USA: ASMPress & Sunderland, D.C., Sinauer Associates.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J., & Bertoni, G. P. (2009). *The World of the Cell* (7th ed.). San Francisco: Pearson Benjamin Cummings Publishing.

19BTU113 CHEMISTRY -1 PRACTICAL 3H - 2C

Instruction Hours/week: **L:0 T:0 P:3** Marks: Internal:**40** External: **60** Total:**100**

End Semester Exam: 3

Course Objectives

- To make the student able to identify the elements and the functional groups present in an organic compound
- This helps students to gain experience to predict the functional group transformations, simple reaction mechanisms
- To know about synthesis of organic molecules by multi-step synthesis strategies
- In addition of that, the course will also help students to understand the reaction mechanism subjects in later stages of their study
- They will be able to evaluate critically chemistry-related information from a variety of sources
- They will understand how chemical principles are applied to address current problems in a variety of fields

Course Outcomes

On successful completion of the course the students should have

1. Learnt about the qualitative analysis of organic compounds.
2. Learnt the detection of elements and functional groups present in an organic compound by systematic analysis.
3. Recognize various organic functional groups.
4. Understand the types of reactions in Organic Chemistry.
5. To provide laboratory experience to the students by performing experiments
6. Based on topics: surface chemistry, photochemistry and macromolecules.

Practical

Systematic analysis of an organic compound

- Preliminary tests
- Detection of elements present
- Aromatic or aliphatic
- Saturated or unsaturated
- Nature of the functional group,
- Confirmatory tests– aldehydes, ketones, amines, diamide, carbohydrates, phenols, acids, esters & nitro compounds.

Note: Each student should analyse minimum 6 compounds.

References

1. Thomas, A.O. (2010). *Practical Chemistry for B.Sc. Main Students*. Cannanore: Kerala, Scientific Book Centre.
2. Ramasamy, R. (2008). *Allied Chemistry Practical Book*. Karur: Priya Publications.
3. Venkateswaran, V., Veeraswamy, R., & Kulandaivelu, A. R. (2004). *Basic Principles of Practical Chemistry* (2nd ed.). New Delhi: S. Chand Publications.

பகுதி - I தமிழ்ப் பாடத்திட்டம் (2019 - 2020)
இரண்டாம் பருவம்
(இளநிலை அறிவியல் பட்ட வகுப்புகளுக்குரியது)
(For I-UG Science Degree Classes) 19LSU201

பாடத்திட்டப் பொதுநோக்கம்

- கற்றல் வழி சிந்தனைத் திறனையும், கருத்து வெளிப்பாட்டுத் திறனையும், மேம்படுத்துதல்.
- ஆய்வுநோக்கை மேம்படுத்துதல்.
- இலக்கியங்கள் உணர்த்தும் வாழ்வின் நுட்பமான பகுதிகளை உணர்த்துதல்.
- மனித மனத்தினைப் பக்குவப்படுத்துதலில் இலக்கியம் தரும் பங்கினை உணர்த்துதல்.
- வளர்ந்து வரும் சமூகத்தில் அறஉணர்வு, பண்பாடு போன்றவை குறித்து அறிவூட்டல்.
- அரசுத் தேர்வுகளுக்கு மாணவர்களை ஆயத்தமாக்குதல்.

பாடத்திட்டப் பயன் விளைவு

- இந்திய குடியுரிமைப் பணி முதலான போட்டித் தேர்வுகளில், விருப்பப் பாடமாக இடம்பெறுகின்ற, 'தமிழ் இலக்கிய வரலாறு' குறித்த முழுமையான அறிமுகம் பெற்றிருத்தல்.
- கல்வெட்டியல், ஓலைச்சுவடியியல் மற்றும் தொல்லியல் சார்ந்த ஆவணத் தேடலுக்குரிய ஆய்வுமனப்பான்மையுடன், இலக்கியங்களை அணுகுதல்.
- தமிழின் வளர்ச்சித் துறையாகிய, 'அறிவியல் தமிழ்' ; 'இணைய தமிழ்' குறித்த பன்நோக்கு அணுகுமுறையிலான ஆய்வுச் சிந்தனை மேம்பாடு.
- வேலைவாய்ப்புக்குரிய சுயதிறன் மேம்பாட்டுடன், படைப்பாக்கத்திறன் மேம்பாடும் பெற்றிருத்தல் .
- சமுதாய மற்றும் வாழ்வியல் மதிப்புகளைப் பேணுவதற்குக் கருவியாக இலக்கியங்களை நாடுகின்ற மனப்பான்மை வளர்ச்சி.
- மொழிபெயப்புத் துறைசார்ந்த வேலைவாய்புத் திறன் பெற்றிருத்தல்

தாள்கள் வரிசையும் தேர்வுச் செயல்திட்டமும் பகுதி-I தமிழ்

பருவம்	தாள்	கற்பிக்கும் நேரம்/வாரம்	தேர்வு மணிகள்	மதிப்பெண் அக/எழுத்து	மொத்தம்	மதிப்பீடு
இரண்டு	II	4	3	40 / 60	100	4

அலகு – I : பக்தி இலக்கியம் (10 மணிநேரம்)

சைவ, வைணவ இலக்கியங்கள் - தோற்றம் ,வளர்ச்சி, வரலாறு.

1. சைவம் - பெரியபுராணம் - திருமூலநாயனார் புராணம்.
2. வைணவம் - பெரியாழ்வார் திருமொழி: 10 பாடல்கள்.

அலகு – II : சங்க இலக்கியம் : (15 மணிநேரம்)

சங்க இலக்கியங்கள் அறிமுகம்

அ). எட்டுத்தொகை

நற்றிணை : பிரசம் கலந்த – பாலை -110

குறுந்தொகை : கருங்கட்டாக் கலை – குறிஞ்சி- 69

ஐங்குறுநூறு : நெய்தல்-தொண்டிப்பத்து: திரைஇமிழ் இன்னிசை- 181

பதிற்றுப்பத்து : சிதைந்தது மன்ற - 27

பரிபாடல்: பரிபாடல் திரட்டு-மதுரை நகர்ச்சிறப்பு –
உலகம் ஒரு நிறையாத்தான்-6, மாயோன் கொப்பூழ்-7, செய்யாட்கு இழைத்த-9, கார்த்திகை காதில்-10, ஈவாரைக் கொண்டாடி-11.

கலித்தொகை : சுடர்தொடீ கேளாய்: குறிஞ்சிக்கலி- 36

அகநானூறு : அன்னாய் வாழி வேண்டன்னை - குறிஞ்சி - 48

புறநானூறு : யாதும் ஊரே யாவருங் கேளிர் –பொதுவியல்- 192

ஆ). பத்துப்பாட்டு

திருமுருகாற்றுப்படை - பழமுதிர்ச்சோலையின் சிறப்பு
முருகன் இருப்பிடங்கள் – 'சிறுதினை மலரொடு' என்பதிலிருந்து தொடங்கி,
'அறிந்தவாறே' என்பது வரையிலான தொடர்கள்: 218-249.
முருகன் அருள்புரிதல் – 'தெய்வம் சான்ற' என்பதிலிருந்து தொடங்கி,
'நல்குமதி' என்பது வரையிலான தொடர்கள்: 286-295.

அலகு - III : காப்பியம் (6 மணிநேரம்)

சிலப்பதிகாரம்:

மங்கல வாழ்த்துப் பாடல்: (21-29) – கண்ணகியின் சிறப்பு: 'நாகநீள் நகரொடு' என்பதிலிருந்து தொடங்கி,
'கண்ணகி என்பாண் மன்னோ' என்பது வரையிலான தொடர்கள்.

நடுகற்காதை: (207-234) - சேரன் செங்குட்டுவன் கண்ணகிக்குக் கோயில் எடுத்தல்: 'அருந்திறலரசர்' என்பதிலிருந்து தொடங்கி, 'மன்னவரேறென்' என்பது வரையிலான தொடர்கள்.

வாழ்த்துக்காதை: (482-485) - செங்குட்டுவனுக்குக் கண்ணகி காட்சியளித்தல்: 'என்னே' என்பதிலிருந்து தொடங்கி, 'விசும்பில் தோன்றுமால்' என்பது வரையிலான தொடர்கள்.

வழக்குரை காதை: பத்தினிப் பெண்டிர் எழுவர் கதை: 'நீர்வார் கண்ணை' என்பதிலிருந்து தொடங்கி, 'புகாரென் பதியே' என்பது வரையிலான தொடர்கள்.

வஞ்சினமாலை: 'வன்னி மரமும்' என்பதிலிருந்து தொடங்கி, 'பதிப்பிறந்தேன்' என்பது வரையிலான தொடர்கள்.

அலகு – IV : சிறுகதை (10 மணிநேரம்)

1. குளத்தங்கரை அரசமரம் – வ.வே.சு.ஐயர்
2. காட்டில் ஒரு மான் - அம்பை
3. நாற்காலி – கி.ராஜநாராயணன்
4. நகரம் – சுஜாதா

அலகு- V : மொழிப்பயிற்சி (7 மணிநேரம்)

படைப்பிலக்கியப் பயிற்சிகள் (கதை, கவிதை, கட்டுரை, உரைநடை)
மொழிபெயர்ப்பு

பாட நூல்: கற்பகச்சோலை – தமிழ் ஏடு. கற்பகம் பல்கலைக்கழகத் தமிழ்த் துறை வெளியீடு.

SEMESTER II

19BTU201 **GENETICS** **4H - 4C**

Instruction Hours/week: **L:4 T:0 P:0** Marks: Internal:**40** External: **60** Total:**100**

End Semester Exam: 3

Course Objectives

The main objectives of the course are,

- To deliver the basic concepts of heredity in different living organisms
- To gain the information about the level of genome organization in various living organisms
- To obtain the knowledge about transmission of genetic information across generation at the individual and population level
- To understand how to identify and classify mutations in DNA.
- To relate the structure and function of the DNA molecule to its functional role in encoding genetic material.
- To describe the basic aspects of the flow of genetic information from DNA to proteins.

Course Outcomes

The learners will be able to,

1. Acquire knowledge about the central theories and methodologies traditional, molecular and population genetics.
2. Acquire information on sex- linked inheritance and associated diseases.
3. Understand the role of genetics in breeding and natural selection.
4. Apply the principles of inheritance as formulated by Mendel.
5. Apply the Hardy-Weinberg Law in analysing population genetics for gene frequency, sex linkage, equilibrium, and heterozygote frequency.
6. Acquire knowledge about the relationship between genetic, physical, and cytogenetic maps.

UNIT- I

Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance. Prokaryotic genetics. Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms.

UNIT-II

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

UNIT-III

Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition – unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, repetitive transposed sequences- SINEs & LINEs. Genetic organization of prokaryotic and viral genome. Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. Concept of cistron, exons, introns, genetic code, gene function.

UNIT-IV

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian).

Sex determination, sex linkage, sex linked diseases: Mechanisms of sex determination, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

UNIT-V

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over. Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting. Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.

References

1. Gardner, E.J., Simmons, M.J., & Snustad, D.P. (2006). *Principles of Genetics* (8th ed.). John Wiley & Sons.
2. Snustad, D.P., & Simmons, M.J. (2009). *Principles of Genetics* (5th ed.). USA: John Wiley and Sons Inc.
3. Russell, P. J. (2009). *Genetics- A Molecular Approach* (3rd ed.). Benjamin Cummings.
4. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C., & Carroll, S.B. (2007). *Introduction to Genetic Analysis* (9th ed.). W. H. Freeman & Co.

Instruction Hours/week: **L:4 T:0 P:0** Marks: Internal:**40** External: **60** Total:**100**
End Semester Exam: 3

Course Objectives

- To make the student to be conversant with the extraction of metals, coordination chemistry, preparation, properties uses and structure of naphthalene and heterocyclic compounds.
- To make the student acquire sound knowledge of electrochemistry, biological functions of amino acids and proteins, thermodynamic laws, entropy, enthalpy change and the principles of electroplating.
- The student will understand the interdisciplinary nature of chemistry and to integrate knowledge of mathematics, physics and other disciplines to a wide variety of chemical problems.
- The student will learn the laboratory skills needed to design, safely conduct and interpret chemical research.
- The student will acquire a foundation of chemistry of sufficient breadth and depth to enable them to understand and critically interpret the primary chemical literature.
- The student will understand the importance of the Periodic Table of the Elements, how it came to be, and its role in organizing chemical information

Course Outcomes

1. The students will be able to understand the metallurgy of metals
2. The students will be able to understand the theories of coordination compounds and the industrial importance of EDTA, haemoglobin and chlorophyll.
3. The students will be able to understand the concept of aromaticity and preparation of aromatic compounds including heterocyclic compounds.
4. The students will be able to understand the preparation, classifications and properties of amino acids, proteins and carbohydrates.
5. The students will be able to understand the concepts of first and second laws of thermodynamics.
6. The students will be able to understand the fundamentals of electrochemistry.

Unit-I

Metals and Coordination Chemistry:

Metals: General methods of extraction of metals-methods of ore dressing-types of furnaces-reduction methods-electrical methods-types of refining-Van Arkel Process-Zone refining.

Coordination Chemistry: Nomenclature-theories of Werner, Sidgewick and Pauling-chelation and its industrial importance-EDTA-haemoglobin-chlorophyll-applications in qualitative and quantitative analysis.

Unit-II

Aromatic Compounds and Heterocyclic Compounds:

Aromatic Compounds: Aromaticity-Huckel's (4n+2) rule- aromatic electrophilic substitution in benzene- mechanism of nitration, halogenation, alkylation, acylation and sulphonation. Naphthalene: Isolation, preparation, properties and structure. **Heterocyclic Compounds:** Preparation and properties of pyrrole, furan, thiophene and pyridine.

Unit-III

Amino acids, Proteins and Carbohydrates: Amino acids: Classification, preparation and properties. Peptides-preparation of peptides (Bergmann method only). **Proteins:** Classification, properties, biological functions and structure. **Carbohydrates:** Classification, preparation and properties of glucose

and fructose- discussion of open chain and ring structures of glucose and fructose-glucose-fructose interconversion.

Unit-IV

Energetics: Type of systems-processes and their types - isothermal, adiabatic, reversible, irreversible and spontaneous processes-statement of first law of thermodynamics-need for the second law of thermodynamics-heat engine-Carnot cycle-efficiency-Carnot theorem-thermodynamics scale of temperature-Joule-Thomson effect- Enthalpy- Entropy and its significance-Free energy change.

Unit-V

Electrochemistry: Kohlrausch law-conductometric titrations-hydrolysis of salts-galvanic cells-E.M.F.-standard electrode potentials-reference electrodes- electrochemical series and its applications-buffer solution-buffer solution in the biological systems-pH and its determination-principles of electroplating.

References

1. Veeraiyan, V., & Vasudevan, A.N.S. (2005). *Text Book of Allied Chemistry* (2nd ed.). Chennai: High mount Publishing House.
2. Puri, B.R., & Sharma L.R. (2002). *Principles of Inorganic Chemistry*. Jalandar: Shoban lal & Company Ltd.
3. Bahl, B.S., & Arun Bahl, (2005). *Advanced Organic Chemistry*. New Delhi: S.Chand & Company Ltd.
4. Puri, Sharma & Pathania, (2003). *Physical Chemistry*. Jalandhar: Vishal Publishing Company Ltd.
5. Gopalan, R. & Sundaram, S. (2003). *Allied Chemistry* (3rd ed.). New Delhi: Sultan Chand & Sons.

19BTU203 GENERAL MICROBIOLOGY 5H - 5C

Instruction Hours/week: **L:5 T:0 P:0** Marks: Internal:**40** External: **60** Total:**100**

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are

- To inculcate knowledge on fundamentals of microorganisms.
- To learn the structural organization, morphology and reproduction of microbes.
- To know the principles of Microscopy and advancements in Microscopy
- To deal with the study of genetic, metabolic strategies and ecology of microorganisms.
- To learn the basic knowledge of the main microbiological techniques to be applied in the laboratory.
- To develop understanding about microbial metabolism, growth, energy generation and disease caused.

Course Outcomes

On completion of the course, students are able to

1. Gain rigorous knowledge on historical perspective of Microbiology
2. Acquire basic knowledge on different structure of microbes.
3. Get Ideas on different type of microscope.
4. Acquire basic knowledge the different applications of microbiology in biotechnology.
5. Acquire basic knowledge of genetic, metabolic strategies and ecology of microorganisms.
6. Acquire basic knowledge about microbial metabolism, growth, energy generation and disease caused.

UNIT-I

Fundamentals, History, Scope and Evolution of Microbiology: Classification of microorganisms: Microbial taxonomy, criteria used to include molecular approaches, Microbial phylogeny and current classification of bacteria.

UNIT-II

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

UNIT-III

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, Media, Types of media, Methods of isolation, Stating and types, Purification and preservation.

UNIT-IV

Microbial growth: Growth curve, Microbial growth kinetics, batch and continuous culture, Measurement of growth, growth factors, factors affecting growth of bacteria. Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

UNIT-V

Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal. Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.

References

1. Aneja, K.R., & Mehrotra, R.S. (2015). *An Introduction to Mycology* (2nd ed.). New Age International.
2. Jay, J.M., Loessner, M.J., & Golden, D.A. (2005). *Modern Food Microbiology* (7th ed.). Delhi: India, CBS Publishers and Distributors.
3. Robert Edward Lee, (2008). *Phycology* (4th ed.). Cambridge University Press.
4. Madigan, M.T., Martinko, J.M., & Parker, J. (2010). *Brock Biology of Microorganisms*. (13th ed.). Pearson/Benjamin Cummings.
5. Willey, J.M., Sherwood, L.M., & Woolverton, C.J. (2008). *Prescott, Harley and Klein's Microbiology* (7th ed.). McGraw Hill Higher Education.
6. Tortora ,G.J., Funke, B.R., & Case ,C.L. (2008). *Microbiology: An Introduction* (9th ed.). Pearson Education.
7. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., & Painter, P.R. (2005). *General Microbiology* (5th ed.). McMillan.
8. Pelczar, M.J., Chan, E.C.S., & Krieg, N.R. (1993). *Microbiology* (5th ed.). McGraw Hill Book Company

19BTU211 GENETICS PRACTICAL 3H - 2C

Instruction Hours/week: **L:0 T:0 P:3** Marks: Internal:**40** External: **60** Total:**100**

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are,

- To learn about prokaryotic and eukaryotic genetic system using modern techniques.
- To inculcate knowledge on cell division stages.
- To develop skills on cell mounting techniques.
- To develop skills on karyotyping
- To inculcate knowledge on pedigree analysis.
- To learn about the mendelian laws and the experiment outcomes.

Course Outcomes

The learners will be able to

1. Gain rich knowledge on genetic model system used in research.
2. Acquire basic knowledge on different stages in cell division.
3. Get Ideas on pedigree analysis for detection of genetic disorders.
4. Acquire basic knowledge on karyotyping
5. Acquire basic knowledge of genetic variations among microorganisms.
6. Apply the principles of inheritance as formulated by Mendel.

Practical

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

References

1. Snustad, D.P., & Simmons, M.J. (2009). *Principles of Genetics* (5th ed.). USA: John Wiley and Sons Inc.
2. Klug, W.S., Cummings, M.R., & Spencer, C.A. (2009). *Concepts of Genetics* (9th ed.). Benjamin Cummings.
3. Gardner, E.J., Simmons, M.J., & Snustad, D.P. (2006). *Principles of Genetics* (8th ed.). John Wiley & Sons.
4. Russell, P. J. (2009). *Genetics- A Molecular Approach* (3rd ed.). Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C., & Carroll, S.B. (2007). *Introduction to Genetic Analysis* (9th ed.). W. H. Freeman & Co.

19BTU212 CHEMISTRY PRACTICAL - II 3H - 2C

Instruction Hours/week: **L:0 T:0 P:3** Marks: Internal:**40** External: **60** Total:**100**

End Semester Exam: 3 Hours

Course Objectives

- The student on successful completion of the course should learn the principles of volumetric analysis
- To estimate the compounds by acidimetry, alkalimetry and permanganometry.
- Experimental practice of quantitative volumetric analysis.
- The objective of the titration is the determination of the concentration or the mass of the minimum formula from the titrated chemical material composing a pure liquid or a solution.
- The main objective of volumetric analysis is to determine the amount of a substanceϖ in a given sample.
- When dealing with volumetric analysis the concept of concentration cannot be avoided. Molarity i.e. moles per litre or decimeter is widely used unit of concentration.

Course Outcomes

1. Student will be able to learn the principles of quantitative analysis of inorganic compounds.
2. Student will be able to learn the estimation of sample present in a solution by volumetric analysis
3. Understand the concepts of quantitative analysis
4. Recognize the indicators, acid and bases used in volumetric analysis
5. Estimate the amount of substance present in a given solution
6. Utilize the mathematical skills doing calculations

Practical
Volumetric Analysis

A. Acidimetry & Alkalimetry

1. Estimation of sodium carbonate using standard sodium hydroxide.
2. Estimation of sodium hydroxide using standard sodium carbonate.
3. Estimation of sulphuric acid using standard oxalic acid.
4. Estimation of potassium permanganate using standard sodium hydroxide.

B. Permanganometry

1. Estimation of ferrous sulphate using standard Mohr's salt.
2. Estimation of oxalic acid using standard ferrous sulphate.
3. Estimation of calcium-direct method.

References

1. Ramasamy, R. (2008). *Allied Chemistry Practical Book*. Karur: Priya Publications.
2. Thomas, A.O. (2010). *Practical Chemistry for B.Sc. Main Students.* Cannanore: Kerala, Scientific Book Centre.
3. Venkateswaran, V., Veeraswamy, R., & Kulandaivelu A. R. (2004). *Basic Principles of Practical Chemistry* (2nd ed.). New Delhi: S. Chand Publications.

19BTU213 GENERAL MICROBIOLOGY PRACTICAL 4H - 2C

Instruction Hours/week: **L:0 T:0 P:4** Marks: Internal:**40** External: **60** Total:**100**

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are

- To understand the basic principles of microscopy ultra-structure of microbes along with staining and sterilization methods
- To understand various accessories for microbiology practicals.
- To acquaint the students with various aspects of basic and applied microbiology.
- To understand the biochemical characterization of isolated microbes.
- To develop practical biological skills such as staining, sterilization etc.
- To develop skills on primary screening of microorganisms.

Course Outcomes

On completion of the course, students are able to

1. Develop basic skill in aseptic techniques
2. Have outline knowledge on isolation, sub culture and maintenance of microbes.
3. Gain experience in microbiological laboratory practices and skills in the design and execution of microbiology related research.
4. Develop skills to prepare useful medias for microbial growth in the laboratory.
5. Use of handling of glass wares, minor equipment for conducting experiments.
6. Learn safety and precautionary measures for working with microbes in a laboratory.

Practical

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

References

1. Brooks, G.F, Carroll, K.C., Butel, J.S., & Morse, S.A. (2007). Jawetz, Melnick and Adelberg's *Medical Microbiology* (24th ed.). McGraw Hill Publication.
2. Goering, R., Dockrell, H., Zuckerman, M., & Wakelin, D. (2007). *Mims' Medical Microbiology* (4th ed.). Elsevier.
3. Willey, J.M., Sherwood, L.M., & Woolverton, C.J. (2008). *Prescott, Harley and Klein's Microbiology* (7th ed.). McGraw Hill Higher Education.

SEMESTER – II

19AEC201 ENVIRONMENTAL STUDIES 4H – 4C

Instruction Hours/week: **L:3 T:0 P:0** Marks: Internal:**40** External: **60** Total:**100**

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are,

- To create awareness about environmental problems among people.
- To develop an attitude of concern for the environment.
- To motivate public to participate in environment protection and improvement.
- To learn about the environment, resources available, biodiversity and its conservation
- To understand the current scenarios- to find ways for protection and betterment of or habitat.
- To understand the concepts and methodologies to analyze the interactions between social and environmental processes.

Course Outcomes

The learners will be able to,

1. Understand the concepts and methods from ecological and physical sciences and their application in environmental problem solving.
2. Study the concepts and methods from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.
3. Learn the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
4. Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales.
5. Apply systems concepts and methodologies to analyse and understand interactions between social and environmental processes.
6. Creating the awareness about environmental problems among people.

UNIT-I

Environment: Definition, scope and importance, components, Ecosystem Definition, Classification of ecosystem, Concept, Structure and functions of ecosystem. Energy flow, Food chains and food webs, Ecological succession.

UNIT-II

Natural Resources: - Renewable and Non-renewable Resources: Natural resources and associated problems. Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources: Use and over-utilization, exploitation. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. Ill-effects of fire works.

UNIT-III

Biodiversity and Its Conservation: Introduction, definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive, productive, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. India as a mega-diversity nation. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

UNIT-IV

Environmental Pollution: - Definition, Causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: Floods, earthquake, cyclone and landslides.

UNIT-V

Social Issues and the Environment: From unsustainable to sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Climate change, nuclear accidents and holocaust. Case studies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. Population growth, variation among nations. Population explosion—Family Welfare Programme. Environment and human health. Human rights. Value education. HIV/AIDS. Women and Child Welfare. Role of Information Technology in environment and human health.

References

1. Tripathy.S.N., & Sunakar Panda. (2004). *Fundamentals of Environmental Studies* (2nd ed.). New Delhi: Vrianda Publications Private Ltd.
2. Arvind Kumar, (2004). *A Textbook of Environmental Science.* New Delhi: APH Publishing Corporation.
3. Verma, P.S., & Agarwal, V.K. (2001). *Environmental Biology (Principles of Ecology).* New Delhi: S.Chand and Company Ltd.
4. Anubha Kaushik, & Kaushik C.P. (2004). *Perspectives in Environmental Studies.* New Delhi: New Age International Pvt. Ltd. Publications.
5. Singh, M.P., & Singh B.S., & Soma Dey S. (2004). *Conservation of Biodiversity and Natural Resources.* New Delhi: Daya Publishing House.
6. Daniel Botkin B., & Edward Keller A. (1995). *Environmental Science.* New York: John Wiley and Sons, Inc.
7. Uberoi, N.K. (2005). *Environmental Studies.* New Delhi: India, Excel Books Publications.

SEMESTER III

19BTU301 PLANT PHYSIOLOGY 4H - 4C

Instruction Hours/week: **L:4 T:0 P:0** Marks: Internal:**40** External: **60** Total:**100**

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are,

- To understand the physiological conditions of the plants and metabolism.
- To understand the basic concepts of Photosystems and their importance in plant growth.
- To gain the information about the economic importance of algae and fungi.
- To develop familiarity with plant development, biochemistry, and metabolism.
- To be familiar with cutting edge technology employed in contemporary plant biology.
- To integrate their knowledge of plant physiology to relevant cultural, social, and legal aspects of their lives.

Course Outcomes

The learners will be able to,

1. Gain adequate knowledge on plant biodiversity and importance.
2. Understand the molecular mechanisms of macro and micro nutrients in plant growth.
3. Get the basic and applied knowledge of plant physiology, growth, development and metabolism.
4. Impart an insight into the various plant water relations
5. Understand the mechanism of various metabolic processes in plants
6. Equip students with skills and techniques related to plant physiology so that they can design their own experiments

UNIT-I

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

UNIT-II

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

UNIT-III

Carbon and nitrogen metabolism: Photosynthesis- Photosynthesis pigments, concept of two photo systems, photphosphorylation, Calvin cycle, CAM plants, photorespiration, compensation point. Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

UNIT-IV

Growth and development: Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberellins, cytokinins, abscisic acid, ethylene). Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization.

UNIT-V

Stress Physiology: Stress adaptation mechanism: Definitions, Indicators of stress response - morphological, physiological, biochemical and molecular level. Stress adaptation and tolerance mechanism – biotic and abiotic stress, Effect of stress on crop productivity, Global warming - physiological effects on crop productivity

References

1. Taiz, L., & Zeiger, E. (2010). *Plant Physiology* (5th ed.). MA: USA, Sinauer Associates Inc.
2. Hopkins,W.G., & Huner, P.A. (2008). *Introduction to Plant Physiology*. John Wiley & Sons.
3. Nelson, D.L., & Cox, M.M. (2004). *Lehninger Principles of Biochemistry* (4th ed.). New York: USA, W.H. Freeman & Company.
4. Dickinson, W.C. (2000). *Integrative Plant Anatomy.* USA: Harcourt Academic Press.
5. Taiz, L., & Zeiger, E. (2006). *Plant Physiology* (4th ed.). MA: USA, Sinauer Associates Inc.
6. Esau, K. (1977) *Anatomy of Seed Plants.* Wiley Publishers.
7. Salisbury, F.B, & Ross, C.W. (1991). *Plant Physiology.* Wadsworth Publishing Co. Ltd.

19BTU302 MOLECULAR BIOLOGY 4H - 4C

Instruction Hours/week: L:4 T:0 P:0 Marks: Internal:40 External: 60 Total:100

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are

- To emphasize the basic knowledge about the structure and functions of nucleic acids (DNA/RNA) and proteins.
- To obtain the adequate knowledge on the structure and functions of biomolecules.
- To gain the information about the DNA damage and repair mechanisms.
- To understand the mechanisms behind gene regulations.
- To understand the mechanism behind translation and transcription
- To understand the mutations and its significance

Course Outcomes

The learners will be able to,

1. Achieve knowledge about the functions of nucleic acids and proteins.
2. Acquire an in-depth knowledge of chemical and molecular processes that occur in and between the cells.
3. Gain an insight into the most significant molecular and cell-based methods used today to expand our understanding of biology.
4. Acquire knowledge about the mechanisms behind gene regulations.
5. Gain knowledge about mechanism behind translation and transcription
6. Acquire an in-depth knowledge about mutation and its significance

UNIT-I

DNA structure and organization: DNA as genetic material, Structure of DNA, Types of DNA, Organization of DNA in prokaryote and eukaryotic cells, Chromosome biology – histone and non-histone proteins, organization, and structure and functions.

UNIT-II

DNA replication: Replication of DNA in prokaryotes and eukaryotes: Semi-conservative nature of DNA replication, Bi-directional replication, DNA polymerases, Replication complex: Pre-priming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT-III

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

UNIT-IV

Regulation of gene expression and translation: Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism

of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation, Posttranslational modifications of proteins.

UNIT-V

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

References

1. Karp, G. (2013). *Cell and Molecular Biology: Concepts and Experiments* (7th ed.). Hoboken, US: John Wiley & Sons. Inc.
2. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2008). *Molecular Biology of the Gene* (6th ed.). Cold Spring Harbour Lab. Press, Pearson Pub.
3. De Robertis, E.D.P., & De Robertis, E.M.F. (2006). *Cell and Molecular Biology* (8th ed.). Lippincott Williams and Wilkins, Philadelphia.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J., & Bertoni, G. P. (2009). *The World of the Cell* (7th ed.). San Francisco: Pearson Benjamin Cummings Publishing.

Instruction Hours/week: L:4 T:0 P:0 **Marks: Internal:40 External: 60 Total:100**
End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are,

- To understand the basic concepts of immunology.
- To expose students to use these principles of immune system to combats infections.
- To gain the information about the auto immune diseases.
- To elucidate the genetic basis for immunological diversity and the generation of adaptive immune responses
- To understand the basic knowledge of immunological processes at a cellular and molecular level
- To learn central immunological principles and concepts

Course Outcomes

The learners will be able to,

1. Gain about the various cells and organs involved in the immune system.
2. Understand the molecular mechanisms of antigen-antibody interactions and also the molecular mechanisms behind the immune response evoked after infection by various pathogens.
3. Learn the theoretical basis for the various immunological techniques.
4. Describe which cell types and organs present in the immune response
5. Apply basic techniques for identifying antigen antibody interactions.
6. Illustrate various mechanisms that regulate immune responses and maintain tolerance

UNIT-I

Immune Response: An overview, components of mammalian immune system, Antigens- Essential features of Ag, haptens, Carrier molecule, Immunological valence, Antigenic determinants. Adjuvants: Freund's complete and incomplete. Antibodies - Molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, Lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

UNIT-II

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

UNIT-III

Hypersensitivity Reactions (HS): Type I: Allergies and anaphylaxis; Type II: Antibody mediated HS reactions; Mechanism and pathogenicity; Type III: Immune complex mediated HS reactions: Mechanism & pathogenicity; Type IV: Delayed type (or) cell-mediated HS reactions; Mechanisms and pathogenicity. Type V: Stimulatory HS reactions. Mechanism and pathogenesis.

UNIT-IV

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

UNIT-V

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

References

1. Abbas, A.K., Lichtman, A.H., & Pillai, S. (2007). *Cellular and Molecular Immunology* (6th ed.). Philadelphia: Saunders Publication.
2. Delves, P., Martin, S., Burton, D., & Roitt, I.M. (2006). *Roitt's Essential Immunology* (11th ed.). Wiley-lackwell Scientific Publication, Oxford.
3. Goldsby, R.A., Kindt, T.J., Osborne, B.A. (2007). *Kuby's Immunology* (6th ed.). New York: W.H. Freeman and Company.
4. Murphy, K., Travers, P., & Walport , M. (2008). *Janeway's Immunobiology* (7th ed.). New York : Garland Science Publishers.
5. Peakman, M., & Vergani, D. (2009). *Basic and Clinical Immunology* (2nd ed.). Edinberg: Churchill Livingstone Publishers.
6. Richard, C., & Geiffrey, S. (2009). *Immunology* (6th ed.). Wiley Blackwell Publication.
7. Punt,J., Stranford, S., Jones, P., Owen, J. Kuby Immunology. 8th edition. (2018). New York: W.H. Freeman and Company.

19BTU304A I.P.R., ENTREPRENEURSHIP, BIOETHICS & BIOSAFETY 3H - 3C

Instruction Hours/week: L:3 T:0 P:0 **Marks: Internal:40 External: 60 Total:100**

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are

- To understand the basic knowledge of copy rights and related property rights.
- To develop the entrepreneurship skills using biological product formation.
- To provide the information of filling the patents and copy rights
- To disseminate knowledge on trademarks and registration aspects
- To disseminate knowledge on Design, Geographical Indication (GI), Plant Variety and Layout Design Protection and their registration aspects
- To learn about current trends in IPR and Govt. steps in fostering IPR

Course Outcomes

On completion of the course, students are able to

1. Acquire the knowledge on filling and submission of copy rights and related property rights.
2. Gain knowledge in developing new pilot scale / large scale industries and associated formalities
3. Understand the importance of patenting /copyrights/Trade marks
4. Acquire the knowledge on fundamental aspects of Intellectual property Rights to students who are going to play a major role in development and management of innovative projects in industries.
5. Disseminate knowledge on patents, patent regime in India and abroad and registration aspects
6. Disseminate knowledge on copyrights and its related rights and registration aspects

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

Biosafety: Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level.

UNIT-V

Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP), NABL, FSSAI, ISI.

References

1. David H. Holt. (1992). *Entrepreneurship: New Venture Creation*.
2. Jack M. Kaplan. (2015). *Patterns of Entrepreneurship*.
3. Gupta, C.B., Khanka, S.S. (2002). *Entrepreneurship and Small Business Management*. Sultan Chand & Sons.
4. Sateesh, M.K. (2010). *Bioethics and Biosafety*, I. K. International Pvt Ltd.
5. Sree Krishna, V. (2007) *Bioethics and Biosafety in Biotechnology*. New age International publishers.
6. Pandey, N., Dharni, K. (2014) Intellectual Property Rights. PHI Learning PVT. LTD. New Delhi.

19BTU304B BIO- ANALYTICAL TOOL 3H - 3C

Instruction Hours/week: L:3 T:0 P:0 Marks: Internal:40 External: 60 Total:100

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are,

- To study the bio-analytical tools and their applications.
- To have sufficient knowledge on the separation of compounds from a mixture.
- To know the application of PCR in biotechnology.
- To develop the skills to understand the theory and practice of bio analytical techniques.
- To provide scientific understanding of analytical techniques and detail interpretation of results.
- To learn how to design experiments and understand the instrumentation.

Course Outcomes

On completion of the course, students are able to

1. Know the working principle, maintenance, and calibrations of bioanalytical tools and technique
2. Estimate the number of biomolecules using the Bioanalytical tool
3. Implement the bioanalytical techniques to analyze the biomolecules
4. Use selected analytical techniques.
5. Be familiar with working principals, tools and techniques of analytical techniques.
6. To understand the strengths, limitations and creative use of techniques for problem-solving.

UNIT-I

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

UNIT-II

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

UNIT-III

Chromatography: Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC, HPTLC, MS, GC-MS, and LC-MS.

UNIT-IV

Electrophoresis: Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), Agarose-gel electrophoresis, 2D- gel electrophoresis.

UNIT-V

Applications: Pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting. Biosensors, Biochips, Microarray. Introduction to Biosensors and Nanotechnology and their applications.

References

1. Karp, G. (2013). *Cell and Molecular Biology: Concepts and Experiments* (7th ed.). Hoboken, US: John Wiley & Sons. Inc.
2. Cooper, G.M., & Hausman, R.E. (2013). *The Cell: A Molecular Approach* (6th ed.). Washington, USA: ASMPress & Sunderland, D.C., Sinauer Associates.
3. De Robertis, E.D.P., & De Robertis, E.M.F. (2006). *Cell and Molecular Biology* (8th ed.). Lippincott Williams and Wilkins, Philadelphia.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J., & Bertoni, G. P. (2009). *The World of the Cell* (7th ed.). San Francisco: Pearson Benjamin Cummings Publishing.

19BTU311 PLANT PHYSIOLOGY PRACTICAL 4H - 2C

Instruction Hours/week: L:0 T:0 P:4 Marks: Internal:40 External: 60 Total:100

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are,

- Know importance and scope of plant physiology.
- To understand the plants and plant cells in relation to water.
- Understand the process of photosynthesis in higher plants with and their pigments.
- Understand the respiration in higher plants with particular emphasis on aerobic and anaerobic respiration.
- Learn about the movement of sap and absorption of water in plant body.
- Understand the plant movements.

Course Outcomes

The learners will be able to

1. Study and impart knowledge about the occurrence, distribution, structure and life history of plants.
2. Enable the students to learn in detail about mono and dicot plant activity.
3. Learn the phylogeny concepts in plants.
4. Understand water relation of plants with respect to various physiological processes.
5. Explain root nodules from a leguminous plant
6. Classify stress indicators

Practical

1. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf.
2. Demonstration of plasmolysis by *Tradescantia* leaf peel.
3. Demonstration of opening & closing of stomata
4. Demonstration of guttation on leaf tips of grass and garden nasturtium.
5. Separation of photosynthetic pigments by paper chromatography.
6. Demonstration of aerobic respiration.
7. Preparation of root nodules from a leguminous plant.
8. Estimation of stress indicators – Proline and osmolyte estimation

References

1. Dickinson, W.C. (2000). *Integrative Plant Anatomy*. USA: Harcourt Academic Press.
2. Nelson, D.L., & Cox, M.M. (2004). *Lehninger: Principles of Biochemistry* (4th ed.). New York: USA, W.H. Freeman and Company.
3. Salisbury, F.B., & Ross, C.W. (1991). *Plant Physiology*. Wadsworth Publishing Co. Ltd.
4. Taiz, L., & Zeiger, E. (2006). *Plant Physiology* (4th ed.). MA: USA, Sinauer Associates Inc.

19BTU312 MOLECULAR BIOLOGY PRACTICAL 4H - 2C

Instruction Hours/week: L:0 T:0 P:4 Marks: Internal:40 External: 60 Total:100

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are,

- To inculcate practical skill in chromosomal and plasmid DNA separation by electrophoresis.
- To develop skills on extraction of proteins from plant and animal sources
- To detect the reverse mutation for carcinogenicity.
- To learn what genes are and how they are inherited
- To learn what are the solutions required for molecular biology experiments and how to prepare it
- To understand the principles and applications of molecular biology

Course Outcomes

The learners will be able to

1. Perform the experiments for isolation, purification and visualize the nucleic acid from various sources
2. Acquire skills on plasmid DNA extraction.
3. Gain basic knowledge on DNA extraction and separation by electrophoresis.
4. Know the protocol for detection of mutation in microbes.
5. Understand what genes are and how they are inherited
6. Know how they control cellular activity and they respond to environment

Practical

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

References

1. Karp, G. (2010). *Cell and Molecular Biology*: Concepts and Experiments (6th ed.). John Wiley & Sons. Inc.
2. Watson, J. D., Baker, T.A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2008). *Molecular Biology of the Gene* (6th ed.). Cold Spring Harbour Lab. Press, Pearson Pub.
3. Sambrook, J., Fritsch, E.F., & Maniatis, T. (2001). *Molecular Cloning-A Laboratory Manual.* (3rd ed.). Cold Spring Harbor Laboratory Press.

19BTU313 IMMUNOLOGY PRACTICAL 4H - 2C

Instruction Hours/week: L:0 T:0 P:4 Marks: Internal:40 External: 60 Total:100

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are,

- To understand the basic concepts of immunology.
- To expose students to use these principles of immune system to combats infections.
- To gain the information about the auto immune diseases.
- To familiarize students with the various immunological techniques
- To identify the cellular and molecular basis of immune responsiveness.
- To describe immunological response and how it is triggered and regulated.

Course Outcomes

The learners will be able to,

1. Gain about the various cells and organs involved in the immune system.
2. Understand the molecular mechanisms of antigen-antibody interactions and also the molecular mechanisms behind the immune response evoked after infection by various pathogens.
3. Learn the theoretical basis for the various immunological techniques.
4. Transfer knowledge of immunology into clinical decision-making through case studies presented in class.
5. Demonstrate a capacity for problem-solving about immune responsiveness.
6. Describe the roles of the immune system in both maintaining health and contributing to disease

Practical

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

References

1. Abbas, A.K., Lichtman, A.H., & Pillai, S. (2007). *Cellular and Molecular Immunology* (6th ed.). Philadelphia: Saunders Publication.
2. Delves, P., Martin, S., Burton, D., & Roitt, I.M. (2006). *Roitt's Essential Immunology*. (11th ed.). Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby, R.A., Kindt, T.J., & Osborne, B.A. (2007). *Kuby's Immunology* (6th ed.). New York: W.H. Freeman and Company.
4. Murphy, K., Travers, P., Walport, M. (2008). *Janeway's Immunobiology* (7th ed.). New York : Garland Science Publishers.
5. Peakman, M. & Vergani, D. (2009). *Basic and Clinical Immunology* (2nd ed.). Edinberg: Churchill Livingstone Publishers.
6. Richard, C., & Geiffrey, S. (2009). *Immunology* (6th ed.). Wiley Blackwell Publication
7.

19BTU314A I.P.R., ENTREPRENEURSHIP, BIOETHICS & BIOSAFETY PRACTICAL 3H - 1C

Instruction Hours/week: L:0 T:0 P:3 Marks: Internal:40 External: 60 Total:100

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are

- To understand the basic knowledge of copy rights and related property rights.
- To develop the entrepreneurship skills using biological product formation.
- To provide the information of filling the patents and copy rights
- To disseminate knowledge on trademarks and registration aspects
- To disseminate knowledge on Design, Geographical Indication (GI), Plant Variety and Layout Design Protection and their registration aspects
- To learn about current trends in IPR and Govt. steps in fostering IPR

Course Outcomes

On completion of the course, students are able to

1. Acquire the knowledge on filling and submission of copy rights and related property rights.
2. Gain knowledge in developing new pilot scale / large scale industries and associated formalities
3. Understand the importance of patenting /copyrights/Trade marks
4. Acquire the knowledge on fundamental aspects of Intellectual property Rights to students who are going to play a major role in development and management of innovative projects in industries.
5. Disseminate knowledge on patents, patent regime in India and abroad and registration aspects
6. Disseminate knowledge on copyrights and its related rights and registration aspects

Practical

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

References

1. Jack Kaplan, M., (2009). *Patterns of Entrepreneurship* (3rd ed.).
2. Gupta, C.B., & Khanka S.S. (2004). *Entrepreneurship and Small Business Management*. Sultan Chand & Sons.
3. David Holt, H., (1992). *Entrepreneurship. New Venture Creation*.
4. Sateesh, M.K. (2010). *Bioethics and Biosafety*. I. K. International Pvt Ltd.
5. Sree Krishna,V. (2007). *Bioethics and Biosafety in Biotechnology*. New age international publishers.

19BTU314B BIO-ANALYTICAL TOOL PRACTICAL 3H - 1C

Instruction Hours/week: L:0 T:0 P:3 Marks: Internal:40 External: 60 Total:100

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are,

- To study the bio-analytical tools and their applications.
- To have sufficient knowledge on the separation of compounds from a mixture.
- To know the application of PCR in biotechnology.
- To develop the skills to understand the theory and practice of bio analytical techniques.
- To provide scientific understanding of analytical techniques and detail interpretation of results.
- To learn how to design experiments and understand the instrumentation.

Course Outcomes

On completion of the course, students are able to

1. Know the working principle, maintenance, and calibrations of bioanalytical tools and technique
2. Estimate the number of biomolecules using the Bioanalytical tool
3. Implement the bioanalytical techniques to analyze the biomolecules
4. Use selected analytical techniques.
5. Be familiar with working principals, tools and techniques of analytical techniques.
6. To understand the strengths, limitations and creative use of techniques for problem-solving

Practical

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

References

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

19BTU401 BIOPROCESS TECHNOLOGY 4H - 4C

Instruction Hours/week: L:4 T:0 P:0 Marks: Internal:40 External: 60 Total:100

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are,

- To learn the procedure for isolation, screening of industrial important microbes
- To derive industrially important products from microbes.
- To acquire knowledge on Downstream processing.
- To learn the principle and applications of bioprocess technology.
- To learn the fundamental calculation in bioprocessing.
- To learn the schematic diagram of upstream and downstream processing for product recovery and purification.

Course Outcomes

The learners will be able to

1. Gain overall knowledge of industrial biotechnology.
2. Obtain information about the application of industrially important microbes.
3. Know the screening, extraction and purification of enzymes.
4. Designing of bioreactors and control necessary for maximizing production.
5. Select and optimize media for maximum production of microbial metabolites.
6. Designing of protocols for strain improvement and separation of molecules after fermentation process.

UNIT- I

Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fed batch and Continuous culture. Types of fermentation- submerged, solid state.

UNIT-II

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inocula development and sterilization.

UNIT-III

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

UNIT-IV

Downstream processing: Filtration, Centrifugation, Cell disruption, Chromatography, liquid-liquid extraction, product recovery and purification. Effluent treatment- product recovery, sludge process, waste disposal.

UNIT-V

Application: Microbial production of ethanol, amylase, lactic acid, and Single Cell Proteins. Fermentation economics.

References

1. Patel, A.H. (2007). *Industrial Microbiology*. Macmillan India Ltd.
2. Stanbury, P.F., Whitaker, A. & S.J. Hall. (2007). *Principles of fermentation technology*. Elsevier Science Ltd.
3. Casida, LE. (1991). *Industrial Microbiology*. (1st ed.). Wiley Eastern Limited.
4. Crueger, W., & Crueger, A. (2000). *Biotechnology: A textbook of Industrial Microbiology* (2nd ed.). New Delhi: Panima Publishing Co.
5. Patel, A.H. (1996). *Industrial Microbiology*. (1st ed.). Macmillan India Limited.

19BTU402 RECOMBINANT DNA TECHNOLOGY 4H - 4C

Instruction Hours/week: L:4 T:0 P:0 Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are,

- To learn the procedure for isolation nucleic acids and Protein.
- To learn the strategies for gene transfer in plants and animals.
- To acquire knowledge on genome mapping.
- To familiarize the student with emerging field of biotechnology
- To acquaint the students to versatile tools and techniques employed in recombinant DNA technology.
- To learn the history and recent developments in rDNA technology, Enzymes used in rDNA technology

Course Outcomes

On completion of the course, students are able to

1. Outline the fundamental steps in a genetic engineering procedure.
2. Describe the mechanism of action and the use of restriction enzymes in biotechnology research and recombinant protein production.
3. Explain the usefulness of plasmid preparations, how they are performed, and how the concentration and purity of plasmid samples can be determined.
4. Discuss cloning strategies and techniques used to probe DNA for specific genes of interest.
5. Conceptualize PCR technique in medical and forensic science.
6. Summarize various applications of rDNA technology in human health care and safety regulations

UNIT-I

Introduction to r-DNA technology: Basic tools and applications – isolation and purification of nucleic acids, Enzymes used in cloning - restriction enzymes, ligases, polymerases, kinases, phosphatases. Gene recombination and gene transfer – transformation, episomes, plasmids and other cloning vectors (bacteriophage-derived, artificial chromosomes), microinjection, electroporation, ultrasonication. Vectors and its types.

UNIT-II

Selection and screening of recombinant clones: Probes – radio labeled and non radio-labeled, guessmer and degenerate probes. Sequence dependent and independent screening, southern, northern hybridization, colony and plaque hybridization, *in situ* chromosomal hybridization, chromosome walking, Genome mapping, DNA fingerprinting, Polymerase chain reaction (PCR), RT-(Reverse transcription) PCR.

UNIT-III

Expression and characterization of cloned DNA: Expression vectors, optimization of protein expression in heterologous systems, Fusion proteins, *In vitro* translation systems. Preparation and comparison of Genomic and cDNA library.

UNIT-IV

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

UNIT-V

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

In animals: Production and applications of transgenic mice, role of Embryonic Stem cells in gene targeting in mice, Therapeutic products - blood proteins, human hormones, immune modulators and vaccines (one example each). Ethical, legal and social issues.

References

1. Clark, D.P., & Pazdernik, N.J. (2009). *Biotechnology-Applying the Genetic Revolution*. USA: Elsevier Academic Press.
2. Brown, T.A., (2006). *Gene Cloning and DNA Analysis* (5th ed.). Oxford: UK, Blackwell Publishing.
3. Primrose, S.B., & Twyman, R.M. (2006). *Principles of Gene Manipulation and Genomics* (7th ed.). Oxford: UK, Blackwell Publishing.
4. Glick, B.R., & Pasternak, J.J. (2003). *Molecular Biotechnology- Principles and Applications of recombinant DNA*. Washington: ASM Press.

19BTU403 GENOMICS AND PROTEOMICS 4H - 4C

Total hours/week: L:4 T:0 P:0 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To import the basic and recent developments in the field of genome sequencing, genome mapping, proteomic data analysis
- To develop the knowledge on gene sequencing methods.
- To know the structure and interactions of proteins.
- To describe advanced genomics and proteomics technologies and the ways in which their data are stored
- To use bioinformatics techniques to query examples of genomic and proteomic databases to analyse cell biology
- To describe the different types of genome variation and their relationship to human diseases

Course Outcomes

On completion of the course, students are able to

1. Have a clear understanding on the application of genetic markers in genome mapping.
2. Application of 2D technique to analyze the structure of protein.
3. Analyze the genomic and proteomic data.
4. Acquire knowledge and understanding of fundamentals of genomics and proteomics, transcriptomics and metabolomics and their applications in various applied areas of biology.
5. Discuss how biological systems information relating to genes, proteins and cellular structures can be used to model living cells, and even to create new synthetic cells
6. Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.

UNIT-I

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

UNIT-II

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

UNIT-III

Genomic mapping: Genetic markers – VNTR, mini and micro satellites, STS, SNPs, ESTs. Types of genome maps, Mapping techniques – Physical and genetic mapping, Map resources, Practical uses genome maps.

UNIT-IV

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

UNIT-V

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution. Reproducibility of 2D-PAGE. Mass spectrometry-based methods for protein identification. De novo sequencing using mass spectrometric data.

References

1. Devarajan Thangadurai, Jeyabalan Sangeetha, 2015. Genomics and Proteomics: Principles, Technologies, and Applications. CRC Press, Tylor & Francis Group
2. Lesk A.M., Introduction to Bioinformatics, Oxford University Press, UK, 2007.
3. Bhat S., Genomics, Bioscience Publishing, New Delhi, 2008.
4. Timothy P., Proteomics, Kluwer Academic Publisher, USA, 2002.
5. Benjamin Lewin, (2006). *Genes IX*. Johns and Bartlett Publisher.
6. Primrose, S.B. (1987). *Modern Biotechnology* (2nd ed.). Blackwell Publishing.
7. Glick, B.R., Pasternak, J.J., & Patten, C.L.(2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA* (4th ed.).
8. Sambrook & Russell (3rd ed.). (1989). *Molecular Cloning: A Laboratory Manual* (Vols. 1to3). Cold Spring Harbor Laboratory Press
9. Primrose, S.B., Twyman, R.M. & Old, R.W. (2001). *Principles of Gene Manipulation* (6th ed.). Blackwell Science.
10. Snustad, D.P., &Simmons, M.J. (2009). *Principles of Genetics* (5th ed.). John Wiley and Sons Inc.
11. Russell, P. J. (2009). *iGenetics- A Molecular Approach* (3rd ed.). Benjamin Cummings.
12. Glick, B.R., & Pasternak, J.J. (2003). *Molecular Biotechnology- Principles and Applications of recombinant DNA*. Washington: ASM Press.

19BTU404A INDUSTRIAL FERMENTATION 3H - 3C

Total hours/week: L:3 T:0 P:0 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To import the basic and recent developments in the field of Industrial fermentation
- To impact knowledge about biological and biochemical technology, with a focus on biological products, the design and operation of industrial practices.
- To discuss the role of microorganisms in industry, as well as to carry out experiments to produce microbial metabolites.
- To learn how to conduct experiments related to industrial fermentation and produce microbial metabolites
- To learn about the downstream and upstream process in fermentation technology.
- To learn about the influence of factors affecting the production of various microbial metabolites

Course Outcomes

On completion of the course, students are able to

1. Have a clear understanding on the application of growth kinetics.
2. Design a fermenter and parameters to be monitored and controlled in fermentation process.
3. Gain knowledge about the principle of sterilization necessary for fermentation.
4. Acquire knowledge about the cell growth and product formation.
5. Evaluate the kinetics and mechanism of microbial growth.
6. Develop protocol for scale-up and harvesting from shake flask to bench top fermenter.

UNIT-I Introduction to industrial fermentations:
Microbial products of pharmacological interest, steroid fermentations and transformations. Primary metabolism – its significance and products. Over production of microbial metabolite, Secondary metabolism – its significance and products. Metabolic engineering of secondary metabolism for highest productivity. Screening for new metabolites, strains used in screening. Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/ organic synthesis. Microbial products of pharmacological interest, steroid fermentations and transformations.

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

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

UNIT- IV

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

UNIT-V

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

References

1. Stanbury PF, Whitaker A and Hall SJ. (2006). *Principles of Fermentation Technology* (2nd ed.). Elsevier Science Ltd.
2. Crueger W and Crueger A. (2000). *Biotechnology: A textbook of Industrial Microbiology* (2nd ed.). Panima Publishing Co. New Delhi.
3. Casida LE. (1991). *Industrial Microbiology*. Wiley Eastern Limited.

19BTU404B ENZYMOLOGY 3H - 3C Total
hours/week: L:3 T:0 P:0 Marks: Internal: 40 External: 60 Total: 100

Course Objectives
The main objectives of the course are,

- To understand the kinetics and mechanisms of action of enzymes, to become familiar with the basic methods of studying enzymes, and to appreciate how individual reactions are controlled and integrated into the metabolic pathways of the cell.
- To acquire theoretical and experimental knowledge will enable students to find appropriate employment in different development, scientific-research laboratories.
- To understand the topics related to the practical use of enzymes, including nomenclature and kinetics, preparation and storage methods, use of enzymes in biotechnology and bioanalytics including biosensors and enzyme reactors.
- To provide general knowledge on protein structure and function, as well as the experimental techniques in protein chemistry and protein engineering
- To develop the ability of identifying the experimental techniques required to solve specific problems related to proteins and enzyme functions
- To train students in the evaluation of the consequences of biochemical and biological tools in their professional activities

Course Outcomes
On completion of the course, students are able to

1. Understand the chemical principles of enzyme catalysis, including cofactor chemistry
2. Show insight in the action of enzymes as biocatalysts and in factors that influence enzyme activity
3. Understand the kinetics of enzymatic reactions
4. Show awareness of the influence of enzyme structure on catalytic properties
5. Show experience with purification, handling and characterization of proteins
6. Show insight in the physico-chemical properties of proteins that underlie purification methods**.**

UNIT-I
Isolation, crystallization and purification of enzymes: homogeneity of enzyme preparation, methods of enzyme analysis. Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin). Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of Km and V_{max} and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories, Significance of activation energy and free energy.

UNIT-II
Enzyme-Substrate reactions: Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki, suicide inhibitor. Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. Techniques for studying mechanisms of action, chemical modification of active site groups, specific examples-: chymotrypsin, lysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase. Enzyme regulation: Product inhibition, feed back control, covalent modification.

UNIT-III
Allosteric enzymes: Allosteric enzymes with special reference to aspartate transcarboxylase and phosphofructokinase. Qualitative description of concerted and sequential models. Negative cooperativity and half site reactivity. Enzyme - Enzyme interaction, Protein ligand binding, measurements analysis of binding isotherm, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes. Isoenzymes– multiple forms

of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acid synthase.

UNIT-IV

Properties of Enzymes: Thermal stability and catalytic efficiency of enzyme, site directed mutagenesis and enzyme engineering– selected examples, Delivery system for protein pharmaceuticals, structure function relationship in enzymes, structural motifs and enzyme evolution. Methods for protein sequencing. Methods for analysis of secondary and tertiary structures of enzymes. Protein folding *in vitro* & *in vivo*.

UNIT-V

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

References

1. Robert Murray, K., David Bender, A., Kathleen Botham, M., Peter Kennelly, J., Victor Rodwell, W., Anthony Weil, P. (2009). *Harper's illustrated Biochemistry* (28th ed.). McGrawHill.
2. Lubert Stryer, (2006). *Biochemistry* (6th ed.). WH Freeman.
3. Donald Voet, & Judith Voet, (1995). *Biochemistry* (2nd ed.). John Wiley andSons.
4. Mary K., & Shawn O.Farrell, (2005). *Biochemistry* (5th ed.). Cenage Learning.
5. Nicholas Price, & Lewis Stevens (1999) *Fundamentals of Enzymology*. Oxford University Press.

19BTU411 BIOPROCESS TECHNOLOGY PRACTICAL 4H - 2C
Total hours/week: L:0 T:0 P: 4 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To learn the procedure for isolation, screening of industrial important microbes
- To derive industrially important products from microbes.
- To acquire knowledge on single cell proteins.
- To learn the principle and applications of bioprocess technology.
- To learn the fundamental calculation in bioprocessing.
- To learn the schematic diagram of upstream and downstream processing for product recovery and purification.

Course Outcomes

The learners will be able to

1. Gain overall knowledge of bioprocess technology.
2. Obtain information about the application of industrially important microbes.
3. Know the screening, extraction and purification of enzymes.
4. Designing of bioreactors and control necessary for maximizing production.
5. Select and optimize media for maximum production of microbial metabolites.
6. Designing of protocols for strain improvement and separation of molecules after fermentation process

Practical

1. Isolation of industrially important microorganism from natural resources.
2. Bacterial growth curve.
3. Calculation of thermal death point (TDP) of microbial samples.
4. Production and analysis of ethanol.
5. Production and analysis of amylase.
6. Production and analysis of lactic acid.

References

1. Stanbury, P.F., Whitaker ,A. & Hall, S.J. (2006). *Principles of Fermentation Technology* (2nd ed.). Elsevier Science Ltd.
2. Crueger, W., & Crueger, A. (2000). *Biotechnology: A textbook of Industrial Microbiology* (2nd ed.). New Delhi: Panima Publishing Co.
3. Casida, L.E. (1991). *Industrial Microbiology* (1st ed.). Wiley Eastern Limited.
4. Patel, A.H. (1996). *Industrial Microbiology* (1st ed.). Macmillan India Limited.

19BTU412 RECOMBINANT DNA TECHNOLOGY PRACTICAL 4H - 2C

Total hours/week: L:0 T:0 P: 4 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To learn the procedure for isolation nucleic acids and Protein.
- To learn the strategies for gene transfer in plants and animals.
- To acquire knowledge on genome mapping.
- To familiarize the student with emerging field of biotechnology
- To acquaint the students to versatile tools and techniques employed in recombinant DNA technology.
- To learn the history and recent developments in rDNA technology, Enzymes used in rDNA technology

Course Outcomes

On completion of the course, students are able to

1. Outline the fundamental steps in a recombinant DNA technique.
2. Describe the mechanism of action and the use of restriction enzymes in biotechnology research and recombinant protein production.
3. Explain the usefulness of plasmid preparations, how they are performed, and how the concentration and purity of plasmid samples can be determined.
4. Discuss cloning strategies and techniques used to probe DNA for specific genes of interest.
5. Conceptualize PCR technique in medical and forensic science.
6. Utilize versatile tools and techniques employed in recombinant DNA technology.

Practical

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E. coli*
3. Qualitative and quantitative analysis of DNA using spectrophotometer and agarose gel Electrophoresis.
4. Plasmid DNA isolation
5. Restriction digestion of DNA/ Plasmid DNA
6. Ligation of DNA insert into plasmid vector
7. Preparation of Competent cells
7. Transformation of competent cells.
8. Demonstration of PCR.

References

1. Brown, T.A. (2006). *Gene Cloning and DNA Analysis* (5th ed.). Oxford: UK, Blackwell Publishing.
2. Primrose, S.B., & Twyman, R.M. (2006). *Principles of Gene Manipulation and Genomics* (7th ed.). Oxford: UK, Blackwell Publishing.
3. Sambrook, J., Fritsch, E.F., & Maniatis, T. (2001). *Molecular Cloning-A Laboratory Manual.* (3rd ed.). Cold Spring Harbor Laboratory Press.
4. S. Janarthanan & S. Vincent (2007), Practical Biotechnology, Methods & Protocol, Universities press, India.

19BTU413 GENOMICS AND PROTEOMICS PRACTICAL 4H - 2C
Total hours/week: L:0 T:0 P: 4 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To import the basic and recent developments in the field of genome sequencing, genome mapping, proteomic data analysis
- To develop the knowledge on gene sequencing methods.
- To know the structure and interactions of proteins.
- To describe advanced genomics and proteomics technologies and the ways in which their data are stored
- To use bioinformatics techniques to query examples of genomic and proteomic databases to analyse cell biology
- To describe the different types of genome variation and their relationship to human diseases

Course Outcomes

On completion of the course, students are able to

1. Have a clear understanding on the application of genetic markers in genome mapping.
2. Application of 2D technique to analyze the structure of protein.
3. Analyze the genomic and proteomic data.
4. Acquire knowledge and understanding of fundamentals of genomics and proteomics, transcriptomics and metabolomics and their applications in various applied areas of biology.
5. Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
6. Utilize the various databases at NCBI and other sites for protein localization

Practical

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

References

1. Glick, B.R., Pasternak, J.J., & Patten, C.L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA* (4th ed.). American Society for Microbiology.
2. Primrose, S.B., & Twyman, R.M. (2006). *Principles of Gene Manipulation and Genomics* (7th ed.). Oxford: UK, Blackwell Publishing.
3. Pevsner, J. (2009). *Bioinformatics and Functional Genomics* (2nd ed.).John Wiley & Sons.
4. Sambrook & Russell (3rd ed.). (1989). *Molecular Cloning: A Laboratory Manual* (Vols. 1 to 3). Cold Spring Harbor Laboratory Press.
5. Devarajan Thangadurai, Jeyabalan Sangeetha, 2015. Genomics and Proteomics: Principles, Technologies, and Applications. CRC Press, Tylor & Francis Group
6. Charles Markoff, 2016. Functional Genomics and Proteomics.

19BTU414A INDUSTRIAL FERMENTATION PRACTICAL 3H - 1C
Total hours/week: L:0 T:0 P:3 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To import the basic and recent developments in the field of Industrial fermentation
- To impact knowledge about biological and biochemical technology, with a focus on biological products, the design and operation of industrial practices.
- To discuss the role of microorganisms in industry, as well as to carry out experiments to produce microbial metabolites.
- To learn how to conduct experiments related to industrial fermentation and produce microbial metabolites
- To learn about the downstream and upstream process in fermentation technology.
- To learn about the influence of factors affecting the production of various microbial metabolites

Course Outcomes

On completion of the course, students are able to

1. Have a clear understanding on the application of growth kinetics
2. Design a fermenter and parameters to be monitored and controlled in fermentation process.
3. Gain knowledge about the principle of sterilization necessary for fermentation.
4. Acquire knowledge about the cell growth and product formation.
5. Evaluate the kinetics and mechanism of microbial growth.
6. Develop protocol for scale-up and harvesting from shake flask to bench top fermenter.

Practical

1. Comparative analysis of design of a batch and continuous fermenter.
2. Calculation of Mathematical derivation of growth kinetics.
3. Solvent extraction & analysis of a metabolite from a bacterial culture.
4. Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/glucosidase etc.)
5. Immobilization of bacteria and enzymes.
6. Production of Butanol from biomass.
7. Production of any one microbial flavours.
8. Biogas/biohydrogen production from waste biomass.

References

1. Stanbury, P.F., Whitaker, A. & Hall, S.J. (2006). *Principles of Fermentation Technology* (2nd ed.). Elsevier Science Ltd.
2. Crueger, W., & Crueger, A. (2000). *Biotechnology: A textbook of Industrial Microbiology* (2nd ed.). New Delhi: Panima Publishing Co.
3. Casida, L.E. (1991). *Industrial Microbiology* (1st ed.). Wiley Eastern Limited.
4. Patel, A.H. (1996). *Industrial Microbiology* (1st ed.). Macmillan India Limited.
5. S. Kulandaivel & S. Janarthanan, Practical Manual on Fermentation Technology, 2012

19BTU414B ENZYMOLOGY PRACTICAL 3H - 1C

Total hours/week: L:0 T:0 P:3 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To understand the kinetics and mechanisms of action of enzymes, to become familiar with the basic methods of studying enzymes, and to appreciate how individual reactions are controlled and integrated into the metabolic pathways of the cell.
- To acquire experimental knowledge will enable students to find appropriate employment in different development, scientific-research laboratories.
- To understand the topics related to the practical use of enzymes, including nomenclature and kinetics, preparation and storage methods, use of enzymes in biotechnology and bioanalytics including biosensors and enzyme reactors.
- To provide practical knowledge on protein
- To develop the ability of identifying the experimental techniques required to solve specific problems related to proteins and enzyme functions
- To train students in the evaluation of the consequences of biochemical and biological tools in their professional activities

Course Outcomes

On completion of the course, students are able to

1. Understand the chemical principles of enzyme catalysis, including cofactor chemistry
2. Show insight in the action of enzymes as biocatalysts and in factors that influence enzyme activity
3. Understand the kinetics of enzymatic reactions
4. Show awareness of the influence of enzyme structure on catalytic properties
5. Show experience with purification, handling and characterization of proteins
6. Show insight in the physico-chemical properties of proteins that underlie purification methods

Practical

1. Preparation of buffer and matrix to separate enzyme from natural resource.
2. Purification of an enzyme from any natural resource.
3. Analysis and quantify the purified enzyme.
4. Quantitative estimation of proteins by Bradford/Lowry's method.
5. Calculation of kinetic parameters such as Km, V_{max}, $K_{cat.}$
6. Enzyme zymography amylase / protease.

References

1. Lubert Stryer, (2006). *Biochemistry* (6th ed.). WH Freeman.
2. Robert Murray, K., David Bender, A., Kathleen Botham, M., Peter Kennelly, J., Victor Rodwell, W., Anthony Weil, P. (2009). *Harper's illustrated Biochemistry* (28th ed.). McGrawHill.
3. Nicholas Price, & Lewis Stevens. (1999). *Fundamentals of Enzymology*. Oxford University Press.
4. Athel Cornish-Bowden, (2004). *Fundamentals of Enzyme Kinetics* (3rd ed.). Portland Press.
5. Hans Bisswanger, (2004). *Practical Enzymology*. Wiley–VCH.
6. Richard, B. (2002). *The Organic Chemistry of Enzyme-catalyzed Reactions*. Silverman Academic Press.

19BTU501A PLANT DIVERSITY -I 3H - 3C
Total hours/week: L:3 T:0 P:0 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To understand the physiological conditions of the plants and metabolism.
- To understand the basic concepts of photosystems and their importance in plant growth.
- To gain the information about the economic importance of algae and fungi.
- Learn about the structure, pigmentation, food reserves and methods of reproduction of Algae
- Learn about the structure, pigmentation, food reserves and methods of reproduction of Fungi
- Studied some plant diseases with special reference to the causative agents, symptoms, etiology and control measures.

Course Outcomes

The learners will be able to,

1. Gain adequate knowledge on plant biodiversity and importance.
2. Understand the molecular mechanisms of macro and micro nutrients in plant growth.
3. Get the basic and applied knowledge of plant physiology, growth, development and metabolism.
4. Discuss about importance of morphological structure, classification, reproduction and economic importance of Algae.
5. Know the control measures of plant diseases.
6. Explain about structure, classification, reproduction, life cycle and economic importance of Bryophytes.

UNIT-I
Algae: General character, classification and economic importance. Life histories of algae belonging to various classes: Chlorophyceae – *Volvox, Oedogonium,* Xantho phyceae –*Vaucheria,* Phaeophyceae – *Ectocarpus* Rhodophyceae-*Polysiphonia*

UNIT-II
Fungi: General characters, classification & economic importance. Life histories of Fungi: Mastigomycontina-*Phytophthora,* Zygomycotina-*Mucor,* Ascomycotina- *Saccharomyces,* Basidomycotina-*Agaricus,* Deutromycotina-*Colletotrichum*

UNIT-III
Lichens : Classification, general structure, reproduction and economic importance.

UNIT-IV
Bryophytes: General characters, classification & economic importance. Life histories of following: *Marchantia. Funaria.*

UNIT-V
Plant Diseases: Casual organism, symptoms and control of following plant diseases. Rust and Smut of Wheat. White rust of Crucifers. Late blight of Potato. Red rot of Sugarcane. Citrus Canker.

References

1. Lee, R.E. (2008). *Phycology* (4th ed.). USA: Cambridge University Press.
2. Sambamurty, (2008). *A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany*. IK : International Publishers.
3. Shaw, A.J., & Goffinet, B. (2000). *Bryophyte Biology.* Cambridge University Press.
4. Van den Hoek, C., Mann, D.J. & Jahns, H.M. (1995). *Algae: An introduction to Phycology.* Cambridge Univ. Press.
5. Vander-Poorteri, (2009). *Introduction to Bryophytes*. COP.
6. Webster, J. & Weber, R. (2007). *Introduction to Fungi* (3rd ed.). Cambridge: Cambridge University Press.

19BTU501B BASICS OF FORENSIC SCIENCE 3H - 3C

Total hours/week: L:3 T:0 P:0 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To give knowledge on molecular analysis in forensic science.
- To offer knowledge to assess DNA finger printing
- To understand the evidence for suspecting victims in crime
- To handle the evidences left out at the crime scene.
- To understand the basic methods for examine the different types of questioned documents.
- To understand the Classification of fire arms.

Course Outcomes

On completion of the course, students are able to

1. Demonstrate competency in the collection, processing, analyses, and evaluation of evidence.
2. Demonstrate competency in the principles of crime scene investigation, including the recognition, collection, identification, preservation, and documentation of physical evidence.
3. Demonstrate an understanding of the scientific method and the use of problem-solving within the field of forensic science.
4. Identify the role of the forensic scientist and physical evidence within the criminal justice system.
5. Demonstrate the ability to document and orally describe crime scenes, physical evidence, and scientific processes.
6. Identify and examine current and emerging concepts and practices within the forensic science field.

UNIT- I

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

UNIT-II

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

UNIT-III

Toxicology and Finger printing: Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints.

UNIT-IV

DNA finger printing: Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers,

UNIT-V

Cyber security: Introduction to Cyber security and recent techniques. development of finger print as science for personal identification, Cyber Crime

References

1. Bernard J. Glick, Jack J. Pasternak , & Cheryl L. Patten. (2010). *Molecular Biotechnology- Principles and Applications of recombinant DNA* (4th ed.). Washington: ASM Press.
2. Nanda, B.B., & Tiwari, R.K. (2001). *Forensic Science in India: A Vision for the Twenty First Century*. New Delhi: Select Publishers.
3. Bhasin, M.K., & Nath S. (2002). *Role of Forensic Science in the New Millennium*. Delhi: University of Delhi.
4. James, S.H., & Nordby J.J. (2005). *Forensic Science: An Introduction to Scientific and Investigative Techniques* (2nd ed.). CRC Press, Boca Raton.
5. Eckert, W.G., & Wright, R.K. (1997). *An Introduction to Forensic Sciences* (2nd ed.). CRC Press, Boca Raton (1997).
6. Saferstein R., (2015). *Criminalistics: An Introduction to Forensic Science* (11th ed.). New Jersey: Prentice Hall.

19BTU502A BIOINFORMATICS 4H - 4C

Total hours/week: L:4 T:0 P:0 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To give knowledge on Bioinformatics and its application
- To offer knowledge to assess biological databases
- To understand and to analyze protein/nucleotide sequences and to predict its 3D structure
- To understand the various online databases for submitting and retrieving data's
- To understand how the phylogeny plays a vital role in finding ambiguities.
- To get practiced with the tools and techniques for analysing the data.

Course Outcomes

On completion of the course, students are able to

1. Understand The relationship between sequence - structure - function of genes
2. Familiarize with the algorithms required to compare sequences and require to know the phylogenetic relationship between the gene sequences
3. Inculcate knowledge on building 3D structures of genes.
4. Locate and use the main databases at the NCBI and EBI resources
5. Know the difference between databases, tools, repositories and be able to use each one to extract specific information
6. Use selected tools at NCBI and EBI to run simple analyses on genomic sequences

UNIT-I

History and milestone of Bioinformatics: Introduction to Bioinformatics – History and Milestones. Data sequence sources- NCBI, EMBL, GenBank, Entrez, UNIGENE. Human genome project.

UNIT-II

Basic concepts of biomolecules: Protein and amino acid, DNA and RNA - Sequence, Structure and function. Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

UNIT-III

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

UNIT-IV

Biological databases: Types of databases, Sequence databases, Nucleic acid sequence databases - Primary (GenBank, EMBL, DDBJ), Secondary (UniGene, SGD, EMI Genomes, Genome Biology), Protein sequence database – Primary (PIR, SWISS-PROT), Secondary (PROSITE, Pfam), Structural databases (PDB, SCOP, CATH), Bibliographic databases and Organism specific databases.

UNIT-V

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools. Gene prediction: Gene prediction in prokaryote and eukaryotes. Extrinsic approaches and Ab initio approaches. Predicting the protein secondary structure (Domain, blocks, motifs), Predicting protein tertiary structure (Homology, Ab-initio, threading and fold recognition) and visualization of predicted structure.

References

1. Ghosh, Z. & Bibekanand M. (2008). *Bioinformatics: Principles and Applications*. Oxford University Press.
2. Pevsner, J. (2009). *Bioinformatics and Functional Genomics* (2nd ed.). Wiley-Blackwell.
3. Campbell, A.M., & Heyer, L.J. (2006). *Discovering Genomics, Proteomics and Bioinformatics* (2nd ed.). Benjamin Cummings.
4. Syed Ibrahim.K., GuruSubramanian, G., Zothansarga, yadav, R.P., Senthil Kumar N., Pandian, S.K., Borah., P., Mohan S., 2017. Bioinformatics- A students companion.

19BTU502B PLANT DIVERSITY-II 4H - 4C

Total hours/week: L:4 T:0 P:0 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To develop the skills on morphological identification of plants.
- Understand the diversity among various plants
- Know the systematic morphology and structure of Pteridophytes.
- Learn about the general characters and classification in Pteridophytes, heterospory and origin of seed habit.
- Know about the structure, life history and Economic importance of Gymnosperms.
- Studied the methods of fossilization and fossil plants

Course Outcomes:

The learners will be able to

1. Study and impart knowledge about the occurrence, distribution, structure and life history of plants
2. Learn in detail about vegetative and reproductive parts of plants.
3. Learn the phylogeny and evolutionary concepts in plants.
4. Learn how to handle a fossilized specimen
5. Acquire knowledge about the structure, life history and Economic importance of Gymnosperms
6. Learn the skills on morphological identification of plants

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

Gymnosperms: Type studies: Life histories of *Cycas* and *Pinus* and economic importance of gymnosperms.

UNIT-V

Angiosperms: General characters, classification, monocot, dicot, floral characters, economic importance.

References

1. Sambamurty, (2008). *A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany*. IK International Publishers.
2. Bhatnager, S.P. & Moitra, A. (1996). *Gymnosperms.* New Delhi: New Age International (P) Ltd. Publishers.
3. Wickens, G.E. (2004). *Economic Botany: Principles and Practices.* Dordrecht: Netherlands, Springer. Kuwer Publishers.
4. Parihar, N.S. (1996). *The Biology and Morphology of Pteridophytes*. Allahabad: Central Book Depot.

19BTU503A PLANT BIOTECHNOLOGY 4H - 4C
Total hours/week: L:4 T:0 P:0 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To introduce biotechnological methods for production of transgenic plants.
- To give knowledge about various methods of gene transfer in plants.
- To cognize and get the knowledge on micro propagation to protect endangered plants.
- To explain the basics of the physiological and molecular processes that occur during plant growth and development and during environmental adaptations
- To use basic biotechnological techniques to explore molecular biology of plants
- To understand the processes involved in the planning, conduct and execution of plant biotechnology experiments

Course Outcomes

On completion of the course, students are able to

1. Understand the growth conditions required to culture the plants in *invitro* conditions.
2. Inculcate the deep understanding of Gene expression system of plants
3. Acquire knowledge on producing Transgenic plants
4. Inculcate the deep knowledge the processes involved in the planning, conduct and execution of plant biotechnology experiments
5. Learn the structure and organization of plant genome
6. Learn the basic techniques for hybridization in producing transgenic plants

UNIT-I

Introduction: Cryo and organogenic differentiation, Types of culture: Seed, Embryo, Callus, Organ, Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture and culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation

UNIT-II

***In vitro* culture:** haploid production Androgenic methods: Anther culture, Microspore culture and ogenesis. Significance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

UNIT-III

Hybridization: Protoplast Isolation and fusion Methods for protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation Nomenclature, methods, applications basis and disadvantages. Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Bio control of pathogens, Growth promotion by free-living bacteria.

UNIT-IV

Structure and organization of plant genome: regulation of plant genome expression, transcriptional, translational and post transcriptional regulation of plant genome. Transfer of nucleic acid to plant cells - Direct transformation by electroporation and particle gun bombardment. - *Agrobacterium*, Ti plasmid vector Theory and techniques for the development of new genetic traits.

UNIT-V

Transgenic plants: herbicides and pest resistant plants, Drought, Salinity and cold tolerant plants; Molecular farming / pharming: carbohydrates, lipids, theraputic proteins, edible vaccines, purification strategies; Oleosin partition technology.

References

1. Gardner, E.J., Simmonns, M.J., & Snustad, D.P. (2008). (8th ed.). *Principles of Genetics*. India: Wiley.
2. Bhojwani, S.S., & Razdan, (2004). *Plant Tissue Culture and Practice*.
3. Brown, T.A., (2006). *Gene Cloning and DNA Analysis* (5th ed.). Oxford: UK, Blackwell Publishing.
4. Raven, P.H., Johnson, G.B., Losos, J.B., & Singer, S.R. (2005). *Biology.* Tata MC Graw Hill.
5. Reinert, J., & Bajaj, Y.P.S. (1997). *Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture*. Narosa Publishing House.
6. Russell, P.J. (2009). *Genetics – A Molecular Approach* (3rd ed.). Benjamin Co.
7. Sambrook, & Russel. (2012). *Molecular Cloning: A laboratory manual* (4th ed.). Cold Spring Harbor Laboratory Press.
8. Slater, A., Scott, N.W., & Fowler, M.R. (2008). *Plant Biotechnology: The Genetic Manipulation of Plants.* Oxford University Press.

19BTU503B EVOLUTIONARY BIOLOGY 4H - 4C

Total hours/week: L:4 T:0 P:0 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are

- To obtain basic concepts of life and gradual evolution of human and other animals
- To ascertain the evolutionary concepts through fossil study of Eukaryotes from Prokaryotes
- To explain Origin of Life especially Prokaryotes as well as Eukaryotes in detail.
- To give detailed explanation of key concepts of Population Genetics in terms of Hardy-Weinberg Law, Genetic Drift and Types of Natural Selection.
- To provide adequate knowledge about Micro-evolutionary changes, Speciation and Adaptive Radiation.
- To impart descriptive knowledge regarding Origin and Evolution of Man

Course Outcomes

On completion of the course, students are able to

1. Get hold of the knowledge on fundamentals of Evolutionary Biology.
2. Expertise on the concepts of evolution, chromosomal aberrations; recombination and random assortment.
3. Acknowledge on the Qualitative Studies Based on Field Observations
4. To develop comprehensive knowledge regarding various Sources of Variations and their role in evolution.
5. To explore salient features of various theories of evolution comprising of Lamarckism, Darwinism and Neo-Darwinism.
6. To impart detailed understanding of Analogy, Homology, Paleontological Evidences, Embryological Evidences and Molecular Phylogeny.

UNIT- I

Historical Review of Evolutionary Concept: Pre-Darwinian ideas – List of contributors influencing Darwin indicated as a *timeline.* Lamarckism – Merits and demerits. Darwinism – Merits and demerits, Post-Darwinian era –Modern synthetic theory; biomathematics and the theory of population genetics leading to Neo-Darwinism

UNIT- II

Life's Beginnings: Chemogeny – An overview of pre-biotic conditions and events; experimental proofs to abiotic origin of micro- and macro-molecules. Current concept of Chemogeny – RNA first hypothesis. Biogeny – Cellular evolution based on proto-cell models (coacervates and proteinoid micro-spheres). Origin of photosynthesis – Evolution of oxygen and ozone buildup. Endosymbiotic theory – Evolution of Eukaryotes from Prokaryotes

UNIT-III

Evidences of Evolution: Paleobiological – Concept of Stratigraphy and geological timescale; fossil study (types, formation and dating methods). Anatomical – Vestigial organs; Homologous and Analogous organs (concept of parallelism and convergence in evolution). Taxonomic – Transitional forms/evolutionary intermediates; living fossils. Phylogenetic – a) Fossil based – Phylogeny of horse as a model. b) Molecule based – Protein model (Cytochrome C); gene model (Globin gene family)

UNIT-IV

Sources of Evolution – Variations as Raw Materials of Change: Types of variations – Continuous and discontinuous; heritable and non-heritable. Causes, classification and contribution to evolution – Gene mutation; chromosomal aberrations; recombination and random assortment (basis of sexual reproduction); gene regulation. Concept of micro- and macro-evolution – A brief comparison

UNIT-V

Forces of Evolution – Qualitative Studies Based on Field Observations: Natural selection as a guiding force – Its attributes and action Basic characteristics of natural selection. Coloration, camouflage and mimicry, Co-adaptation and co-evolution, Man-made causes of change – Industrial melanism; brief mention of drug, pesticide, antibiotic and herbicide resistance in various organisms. Modes of selection, Polymorphism, Heterosis and Balanced lethal systems. Genetic Drift (Sewall Wright effect) as a stochastic/random force – Its attributes and action. Basic characteristics of drift; selection vs. drift, Bottleneck effect. Founder principle.

References

1. Ridley, M. (2004). *Evolution* (3rd ed.). Blackwell.
2. Hall, B. K., & Hallgrimson, B. (2008). *Strickberger's Evolution* (4th ed.). Jones and Barlett
3. Zimmer, C., & Emlen, D. J. (2013). *Evolution: Making Sense of Life.* Roberts & Co.

19BTU504A ANIMAL BIOTECHNOLOGY 4H - 4C
Total hours/week: L:4 T:0 P:0 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To introduce biotechnological methods for production of transgenic animals.
- To give knowledge about various methods of gene transfer in animals.
- To cognize and get the knowledge on techniques to protect endangered animals.
- To explain the basics of the physiological and molecular processes for animals facing environmental adaptations
- To use basic biotechnological techniques to explore molecular biology of animals
- To understand the processes involved in the planning, conduct and execution of animal biotechnology experiments

Course Outcomes

On completion of the course, students are able to

1. Understand the growth conditions required to culture the animals in *invitro* conditions.
2. Inculcate the deep understanding of Gene expression system of animal
3. Acquire knowledge on producing Transgenic animal
4. Inculcate the deep knowledge the processes involved in the planning, conduct and execution of animal biotechnology experiments
5. Learn the structure and organization of animal genome
6. Learn the basic techniques for hybridization in producing transgenic animal

UNIT- I
Animal Tissue Culture: Laboratory design: aseptic techniques – handling instruments: Microscopes, Clean-bench, etc., and bio safety. Animal Cell Culture Media: Natural and artificial media – their constituents; Physicochemical properties of media; Serum supplemented and serum-free media; Sterilization methods.

UNIT - II
Primary Cell Culture: Methods of tissue disaggregation - isolations of tissues from chick embryo, mouse and human; Continuous and established cell cultures; Cell separation and characterization; Organ culture-types.

UNIT-III
Gene transfer methods in Animals: Microinjection, Gene Gun, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.

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

UNIT-V
Production and applications: Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, problems and ethics. Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Zebra Fish

References

1. Glick, B.R., & Pasternak, J.J. (2009). *Molecular biotechnology- Principles and applications of recombinant DNA* (4th ed.). Washington, USA: ASM press.
2. Watson, J.D., Myers, R.M., Caudy, A., & Witkowski, J.K. (2007). *Recombinant DNA genes and genomes- A short course* (3rd ed.). NY:USA, Freeman & Co.
3. Butler, M. (2004). *Animal cell culture and technology: The basics* (2nd ed.). Bios scientific publishers.
4. Griffiths, A.J.F., Miller, J.H., Suzuki, D.T., Lewontin, R.C., & Gelbart, W.M. (2009). *An introduction to genetic analysis* (9th ed.). NY:USA, Freeman & Co.

19BTU504B ANIMAL DIVERSITY -I 4H - 4C
Total hours/week: L:4 T:0 P:0 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To provide the students with an in-depth knowledge of the diversity in form, structure and habits of invertebrates.
- To learn the basics of systematic and understand the hierarchy of different categories.
- To learn the diagnostic characters of different phyla through brief studies of examples.
- To obtain an overview of economically important invertebrate fauna.
- To explain the organizational hierarchies and complexities of invertebrates.
- To describe the evolutionary trends in external morphology and internal structure.

Course Outcomes

The learners will be able to

1. Outline the origin and classification of animal kingdom
2. Describe the origin of animals and how they differ from other living organisms;
3. Explain the relationship between animal diversity and evolutionary derived changes in animal body plans
4. Analyze the various modes of adaptations in animals
5. Identify and classify with examples the invertebrates
6. Analyze the various modes of adaptations in animals

UNIT- I

a) Outline of classification of Non- Chordates up to subclasses. Coelomata, Acoelomata, Symmetries, Deutrostomes, Protostomes.

b) Protozoa: Locomotion, Reproduction, evolution of Sex, General features of *Paramecium* and *Plasmodium*. Pathogenic protozoans

UNIT-II

a) Porifera: General characters, outline of Classification; skeleton, Canal System

b) Coelenterata: General Characters, Outline of classifications Polymorphism, Various types of stinging cells; Metagenesis, coral reefs and their formation.

UNIT-III

a) Platyhelminthes- General Characters; Outline of classification; Pathogenic flatworms: Parasitic adaptations.

b) Aschelminthes: General features, Outline of classification, Pathogenic roundworms and their vectors in relation to man: Parasite adaptation.

UNIT-IV

a) Annelida: - General features, Outline of classification, Coelom: Metameric segmentation, General features of Earthworm, Vermicomposting.

b) Arthropoda: General Features, Outline of Classification; Larval forms of crustacean, Respiration in Arthropoda; Metamorphosis in insects; Social insects; Insect vectors of diseases; Apiculture, Sericulture.

UNIT-V

a) Mollusca: general features, Outline of classification, Shell Diversity; Torsion in gastropoda,

b) Echinodermata: General features, Outline of Classification Larval forms

c) Hemichordata: Phylogeny: Affinities of *Balanoglossus.*

References

1. Ruppert, Edward, E., Fox Richard, S. & Barnes Robert, D. (2009). *Invertebrate Zoology: A Functional Evolutionary Approach* (7th ed.). Thomson Brooks/Cole.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. & J.I., Spicer (2002). *The Invertebrates: A New Synthesis* (3rd ed.). Blackwell Science.
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions* (2nd ed.). E.L.B.S. and Nelson.
4. Kent, G.C., & Carr, R.K. (2000). *Comparative Anatomy of the Vertebrates* (9th ed.). The McGraw-Hill Companies.

19BTU511A PLANT DIVERSITY -I PRACTICAL 3H - 1C

Total hours/week: L:0 T:0 P:3 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To understand the physiological conditions of the plants and metabolism.
- To understand the basic concepts of photosystems and their importance in plant growth.
- To gain the information about the economic importance of algae and fungi.
- Learn about the structure, pigmentation, food reserves and methods of reproduction of Algae
- Learn about the structure, pigmentation, food reserves and methods of reproduction of Fungi
- Studied some plant diseases with special reference to the causative agents, symptoms, etiology and control measures.

Course Outcomes

The learners will be able to,

1. Gain adequate knowledge on plant biodiversity and importance.
2. Understand the molecular mechanisms of macro and micro nutrients in plant growth.
3. Get the basic and applied knowledge of plant physiology, growth, development and metabolism.
4. Discuss about importance of morphological structure, classification, reproduction and economic importance of Algae.
5. Know the control measures of plant diseases.
6. Explain about structure, classification, reproduction, life cycle and economic importance of Bryophytes.

Practical

1. Comparative study of thallus and reproductive organs of various algae mentioned in theory.
2. Comparative study of vegetative and reproductive parts of various fungi mentioned in theory.
3. Study and section cutting and lectophenol mount of plant disease materials studied in theory.
4. Study of various types of lichens.
5. Study of external features & anatomy of vegetative and reproductive parts of Marchantia and Funaria.
6. Collection of plant disease materials and bryophytes available locally.

References

1. Aneja, K.R., & Mehrotra, R.S. (2015). *An Introduction to Mycology* (2nd ed.). New Age International pubishers.
2. Agrios, G.N. (2004). *Plant Pathology* (5th ed.). UK: Academic Press.
3. Kumar, H.D. (1999) *Introductory Phycology*. Aff. East-West Press Pvt Ltd., Delhi.
4. Lee, R.E. (2008). *Phycolog*y (4th ed.). USA: Cambridge University Press.
5. Sambamurty, (2008). *A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany*. IK International Publishers.

19BTU511B BASICS OF FORENSIC SCIENCE PRACTICAL 3H –1 C
Total hours/week: L:0 T:0 P:3 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To give knowledge on molecular analysis in forensic science.
- To offer knowledge to assess DNA finger printing
- To understand the evidence for suspecting victims in crime
- To handle the evidences left out at the crime scene.
- The basic methods for examine the different types of questioned documents.
- Identify the different petroleum products by TLC examination.

Course Outcomes

On completion of the course, students are able to

1. Apply the Laboratory skills to participate in the career needs of Forensic community.
2. Become trained in the laboratory skills of different division of Forensic Science.
3. Be able to work with different R&D organizations.
4. Identify the role of the forensic scientist and physical evidence within the criminal justice system.
5. Demonstrate the ability to document and orally describe crime scenes, physical evidence, and scientific processes.
6. Identify and examine current and emerging concepts and practices within the forensic science field.

Practical

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

References

1. Tilstone, W.J., Hastrup, M.L., & Hald, C. (2013). *Fisher's Techniques of Crime Scene Investigation*. CRC Press.
2. Bernard J. Glick, Jack J. Pasternak , & Cheryl L. Patten. (2010). *Molecular Biotechnology- Principles and Applications of recombinant DNA* (4th ed.). Washington: ASM Press.
3. Nanda, B.B., & Tiwari, R.K. (2001*). Forensic Science in India: A Vision for the Twenty First Century*. New Delhi :Select Publishers.
4. Bhasin, M.K., & Nath S. (2002). *Role of Forensic Science in the New Millennium.* Delhi: University of Delhi.
5. James, S.H., & Nordby J.J. (2005). *Forensic Science: An Introduction to Scientific and Investigative Techniques* (2nd ed.). CRC Press, Boca Raton.
6. Eckert, W.G., & Wright, R.K. (1997). *An Introduction to Forensic Sciences* (2nd ed.). CRC Press, Boca Raton (1997).
7. Saferstein R. (2004). *Criminalistics: An Introduction to Forensic Science* (8th ed.). New Jersey: Prentice Hall.
8. Syed Ibrahim.K., GuruSubramanian, G., Zothansarga, yadav, R.P., Senthil Kumar N., Pandian, S.K., Borah., P., Mohan S., 2017. Bioinformatics- A students companion

19BTU512A BIOINFORMATICS PRACTICAL 4H - 2C
Total hours/week: L:0 T:0 P:4 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To give knowledge on Bioinformatics and its application
- To offer knowledge to assess biological databases
- To understand and to analyze protein/nucleotide sequences and to predict its 3D structure
- To understand the various online databases for submitting and retrieving data's
- To understand how the phylogeny plays a vital role in finding ambiguities.
- To get practiced with the tools and techniques for analysing the data.
-

Course Outcomes

On completion of the course, students are able to

1. Understand The relationship between sequence - structure - function of genes.
2. Familiarize with the algorithms required to compare sequences and require to know the phylogenetic relationship between the gene sequences.
3. Inculcate knowledge on building 3D structures of genes.
4. Locate and use the main databases at the NCBI and EBI resources
5. Know the difference between databases, tools, repositories and be able to use each one to extract specific information.
6. Use selected tools at NCBI and EBI to run simple analyses on genomic sequences.

Practical

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

References

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

19BTU512B PLANT DIVERSITY -II PRACTICAL 4H - 2C

Total hours/week: L:0 T:0 P:4 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- Provide practical knowledge about the various morphological, anatomical characteristic of bryophytes
- Provide practical knowledge about the Pteridophytes, Gymnosperms and angiosperm in ecosystem to the students
- To develop the skills on morphological identification of plants
- Understand the diversity among various plants
- Know the systematic morphology and structure of lichens
- Know specimen handling techniques

Course Outcomes

The learners will be able to

1. Understand the various morphological, anatomical characteristic of bryophytes
2. Understand the Pteridophytes, Gymnosperms and angiosperm in ecosystem
3. Study and impart knowledge about the occurrence, distribution, structure and life history of lower plants such as algae, fungi and lichens
4. Learn in detail about vegetative parts of various fungi
5. Learn in detail about reproductive parts of various fungi
6. Learn the phylogeny and evolutionary concepts in plants

Practical

1. Examination of morphology and anatomy of vegetative and reproductive parts of *Selaginella.*
2. Examination of morphology and anatomy of vegetative and reproductive parts of *Equisetum.*
3. Examination of morphology and anatomy of vegetative and reproductive parts of *Pteris*.
4. Examination of morphology and anatomy of vegetative and reproductive parts of – *Cycas & Pinus*
5. Examination of morphology and anatomy of vegetative and reproductive parts of –*Pinus*
6. Plant collection -pteridophytes.
7. Plant collection - gymnosperms.

References

1. Sambamurty, (2008). *A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany*. IK International Publishers.
2. Wickens, G.E. (2004). *Economic Botany: Principles and Practices*. Dordrecht: Netherlands, Springer, Kluwer Publishers.
3. Bhatnager, S.P., & Moitra, A. (1996). *Gymnosperms*. New Delhi:New Age International (P) Ltd. Publishers.
4. Parihar, N.S. (1996). *The Biology and Morphology of Pteridophytes*. Allahabad: Central Book Depot.

19BTU513A PLANT BIOTECHNOLOGY PRACTICAL 4H - 2C
Total hours/week: L:0T:0 P:4 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To develop the skills on morphological identification of suitable explants
- Understand the growth hormones of culture medium
- Know the systematic morphology and structure of plants
- Learn about the general culture techniques
- Know about the sterilization process in PTC Lab
- Studied the methods of Micropropagation

Course Outcomes:

The learners will be able to

1. Study and impart knowledge about the occurrence, distribution, of plants and suitable explants
2. Learn in detail about growth hormones
3. Learn the sterilize and prepare an explant of plants
4. Learn how to handle a PTC equipments
5. Acquire knowledge about aseptic condition maintained in lab
6. Learn the skills on plant culture techniques

Practical

1. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid.
2. Preparation of complex nutrient medium (Murashige & Skoog's medium).
3. To selection, Pure, sterilize and prepare an explant for culture.
4. Significance of growth hormones in culture medium.
5. To demonstrate various steps of Micropropagation using banana/tomato/potato.
6. To demonstrate the meristem culture.

References

1. Bhojwani, S.S., & Razdan, (2004). *Plant Tissue Culture and Practice*.
2. Brown, T.A., (2006). *Gene Cloning and DNA Analysis* (5th ed.). Oxford: UK, Blackwell Publishing.
3. Gardner, E.J. , Simmonns, M.J., & Snustad, D.P. (2008). (8th ed.). *Principles of Genetics*. India: Wiley.
4. Raven, P.H., Johnson, G.B., Losos, J.B., & Singer, S.R. (2005). *Biology*. Tata MC Graw Hill.
5. Reinert, J., & Bajaj, Y.P.S. (1997). *Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture*. Narosa Publishing House.
6. Russell, P.J. (2009). *Genetics – A Molecular Approach* (3rd ed.). Benjamin Co.
7. Sambrook, & Russel. (2012). *Molecular Cloning: A laboratory manual* (4th ed.). Cold Spring Harbor Laboratory Press.
8. Slater, A., Scott, N.W. ,& Fowler, M.R. (2008). *Plant Biotechnology: The Genetic Manipulation of Plants*. Oxford University Press.

19BTU513B EVOLUTIONARY BIOLOGY PRACTICAL 4H - 2C
Total hours/week: L:0 T:0 P:4 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are

- To obtain practical concepts of types of fossils
- To ascertain the evolutionary concepts through fossil study of Eukaryotes from Prokaryotes
- To explain Origin of Life especially Prokaryotes as well as Eukaryotes in detail.
- To give detailed explanation of key concepts of living fossil
- To provide adequate knowledge about Micro-evolutionary changes, Speciation and Adaptive Radiation.
- To impart descriptive knowledge regarding Origin and Evolution of Man

Course Outcomes

On completion of the course, students are able to

1. Get hold of the practical knowledge on fundamentals of Evolutionary Biology.
2. Expertise on the Sampling techinques.
3. Acknowledge on the Qualitative Studies Based on Field Observations
4. To develop comprehensive knowledge regarding various Sources of Variations and their role in evolution.
5. To explore salient features of various theories of evolution comprising of Lamarckism, Darwinism and Neo-Darwinism.
6. To impart detailed understanding of Analogy, Homology, Paleontological Evidences, Embryological Evidences and Molecular Phylogeny.

Practical

(A) Evidence of fossils

1. Study of types of fossils (e.g. trails, casts and moulds and others) and Index fossils of Palaeozoic era
2. Connecting links/transitional forms - Eg. Euglena, Neopilina, Balanoglossus, Chimaera, Tiktaalik, Archaeopteryx, Ornithorhynchus
3. Living fossils - Eg. Limulus, Peripatus, Latimeria, Sphaenodon
4. Vestigial, Analogous and Homologous organs using photographs, models or specimen.

(B) Variations

1. Sampling of human height, weight and BMI for continuous variation.
2. Sampling for discrete characteristics (dominant *vs* recessive) for discontinuous variations e.g hitch-hiker's thumb, dexterity, tongue rolling, ear lobe (data categorization into 16 groups based on the combination of 4 traits; assigning each subject to the respective group).

(C) Selection Exemplifying Adaptive strategies (Colouration, Mimetic form, Co-adaptation and co-evolution; Adaptations to aquatic, fossorial and arboreal modes of life) using Specimens.

(D) Neo-Darwinian Studies

1. Calculations of genotypic, phenotypic and allelic frequencies from the data provided
2. Simulation experiments using coloured beads/playing cards to understand the effects of Selection and Genetic drift on gene frequencies

(E) Phylogeny.

References

1. Ridley, M. (2004). *Evolution* (3rd ed.). Blackwell.
2. Hall, B. K., & Hallgrimson, B. (2008). *Strickberger's Evolution* (4th ed.). Jones and Barlett
3. Zimmer, C., & Emlen, D. J. (2013). *Evolution: Making Sense of Life.* Roberts & Co.
4. Barton, Briggs, Eisen, Goldstein, & Patel, (2007). *Evolution.* Cold Spring Harbor Laboratory Press.

19BTU514A ANIMAL BIOTECHNOLOGY PRACTICAL 4H - 2C
Total hours/week: L:0 T:0 P:4 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To introduce biotechnological methods for ATC.
- To give knowledge about various methods of gene transfer in animals.
- To cognize and get the knowledge Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization.
- To explain the basics of the physiological and molecular processes for animals Facing environmental adaptations
- To use basic biotechnological techniques to explore molecular biology of animals
- To understand the processes involved in the planning, conduct and execution of animal biotechnology experiments

Course Outcomes

On completion of the course, students are able to

1. Understand the growth conditions required to culture the animals in *invitro* conditions.
2. Inculcate the deep understanding of Laboratory sterilization
3. Acquire knowledge on DNA isolation from animal tissue
4. Understand the Minimal Essential Growth medium
5. Inculcate the deep knowledge the processes involved in the planning, conduct and execution of animal biotechnology experiments
6. Learn the structure and organization of animal genome

Practical

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

References

1. Glick, B.R., & Pasternak, J.J. (2009). *Molecular biotechnology- Principles and applications of recombinant DNA* (4th ed.). Washington, USA: ASM press.
2. Griffiths, A.J.F., Miller, J.H., Suzuki, D.T., Lewontin, R.C., & Gelbart, W.M. (2009). *An introduction to genetic analysis* (9th ed.). NY:USA, Freeman & Co.
3. Watson, J.D., Myers, R.M., Caudy, A., & Witkowski, J.K. (2007). *Recombinant DNA genes and genomes- A short course* (3rd ed.). NY:USA, Freeman & Co.
4. Butler, M. (2004). *Animal cell culture and technology: The basics* (2nd ed.). Bios scientific publishers.

19BTU514B ANIMAL DIVERSITY - I PRACTICAL 4H - 2C

Total hours/week: L:0 T:0 P:4 Marks: Internal: 40 External: 60 Total: 100

Course Objectives

The main objectives of the course are,

- To provide the students with an in-depth knowledge of the diversity in form, structure and habits of invertebrates.
- To learn the basics of systematic and understand the hierarchy of different categories.
- To learn the diagnostic characters of different phyla through brief studies of examples.
- To obtain an overview of economically important invertebrate fauna.
- To explain the organizational hierarchies and complexities of invertebrates.
- To describe the evolutionary trends in external morphology and internal structure.

Course Outcomes

The learners will be able to

1. Outline the origin and classification of animal kingdom
2. Describe the origin of animals and how they differ from other living organisms;
3. Explain the relationship between animal diversity and evolutionary derived changes in animal body plans
4. Analyze the various modes of adaptations in animals
5. Identify and classify with examples the invertebrates
6. Analyze the various modes of adaptations in animals

List of Practicals

1. Identification and Classification of any these of the following –Porifera*: Scypha, Leucosolenia, Euspongia, Hylonema, Euplectella Cnidaria: Medrepora, Millepora, Physalia, Porpita, Valella, Aurelia, Metridium* Platyhelminthes: *Taenia, Fasciola*, Aschelminthes*: Ascaris, Ancylostoma, Enterobius* Annelida: *Pheretima, Hirudinaria, Chaetopterus, Nereis, Aphrodite* Arthropoda: *Julus, Scolopendra, Peripatus, Carcinus, Limulus, Lepisma, Dragonfly, Musca, Acheta* ollusca: *Pila, Unio, Mytilus, Loligo, Sepia, Octopus, Solen* Echinodermata: *Asterias, Ophiothrix, Echinus, Holothuria, Astrophyton* Hemichordata: *Balanoglossus*

2. Identification of slides with two points of identification. *Amoeba, Paramoecium, Ceratium, Plasmodium, Opalina*, L.S. Sponge, Spicules of sponges, L.S. *Hydra, Obelia, Bougainvillia*, Larvae of *Fasciola,* Seta of Earthworm, Radula

3. Ecological Note – On any of the specimens in Exercise No 1 Models of dissection of Earthworm, Cockroach Earthworm: Digestive, Nervous System, Cockroach: Digestive Reproductive, Nervous System.

References

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. & J.I., Spicer (2002).*The Invertebrates: A New Synthesis* (3rd ed.). Blackwell Science.
2. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions* (2nd ed.). E.L.B.S. and Nelson.
3. Ruppert, Edward, E., Fox Richard, S. & Barnes Robert, D. (2009). *Invertebrate Zoology: A Functional Evolutionary Approach* (7th ed.). Thomson Brooks/Cole.
4. Kent, G.C., & Carr, R.K. (2000). *Comparative Anatomy of the Vertebrates* (9th ed.). The McGraw-Hill Companies.

Instruction Hours/week: **L:3 T:0 P:0** Marks: Internal:**40** External:**60** Total: **100**

End Semester Exam: 3

Course Objectives

The main objectives of the course are

- To obtain basic concepts of molecules and its effect on human and other animals.
- To ascertain the diagnostics tools for infectious diseases.
- To achieve a complete knowledge about molecular diagnostics techniques on human welfare.
- To understand the utility and limitations of various molecular diagnostic tests used for managing patient care.
- To attain the concepts of molecular methods used in clinical microbiology.
- To recognize the importance of proper specimen collection and preparation for molecular detection.

Course Outcomes

On completion of the course, students are able to

1. Get hold of the knowledge on fundamentals of molecular diagnostic techniques.
2. Expertise on the concepts of infection, diagnosis and control assortment.
3. Acknowledge on the qualitative studies based on biomarker observations.
4. Apply methodologies of laboratory diagnostics to relevant states of health.
5. Be aware of characteristics signs of clinical manifestations.
6. Comprehend and analyse the concept of disease management.

UNIT-I

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

UNIT-II

Molecular methods in clinical microbiology: Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

UNIT-III

Diagnosis and Standardization: Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies.

UNIT-IV

Diagnostic immunology: Concepts and methods in idiotypes. Anti-idiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno-florescence. Radioimmunoassay.

UNIT-V

Applications:

GC, HPLC, Electron microscopy, flow cytometry and cell sorting, PCR, reverse transcriptase PCR, fluorescence microscopy, Hybridization methods like Southern, Northern blotting, FISH, DNA and RNA fingerprinting and Transgenic animals

References

1. Darnell. J., Lodish. H and Baltimore D (1990), Molecular Cell Biology, Scientific Amer Inc.,2nd edition.
2. Bruce Alberts (2014), Molecular Biology of cell, W. W. Norton & Company, 6th edition.
4. Bruce Alberts (2002), Molecular Biology of cell, Garland Science; 4 edition.
5. De Robertis and De robertis (2006), Cell and molecular Biology, 8th edition, Lipincott and Wilkins.
6. Benjamin Lewin (2006), *Molecular Biology Jones* and Bartlett Publishers, Inc, 9th edition.

19BTU601B BIOTECHNOLOGY AND HUMAN WELFARE 3H - 3C

Instruction Hours/week: **L:3 T:0 P:0** Marks: Internal:**40** External:**60** Total: **100**

End Semester Exam: 3

Course Objectives:

The main objectives of the course are

- learn the basics and lay strong foundation in understanding the biotechnological techniques in human welfare.
- To ascertain the knowledge about solid waste management and wastewater treatment.
- To achieve a novel treatment strategy for waste.
- To learn DNA based methods used in forensic science laboratory
- To obtain knowledge about biotechnological approaches beneficial for industries
- Exposure of simple concepts that will complement the course "Biotechnology in Human Welfare

Course Outcomes:

On completion of the course, students are able to

1. Apply the biotechnology concept for environmental and social welfare.
2. Expertise on the concepts of treatment strategies for waste to renewable energy.
3. Able to produce by-products from waste with help of biotechnology techniques.
4. Able to apply DNA based methods used in forensic science laboratory
5. Able to entry into a wide range of biotechnology industries and research enterprises.
6. Development of non-toxic therapeutic agents, recombinant live and DNA vaccines and gene therapy

UNIT- I

Introduction

Industry: Protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation vs. whole cell, Enzyme Immobilization, Ribozyme, Abzyme, Industrial application of enzyme. Fermentation, Types of fermentation, Downstreaming processing, fermented foods.

UNIT-II

Agriculture Biotechnology: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock, Insect resistance, Drought resistance, Biofertilizers, Biopesticide and Biocontrol agents.

UNIT-III

Environment Biotechnology: Chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.

UNIT-IV

Forensic science: DNA fingerprinting and its applications in human welfare, Identification of origin - Paternity, crime.

UNIT-V

Medical Biotechnology: Development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, Types of gene therapy, Stem cell technology, Targeted gene therapy, ethical issues, diagnostics, monoclonal in *E.coli*, human genome project.

References

1. Sateesh, M.K. (2010). *Bioethics and Biosafety*. I. K. International Pvt Ltd.
2. Sree Krishna,V. (2007) *Bioethics and Biosafety in Biotechnology*. New age international publishers.
3. Singh B.D., Biotechnology, Expanding Horizon (2010), 3rd edition, Kalyan Publication
4. Rattage, C and Kristiansen B.,(2008), Basic Biotechnology , Cambridge University Press, London.
5. Cruger and Cruger(1990), BiotechnologyA Textbook of industrial microbiology, 2nd edition, Panima publication corporation, New Delhi.

19BTU602A **MEDICAL MICROBIOLOGY** **4H - 4C**

Instruction Hours/week: **L:4 T:0 P:0** Marks: Internal:**40** External:**60** Total: **100**

End Semester Exam: 3

Course Objectives

The main objectives of the course are

- To identify common infectious agents and the diseases that they cause.
- To evaluate methods used to identify infectious agents in medical microbiology lab.
- To recall microbial physiology including metabolism, regulation and replication of pathogenic microbes.
- To explain general and specific mechanisms by which an infectious agent causes disease.
- To recognize and diagnose common infectious diseases from the clinical presentation and associated microbiology.
- To describe the epidemiology of infectious agents including how infectious diseases are transmitted.

Course Outcomes

On completion of the course, students are able to

1. Apply the biotechnology concept for controlling infectious agents.
2. Expertise on the concepts of metabolism, regulation and replication of pathogenic microbes.
3. Able to get knowledge on the toxins released by microbes.
4. Able to enter into a wide range of biotechnology industries with research enterprises.
5. Develop of non-toxic therapeutic agents from microbes
6. Able to get knowledge on Fungal and Protozoan infections

UNIT- I

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

UNIT-II

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

UNIT- III

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

UNIT- IV

Fungal and Protozoan infections:. Dermatophytoses (*Trichophyton, Microsporun and Epidermophyton*) Subcutaneous infection (*Sporothrix, Cryptococcus*), systemic infection (*Histoplasma, Coccidoides).*
Parasitiology : Medical importance of *Entameoba, Giardia, Plasmodium, Taenia, Ascaris, Wucherhiria*

UNIT- V

Opportunistic fungal infections (*Candidiasis, Aspergillosis*), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria).

References

1. Brooks, G.F., Carroll, K.C., Butel, J.S., & Morse, S.A. (2007). *Jawetz, Melnick and Adelberg's Medical Microbiology* (24th ed.). McGraw Hill Publication.
2. Goering, R., Dockrell, H., Zuckerman, M., & Wakelin, D. (2007). *Mims' Medical Microbiology* (4th ed.). Elsevier.
3. Willey, J.M., Sherwood, L.M., & Woolverton, C.J. (2008). *Prescott, Harley and Klein's Microbiology* (7th ed.). McGraw Hill Higher Education.
4. David greenwood, Richard CD., Slack., John forrest (1992), Medical Microbiology, 14th edition , Churchilll Livingstone.

19BTU602B ENVIRONMENTAL BIOTECHNOLOGY 4H - 4C

Instruction Hours/week: **L:4 T:0 P:0** Marks: Internal:**40** External:**60** Total: **100**

End Semester Exam: 3

Course Objectives

The main objectives of the course are

- To obtain basic concepts of biotechnology to solve the environmental problems
- To ascertain the knowledge about solid waste management and wastewater treatment.
- To achieve a novel treatment strategy for waste to Bioenergy.
- To gain knowledge about the biological and biotechnological measures for restoring environment.
- To involve in the present scenarios and find valuable solutions for remedy
- To update about the management strategies followed up by the industries and government.

Course Outcomes

On completion of the course, students are able to apply their knowledge on

1. Bio-management of soil
2. Bio-management of Petroleum Contaminants
3. Environmental significance of genetically modified microbes, plants and animals
4. Biosurfactants
5. Treatment of municipal waste and Industrial effluents
6. Genetic engineering of bacteria and their potential for bioremediation

UNIT-I

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

UNIT- II

Waste management: Treatment of municipal waste and Industrial effluents. Basic aspects of Solid waste management (an introduction), Aerobic and anaerobic treatments of SWM, Composting, Vermicomposting, Biogas production, Treatment of Hazardous waste, treatment stratergies of PCBP., Biomedical wastes, Types of biomedical waste, Hazards caused by Biomedical waste, Treatment strategies of Biomedical waste.

UNIT- III

Bio-fertilizers and Bioleaching: Bio-fertilizers Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM). Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium), Heavy metal pollution.

UNIT-IV

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

UNIT- V

GMO's: Environmental significance of genetically modified microbes, plants and animals and its impact on environment.

References

1. Santra, S.C. (2011). *Environmental Science* (3rd ed.). New Central Book Agency.
2. Pradipta Kumar Mohapatra, (2007). *Environmental Biotechnology*. I.K. International Publishing House.
3. Hans-Joachim Jordening,& Jesef Winter, (Eds.). (2005). *Environmental Biotechnology*: Concepts and Applications. Wiley-VCH.
4. Metcalf, & Eddy, (2003). *Waste Water Engineering: Treatment and Reuse* (4th ed.). Tata McGraw hill.
5. Purohit, S.S. (2003). *Agricultural Biotechnology* (2nd ed.). Updesh Purohit.
6. Alicia, L., Ragout De Spencer, & John Spencer, F.T. (Eds.). (2004).*Environmental Microbiology: Methods and Protocols*. Humana Press.
7. Milton Wainwright, (1999). *Introduction to Environmental Biotechnology*. Spring.
8. Gilbert Masters, (2007). *Principles of Environmental Engineering* (3rd ed.). Prentice Hall.
9. Metcalf, & Eddy. (2002). *Wastewater Engineering* (4th ed.). McGraw-Hill Higher Education.

Instruction Hours/week: **L:4 T:0 P:0** Marks: Internal:**40** External:**60** Total: **100**

End Semester Exam: 3

Course Objectives

The main objectives of the course are

- To gain mathematical approach for analyzing the data.
- To learn the knowledge about graphical and diagrammatic representation of Statistical data.
- To learn the knowledge about Scope and applications of biostatistics
- To learn the knowledge about collection, processing and presentation of data and Testing of hypothesis
- To learn the knowledge about Measures of central tendency, Measures of dispersion
- To learn the knowledge about Correlation analysis and regression analysis

Course Outcomes

On completion of the course, students are able to

1. Apply the statistical tool knowledge for research data analysis.
2. Understand the concept of various hypothesis regarding data analysis.
3. To perform analysis for the data based on graphical representation (Bar, multiple bars, histogram, pie chart etc.)
4. To perform analysis to determine the mean, median, mode and standard deviation of given sample/data
5. To perform analysis, determine the probability of given sample/data
6. To perform the t-test/F-Test and Chi-square test of given data

UNIT-I

Statistics: Meaning, Definitions, Introduction to Bio-Statistics -Types of Data, Collection of data; Primary & Secondary data, Classification and tabulation of data, construction of frequency distribution. Graphical and diagrammatic representation of Statistical data.

UNIT-II

Measures of central tendency: Mean, Median and Mode. Measures Dispersion – Absolute and relative measures dispersion – Range, Standard deviation and coefficient of variation. Measures of Skewness and Kurtosis.

UNIT-III

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

UNIT-IV

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

UNIT-V

Correlation and regression: Types of correlation, degrees of correlation, methods of calculating correlation coefficient – scatter diagram, Karl Pearson and Spearman rank correlation coefficients. Regression – regression lines, regression equation, regression coefficients, methods of forming regression equations. Emphasis on examples from Biological Sciences. Statistical software R or SAS and its implementation of statistics**.**

References

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

19BTU603B ENVIRONMENT MANAGEMENT 4H - 4C

Instruction Hours/week: **L:4 T:0 P:0** Marks: Internal:**40** External:**60** Total: **100**

End Semester Exam: 3

Course Objectives

The main objectives of the course are

- To obtain basic concepts of Geological consideration of Atmosphere
- To ascertain the knowledge about Energy transfer in an Ecosystem.
- To obtain knowledge Pollution and environmental Health.
- To gain knowledge about the biotechnological measures for restoring environment.
- To involve in the present scenarios and find valuable solutions for remedy
- To update about the management strategies by Bio-transformation.

Course Outcomes

On completion of the course, students are able to apply their knowledge on

1. Principles & Concepts of Ecosystem
2. Ecological efficiencies
3. Environmental significance of Detection of Environmental pollutants
4. Bio-geochemical cycles
5. Hazardous wastes Environmental cleanup
6. Genetic engineering of bacteria and their potential for bioremediation

UNIT-I

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

UNIT-II

Energy flow and environment: Energy transfer in an Ecosystem, Food chain, food web, Energy budget, Production & decomposition in a system. Ecological efficiencies, Trophic structure & energy pyramids, Ecological energetic, principles pertaining to limiting factors, Bio-geochemical cycles (Nitrogen, Carbon and Phosphate cycles).

UNIT-III

Pollution: Pollution and environmental Health related to Soil, Water, Air, Food, Pesticides, Metals, Solvents, Radiations Carcinogen, Poisons. Detection of Environmental pollutants. Indicators & detection systems.

UNIT-IV

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

UNIT-V

Case studies: Disaster management, Bio-transformation, Plastic, Aromatics, Hazardous wastes Environmental cleanup, Industrial safety and its product management.

References

1. Robert May, & Angela McLean. (Eds.). (2007). *Theoretical Ecology: Principles and Applications* (3rd ed.). USA: Oxford University Press.
2. Divan Rosencraz, (2002). *Environmental laws and policies in India*. Oxford Publication.
3. Ghosh, S.K., &Singh, R. (2003). *Social forestry and forest management*. Global Vision Publishing House
4. Joseph, B. (2005). *Environmental studies*. Tata Mc Graw Hill.
5. Michael Allabay, (2000). *Basics of environmental science* (2nd ed.). Routledge Press.
6. Miller, G.T. (2002). *Sustaining the earth, an integrated approach* (5th ed.). Books/Cole,Thompson Learning, Inc.
7. Mohapatra, P.K., (2007). *Textbook of environmental biotechnology*. IK publication.
8. Rana, S.V.S., (2013). *Environmental pollution – health and toxicology* (2nd ed.). Narosa Publication.
9. Sinha, S. (2010*). Handbook on Wildlife Law Enforsement in India*. India: TRAFFIC.
10. Thakur, I. S. (2011). *Environmental Biotechnology*. I K Publication.

19BTU611A MOLECULAR DIAGNOSTICS PRACTICAL 3H - 1C

Instruction Hours/week: **L:0 T:0 P:3** Marks: Internal:**40** External:**60** Total: **100**

End Semester Exam: 3

Course Objectives

The main objectives of the course are

- To obtain basic concepts of Identification of pathogenic bacteria
- To ascertain the diagnostics tools for infectious diseases – RFLP, RAPD.
- To achieve a complete knowledge about molecular diagnostics techniques on microbial infection.
- To understand the utility and limitations of various molecular diagnostic tests used for managing patient care.
- To attain the concepts of molecular methods used in clinical microbiology.
- To recognize the importance of proper specimen collection and preparation for molecular detection.

Course Outcomes

On completion of the course, students are able to

1. Get hold of the knowledge on fundamentals of molecular diagnostic techniques.
2. Expertise on the concepts of infection, diagnosis and control assortment.
3. Acknowledge on the qualitative studies based on biomarker observations.
4. Apply methodologies of laboratory diagnostics to relevant states of health.
5. Be aware of characteristics signs of clinical manifestations.
6. Comprehend and analyses the concept of disease management

Practical

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

References

1. Willey, J.M., Sherwood, L.M., & Woolverton, C.J. (2008). *Prescott, Harley and Klein's Microbiology* (7th ed.). McGraw Hill Higher Education.
2. Goering, R., Dockrell, H., Zuckerman, M., & Wakelin, D. (2007). *Mims' Medical Microbiology* (4th ed.). Elsevier.
3. Ananthanarayan, R., & Paniker, C.K.J. (2005). *Textbook of Microbiology* (7th ed.). University Press Publication.
4. Brooks, G.F., Carroll, K.C., Butel, J.S., & Morse, S.A. (2007). Jawetz, Melnick and *Adelberg's Medical Microbiology* (24th ed.). McGraw Hill Publication.
5. Joklik, W.K., Willett, H.P., & Amos, D.B. (1995). *Zinsser Microbiology* (19th ed.). Appleton- Centuary-Crofts publication.

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

19BTU611B BIOTECHNOLOGY AND HUMAN WELFARE PRACTICAL 3H - 1C

Instruction Hours/week: **L:0 T:0 P:3** Marks: Internal:**40** External:**60** Total: **100**

End Semester Exam: 3

Course Objectives

The main objectives of the course are

- Learn the basics and lay strong foundation in understanding the biotechnological techniques in human welfare.
- To ascertain the knowledge about Endophyte.
- To achieve a estimation treatment strategy.
- To learn about ethical issues.
- To obtain knowledge about biotechnological approaches beneficial for industries
- To expose simple experiments that will complement the course "Biotechnology in Human Welfare

Course Outcomes

On completion of the course, students are able to

1. Apply the biotechnology concept for industry products.
2. Expertise on the concepts of treatment strategy.
3. Able to understand the plant part infected with a microbe.
4. Able to enter into a wide range of research enterprises.
5. Get expertise in Bioethics.
6. Understand the concepts of complement course "Biotechnology in Human Welfare

Practical

1. Fermentation - Protein/ enzymes/ alcohol.
2. Study of a plant part infected with a microbe
3. To perform quantitative estimation of residual chlorine in water samples
4. Isolation and analysis of DNA from minimal available biological samples
5. Case studies on Bioethics (any two)

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

References

1. Sateesh ,M.K. (2010). *Bioethics and Biosafety.* I. K. International Pvt Ltd.
2. Sree Krishna, V. (2007). *Bioethics and Biosafety in Biotechnology.* New Age International publishers.
3. P. Ramados (2007), Practical Biotechnology, Jaypee Brothers, Medical publishers PVT., Limited.
4. S. Harisha (2007), Biotechnology procedures and experiments, Handbook, Infinity science press , LLC

19BTU612A MEDICAL MICROBIOLOGY PRACTICAL 4H - 2C

Instruction Hours/week: **L:0 T:0 P:4** Marks: Internal:**40** External:**60** Total: **100**

End Semester Exam: 3

Course Objectives

The main objectives of the course are

- To obtain basic concepts of Identification of pathogenic bacteria
- To ascertain the diagnostics tools for infectious diseases
- To achieve a complete knowledge about diagnostics techniques on microbial infection.
- To understand the utility and limitations of various molecular diagnostic tests used for managing patient care.
- To attain the concepts of molecular methods used in clinical microbiology.
- To recognize the importance of proper specimen collection and preparation for molecular detection.

Course Outcomes

On completion of the course, students are able to

1. Get hold of the knowledge on fundamentals of diagnostic techniques.
2. Expertise on the concepts of infection, diagnosis and control assortment.
3. Acknowledge on the qualitative studies based on biomarker observations.
4. Apply methodologies of laboratory diagnostics to relevant states of health.
5. Be aware of characteristics signs of clinical manifestations.
6. Comprehend and analyse the concept of disease management.

Practical

1. Identification of pathogenic bacteria (any two) based on cultural, morphological and biochemical characteristics.
2. Growth curve of a bacterium.
3. To perform antibacterial testing by Kirby-Bauer method.
4. To prepare temporary mounts of *Aspergillus* and *Candida* by appropriate staining.
5. Staining methods: Gram's staining permanent slides showing acid fast staining, Capsule staining and spore staining.
6. Hanging drop method

References

1. Brooks, G.F, Carroll, K.C, Butel, J.S., & Morse, S.A. (2007). *Jawetz, Melnick and Adelberg's Medical Microbiology* (24th ed.). McGraw Hill Publication.
2. Goering, R., Dockrell, H., Zuckerman, M., & Wakelin, D. (2007). *Mims' Medical Microbiology.* (4th ed.). Elsevier. .
3. Willey, J.M., Sherwood, L.M., & Woolverton, C.J. (2008). *Prescott, Harley and Klein's Microbiology.* (7th ed.). McGraw Hill Higher Education.

19BTU612B ENVIRONMENTAL BIOTECHNOLOGY PRACTICAL 4H - 2C

Instruction Hours/week: **L:0 T:0 P:4** Marks: Internal:**40** External:**60** Total: **100**

End Semester Exam: 3

Course Objectives

The main objectives of the course are

- To obtain practical knowledge to solve the environmental problems
- To ascertain the knowledge about wastewater treatment.
- To achieve a water treatment strategy.
- To gain knowledge about for restoring environment
- To involve in the present scenarios and find valuable solutions for remedy
- To update about the microbial load in water sample.

Course Outcomes

On completion of the course, students are able to apply their knowledge on

1. Environmental problems
2. Wastewater treatment
3. BOD and its calculation
4. COD and its calculation
5. Bacterial Examination of Water
6. Biofertilizers

Practical

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of BOD of water sample.
3. Calculation of COD of water sample.
4. Bacterial Examination of Water by MPN Method.
5. Production of bio fertilizers using waste.

References

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2. Pradipta Kumar Mohapatra, (2007). *Environmental Biotechnology.* I.K. International Publishing House.
3. Hans-Joachim Jordening,& Jesef Winter, (Eds.). (2005). *Environmental Biotechnology: Concepts and Applications*. Wiley-VCH.
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6. Alicia, L., Ragout De Spencer, & John Spencer, F.T. (Eds.). (2004).*Environmental Microbiology: Methods and Protocols.* Humana Press.
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8. Gilbert Masters, (2007). *Principles of Environmental Engineering* (3rd ed.). Prentice Hall.
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SEMESTER – VI

19BTU613A BIOSTATISTICS PRACTICAL 4H - 2C

Instruction Hours/week: **L:0 T:0 P:4** Marks: Internal:**40** External:**60** Total: **100**

End Semester Exam: 3

Course Objectives

The main objectives of the course are

- To gain mathematical approach for analyzing the data.
- To learn the knowledge about graphical and diagrammatic representation of Statistical data.
- To learn the knowledge about Scope and applications of biostatistics
- To learn the knowledge about collection, processing and presentation of data and Testing of hypothesis
- To learn the knowledge about Measures of central tendency, Measures of dispersion
- To learn the knowledge about Correlation analysis and regression analysis

Course Outcomes

On completion of the course, students are able to

1. Apply the statistical tool knowledge for research data analysis.
2. Understand the concept of various hypothesis regarding data analysis.
3. To perform analysis for the data based on graphical representation (Bar, multiple bars, histogram, pie chart etc.)
4. To perform analysis to determine the mean, median, mode and standard deviation of given sample/data
5. To perform analysis, determine the probability of given sample/data
6. To perform the t-test/F-Test and Chi-square test of given data

Practical

Based on graphical Representation

1. Drawing of bar and multiple bar diagram
2. Drawing of Histogram
3. Drawing of Pie diagram

Based on measures of Central Tendency

4. Calculation of Mean for individual, discrete series using SPSS Package
5. Mean for continuous series using SPSS Package
6. Median for individual and discrete series using SPSS Package
7. Median for continuous series using SPSS Package
8. Mode for individual and discrete series using SPSS Package

Based on measures of Dispersion

9. Standard deviation for individual and discrete series using SPSS Package
10. Coefficient of variation for individual and discrete series using SPSS Package

Based on Distributions Binomial, Poisson and Normal

11. Calculation of Mean and variance for binomial distribution using SPSS Package
12. Calculation of Mean and variance for Poisson distribution using SPSS Package

Based on t, f, z and Chi-square

13. Karl Pearson's Correlation using SPSS Package
14. Rank Correlation Coefficient for Untied Rank using SPSS Package
15. Rank Correlation Coefficient for Tied Rank using SPSS Package

References

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

19BTU613B ENVIRONMENT MANAGEMENT PRACTICAL 4H - 2C

Instruction Hours/week: **L:0 T:0 P:4** Marks: Internal:**40** External:**60** Total: **100**

End Semester Exam: 3

Course Objectives

The main objectives of the course are

- To obtain basic concepts of biotic and abiotic components of any simple ecosystem
- To ascertain the knowledge about Simpson's and Shannon- Weiner diversity index.
- To achieve a life table and fecundity table.
- To gain knowledge about Principle of GPS.
- To involve in the present scenarios of types of soil, their texture
- To update about the endangered/ threatened species.

Course Outcomes

On completion of the course, students are able to apply their knowledge on

1. Ecosystem of soil
2. GPS and related concepts
3. Soil and their texture
4. Population density
5. Treatment of municipal waste and Industrial effluents
6. Species variation and threatened species.

Practical

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

References

1. Divan Rosencraz. (2002). *Environmental laws and policies in India*. Oxford Publication.
2. Ghosh, S.K., & Singh, R. (2003). *Social forestry and forest management.* Global Vision Publishing House
3. Joseph, B. (2005). *Environmental studies.* Tata Mc Graw Hill.
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19BTU691	**PROJECT – *VIVA VOCE***	**8H-6C**
Instruction Hours/week: L:0 T:0 P:8	Marks: Internal:40 External:60 Total: 100	

Course Objectives

The main objectives of the course are

- The hands-on training through one full semester project with thesis gives special expertise within one of the research areas represented at The Department of Biotechnology

Course Outcomes

On completion of the course, students are able to apply their knowledge on

1. This dissertation programme provides the candidate with knowledge, general competence, and analytical skills on an advanced level, needed in industry, consultancy, education and research.