

**DEPARTMENT OF BIOTECHNOLOGY
JAMIA MILLIA ISLAMIA
NEW DELHI-110025**

Minutes of the Meeting of the Board of Studies, Department of Biotechnology held on 26.05.2015 at 3.00 P.M.

An meeting of the BOS, Department of Biotechnology was held on 26.05.2015. in the office of the undersigned. Followings members were present:

- | | |
|---|------------|
| 1. Dr. Mohammad Husain | (Chairman) |
| 2. Professor Shafiq Ahmad Ansari, CIRBS, JMI | (Member) |
| 3. Dr. M. Irfan Qureshi, Department of Biotechnology, JMI | (Member) |
| 4. Dr. Kapil Dev, Department of Biotechnology, JMI | (Member) |
| 5. Dr. Meetu Gupta | (Member) |
| 6. Dr. Sadaf Fatima, Department of Biotechnology, JMI | (Member) |
| 7. Dr. Abdur Rub, Department of Biotechnology, JMI. | (Member) |

The Minutes of the last meetings were confirmed

Agenda Item No. 1 Time Table 250

The BOS discussed at length for the allocation of papers of M.Sc. Biotechnology I & III semester and B.Sc. Biotechnology I, III & V semesters and allocated the papers to the faculty members and the to the guest faculties of the Department. (Time-table enclosed)

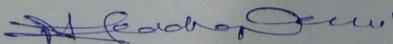
Agenda Item No. 2 Guest teachers 2015

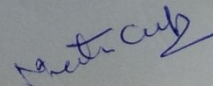
Requirement of guest teachers were discussed and approved by the BOS (list enclosed)

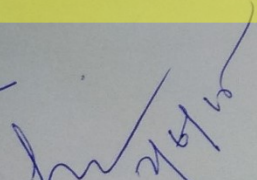
Agenda Item No. 3 Any other item with the permission of chair

1. The BOS discussed about the evaluation of Ph.D. students project and bibliography and it was suggested by the members that the Research project outline may be followed according to the UGC project proposal or any other funding agency which was approved by the BOS,
2. On the request of Dr. Kapil Dev, Supervisor of the Ph.D. Scholar Ms. Deepti Bhatt for removal of Co-Supervisor Dr. Taposh K.Das, Professor, Department of Anatomy, AIIMS, New Delhi as he died on 6.05.2015. The BOS considered his request and approved the same.
3. The BOS directed that six monthly project reports have to be made in proper format with details of title, objective and work done.
4. The BOS has approved the Departmental Research Committee (DRC) consisting of all the faculty member of the Department.
5. The BOS discussed the credit system of the papers of M.Sc. Biotechnology. The BOS felt that the two credit papers of M.Sc. Biotechnology be converted into four credits and revise the syllabus to the weightage of 4 credits accordingly.

The meeting ended with thanks to the chair.


(Dr. Mohammad Husain)
Head





(2)

DEPARTMENT OF BIOTECHNOLOGY
JAMIA MILLIA ISLAMIA, NEW DELHI

Minutes of the meeting of the BOS, Department of Biotechnology held on
22/09/2014 at 3.00 p.m.:

A meeting of the BOS, Department of Biotechnology was held on 22/09/2014 at 3.00
P.M. in the chamber of the HOD. The following members were present in the meeting:

Dr. Mohammad Husain	Chairman
Dr. M. Irfan Qureshi	Member
Dr. Kapil Dev	Member
Dr. Meetu Gupta	Member
Dr. Sadaf Fatima	Member
Dr. Abdur Rub	Member

Following members were absent in the meeting:

Prof. B.C. Das
Prof. M.M. Chaturvedi
Prof. M. Sami
Prof. Hasan Shahid

Agenda Item No.1: Confirmation of last meeting dated 08.09.2014 & 09.09.2014:

- (i) The minutes of the last meeting of the BOS held on 08/09/2014 and 09/09/2014 were confirmed.

Agenda Item No.2: Re-Constitution of various committees of the Department:

- (i) The tenure of BOS members (internal and external) will be over by 17.11.2014. Therefore, the BOS recommended the names of two external members.

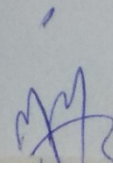
1. Prof.Suman Kumar Dhar, Professor, Special Centre for Molecular Medicine, Jawahar Lal Nehru University, Delhi.
2. Prof. Ramesh Chander Kuhad, Department of Microbiology, University of Delhi South Campus, Benito Juarez Road, New Delhi.

The two internal members have to be nominated by the honorable Vice Chancellor.

- (ii) The BOS also proposed the reconstitution of various other committees of the Department and recommended the following names:

Sub Purchase Committee:

Dr. Mohammad Husain	- Chairperson
Dr. Kapil Dev	- Member



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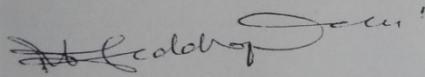
Agenda Item No. 7: Review and modification of Ph.D. coursework:

The BOS reviewed and modified the Ph.D. Biotechnology coursework Structure and syllabus of the papers. The revised Ph.D. Biotechnology coursework structure and syllabus of the papers is enclosed. (Annexure III).

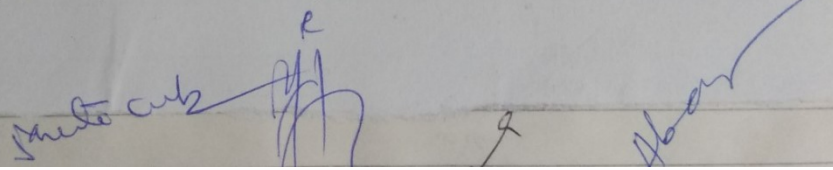
Agenda Item No. 8: Any other Items:

The BOS recommended the inclusion of the Educational Tour in the course curriculum of the UG and PG program.

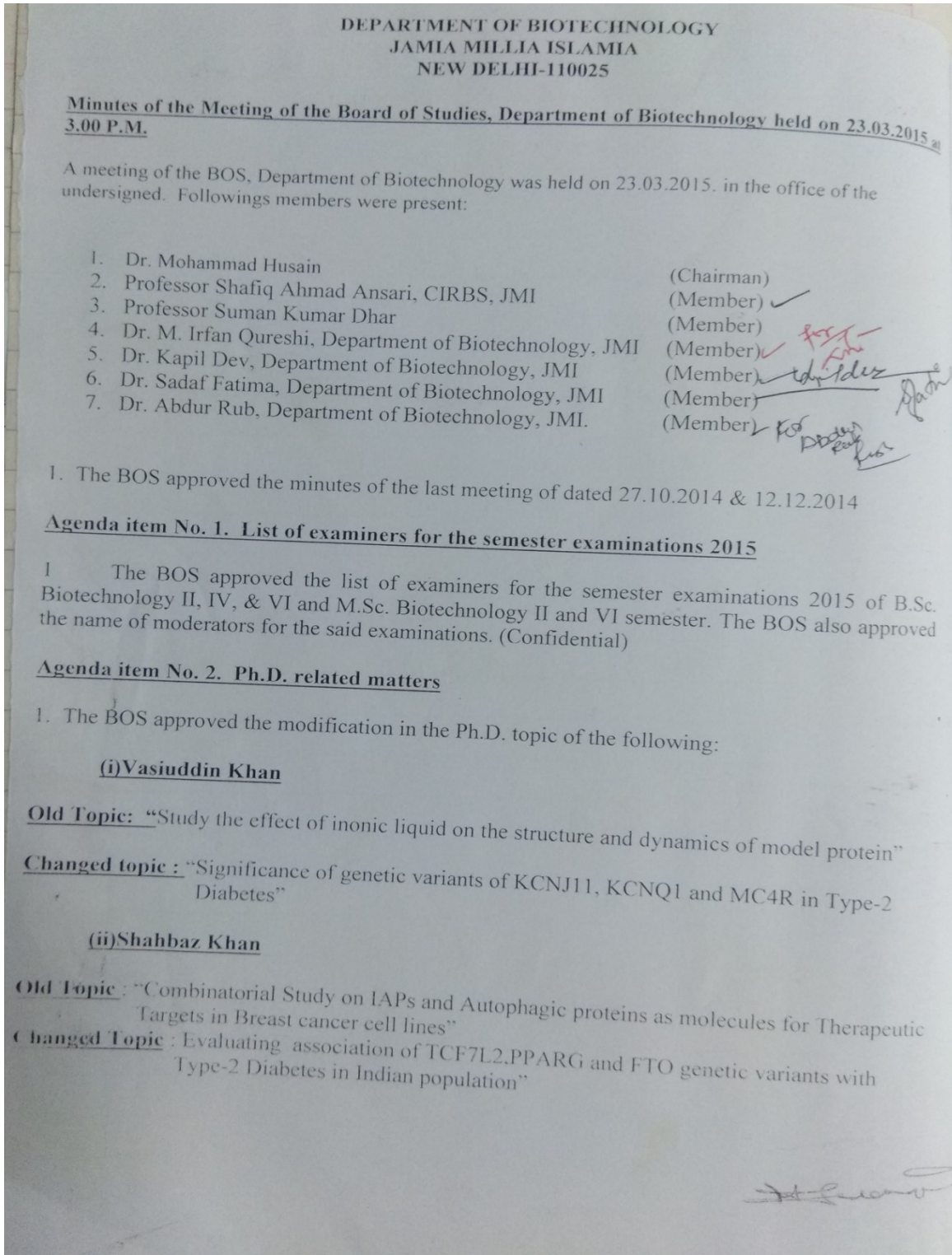
The meeting ended with the thanks to the chair at 5.30 P.M. on 22/09/2014.



(Dr. Mohammad Husain)
Head



(3)



Continued.....

Agenda item No. 3. Revision of Syllabus

1. The BOS approved the following composition of the committee for the enhancement of the syllabus of B.Sc., M.Sc. and Ph.D. of the Department of Biotechnology.

- (i) All faculty members of the Department
- (ii) One external member from outside university
- (iii) One member from the university.

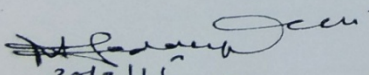
Agenda item No. 4. Module of Practical B.Sc. and M.Sc. Biotechnology

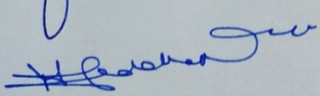
1. The BOS authorized the HOD to finalize the module of practical of B.Sc. & M.Sc. Biotechnology with the help of faculty members

Agenda item No. 5. Any other item with the permission of chair

1. M.Sc. Project work will be evaluated as done previously involving all the faculty members.
2. The BOS felt that in the seminar presentation of M.Sc. examination one external member should be included.
4. Professor Suman kumar Dhar and Professor Shafique Ansari suggested to form a Departmental research committee for issues such as for Advisory of synopsis of Ph.D and research project. The same committee may be used for conversion of JRF to SRF.

The meeting ended with thank to the chair.


30/3/11
(Dr. Mohammad Husain)
Head

Confirmed


(4)

DEPARTMENT OF BIOTECHNOLOGY
JAMIA MILLIA ISLAMIA
NEW DELHI-110025

Minutes of the Meeting of the Board of Studies, Department of Biotechnology held on 26.07.2017

A meeting of the BOS, Department of Biotechnology was held on 26.07.2017 in the office of the undersigned. Following members were present:

1. Professor Mohammad Husain	Chairman
2. Professor Zahid Ashraf	Member
3. Professor Shafique Ahmad	Member
3. Dr. M. Irfan Qureshi	Member
4. Dr. Kapil Dev	Member
5. Dr. Meetu Gupta	Member
6. Dr. Syed Mansoor Ali	Member
7. Professor Nasim Ahmad	Members

Agenda Item No. 1. Confirmation of the meeting of the last meeting

The minutes of the last meeting were confirmed.

Agenda Item No. 2. Project Evaluation of Ph.D. Course Work

The BOS evaluated the project of the course work of the Ph.D. students of Department of Biotechnology for the session 2016-2017 and the evaluated marks will be sent to the Controller of examination for further necessary action.

Agenda Item No. 2. revision of syllabus

The revised syllabus of B.Sc. & M.Sc. Biotechnology was placed before the BOS and it was approved unanimously.

M.Sc. Biotechnology 1st Semester

1. Molecular Biology
2. Cell Biology
3. Biochemistry and Biophysics
4. Genetics
5. Metabolism and Enzymology (CBCE)

M.Sc. Biotechnology 2nd Semester

1. Microbiology
2. Immunology

(5)

JAMIA MILLIA ISLAMIA
(A Central University by an Act of Parliament)



Department of Biotechnology
Faculty of Natural Sciences

Maulana Mohammed Ali Jauhar Marg, New Delhi-110025
Tel. +91-011-26988335, 26981717 Extn. : 3426
Fax : +91-011-26980229 Website : <http://jmi.ac.in>



1d-421069

The Vice Chancellor
Jamia Millia Islamia
New Delhi-110025

October 25, 2017

Subject: Nomination of External and Internal members name for the Board of Studies
Sir,

The Departmental meeting held on 23.10.2017 has unanimously proposed the following names of external and internal members for the Board of Studies of Department of Biotechnology. The approval for nomination of two External members and two members from within the university are required.

External Members (two)

✓ **Dr. Dhananjay Kumar Tewary**
Joint Director/Scientist E & Program Officer
Email: ghananjay.tewary@nic.in
Phone: 011-24369611

✓ **Dr. Shailender Goel.**
Professor,
Department of Botany,
University of Delhi,
Delhi – 110007
e-mail: shailendragoel@gmail.com

Dr. Wasim Ahmad
Professor and Chairman
Department of Zoology
AMU, Aligarh
Email: ahmadwasim57@gmail.com
Phone: +91-571-2700920 – 3441

Dr. Asad U Khan
Professor
Interdisciplinary Biotechnology Unit
AMU
Email: asadukhan72@gmail.com
Phone: 9837021912

Mahfuz Hossain

JAMIA MILLIA ISLAMIA
(A Central University by an Act of Parliament)



Department of Biotechnology

Faculty of Natural Sciences

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Tel.: +91- 011-26988335, 26981717 Extn. : 3426
Fax : +91-011-26980229 Website : <http://jmi.ac.in>

Internal members

Dr. M. Ejaz Hussain
Professor & Director

Centre for Physiotherapy & Rehabilitation Sciences
Jamia Millia Islamia, New Delhi
Phone: 011-26980544 (Direct), 011-26981717, 4523 (Extn)
Email: ehussain@jmi.ac.in

Dr. Shakeb Ahmad Khan
Professor

Department of Electrical Engineering,
Faculty of Engineering, & Technology,
Jamia Millia Islamia, New Delhi
Phone: +91-11-26982651 (Direct)
Email: skhan3@jmi.ac.in

Dr. Imran Ali
Professor

Department of Chemistry
Jamia Millia Islamia
New Delhi-110025.
Email: iali2@jmi.ac.in
Phone: 9211458226

Dr. Haseeb Ahsan
Professor

Faculty of Dentistry,
Jamia Millia Islamia,
Jamia Nagar- New Delhi-110025
Email: hahsan@jmi.ac.in

Thanking you,

Yours sincerely,

(Dr. Mohammad Mahfuzul Haque)
Professor & Head

(6)

JAMIA MILLIA ISLAMIA
(A Central University by an Act of Parliament)

Department of Biotechnology
Faculty of Natural Sciences

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Dean Office, Natural Sciences
File Tracking Section
Doc. No. 421809/12860-2017
Date 31.10.17



VICE
UNIT
FILE 421809
DATE 26.11.17

October 31, 2017

tel- 421809

The Vice Chancellor
Jamia Millia Islamia
New Delhi-110025

Through Proper Channel

Sir,

This is to inform you that the BOS in its meeting held on 23.10.2017 approved the DRC consisting of the following: This is for your kind perusal and approval.

Dr. M. Ejaz Hussain, V.C. nominee (letter attached)
Professor & Director
Centre for Physiotherapy & Rehabilitation Sciences
Jamia Millia Islamia
New Delhi

Dr. Mohammad Mahfuzul Haque, Professor & Head
Dr. Mohammad Husain, Professor
Dr. M. Zahid Ashraf, Professor
Dr. M. Irfan Qureshi, Asstt. Professor
Dr. Meetu Gupta, Asstt. Professor

Dr. Rupesh Chaturvedi, Associate Professor (External member)
School of Biotechnology
JNU, New Delhi

Dr. Luqman Ahmad Khan, Professor (External member)
Department of Biosciences,
Jamia Millia Islamia
New Delhi

Thanking you,

Yours sincerely,

(Dr. Mohammad Mahfuzul Haque)
Professor & Head

Composition of DRC is as per notification. Honorable V.C. is requested for approval. (B) 23/11

Honorable V.C.

*forwarded-
Sharif Ahmad
1/11/17*

Dean
Faculty of Natural Sciences
Jamia Millia Islamia
New Delhi-110025

*Jal Dix (Research)
4/11/17*

*Registration
2/11/17*

24/11/17

*ARCA/EC
11/11*

JAMIA MILLIA ISLAMIA

Accredited by NAAC in 'A' Grade
(A Central University by an Act of Parliament)
Maulana Mohammed Ali Jauhar Marg, New Delhi-110025

جامیہ ملیہ اسلامیہ

(मसूदीय अधिनियमानुसार केन्द्रीय विश्वविद्यालय)
मौलाना मोहम्मद अली जौहर मार्ग, नई दिल्ली-110025

Tel: 26984075, 26988044

26981717, 26985176

Fax: 011-26980229

Grams: JAMIA

E-mail: registrar@jmi.ac.in

Website: <http://jmi.ac.in>



Office of the Registrar

F.No.AC-10(2)/RO/2017/

कुलसचिव कार्यालय

دفتر

04.10.2017

CORRIGENDUM

In partial modification to the Notification No. AC-9(2)/RO/2017 dated 30.03.2017, each Faculty/Department/Centre has to constitute a Departmental Research Committee (DRC)/ Centre's Research Committee (CRC) as per the new Ordinance passed by Majlis-i-Talimi (Academic Council) in its meeting held on 12.09.2017 and subsequently by Majlis-i-Muntazimah (Executive Council) on 27.09.2017.

The Head/Director of the Department/Centre must ensure that the admission to M. Phil. /Ph.D programme in academic session 2017-18 must be done in accordance with the New Ordinance.

The VC's Nominee for the DRC/CRC shall be informed to each Department/Centre separately. Further, a copy of the newly constituted DRC/CRC may be sent to the Director (Research) office.

(A.P. Siddiqui), IPS
Registrar

Copy for information & necessary action to:

1. All Deans/HoDs/Directors of Centres, JMI
2. The Finance Officer, JMI
3. The Controller of Examinations, JMI
4. The Hony. Director (Research), JMI
5. The Offg. DSW, JMI
6. The Hony. Director, FTK-CIT for uploading on University's website.
7. The Secretary to Vice-Chancellor, JMI.
8. The Consultant, Office of the Pro-Vice-Chancellor, JMI
9. The Asst. Registrar, Registrar's Sectt., JMI
10. File/ folder.

All HODs are
advised to do the
needful accordingly
Shariq Ahmed
4/10/17

Asst. Registrar (A&C)

Dean
Faculty of Natural Science
Jamia Millia Islamia
New Delhi-110025

(7)

**Department of Biotechnology
Jamia Millia Islamia
New Delhi-110025**

Minutes of the meeting of the DRC Department of Biotechnology held on 16.02.2018

A meeting of the DRC Department of Biotechnology was held on 16.02.18 at 3.00 p.m. in the office of the HOD, Department of Biotechnology. Following members were present:

1. Professor Mohammad Mahfuzul Haque(HOD)
2. Professor Ejaz Husain (V.C. Nominee)
3. Professor Luqman Ahmad Khan
4. Professor Mohammad Husain
5. Dr. M. Irfan Qureshi
6. Dr. Meetu Gupta
7. Dr. Merajul Haque
8. Dr. Ahmad Sayeed

1. The DRC, Department of Biotechnology approved the name of moderators of Entrance Test papers of Ph.D. in Biotechnology and Ph.D. in Unani Medecine. (Confidential)
2. The DRC also approved the name of evaluators for the evaluation of Entrance Test papers of Ph.D. in Biotechnology and Ph.D. in Uanni Medicine. (Confidential)
3. The DRC approved the change of topic of Ph.D. Scholar Medha Panthri, working under the supervision of Dr. Meetu Gupta

Old Topic: "Identification and characterization of the promoter of genes regulated by arsenic stress in rop plants"

New Topic: "Cross-talk of arsenic and iron exposure in rice (*Oryza sativa*) varieties differing in iron content using biochemical and molecular approaches"

4. The DRC approved the Ph.D. syllabus of paper III & IV for Ph.D. Course work.

The meeting ended with thanks to the chair.



(Dr. Mohammad Mahfuzul Haque)
Professor & Head



OFFICE OF THE CONTROLLER OF EXAMINATIONS
JAMIA MILLIA ISLAMIA, NEW DELHI-110025

Schedule of Ph.D. Biotechnology-I, [Examination-2019]

Department of Biotechnology

Time : 2:00 pm to 4:00 pm [Monday to Thursday]

: 2:30 pm to 4:30 pm [Friday]

Venue : Concern Department.

Date	Paper Code	Paper Name/ Code
23.09.2019	PBT-101	Research Methodology and Biotechnology
24.09.2019	✓ PBT-103	Genomics
25.09.2019	✓ PBT-104	Molecular Medicine and Industrial Biotechnology

SUBJECT TO CORRECTION

PBT-102: Annotated Research paper,
Review & Annotated Bibliography.

(Jitender Singli)

Dy. Registrar (Exams.)

Dated: 16.09.2019



Minutes.

COURSE STRUCTURE AT A GLANCE

**B.Sc. Biotechnology-Semester and Choice Based Credit System
Jamia Millia Islamia, New Delhi-110025**

FIRST YEAR

SEMESTER I					SEMESTER II				
N	Papers	Code	Credit	MM	N	Papers	Code	Credit	MM
1	Biochemistry & Metabolism	BBT-101	4	100	1	Mammalian Physiology	BBT-201	4	100
2	Cell Biology	BBT-102	4	100	2	Plant Anatomy & Physiology	BBT-202	4	100
3	Plant Diversity-I	BBT-103	4	100	3	Animal Diversity-I	BBT-203	4	100
4	Biotechnology & Human Welfare (CBCE)	BBT-104	4	100	4	Bioethics & Biosafety (CBCE)	BBT-204	4	100
5	Lab Course-I	BBT-105	4	100	5	Lab Course-II	BBT-205	4	100

SECOND YEAR

SEMESTER III					SEMESTER IV				
N	Papers	Code	Credit	MM	N	Papers	Code	Credit	MM
1	Genetics	BBT-301	4	100	1	Gen Microbiol.	BBT-401	4	100
2	Mol. Biology	BBT-302	4	100	2	Immunology	BBT-402	4	100
3	Chemistry-I	BBT-303	4	100	3	Chemistry-II	BBT-403	4	100
4	Plant Div-II	BBT-304	4	100	4	Animal Div-II	BBT-404	4	100
5	Med. Biotech (AECC)	BBT-305	4	100	5	Dev. Biology (CBCE)	BBT-405	4	100
6	Lab Course-III	BBT-306	4	100	6	Lab Course-IV	BBT-406	4	100

THIRD YEAR

SEMESTER V					SEMESTER VI				
N	Papers	Code	Credit	MM	N	Papers	Code	Credit	MM
1	Bioprocess Tech	BBT-501	4	100	1	Bioanalytical Tools	BBT-601	4	100
2	rDNA Tech. (CBCE)	BBT-502	4	100	2	Animal Biotech	BBT-602	4	100
3	Plant Biotech	BBT-503	4	100	3	Env. Biotech	BBT-603	4	100
4	Bioinformatics	BBT-504	4	100	4	Biostatistics	BBT-604	4	100
5	Essential Maths	BBT-505	4	100	5	Enzymology (SEC)	BBT-605	4	100
6	Lab Course-V	BBT-506	4	100	6	Lab Course-VI	BBT-606	4	100

Total Duration of Course	3 Yrs		Total Credits	136
Total Semesters	06		Total Marks	3400

SEMESTER - I

BIOCHEMISTRY AND METABOLISM (Code: BBT-101)

Credits: 4 MM: 100

UNIT I: Introduction to Biochemistry (10 Periods)

A historical perspective:

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

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

UNIT II (10 Periods)

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

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

UNIT III (20 Periods)

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

UNIT IV (20 Periods)

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

SUGGESTED READING

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

CELL BIOLOGY (Code: BBT-102)

Credits: 4 MM: 100

UNIT I (10 Periods)

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation.

Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

UNIT II (15 Periods)

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments.

Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III (20 Periods)

Lysosomes: Vacuoles and micro bodies: Structure and functions

Ribosomes: Structures and function including role in protein synthesis.

Mitochondria: Structure and function, Genomes, biogenesis.

Chloroplasts: Structure and function, genomes, biogenesis

Nucleus: Structure and function, chromosomes and their structure.

UNIT IV (15 Periods)

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

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

SUGGESTED READING

1.Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.

2.De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.

3.Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

4.Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

PLANT DIVERSITY-I (Code: BBT-103)

Credits: 4 MM: 100

UNIT I

Algae: (20 Periods)

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

Chlorophyceae – *Volvox*, *Oedogonium*

Xanthophyceae – *Vaucheria* Phaeophyceae – *Ectocarpus* Rhodophyceae – *Polysiphonia*

UNIT II

Fungi: (20 Periods)

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

Mastigomycotina- *Phytophthora* Zygomycotina-*Mucor* Ascomycotina-

Saccharomyces Basidiomycotina-*Agaricus* Deutromycotina-*Colletotrichum*

UNIT III

Lichens : (10 Periods)

Classification, general structure, reproduction and economic importance. Plant diseases:

Casual organism, symptoms and control of following plant diseases. Rust & Smut of Wheat.

White rust of Crucifers. Late blight of Potato. Red rot of Sugarcane. Citrus Canker.

UNIT IV

Bryophytes: (10 Periods)

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

Marchantia.

Funaria.

SUGGESTED READING

1. Agrios, G.N. 1997 Plant Pathology, 4th edition, Academic Press, U.K.

2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996 Introductory Mycology, 4th edition, John Wiley and Sons (Asia) Singapore.

3. Bold, H.C. & Wayne, M.J. 1996 (2nd Ed.) Introduction to Algae.

4. Kumar, H.D. 1999. Introductory Phycology. Aff. East-West Press Pvt Ltd., Delhi.

5. Lee, R.E. 2008. Phycology, Fourth Edition, Cambridge University Press, USA.

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

7. Shaw, A.J. and Goffinet, B. 2000 Bryophyte Biology. Cambridge University Press.

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

BIOTECHNOLOGY AND HUMAN WELFARE (Code: BBT-104)

Credits: 4 MM: 100

UNIT I (10 Periods)

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

UNIT II (10 Periods)

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

UNIT III (15 Periods)

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

UNIT IV (12 Periods)

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

UNIT V (13 Periods)

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

SUGGESTED READING

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

SEMESTER - II

MAMMALIAN PHYSIOLOGY (Code: BBT-201)

Credits: 4 MM:100

UNIT I: Digestion and Respiration (15 Periods)

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice

Respiration: Exchange of gases, Transport of O₂ and CO₂, Oxygen dissociation curve, Chloride shift.

UNIT II: Circulation (15 Periods)

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

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

UNIT III: Muscle physiology and osmoregulation (15 Periods)

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

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

UNIT IV: Nervous and endocrine coordination (15 Periods)

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

Mechanism of action of hormones (insulin and steroids)

Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

SUGGESTED READING

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Herculon Asia PTE Ltd. /W.B. Saunders Company.

2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI

PLANT ANATOMY & PHYSIOLOGY (Code: BBT-202)

Credits: 4 MM:100

UNIT I: Anatomy (10 Periods)

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

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

Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing.

Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport

UNIT III: Carbon and nitrogen metabolism (20 Periods)

Photosynthesis- Photosynthesis pigments, concept of two photo systems, photophosphorylation, calvin cycle, CAM plants, photorespiration, compensation point

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

UNIT IV: Growth and development (18 Periods)

Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberellins, cytokinins, abscisic acid, ethylene)

Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization

SUGGESTED READING

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. J. Wiley & Sons.
5. Mauseth, J.D. 1988 Plant Anatomy. The Benjamin/Cummings Publisher, USA.
6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4th edition, W.H. Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.
8. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4th ed. Sinauer Associates Inc .MA, USA

ANIMAL DIVERSITY-I (Code: BBT-203)

Credits: 4 MM:100

UNIT I (15 Periods)

- 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 *Paramoecium* and *Plasmodium*. Pathogenic protozoans
- c).Porifera: General characters, outline of Classification; skeleton, Canal System

UNIT II (15 Periods)

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

UNIT III (15 Periods)

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

UNIT IV (15 Periods)

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

SUGGESTED READING

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

BIOETHICS AND BIOSAFETY (Code: BBT-204)

Credits: 4 MM:100

UNIT-I (15 Periods)

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

UNIT II (20 Periods)

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

UNIT III (10 Periods)

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

UNIT IV (15 Periods)

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

SUGGESTED READING

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

SEMESTER - III

GENETICS (Code: BBT-301)

Credits: 4 MM:100

UNIT I (12 Periods)

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

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

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

UNIT II (18 Periods)

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

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

Genetic organization of prokaryotic and viral genome.

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

UNIT III (15 Periods)

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

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

UNIT IV (15 Periods)

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

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

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

SUGGESTED READING

1.Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.

2.Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.

3.Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.

4.Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.

5.Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

MOLECULAR BIOLOGY (Code; BBT-302)

Credits: 4 MM:100

UNIT I: DNA structure and replication (15 Periods)

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

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

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

UNIT III: Transcription and RNA processing (17 Periods)

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

UNIT IV: Regulation of gene expression and translation (18 Periods)

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

SUGGESTED READING

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

CHEMISTRY-I (Code: BBT-303)

Credits: 4 MM:100

Unit I: Alcohols

Classification and Nomenclature

Dihydric alcohols- Nomenclature, methods of preparation, chemical reactions of vicinal glycols, eg: Oxidative cleavage using $(\text{Pb}(\text{OAc})_4)$ & HIO_4 and pinacol-pinacolone rearrangement.

Trihydric alcohols- Nomenclature and methods of preparation, chemical reactions of glycol.

Unit II: Phenols

Nomenclature, structure and bonding of phenols, Physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenol. Electrophilic aromatic substitution, acylation and carboxylation, mechanism of Fries rearrangement, Claisen rearrangement, Reimer Tiemann reaction.

Unit III: Ethers and Epoxides

A. Nomenclature of ethers and methods of their preparation, Physical properties. Chemical reactions- Cleavage and autoxidation, Ziesel's method.

B. Synthesis of epoxides, Acid and base catalysed ring opening, reaction of Grignards and organolithium reagents with epoxides.

Unit IV: Aldehydes and Ketones

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes from acid chlorides, synthesis of ketones from nitriles and from carboxylic acids. Physical properties, Mechanism of nucleophilic addition to Carbonyl compounds. Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction.

SUGGESTED READING

1. Organic Chemistry by P.Y. Bruice
2. Organic Chemistry, I L Finar, Pearson Education, New Delhi .
3. Organic Chemistry, Morrison & Boyd, Pearson Education, New Delhi.

PLANT DIVERSITY II (Code: BBT-304)

Credits: 4 MM:100

UNIT I: Pteridophytes

General characters of pteridophytes, affinities with bryophytes & gymnosperms, classification, economic importance, study of life histories of fossil Pteridophytes – *Rhynia*. (10 Periods)

UNIT II: Pteridophytes: Type studies

Life histories of *Selaginella*- (Heterospory and seed habit), *Equisetum*, *Pteris*, *Lycopodium*. (20 Periods)

UNIT III: Gymnosperms

General characters, classification, geological time scale, theories of fossil formation, types of fossils, fossil gymnosperms- *Williamsonia* & *Glossopteris*, telome and stele concept. (20 Periods)

UNIT IV: Gymnosperms: Type studies

Life histories of *Cycas* & *Pinus*, economic importance of gymnosperms. (10 Periods)

SUGGESTED READING

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

Medical Biotechnology (BBT-305)

Credits: 4 MM:100

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*, *C.tetani*, *C.botulinum*, *C.diphtheriae*, *M.tuberculosis*, *M. Leprae*) and gram negative bacteria: (*E.coli*, *N. gonorrhoea*, *P. aeruginosa*, *S. typhi*, *Y. pestis*, *V. cholerae*, *T. Pallidum*, *Rickettsiaceae*, *Chlamydiae*)

Resistance to antimicrobials: Biochemical mechanisms of resistance, Genetics of resistance; Laboratory safety regulations.

UNIT II

Viral disease and diagnosis- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses. Antiretrovirals.

UNIT III

Enzyme Immunoassays:

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. Immuno florescence.

UNIT IV

Molecular Diagnostics:

Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing of bacterial pathogens. flowcytometry and cell sorting.

SUGGESTED READINGS

1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier. .
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
4. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
5. Bioinstrumentation, Webster
6. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe, Kluwer Academic
7. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.

SEMESTER – IV

GENERAL MICROBIOLOGY (Code: BBT-401)

Credits: 4 MM:100

UNIT I (10 Periods)

Fundamentals, History and Evolution of Microbiology.

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

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

UNIT II (10 Periods)

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

UNIT III (20 Periods)

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

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways

Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

UNIT IV (20 Periods)

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents

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

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

SUGGESTED READING

1.Alexopoulos CJ, Mims CW, and Blackwell M. (1996). *Introductory Mycology*. 4 th edition. John and Sons, Inc.

2.Jay JM, Loessner MJ and Golden DA. (2005). *Modern Food Microbiology*. 7th edition, CBS Publishers and Distributors, Delhi, India.

3.Kumar HD. (1990). *Introductory Phycology*. 2nd edition. Affiliated East Western Press.

4.Madigan MT, Martinko JM and Parker J. (2009). *Brock Biology of Microorganisms*. 12th edition. Pearson/Benjamin Cummings.

5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education

IMMUNOLOGY (Code: BBT-402)

Credits: 4 MM:100

UNIT I (20 Periods)

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

UNIT II (15 Periods)

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

UNIT III (13 Periods)

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

UNIT IV (12 Periods)

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

SUGGESTED READING

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

CHEMISTRY-II (Code: BBT-403)

Credits: 4 MM:100

Unit –I: Arenes and Aromaticity

Structure of benzene-molecular formula and Kekule structure, Stability and carbon-carbon bond lengths in benzene, Aromaticity-the Huckel rule, Aromatic electrophile substitution –general pattern of the mechanism, effect of substituent groups. Mechanism of nitration, halogenation, sulphonation, Friedal-Crafts alkylation, Friedal-Crafts acylation.

Unit -II: Haloalkanes and Haloarenes

Nomenclature and classes of alkyl halides, methods of preparation, Nucleophilic substitution in haloalkanes. Mechanisms of nucleophilic Substitution (S_N2 and S_N1) reactions, β -Elimination, mechanisms of β -elimination.

Methods of formation of Haloarenes, Nucleophilic aromatic substitution Through addition elimination and the elimination addition mechanisms(Benzyne mechanisms)

Unit- III: Amines

Structure and nomenclature of amines, stereochemistry of amines, separation of a mixture of primary, Secondary and tertiary amines structural features effecting basicity of amines preparation of alkyl and arylamines by reduction of nitro compounds and nitriles, reductive amination of aldehydes and ketones compounds, Gabriel phthalimide reaction, Hofmann bromamide reaction.

Reaction of amines, electrophilic aromatic substitution in aryl amines. Reactions of amines with nitrous acid, synthetic transformations of aryl diazonium salts, azo coupling.

Unit- IV: Heterocyclic Compounds

General introduction to heterocyclic systems, Five-membered rings-Structure of pyrrole, furan and thiophene, electrophilic substitution in pyrrole, furan and thiophene, Six-membered rings-Structure of pyridine, basicity of pyridine. electrophilic and nucleophilic substitution in pyridine.

Books suggested:

1. Organic Chemistry by P.Y. Bruice
2. Organic Chemistry, I L Finar, Pearson Education, New Delhi .
3. Organic Chemistry, Morrison & Boyd, Pearson Education, New Delhi.

ANIMAL DIVERSITY II (Code: BBT-404)

Credits: 4 MM:100

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

Proto-chordates: Outline of classification, General features and important characters of *Herdmania*, *Branchiostoma*

Origin of Chordates

Pisces: Migration in Pisces, Outline of classification Amphibia: Classification, Origin, Parental care, Paedogenesis

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

Reptelia: Classification, Origin

Aves: Classification, Origin, flight- adaptations, migration

Mammalia: Classification, Origin, dentition

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

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

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

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

Autonomic Nervous system in Mammals

SUGGESTED READING

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

DEVELOPMENTAL BIOLOGY (Code: BBT-405)

Credits: 4 MM:100

UNIT I: Gametogenesis and Fertilization (10 Periods)

Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

UNIT II: Early embryonic development (20 Periods)

Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.

UNIT III: Embryonic Differentiation (20 Periods)

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

UNIT IV: Organogenesis (10 Periods)

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germ layers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals.

SUGGESTED READING

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

SEMESTER - V

Bioprocess Technology (Code: BBC-501)

Credits: 4 MM:100

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, Fedbatch and Continuous culture.

UNIT II (20 Periods)

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 (15 Periods)

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

UNIT IV (15 Periods)

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

SUGGESTED READING

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

RECOMBINANT DNA TECHNOLOGY (Code: BBT-502)

Credits: 4 MM:100

UNIT I (15 Periods)

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

UNIT II (20 Periods)

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

UNIT III (10 Periods)

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

UNIT IV (15 Periods)

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

SUGGESTED READING

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

PLANT BIOTECHNOLOGY (Code: BBT-503)

Credits: 4 MM:100

UNIT I

Introduction, Cryo and organogenic differentiation, Types of culture: Seed , Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation. **(15 Periods)**

UNIT- II

In vitro haploid production Androgenic methods: Anther culture, Microspore culture androgenesis Sgnificance and use of haploids, Ploidy level and chromosome doubling, diploidization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals. **(20 Periods)**

UNIT - III

Protoplast Isolation and fusion Methods of 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.

UNIT - IV

Plant Growth Promoting bacteria.

Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation,

Biocontrol of pathogens, Growth promotion by free-living bacteria.

(10 Periods)

SUGGESTED READING

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

BIOINFORMATICS (Code: BBT-504)

Credits: 4 MM:100

UNIT I (10 Periods)

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

UNIT II (20 Periods)

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

UNIT III (20 Periods)

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

UNIT IV (10 Periods)

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

SUGGESTED READING

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

ESSENTIAL MATHEMATICS (Code: BBT-505)

Credits: 4 MM:100

Unit-I:

Definition and examples of matrices, types of matrices, basic operations, equality of matrices, addition and scalar multiplication of matrices, properties of addition and scalar multiplication, transpose of a matrix, symmetric and skew symmetric matrices and their properties, matrix multiplication in general and its properties. Definition of Determinant, minors and cofactors of an element of a determinant, singular and non-singular matrices, multiplicative inverse of a matrix and its properties, Applications. Set and their representations, finite and infinite sets, subsets, type of sets, operations on sets and their algebraic properties, Venn diagram, ordered pair, Cartesian product & relation.

Unit-II:

Concept of functions and Relation in biological terminology, its domain and range, Types and classification of function, graphs of some well known functions, even and odd functions, periodic functions, algebra of functions, composite functions, inverse of a function. Limits, left hand and right hand limits, algebra of limits, continuity of a function at a point, over an open/closed interval, differentiability of a function at a point, left hand and right hand differentiability, relation between continuity and differentiability, Derivative of a function, its geometrical and physical significance, Applications.

Unit-III:

Introduction of indefinite integral, anti-derivative or primitive function, standard formulae, and fundamental laws of integrations, methods of integration: by substitution, by parts, by long division, by partial fractions, by successive reduction, Integration of some well known forms. Definition of definite integral as the limit of sum, The fundamental theorem of calculus (without proof), evaluation of definite integral, transformation of definite integral by substitution, by parts. Properties of definite integral and problems based on these properties, Applications.

Unit-IV:

Differential equation, order and degree of a differential equation, solution of a (first order and first degree) differential equation by the method of variable separable, Homogeneous differential equation and their solution, solution of the linear differential equation of the first order of type: $dy/dx+P(x).y=Q(x)$.

Suggested Books:

1. Seymour Lipschutz, 1981, Set Theory, (Schaum's Outline Series) McGraw Hill Book co.
2. Frank Ayres, J.R.,1974, Matrices, (Schaum's Outline Series) McGraw Hill Inc.
3. Shanti Narayan, 1999, Differential and Integral Calculus, S. Chand and Co. Ltd.
4. Frank Ayres, J.R.,1992, Theory and Problems of Differential Equations, (Schaum's Outline Series) McGraw Hill Inc.
5. Pishkunov, N.,1981, Differential and Integral Calculus, CBS Publishers and distributors.
6. Shanti Narayan, 1999, Differential and Integral Calculus, S. Chand and Co. Ltd.

7. Frank Ayres, J.R., 1992, Theory and Problems of Differential Equations, (Schaum's Outline Series) McGraw Hill Inc.
8. Pishkunov, N., 1981, Differential and Integral Calculus, CBS Publishers and distributors.
9. Khalil Ahmad, 2013, Text Book of Differential Equations, Real World Education Publishers, New Delhi.
10. Khalil Ahmad, 2013, Text Book of Calculus, Real World Education Publishers, New Delhi.

SEMESTER – VI

BIO-ANALYTICAL TOOLS (Code: BBT-601)

Credits: 4 MM:100

UNIT I (10 Periods)

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

UNIT II (15 Periods)

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

UNIT III (15 Periods)

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

UNIT IV (20 Periods)

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

SUGGESTED READING

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

ANIMAL BIOTECHNOLOGY (Code: BBT-602)

Credits: 4 MM:100

UNIT I (10 Periods)

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

UNIT II (10 Periods)

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

UNIT III (20 Periods)

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

UNIT IV (20 Periods)

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

SUGGESTED READING

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

ENVIRONMENTAL BIOTECHNOLOGY (Code: BBT-603)

Credits: 4 MM:100

UNIT I (18 Periods)

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

UNIT II (20 Periods)

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

UNIT III

Treatment of municipal waste and Industrial effluents. Bio-fertilizers
Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)

UNIT IV (10 Periods)

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

SUGGESTED READING

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

BIostatISTICS (Code: BBT-604)

Credits: 4 MM:100

UNIT I (12 Periods)

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

UNIT II (18 Periods)

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

UNIT III (18 Periods)

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

UNIT IV

(12 Periods)

Correlation and Regression. Emphasis on examples from Biological Sciences.

SUGGESTED READING

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

ENZYMولوجY (Code: BBT-605)

Credits: 4 MM:100

UNIT - I (20 Periods)

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

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

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

Different plots for the determination of K_m 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 (15 Periods)

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of K_i , 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 backcontrol, covalent modification.

(12 Periods)

UNIT – III (13 Periods)

Allosteric enzymes with special reference to aspartate transcarbamylase 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

Enzyme Technology: Methods for large scale production of enzymes.

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

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

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

SUGGESTED READING

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

Lab Courses B.Sc. Biotechnology

(6 Semester UG Degree Course)

(Choice Based Credit System)

Department of Biotechnology

Jamia Millia Islamia, New Delhi

SEMESTER - I

Lab Course-I (BBT 105)

1. To study the principle and working of compound microscope
2. To study the plasmolysis and de-plasmolysis in the given plant part
3. To study the structures of Prokaryotic and Eukaryotic cell.
4. To observe the mammalian cell line and *Leishmania* under the inverted microscope
5. Staining of *Leishmania* infected macrophages through Giemsa stain
6. To Study various stages of mitosis and meiosis in onion root tip.
7. To study the barr-body detection and its significance.
8. Identification of algal species by studying their permanent slides.
9. Study of thallus and reproductive structures by slide preparation and staining of the following algal species.
 - a. *Volvox*, *Oedogonium*, *Vaucheria*, *Ectocarpus*, *Polysiphonia*
10. Identification of different plant diseases by studying the permanent slides.
11. Study of plant disease by slide preparation and staining for the following diseases.
Rust of wheat, Black smut of wheat, citrus canker, late blight of potato, white rust of crucifers, red rot of sugarcane
12. Preparation of solutions and buffers
13. Qualitative tests for biomolecules (protein, lipids, carbohydrates, nucleic acid)
14. Estimation of protein in given sample by Lowry method
15. Measuring the enzyme activity under different conditions
16. To study Beer Lambert law using proteins: Absorbance vs concentration
17. Determination of concentration of protein using Absorption Coefficient
18. Comparative study of thallus and reproductive organs of various algae mentioned in theory.
19. Comparative study of vegetative and reproductive parts of various fungi mentioned in theory.
20. Section cutting and lectophenol mount of plant disease materials
21. To study the various types of lichens.
22. Study of external features & anatomy of vegetative and reproductive parts of *Marchantia* and *Funaria*.
23. Collection of algae, fungi, plant diseased materials and bryophytes available locally.

SEMESTER - II

Lab Course II (BBT 205)

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Counting of mammalian RBCs
4. Determination of TLC and DLC
5. Demonstration of action of an enzyme
6. Determination of Haemoglobin
7. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf.
8. Demonstration of plasmolysis by *Tradescantia* leaf peel.
9. Demonstration of opening & closing of stomata
10. Demonstration of guttation on leaf tips of grass and garden nasturtium.
11. Separation of photosynthetic pigments by paper chromatography.
12. Demonstration of aerobic respiration.
13. Preparation of root nodules from a leguminous plant.
14. Proxy filing of Indian Product patent
15. Proxy filing of Indian Process patent
16. Planning of establishing a hypothetical biotechnology industry in India
17. A case study on clinical trials of drugs in India with emphasis on ethical issues.
18. Case study on women health ethics.
19. Case study on medical errors and negligence.
20. Case study on handling and disposal of radioactive waste
21. Identification and Classification of Any three of the following –
Porifera: Scypha, Leucosolenia, Euspongia, Hylonema, Euplectella
Cnidaria: Medusozoa, 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
Mollusca: Pila, Unio, Mytilus, Loligo, Sepia, Octopus, Solen
Echinodermata: Asterias, Ophiothrix, Echinus, Holothuria, Astrophyton
Hemichordata: Balanoglossus
22. Identification of slides with two points of identification.
Amoeba, Paramecium, Ceratium, Plasmodium, Opalina, L.S. Sponge, Spicules of sponges, L.S. Hydra, Obelia, Bougainvillia, Larvae of Fasciola, Seta of Earthworm, Radula

SEMESTER - III

Lab Course III (BBT 306)

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. Examination of morphology and anatomy of vegetative and reproductive parts of Selaginella, Equisetum & Pteris.
7. Examination of morphology and anatomy of vegetative and reproductive parts of –Cycas & Pinus.
8. Collection of pteridophytes & gymnosperms
9. Permanent and temporary mount of mitosis.
10. Permanent and temporary mount of meiosis.
11. Mendelian deviations in dihybrid crosses
12. Demonstration of – Barr Body _ Rhoeo translocation.
13. Karyotyping with the help of photographs
14. Pedigree charts of some common characters like blood group, colorblindness and PTC tasting.
15. Study of polyploidy in onion root tip by colchicines treatment.

16. Identification of pathogenic bacteria (any two) based on cultural, morphological and biochemical characteristics.
17. To study the different staining methods: Gram's staining permanent slides showing Acid fast staining, Capsule staining and spore staining.
18. Perform/demonstrate RFLP and its analysis
19. Kirby-Bauyer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture
20. A kit-basd detection of a microbial infection (Widal test)
21. To perform any one immuno diagnostic test

SEMESTER - IV

Lab Course IV (BBT 406)

1. To study the permanent slides of different developmental stages of Frog.
2. Staining and mounting of blastoderm of chicken embryo.
3. Study of chick embryo using permanent slides. 1. To recognize bacterial strain by using Gram Staining Technique.
4. To perform Sterilization Techniques for Microbiology experiments.
5. To perform Acid Fast staining technique by using ZiehlNesselson s staining method.
6. To identify various strains of bacteria using light microscopy.
7. To prepare culture Media for the various bacterial cultures.
8. To inoculate bacterial culture using streaking technique in sterilized experimental conditions.
9. To prepare the Blood smears of Man and identification of Leucocytes by Giemsa staining.
10. To perform calculation of differential count of Leucocytes in Human blood.
11. Separation of Serum from Blood
12. Determination of blood groups (ABO and Rh type) in human.
13. Dot blot or immunoblotting
14. Demonstration of ELISA
15. Identification & Classification upto order of the Following:
 - Proto –chordate : Salpa, Doliolum, Herdmania, Branchiostoma
 - Cyclostomata : Myxine, Petromyzon
 - Chondrichthyes : Scoliodon, Zygnema, Pristis, Trygon, Raja , Chimaera
 - Ostiechthyes : Labeo, Mystus, Catla, Hippocampus, Anabas, Echeneis, Lophius
 - Polypeterus Amphibia : Rana, Hyla, Amblystoma, Necturus, Proteus,
 - Reptiles : Hemidactylus, Calotes, Draco, Phrynosoma, Naja Vipera,
 - Bungarus Aves : Columba, Alcedo, Passer
 - Mammalia : Ornithorhynchus, Macropus, Didelphes, Dasyus.
16. An Ecological Note on any one of the specimens mentioned above.
17. Identification of the following slides
 - Mammalian Histology : Liver, Lung Intestine, Kidney, Ovary, Testes Slides of Salpa, Doliolum, Spicules of Herdmania, Tadpole of Frog
18. Preparation of a permanent mount of Salpa, Placoid scales, spicules of Herdmania, Pharynx of Amphioxus, Tadpole Larva of frog.
19. Identification of endoskeletons (Axial & Appendicular skeletons) of frog and rabbit.

SEMESTER - V

Lab Course V (BBT 506)

1. Isolation of amylase producing bacteria from soil by serial dilution using starch as a carbon source.
2. Growth curve analysis of *E. coli* using Luria Bertini broth.
3. Isolation of protease producing micro-organisms from garden soil by serial dilution using casein as a carbon source.
4. Isolation of lactic acid bacteria from yogurt and fermentation of lactic acid using different carbon sources.
5. To study the alcohol fermentation by *Sacharomyces cerevesiae* using different simple and complex carbon sources.
6. To have on site overview of lab safety, troubleshooting and good laboratory practices.
7. Preparation of modified MS Media for Plant Tissue Culture.
8. *In vitro* induction, culturing and sub-culturing of callus induced from plant explants.
9. Preparation of artificial seeds.
10. Extraction, purification and quantification of plant genomic DNA
11. Electrophoresis of plant genomic DNA
12. Isolation of DNA from plant tissue and its qualitative and quantitative analysis .
13. To perform the restriction digestion of DNA.
14. Plasmid DNA isolation.
15. Demonstration of PCR
16. To introduce Entrez as a biological data retrieval system and to learn how to use Entrez search engine to retrieve nucleotide/protein sequence data.
17. Understanding the use of various web resources: EMBL, Genbank and Protein Information Resources (PIR).
18. To introduce PubMed database and its features and to learn how to retrieve articles from PubMed of NCBI.
19. To introduce PDB, SwissProt and TREMBL databases.
20. To learn how to retrieve structural data of a protein using PDB database.
21. To study the pairwise sequence similarity search using BLAST algorithm and interpret its results.
22. To design (or find) PCR primers from a given nucleotide sequence using a bioinformatics tool.
23. To learn how ORF Finder searches for open reading frames in a DNA sequence using the standard or alternative genetic codes.
24. To identify all the possible open reading frames in a nucleotide sequence
25. To perform multiple sequence alignment using Clustal W.

SEMESTER - VI

Lab Course VI (BBT 606)

1. To learn the sterilization techniques: Glassware sterilization, media sterilization.
2. Isolation of lymphocytes from blood and culturing in complete RPMI media.
3. Culturing of adherent cell lines in complete DMEM medium.

4. Culture of suspension cell lines in complete RPMI medium.
5. Transfection of GFP plasmid in adherent cell lines and its visualization by fluorescent microscopy.
6. Isolation of DNA from animal tissue, its quantification and analysis on agarose gel.
7. To estimate dissolved oxygen (DO) in the given water sample by Winkler's method.
8. Analysis of Biological oxygen Demand (BOD) in the given water samples.
9. To compare bacterial load in different water samples
10. Bacterial examination of water by MPN method
11. To study the Principle of measuring chemical oxygen demand (COD) in water samples.
12. Demonstration of SDS-polyacrylamide gel electrophoresis of proteins under reducing conditions.
13. To perform the Western blotting of SDS-PAGE separated proteins.
14. Separation of amino acids by Thin-Layer Chromatography (TLC).
15. To learn the gel filtration chromatography
16. To verify the validity of Beer's law and determination of the molar extinction coefficient of various biomolecules.
17. To study the effect of temperature and pH change of a protein solution on its absorption spectra, using UV-Visible Spectrophotometer.
18. Preparation of protoplasts from leaves.

Course Structure at a Glance

M.Sc. Biotechnology

(4 Semester PG Degree Course)

(Choice Based Credit System)

Department of Biotechnology

Jamia Millia Islamia, New Delhi

Semester I			
Paper Code	Paper Title	Maximum Marks	Credits
MBT 101	Molecular Biology	100	4
MBT 102	Cell Biology	100	4
MBT 103	Biochemistry and Biophysics	100	4
MBT 104	Genetics (CBCE)	100	4
MBT 105	Immunology	100	4
MBT 106	Lab Course-I	100	4

Semester II			
Paper Code	Paper Title	Maximum Marks	Credits
MBT 201	Microbiology	100	4
MBT 202	Metabolism and Enzymology	100	4
MBT 203	Animal Biotechnology	100	4
MBT 204	Genetic Engineering	100	4
MBT 205	Cellular and Molecular Physiology (CBCE)	100	4
MBT 206	Modern (-Omics) Technologies (SEC)	100	4
MBT 207	Lab Course-II	100	4
MBT 208	Seminar-II	25	

Semester III			
Paper Code	Paper Title	Maximum Marks	Credits
MBT 301	Bioprocess Engineering and Fermentation Technology	100	4
MBT 302	Plant Biotechnology	100	4
MBT 303	Environmental Biotechnology	100	4
MBT 304	Biostatistics and Bioinformatics	100	4
MBT 305	Medical Biotechnology and Mol. Medicine (CBCE)	100	4
MBT 306	IPR, Bioethics and Entrepreneurship (AECC)	100	4
MBT 307	Lab Course- III	100	4
MBT 308	Seminar III	25	

Semester IV			
Paper Code	Paper Title	Maximum Marks	Credits
MBT 401	Research Project	400	16
MBT 402	Seminar IV	100	4

Semesters	Marks	Credits
Semester-I	600	24
Semester-II	725	28
Semester-III	725	28
Semester-IV	500	20
Total	2550	100

SEMESTER- I

Molecular Biology (Code: MBT-101)

**4 Credits
MM:100**

Unit 1: Structure and organisation of genome

Packaging and organisation of genomes in virus, bacteria and eukaryotes, structure of chromatin, nucleosome, chromatin organisation and remodelling, chromosome, centromere, telomeres, histone proteins, heterochromatin and euchromatin, torsional stress, DNA topology- linking number, twist, writhe, supercoiling, topoisomers.

Unit 2: DNA replication, repair and recombination

DNA replication models, Meselson and Stahl experiment, DNA polymerases, DNA replication in viruses, bacteria and eukaryotes, replication fork, trombone model, proofreading and fidelity of replication, extrachromosomal replicons, end replication problem and telomerase, replication inhibiting drugs, DNA damaging agents, DNA repair mechanisms (nucleotide excision repair, base excision repair, mismatch repair, recombination repair, double strand break repair, transcriptional coupled repair, recombination- homologous, non-homologous and site-specific recombination), gene conversion, recombination proteins- RecA, RuvA, B, C.

Unit 3: Gene expression and regulation

Structure of prokaryotic and eukaryotic genes, regulatory regions, transcription factors, transcription machinery, RNA polymerases, RNA processing, RNA transport, structure and functions of different RNA types, initiation complex formation, elongation, termination, operon concept- lac operon, trp operon, ara operon, λ -repressor, lexA repressor, transduction, lysogenic and lytic cycles of bacteriophages, quorum sensing, riboswitches, chromatin remodelling in transcription, Swi/Snf complex, inhibitors of transcription.

Unit 4: Protein synthesis, processing and transport

mRNA translation, translational machinery, translation mechanics, structure of ribosomes, genetic code, wobble hypothesis, codon degeneracy, economy of tRNA, aminoacylation of tRNA, proofreading in translation, post-translational modifications in proteins, regulation of protein synthesis, role of mTOR pathway in protein synthesis, transport of synthesized proteins, protein turnover and degradation, translational inhibitors.

Unit 5: Methods and techniques in molecular biology

Methods of isolating DNA (genomic and plasmid) and RNA, DNA and RNA analysis by electrophoresis, agarose and polyacrylamide gels, PFGE, DNA and RNA purity analysis, DNase I footprinting, EMSA, yeast-two hybrid system, PCR.

Suggested readings:

1. Molecular Cell Biology: 7th Edition, (2012)- Lodish H., Berk A, Kaiser C., KReiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA.

2. *Genes XI: 11th edition (2012)*- Benjamin Lewin, Publisher - Jones and Barlett Inc. USA.
3. *Molecular Biology of the Gene, 6th Edition (2008)*- James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA.
4. *Molecular Biology, 5th Edition (2011)*- Weaver R., McGraw Hill Science. USA.
5. *Fundamentals of Molecular Biology, (2009)*- Pal J.K. and Saroj Ghaskadbi, Oxford University Press. India.
6. *Molecular Biology: genes to proteins, 4th edition (2011)*- Burton E Tropp, Jones & Bartlett Learning, USA.

Cell Biology (Code: MBT-102)

4 Credits
MM:100

Unit 1: Cellular structure and composition

Prokaryotic and eukaryotic cell structure, compartmentalisation of cells, structure and functional features of cellular organelles; nucleus and its components, endoplasmic reticulum, golgi apparatus, lysosome, mitochondria, chloroplast, peroxisome, vacuoles, microtubules, flagella, microfilaments, cell junctions, animal and plant cell walls, plasmodesmata, interrelationships between cell organelles.

Unit 2: Membrane structure and function

Plasma membranes, lipid bilayers, membrane models, cytoplasmic membrane system, structural and functional properties of plasma membrane, transport across plasma membrane, sorting and regulation of intracellular transport, membrane electric potentials, vesicular traffic, exocytosis, endocytosis, pinocytosis, protein trafficking.

Unit 3: Cell signalling

Extracellular and intracellular signaling, signal transduction receptors, ligands, structure and function of G-protein coupled receptors, receptor and non-receptor kinases, intracellular signalling transducers, kinases, phosphorylations, PI3K, MAPK and JAK-STAT pathways, signalling molecules, IP3/DAG, cAMP, secondary messengers, hormones and non-receptors signalling pathways, control of gene activity by signaling pathways- activation of transcription factors by signaling.

Unit 4: Cell differentiation, cell death, cell cycle and cancer

Cell differentiation, programmed cell death, necrosis, cell cycle and its regulation, role of hormones and growth factors in- regulation of differentiation, cell death and cell cycle, pluripotency and proliferation, cell transformation and cancer, hallmarks of cancer, initiation, progression and evolution of cancer, oncogenes and tumour suppressor genes and their mutations, cancer causing viruses, metastasis, role of mutations in cancer.

Unit 5: Methods and techniques in cell biology

Microscopy to study cellular localisation of proteins, GF and RF proteins, immunofluorescence microscopy, freeze-etching, freeze-fracture, sample staining and fixation for microscopy, radio-labelling and radioisotopes, fractionation of sub cellular

components- cell disruption, centrifugation (differential and density gradient), purification of organelles using antibodies, cell sorting (flow cytometry).

Suggested readings:

1. *The Cell: A Molecular Approach, 6th edition (2013)- Geoffrey M. Cooper, Robert E.Hausman, Sinauer Associates, Inc. USA*
2. *Molecular Biology of the Cell: 5th edition (2007)- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science, USA.*
3. *Cell Biology: 6th edition, (2010)- Gerald Karp. John Wiley & Sons., USA*
4. *Molecular Cell Biology: 7th Edition, (2012)- Lodish H., Berk A, Kaiser C., KReiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA*

Biochemistry and Biophysics (Code: MBT-103)

4 Credits

MM:100

Unit 1: Biomolecules

Atomic and molecular structure, chemical bonds, structure of macromolecules (DNA, RNA, proteins, lipids, carbohydrates), non-covalent interactions (Vander Waals, electrostatic, hydrogen bonding, hydrophobic interactions), conformation of nucleic acids (A, B, Z DNA helix, tRNA, mRNA, rRNA) and proteins (Ramachandran plot, primary, secondary, tertiary and quaternary structures, domain, motif and folds), stability of nucleic acids and proteins, structure of carbohydrates and lipids, mono-, di- and polysaccharides, storage carbohydrates, glycogen, cellulose, peptidoglycan, chitin, lipids- glycoproteins and glycolipids, lipoproteins, structure of nucleotides, ATP, amino acids, vitamins, prosthetic groups, co-enzymes.

Unit 2: Biophysical chemistry

Concepts of pH, buffer, reaction kinetics, Henderson-Hasselbalch equation, thermodynamics, enthalpy, free energy, entropy, Gibbs-helmholtz equation, spontaneous and non-spontaneous reaction, endergonic and exergonic reactions, reversible and irreversible reactions, colligative properties, concepts of- molarity, normality, moles, Avogadro number, dielectric constant and molarity of water.

Unit 3: Protein biochemistry

Protein folding, folding funnel hypothesis, free energy changes during folding, Levinthal's paradox, chaperones, molten globule, protein misfolding and aggregation, protein misfolding diseases, effect of denaturants and reducing agents on protein folding and structure, protein degradation- ubiquitination, proteosomal degradation, lysosomal degradation, protein half-life, N-terminal rule, degran.

Unit 4: Methods and techniques

Electrophoresis- SDS and native polyacrylamide gel electrophoresis, 1- and 2 dimensional electrophoresis, isotachopheresis, isoelectric focusing, protein purification, dialysis, salting-in and salting-out, affinity, size-exclusion, and ion-exchange chromatography, molecular

structure determination- X-ray diffraction, NMR and cryo-electron microscopy, UV-Visible spectroscopy, circular dichroism, ESR, differential scanning calorimetry, FTIR, protein quantitation, and detection- Bradford method, Lowry method, ELISA.

Suggested readings:

1. *Lehninger, Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.*
2. *Fundamentals of Biochemistry. 3rd Edition (2008), Donald Voet & Judith Voet, John Wiley and Sons, Inc. USA*
3. *Proteins: Structure and Molecular Properties by T.E. Creighton*
4. *Physical Biochemistry by David Freifelder*
5. *Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England*
6. *Biochemistry: 7th Edition, (2012), Jeremy Berg, Lubert Stryer, W.H. Freeman and company, NY*
7. *Introduction to Practical Biochemistry, (2000), S. K. Sawhney, Randhir Singh Narosa, 2000. Practical Enzymology, 2nd edition (2011), Hans Biss Wanger, Wiley-Blackwell, USA*

Genetics (Code: MBT-104) : CBCE

4 Credits

MM:100

Unit 1: Inheritance biology

Mendelian genetics- dominance, segregation, independent assortment, co-dominance, incomplete dominance, gene interactions, pleiotropy, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters, gene mapping- linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, extra-chromosomal inheritance- inheritance of mitochondrial and chloroplast genes, maternal inheritance, pedigree analysis, LOD score for linkage testing, karyotypes, genetic disorders, polygenic inheritance, heritability and its measurements, QTL mapping.

Unit 2: Mutations and chromosomal abnormalities

Mutations- types, causes and detection, mutant types- lethal, conditional, biochemical, loss of function, gain of function, germinal versus somatic mutants, insertional mutagenesis, structural and numerical alterations of chromosomes- deletion, duplication, inversion, translocation, ploidy and their genetic implications.

Unit 3: Molecular genetics

C-value paradox and genome size, Cot curves, repetitive and non-repetitive DNA sequences, transposons in prokaryotes and eukaryotes, replicative and non-replicative transposons, IS elements, SINES, LINES and retrotransposons, DNA hyperchromicity, annealing, hybridisation, denaturation, $Cot^{1/2}$ and $Rot^{1/2}$ values, satellite DNA, DNA melting and buoyant density, gene families, clusters, pseudogenes, super-families, organelle genomes.

Important model system in genetics and methodologies- *Drosophila*, *C. elegans*, Zebrafish, *Arabidopsis*

Unit 4: Mechanisms of gene regulation

Epigenetic control of gene expression, DNA methylation, CpG islands, histone code, histone acetylation and de-acetylation, RNA editing, splicing, transcriptional regulation in prokaryotes and eukaryotes, operons, non-coding RNAs, microRNAs, ceRNAs, siRNAs, ribonucleoproteins, ribosome and transcriptome, gene silencing, siRNAs, shRNAs.

Unit 5: Methods and techniques

DNA microarray, qPCR, RFLP, RAPD and AFLP techniques, FISH, chromosome painting, karyotyping, luciferase assay, mutagenesis and deletion techniques for identification of regulatory regions, Ames test.

Suggested readings:

1. *Concepts of Genetics*, Klug W. S. and Cummings M. R, Prentice-Hall
2. *Principles of Genetics*, Snustad D. P. and Simmons M. J. John Wiley & Sons
3. *Genetics-a Conceptual Approach*, Pierce B. A. Freeman
4. *Molecular Cell Biology: 7th Edition*, (2012)- Lodish H., Berk A, Kaiser C., Krieger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA.
5. *Genes XI: 11th edition* (2012)- Benjamin Lewin, Publisher - Jones and Bartlett Inc. USA.
6. *Molecular Biology of the Gene*, 6th Edition (2008)- James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA.
7. *Molecular Biology*, 5th Edition (2011)- Weaver R., McGraw Hill Science. USA.
8. *Fundamentals of Molecular Biology*, (2009)- Pal J.K. and Saroj Ghaskadbi, Oxford University Press. India.
9. *Molecular Biology: genes to proteins*, 4th edition (2011)- Burton E Tropp, Jones & Bartlett Learning, USA.

Immunology (Code: MBT-105)

4 Credits

MM:100

Unit 1: Introduction to immune system

Cells, organs and tissues of immune system, types of Immunity - innate immunity, acquired immunity, humoral and cellular immune response, primary and secondary immune modulation, cells and molecules involved in innate and adaptive immunity, B and T cells, toll-like receptors, cell mediated effector functions.

Unit 2: Antigens and antibody

Concept of self and non-self discrimination, antigens, antigenicity, immunogenicity, epitope, adjuvants, haptens, the immunoglobulin molecule: structure and function antibody, light and heavy chains, hyper variable regions, antibody generation and diversity, V-J and V-D-J rearrangements, antigenic determinants, antibody types, isotypes, idiotypes, allotypes, monoclonal and polyclonal antibodies, hybridoma technology, cross-reactivity, antigen-antibody reactions and their applications in diagnostics, antibody engineering, chimeric antibodies, phage display, humanised antibody.

Unit 3: Complement system, MHC, hypersensitivity and transplantation immunology

Components of complement system, pathways of complement activation, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, inflammation, hypersensitivity, auto immunity, molecular mimicry, therapy, transplant immunology, graft rejection, immunosuppressants.

Unit 4: Parasitic, tumor immunology and immune diseases

Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, immunology of tumors, congenital and acquired immunodeficiencies.

Unit 5: Experimental and applied immunology

Vaccine development, recombinant vaccines, animal models in immunological studies, routes of inoculation, relevance of transgenic animals in immunology, immunodiagnostics.

Suggested readings:

1. *Kuby immunology*, Judy Owen , Jenni Punt , Sharon Stranford, 7th edition (2012), Freeman and Co., NY
2. *Textbook of basic and clinical immunology*, 1st edition (2013), Sudha Gangal and Shubhangi Sontakke, University Press, India
3. *Immunology*, 7th edition (2006), David Male, Jonathan Brostoff, David Roth, Ivan Roitt, Mosby, USA.

SEMESTER- II

Microbiology (Code: MBT-201)

4 credits

MM:100

Unit 1: Fundamentals of bacteriology

History of bacteriology, landmarks in bacteriology, scope of bacteriology, bacterial cell, size, shapes, flagella, fimbriae and pilli, capsule, sheath, prosthecae and stalk, structure and chemical composition of cell wall (Gram +ve and Gram -ve), cytoplasmic membrane, protoplast, spheroplast, cytoplasmic inclusions, genetic material, spores, and cysts, growth yield and characteristics, strategies of cell division, stress response, methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.

Unit 2: Basic virology

General properties of viruses, morphology and ultrastructure of viruses, structure of HIV, classification of viruses- ICTV system, Baltimore system, DNA and RNA virus, bacteriophages, retroviruses, genome organization in virus, DNA replication in viruses, rolling circle model, viral replication- DNA and RNA virus, bacteriophages- transduction, lysogenic and lytic cycles of bacteriophages, replication of HIV, HIV proteins and their function, viral diagnosis: cultivation, serological and molecular methods, infectivity assays, immunodiagnosis, plaque assay.

Unit 3: Microbes in diseases and antibiotics

Human diseases and causing microbes (bacteria, fungi and viruses), pathogenicity and virulence of bacteria, antibiotics, classes and generations, mechanisms of action, sulfonamides, penicillin, cephalosporin, aminoglycosides, chloramphenicol and other antibiotics, antifungal drugs, drug resistance, superbugs, mechanisms of drug resistance, origin and transmission, antibiotic susceptibility.

Unit 4: Laboratory and industrial microbiology

Control of bacterial growth (sterilization and disinfection methods), handling pathogens, safety in microbiology laboratory, nutrition (nutritional classes) and growth media types, microbial fermentation, industrial microbiology, microbes in meat and dairy industry.

Unit 5: Tools of microbiology

Cultivation of aerobes, anaerobes and microaerophiles. pure culture techniques (streak and spread plate, serial dilution, pour plate, enrichment and single cell isolation), cell visualisation by microscopy- light, bright field, phase contrast microscopy, fluorescence and confocal (deconvolution) microscopy, concept of resolving power and magnification, microscopy for dead and living cells, stained and unstained cells, Gram staining, SEM and TEM, sample preparation in microscopy and electron microscopy.

Suggested readings:

1. *Brock's Biology of Microorganisms. 11th Edition, (2006). Madigan MT, Martinko JM. Pearson Education Inc., USA*

2. *Prescott's Microbiology: Ninth Edition*, Joanne Willey, Linda Sherwood, Chris Woolverton McGraw-Hill Higher Education, 2013
3. *Microbiology* / Michael J. Pelczar, Jr., Roger D. Reid, E. C. S. Chan, Fifth Edition, Tata McGraw-Hill Education Pvt. Ltd
4. *Introduction to Microbiology. 3rd Edition*, (2004), Ingraham JL and Ingraham CA. Thomson Brooks / Cole.
5. *Principles of Virology, Third edition*, (1999), Flint Jane. S., ASM (American Society of Microbiology) Press Publisher, 2 volumes., USA
6. *Field's Virology - 2 volumes, 5th edition*, (2006), Bernard.N. Fields, Lippincott and Williams Wilkins, USA

Metabolism & Enzymology (Code: MBT-202)

4 Credits

MM:100

Unit 1: Digestive physiology and metabolism

Introduction to digestion, digestive enzymes, absorption, mechanisms of transport of absorbed nutrients to cells of body, BMR. Introduction to metabolism, functions of metabolism, characteristics of metabolic pathways, metabolic reactions, laws of thermodynamics, ATP structure and function, history of glycolysis, experimental approaches to the study of metabolism, one gene-one enzyme hypothesis.

Unit 2: Concepts of enzymology

General characteristics of enzymes, classification of enzymes, activation energy, catalysis and catalytic power of enzymes, enzyme activity, effect of pH, temperature, substrate and product concentrations on enzyme activity, feedback and feed-forward regulation of enzymes, concepts of enzyme kinetics, Michaelis-Menten equation, double reciprocal plots, allosteric enzymes and their regulation, T and R state, haemoglobin and myoglobin kinetics, enzyme inhibition and activation, immobilisation of enzymes and its applications, specific activity of enzyme, isozymes, abzymes.

Unit 3: Glucose metabolism

Glycolysis, reaction and enzymes, regulatory reaction, metabolic fates of pyruvate, glycolysis as central metabolic pathways, entry of important hexoses in glycolysis, HMP pathway, gluconeogenesis, glycogen synthesis and degradation, TCA cycle: reactions, enzymes and regulation, anaplerosis, oxidative phosphorylation, mechanics of ATP synthesis, reactive oxygen species, concept of uncoupling, glyoxylate pathway, metabolism of fasting and starvation, hormonal control of glucose metabolism.

Unit 4: Lipid and amino acid metabolism

Lipids, transport of lipids, fatty acid activation and transport into mitochondria, beta-oxidation, oxidation of odd chain & unsaturated fatty acids, formation and oxidation of ketone bodies, fatty acid biosynthesis, elongation and desaturation of fatty acids, arachidonate metabolism, cholesterol biosynthesis, biosynthesis of triacylglycerol and

glycerophospholipids. Amino acid metabolism: transamination reactions, transport of amino groups, urea cycle, metabolic breakdown of individual amino acids, biosynthesis of non-essential and essential amino acids, heme biosynthesis and degradation, genetic defects in amino acid metabolism.

Unit 5: Nucleotide metabolism

Structures of nucleotides, synthesis of purines and pyrimidines- de novo and salvage pathways, catabolism of purine & pyrimidines, fates of uric acid, genetic defects in nucleotide metabolism, enzymes of nucleotide metabolism as targets of anticancer agents.

Suggested readings:

1. *Lehninger Principles of Biochemistry, 3rd edition, May 2000, David L. Nelson, David L. Nelson, Albert L. Lehninger, Michael M. Cox, Worth Publishing, ISBN: 1572599316*
1. *Biochemistry, 5th Ed, February 2002, Lubert Stryer, John L. Tymoczko, Jeremy Mark Berg, Pub. W. H. Freeman Company, ISBN: 0716730510*
2. *Harper's Illustrated Biochemistry; 26th Ed March, 2003 by Robert K. Murray, Darryl K. Granner, Peter A. Mayes, Victor W. Rodwell Pub: McGraw-Hill Medical ISBN-10: 0071389016*

Animal Biotechnology (Code: MBT-203)

4 Credits

MM:100

Unit 1: Introduction to animal tissue culture

Tissue culture- definition, concept and significance, maintenance of sterility and use of antibiotics, detection of various biological contamination, cross contamination, formulation of tissue culture media- serum and synthetic media, sterilization of culture media and reagents, introduction to the balance salt solutions, simple growth media, culture conditions, role of temperature, pH, carbon dioxide and oxygen in animal cell culture, role of different media components in cell culture.

Unit 2: Tissue culture characteristics

Primary culture, establishment of cell lines, immortalisation of cell lines, maintenance and passaging, cryo-preservation and revival of cells in culture, freezing and storage of culture cells, cell growth curve, adherent and suspension culture, biology of cultured cells, adhesion molecules, cell surface molecules, anchorage dependent and independent growth, soft-agar assays, role of growth factors in cell culture, various methods of cell separation, flow cytometry.

Unit 3: Organ culture

3D culture and spheroid formation, applications of 3D culture, organ explant and utility of organ culture, histotypic and organotypic cultures, organ transplants, tissue engineering.

Unit 4: Tissue culture applications

Experimental applications- cell proliferation assays, study of cell cycle, cell synchronization, mitosis in growing cells, measurement of viability and cytotoxicity. cell cloning, transformation, transfection, micro-manipulation, nuclear transplantation, cell hybridization, combining embryo cells, intracellular manipulations and conservation of manipulated embryos, in vitro drug testing in cell culture, production of vaccines and proteins of pharmaceutical relevance, recombinant protein production, harvesting and purification.

Unit 5: Applied animal biotechnology

Artificial breeding – in vitro fertilization and embryo transfer technology, artificial insemination, germ cell storage, transgenic animals- fish, mice and sheep, gene targeting and transfer, mouse models for human genetic disorder and diseases, knock-out and knock-in mice.

Suggested readings:

1. R. Ian Freshney. *Culture of Animal cells, 5th Edition, 2010. A John Wiley & Sons, Inc., Publications, USA*
2. *Gene Transfer to Animal Cells, 1st edition (2005), R. M. Twyman, Taylor & Francis USA.*
3. *Molecular Biotechnology: 4 edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA*

Genetic engineering (Code: MBT-204)

4 Credits

MM:100

Unit 1: Tools of genetic engineering

DNA modifying enzymes, restriction enzymes, vectors in gene cloning- plasmid, cosmid, phages, phasmids, advanced cloning vectors-BAC, YAC, PAC, transformation, transduction and transfection, cDNA and genomic DNA library.

Unit 2: Recombinant gene expression

Gene cloning, various expression vectors in bacteria and eukaryotes- yeast, baculoviruses, mammalian and shuttle vectors, induced expression strategies and protocols. Expression of industrially important gene products, recombinant protein expression.

Unit 3: Tools and techniques of rDNA technology

DNA sequencing- Maxam-Gilbert method, Sanger's Dideoxy chain termination method, automated DNA sequencing, PCR and its types-inverse, nested, reverse transcription-PCR, hot start PCR, qPCR, use in diagnosis of diseases, genetic and physical mapping techniques.

Unit 4: Applications of genetic engineering

Gene therapy and gene delivery systems, detection and diagnosis of genetic diseases, DNA fingerprinting, genetically engineered bio-therapeutics and vaccines and their manufacturing, transgenic animals and bio-pharming, immuno-PCR, site-directed mutagenesis, generation of knock-out and knock-in mice, DNA chip technology, CRISPR/Cas9, Cre/lox and FLP/FRT systems and their applications.

Suggested readings:

1. *From Genes to Genomes, 2nd edition, (2008), J.Dale and M.Schantz, John Wiley & Son Ltd. USA*
2. *Gene Cloning and DNA Analysis: an introduction, 6th edition, (2010) T. A. Brown, Wiley-Blackwell Publisher, UK*
3. *From Gene to Clones ; Introduction to gene technology, 4th edition, (2003), E. Winnacker, Panima Publisher, India*
4. *Molecular Biology Problem solver: A laboratory guide (2004), A. Gerstein, A John Wiley & Sons, Inc., Publication, USA.*
5. *Molecular Biology of the Gene, 6th Edition (2008), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA*
6. *Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA.*
7. *Principles of Gene Manipulation & Genomics, 7th Edition (2006), Primrose and Twyman, Blackwell Publishing, USA.*
8. *Molecular cloning – a laboratory manual – (Vol. 1-3), 4th edition, (2012), Green and Sambrook, Cold Spring Harbor Laboratory Press, USA*

Cellular & Molecular Physiology (CBCE) (Code: MBT-205)

4 Credits

MM:100

Unit 1: Vascular and respiratory physiology

Blood and circulation- blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, carbon dioxide and oxygen transport, Bohr effect, homeostasis. Heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation. Respiratory system- comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.

Unit 2: Endocrinology and reproduction

Endocrine glands, basic mechanism of hormone action, hormones and diseases, different types of hormones, classes of hormones, hormone receptors, function of different hormones, regulation of hormone secretion and feedback mechanism, reproductive processes and its hormonal regulation, gametogenesis, ovulation, neuroendocrine regulation.

Unit 3: Nervous system and sense organs

Neurons, synapse, action potential, nerve impulses and excitation, neurotransmitters, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture, motor plates and neuromuscular junctions. Vision, hearing and tactile response.

Unit 4: Excretory and thermoregulatory system

Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance. Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.

Suggested readings:

1. *Textbook of Medical Physiology 10th Ed Aug 2000 by Arthur C. Guyton, John E. Hall, A.C. and Hall, J.E., W.B. Saunders Company, ISBN-10: 072168677X*
2. *Review of Medical Physiology, 21st Ed 2003 by William F. Ganong, H; McGrawHill.*
3. *Human Anatomy & Physiology, 6th Ed May, 2003 by Elaine N. Marieb; Benjamin Cummings, ISBN-10: 080535462X*

Modern (OMICS) Technology (SEC) (Code: MBT-206)

4 Credits

MM:100

Unit 1: Genomics

Introduction to genomics, large scale DNA sequencing methods- whole genome analysis, next generation sequencing, genome mapping, structural and functional genomics, comparative genomics, metagenomics, toxicogenomics, pharmacogenomics, different methods for characterization of animal genomes, SNP, STR, QTL, RFLP, RAPD, genome bioinformatics, genome annotation.

Unit 2: Transcriptomics and microarray technology

Transcriptome and expression profiling, DNA and RNA microarray, RNA seq, microarray databases and bioinformatics tools.

Unit 3: Proteomics

Introduction to proteomics, concept and applications, structural proteomics, functional proteomics, tools and techniques in proteomics- IEF, 2D PAGE and mass spectrometry, analytical chromatography (HPLC, UPLC, nano-HPLC) and working principle of mass-spectrometry, types and variants of mass-spectrometry (ESI, MALDI-TOF, FT-MS, Triple-Quad, MS/MS, Quadrupole), MS1 and MS2, use of mass-spectrometry in proteomic analysis, interactome and PTM analysis by mass-spectrometry, protein identification, expressional, functional and structural proteomics in health and disease, diagnostics and biomarker discovery.

Unit 4: Metabolomics

Introduction, concept and applications, metabolomics instrumentation, use of NMR and mass-spectrometers in metabolomics, metabolomics in health and disease, metabolomics in diagnostics and biomarker discovery.

Suggested Readings:

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

SEMESTER- III

Bioprocess Engineering and Fermentation Technology (Code: MBT-301) 4 Credits

MM:100

Unit 1: Bioreactors and their design

Design of fermenters/ bioreactors, design of stirred tank reactor and non-mechanically agitated bioreactors (Air lift and Bubble column), operation of bioreactors: batch, fed-batch and continuous processes. Mass transfer: concept of mass transfer, molecular diffusion and role in bioprocess, two– film theory, convective and volumetric mass transfer (KLa introduction), aeration and agitation, oxygen transfer rate, heat control, scale-up bioprocess.

Unit 2: Fermentation technology

Fermentation and its types, biofuels, fermentation media, sterilization and monitoring of process variables, media components and their optimization. Sterilization of media: kinetics of destruction of microorganisms, indicator organism Del factor, designs of Batch and continuous sterilization (Del factor calculation). Monitoring of process variables: types of sensors, measurement and control of various parameters (pH, temperature, dissolved oxygen, microbial biomass, inlet and exit gases, fluid flow, Pressure, Foam). scale-up and scale down.

Unit 3: Cellular and molecular engineering

Strains and pathways important in biotech industry, their genetic manipulation, protoplast fusion, parasexual cycle and genetic engineering for strain improvements, product formation and inhibition of pathways and their regulation; applications in medicine, agriculture and industry.

Unit 4: Downstream processing

Concept of primary (growth associated) and secondary metabolites (Growth non -associated) metabolites, kinetics of growth and product formation. Yield coefficient and efficiency. Biomass separation by centrifugation, filtration, flocculation and other recent developments. Cell disintegration: Physical, chemical and enzymatic methods. Extraction: Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods. Concentration by precipitation, ultra-filtration, reverse osmosis. Drying and crystallization. Treatment of effluent and its disposal strategies.

Suggested readings:

1. Stanbury, P. F. and Whittaker, A. (1984) *Principles of Fermentation technology*, Pergamon press
2. Pepler, H. L 1979, *Microbial Technology, Vol I and II*, Academic Press.
3. Casida, L. E., 1984, *Industrial Microbiology*, Wiley Easterns, New Delhi
4. Prescott. S.C and Dunn, C. G., 1983 *Industrial Microbiology*, Reed G. AVitech books.
5. *Operational Modes of Bioreactors*, BIOTOL series - Butter worth, Heinemann 1992

6. *Bioreactor Design & Product Yield, BIOTOL series - Butter worth Heinemann 1992*
7. *A. H. Patel. (1985), Industrial Microbiology, Macmillan India Ltd. Crueger, W. and Crueger, A. (2005) A Text Book Of Industrial Biotechnology, Panima ,New Delhi.*
8. *Satyanarayan U, Biotechnology, Arunabha Sen Books allied Publishers.*
9. *Schuler, M. and Kargi, F. Bioprocess Engineering -Basic Concept, Prentice Hall of India, New Delhi.*
10. *Bioprocess Engineering Principles - Pauline Doran, Academic Press 1995*
11. *Lydersen, Bioprocess Engineering : Systems, Equipment & Facilities*

Plant Biotechnology (Code: MBT- 302)

4 Credits

MM:100

Unit 1: Plant tissue culture, protoplast fusion and somatic hybridisation

Protoplast isolation, culture, immobilization, preservation and regeneration. Protoplast fusion and somatic hybridization, markers for identifying somatic hybrids, gross phenotypic differences, cybrids. Totipotency, organogenesis; somatic embryogenesis- regulation and applications, artificial seed production; micropropagation; somaclonal variation; androgenesis and its applications in genetics and plant breeding; germplasm conservation and cryopreservation. Selectable genetic markers and biochemical markers. Role in crop improvement.

Unit 2: Genetic engineering, molecular mapping and marker assisted selection

Agrobacterium-plant interaction, virulence genes, Ti and Ri plasmids, hairy root features, T-DNA transfer, disarming the Ti plasmid. Agrobacterium-mediated gene delivery; Co integrate and binary vectors and their utility; Direct gene transfer-PEG-mediated, electroporation, particle bombardment. Screenable and selectable markers; Characterization of transgenics; Chloroplast transformation; Marker-free methodologies; Gene targeting. Quantitative and qualitative traits; MAS for genes of agronomic importance, e.g. insert resistance, grain quality and grain yield; Molecular polymorphism, RFLP, RAPD, STSAFLP, SNP markers; Construction of genetic and physical map; Gene mapping and cloning; QTL mapping and cloning.

Unit 3: Transgenic plants

Gene transfer- vertical and horizontal, issues with horizontal gene transfer, methods of gene transfer. Transgenic plants-for- biotic and abiotic stress tolerance, production of secondary metabolites, manipulation of photosynthesis and nitrogen fixation for increased productivity by, molecular farming (improvement in protein, lipids, carbohydrates, plantibodies, vaccines, therapeutic proteins and active principles).

Unit 4: Applied plant biotechnology

Plant as biofactories- production of industrial enzymes, vitamins and antibiotics and other biomolecules, plant cell cultures for secondary metabolite production, production of pharmaceutically important compounds, bioenergy generation, examples of engineered plants

in human health and disease. Algal and Fungal biotechnology- qualitative (product improvement, strainimprovement) and quantitative (yield) improvement in economicallyimportant algae and fungus.

Suggested readings:

1. Altman A, Hasegawa PM (Ed) (2012) – *Plant Biotechnology and agriculture. Prospectsfor the 21st century* (Academic press)
2. Bhojwani SS. & Razdan MK (1996). - *Plant Tissue Culture : Theory & Practice*(Elsevier)
3. Chawla HC (2004) – *Introduction to plant biotechnology* (Science Publ.)
4. Slater A, Scott NW, Fowler MR (2008) – *Plant Biotechnology: the genetic manipulationof plants*(Oxford Press)
5. Rai M (2009) – *Fungal Biotechnology* (IK International)
6. Vasil IK, Thorpe TA (1994) – *Plant cell and tissue culture* (Springer)
7. H K Das *Textbook of Biotechnology 4th Edition*
8. *Plants Cell Culture 1994, Chrisped, M.J. and Sadana, D.E., Bios Sceintific Publishers, Oxford,UK.*
9. *Plant Cell and Tissue Culture, 1994, Vasis, I.K. and Thorpe, T.A., Klmeer Academic Press, The Netherlands.*
10. *An Introduction to Plant Tissue Culture, 1993, Razdan, M.K., Published by Oxford and I.B.H.Publishing Co. Pvt. Ltd. New Delhi.*
11. *Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture, 3rd Ed 1992, Rienert,J. and Bajaj Y.P.S.; Narosa Publishing House, New Delhi.*
12. *Biotechnology and Plant Genetic Resources, 1997, Callom, J.A., Ford – Lloyd, B.V. andNewbury, H.J., Conservation and use, CAB International, Oxon, UK.*

Environmental Biotechnology (Code: MBT-303)

4 Credits

MM:100

Unit 1: Environmental monitoring

Environmental and ecosystem process (components of ecosystems, major ecosystems, biological magnification), industrial sites, level and type of contaminants,atmospheric pollutants(air, water and soil pollution), air, water and soil quality index, physical, chemical and biological analysis of samples, use of recombinant DNA technology for the study of bacterial community,determination of dissolved oxygen, biological oxygen demand(BOD), chemical oxygen demand (COD),pollution monitoring (bio indicators and biomarkers), toxicity testing using biological material.

Unit 2: Solid waste management and sewage treatment

Basic aspects of solid waste management,aerobic and anaerobic management of solid wastes,function of the waste treatment system,sewage- treatment methods (Lagoons, trickling filters, Activated sludge process (ASP), operating parameters, operating factors, sludge residence time, plant and sludge loading, sludge settling and recirculation mode of operation), modification to existing processes,removal of nitrogen and phosphorus (nitrification and denitrification),sludge treatment and disposal.

Unit 3: Bioremediation, biotransformation and biodegradation

Bioremediation strategies, *in-situ* and *ex-situ* bioremediation; phytoremediation, applications of genetic engineering to phytoremediation, metals and gaseous bioremediation; biocatalyst; Recovery of metals; Factors affecting process of biodegradation, Biochemical pathway of biodegradation, Xenobiotics; Persistence and bio magnification of xenobiotic molecules.

Unit 4: Biotechnology for management of resources and sustainable technology

Need for management of resources, biogas and biofuel production, bio-fertilizers and biopesticides, bioleaching, composting, integrated waste management, provision of bulk and fine chemicals, microbial polymers and plastics, industrial processes and clean technology.

Suggested readings:

1. *Ecology and environmental biology* (2011) Saha T K Books & Allied (p) Ltd, Delhi
2. *Environment Problems & Solutions* (2001) Asthana & Asthana S. Chand Limited, New Delhi
3. *Wastewater Engineering Treatment and Reuse, 4th Ed 2005* by Metcalf & Eddy, Inc. from C.H.I.P.S.
4. *Introduction to Environmental Biotechnology 2002*, Chatterji, A.K; Prentice Hall of India Pvt. Ltd., New Delhi.
5. *Bioremediation* (1994) Baker, K.H and Herson, D.S. Mc Graw Hill, Inc. New York
6. *Biotreatment of Industrial & Hazardous Waste* (1993) M.V. Levin and Gealt, M.A
7. McGraw Hill. Inc, New York
8. *Renewable Energy Sources and their Environmental Impact, 2002*, Abbasi, S.A. and Abbasi, N; Prentice-Hall of India Pvt. Ltd., New Delhi.
9. *Environmental Chemistry*, De, A.K., 1993, Wiley Eastern Ltd.
10. *Biotechnology for Waste Water Treatment 2001*, Nicholas P. Cheremisinof; Printice Hall of India Private Ltd. New Delhi
11. *Biochemistry of Microbial Degradation 1994*, C. Ratledge; Kulwer Academic Publisher.
12. *Concept of Ecology, 1989*, Kormondy, E.J.; Prentice-Hall of India Pvt. Ltd. New Delhi
13. *Environmental Biology and Toxicology, 1993*. Sharma, P.D.
14. *Environmental Biology Principles of Ecology, 1998*, Verma, P.S., V.K. Agarwal; S. Chand & Co. Ltd., New Delhi

Biostatistics & Bioinformatics (Code: MBT-304)

4 Credits

MM:100

Unit 1: Measure of Central tendency, correlation and regression

Measures of central tendency (mean, median and mode) and dispersal, measure of variation (mean deviation and standard deviation), frequency distribution and its graphical representation, probability distribution (Binomial, Poisson and normal). Correlation, Karl

Pearson's coefficient of correlation, interpretation of correlation coefficient, method of least square, regression and calculation of regression coefficient.

Unit 2: Sampling distribution and hypothesis testing

Sampling distribution, difference between parametric and non-parametric statistics, errors, confidence intervals, levels of significance, null hypothesis, Chi-square test, ANOVA, univariate and multivariate analysis.

Unit 3: Bioinformatics in data analysis

Sequence Alignments- algorithms, scoring matrices, multiple sequence alignment (MSA), detecting open reading frames, outline of sequence assembly, mutation/substitution matrices, pairwise alignments, primer designing, FASTA, BLAST, in-silico PCR. Biological database searching and data retrieval, disease databases, genome annotation, gene ontology and GO terms, identification of pathway represented by set of genes using online tools- DAVID, PANTHER. Web based servers and softwares for genome analysis- ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome.

Unit 4. Molecular modelling and structural bioinformatics

Acquisition and visualization of molecular structures and energy optimization methods., sequence and structure based predictions- simulation of molecular interactions, phylogenetic analysis and tree construction methods, protein information sources, PDB, SWISSPROT, TREMBL, structural bioinformatics- SCOP and CATH, introduction to protein motifs and domain prediction. Use of bioinformatics in drug design and target, introduction to immunoinformatics and cheminformatics, applications of immuno- and chemi-informatics.

Suggested readings:

1. *A text book of bioinformatics (2008) Sharma, Munjal and Shankar. Rastogi Publications, Meerut.*
2. *An introduction to Bioinformatics Algorithms (2004) Neil Jones, Pavel Pevzner A Bradford Book, The MIT Press, USA*
3. *Daniel W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.*
4. *Bioinformatics-Sequence and Genome Analysis (2004) David W Mount Cold Spring Harbor Laboratory Press; 2nd edition, USA*
5. *Discovering genomics, Proteomics and Bioinformatics (2006) A. Malcolm Campbell, Laurie J. Heyer Pearson-Benjamin Cummings; 2nd edition, USA*
6. *Immunoinformatics (2008) Schönbach, Ranganathan, Brusica Springer, New York*
7. *Protein Structure Prediction, methods and protocol (2000) David M. Webster Springer, New York*
8. *Bioinformatics, Concept, Skills & Applications, 2003, Rastogi, S C, Mendiratta, Namita, Rastogi, Parag; CBS Publications. ISBN-8123908857*
9. *Glaser AN (2001) High Yield™ Biostatistics. Lippincott Williams and Wilkins, USA*

Medical Biotechnology & Molecular Medicine (CBCE) (Code: MBT-305) 4 Credits

MM:100

Unit 1: Molecular diagnostics and therapeutics

Diagnosis of biochemical disorders and inherited disorders, antibody based diagnosis: diagnosis of bacterial, viral and parasitic diseases using ELISA and Western blot. PCR and array based diagnosis of diseases, present methods for diagnosis of specific diseases like tuberculosis, malaria, AIDS, CML bcr/abl. Prenatal diagnosis- indications for prenatal diagnosis; pre-implantation genetic diagnosis; invasive techniques- amniocentesis, fetoscopy, chorionic villi sampling (CVS); non-invasive techniques- ultrasonography, X-ray, TIFA, maternal serum screening and fetal cells in maternal blood, Diagnosis using protein and enzyme markers (PKU- Guthrie test, Dystrophy- Creatine kinase).

Unit 2: Stem cell technology and regenerative medicine

Stem cells: definition, properties and potency of stem cells, embryonic and adult stem cells, concept of tissue engineering, hematopoietic stem cell therapy, cancer stem cells, potential uses of stem cells in cell based therapies. Bioartificial organs- liver, heart auricles, blood vessels & skin.

Unit 3: Nanobiotechnology

Introduction, biomolecules as nanostructures and their applications in nanotechnology- biosensors, separation of cells and cell organelles, cancer therapy, gene therapy etc. Nanomedicine: nanomaterials in medicine- quantum dots, dendrimers, peptidnanotubes, smartdrugs, nanopore sensors, nanopore immune isolation devices, nanorobots (microbivores, respirocyte), DNA based nano devices; nanomedicine in cancer, drug delivery systems- criteria for drug delivery systems, drug delivery carriers, controlled release mechanisms, administration routes.

Unit 4. Clinical biotechnology

Clinical applications of recombinant technology: erythropoietin, insulin analogs and its role in diabetes, recombinant human growth hormone, streptokinase and urokinase in thrombosis, recombinant coagulation factors, pharmacogenomics and its relevance in personalised medicine, gene therapy, strategies and vectors used in gene therapy, enzyme therapy, DNA based vaccines.

Suggested readings:

- 1. Introduction to Human Molecular Genetics- J.J Pasternak, John Wiley Publishers*
- 2. Human Molecular Genetics- Tom Strachen and A P Read, Bios Scientific Publishers*
- 3. Human Genetics Molecular Evolution- Mc Conkey*
- 4. Recombinant DNA Technology- AEH Emery*
- 5. Principles and Practice of Medical Genetics, I, II, III Volumes by AEH Edts. Emery*
- 6. Medical Biotechnology- Pratibha Nallari, V. Venugopal Rao- Oxford Press*

7. *Medical Biotechnology 1st Edition- Judit pongracz, Mary Keen*
8. *Medical Biotechnology by Bernard R. Glick, Terry L. Delovitch, Cheryl L. Pattern. ASM press, 2014*
9. *Molecular Biotechnology-Principles and Applications of Recombinant DNA- 4th Edition by Bernard R. Glick, Jacj J. Pasternack, Cheryl L. Pattern*
10. *Nanotechnology; Principals and Practices by Sulabha K. Kulkarni, (2009 Revised edition), Capital Publishing company , New Delhi.*
11. *Biological Nanostructures and Application of Nanostructures in Biology by Michael A. Stroschio and Mitra Dutta (2004),Kulwer Academic Publishers,*
12. *BioNanotechnology,Elisabeth S. Papazoglou, Aravind Parthasarathy, First Edition (2007), Morgan & Claypool Publishers ' series.*
13. *Bionanotechnology, by David S. Goodsell (2004), John Wiley & Sons, Inc,Publication*

IPR, Bioethics and Entrepreneurship (AECC) (Code: MBT-306)

4 Credits

MM:100

Unit 1: Intellectual property rights (IPR)

Introduction to Intellectual Property: types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; international framework for the protection of IP, IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; Introduction to history of GATT, WTO, WIPO and TRIPS.

Unit 2: Patents and related issues

Invention in context of “prior art”; patent databases; searching international databases; country-wise patent searches (USPTO, EPO, India etc.); analysis and report formation, types of patents; Indian Patent Act 1970; recent amendments; filing of a patent application; precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; role of a country patent office; procedure for filing a PCT application. Patenting by research students, lecturers and scientists-University/organizational rules in India and abroad, credit sharing by workers, financial incentives. Patent infringement-meaning, scope, litigation, case studies and examples

Unit 3: Bioethics

Introduction to bioethics, philosophical considerations; epistemology of Science; ethical terms; principles & theories; Relevance to Biotechnology. Ethics and the law issues in genetic engineering, stem cells, cloning, medical techniques, transhumanism, bioweapons. Ethical issues in research- animal Rights, ethics of human cloning, use of genetic evidence in civil and criminal court cases, challenges to Public Policy - to Regulate or notto regulate.

Unit 4: Bio-Entrepreneurship

Definition of entrepreneur, role and functions of entrepreneur, role of entrepreneurs in economic development, entrepreneurship in India, biotechnology and entrepreneurship, business models and opportunities in biotechnology, development of products in the biotech industry, biotech business, market and market potential, marketing research, role of government and schemes, financial institutions in promoting bio-entrepreneurship.

Suggested readings:

1. <http://www.w3.org/IPR/>
2. <http://www.wipo.int/portal/index.html.en>
http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
3. www.patentoffice.nic.in
4. www.iprlawindia.org/ - 31k - Cached - Similar page
5. <http://www.cbd.int/biosafety/background.shtml>
6. www.oecd.org/dataoecd/16/9/40181372.pdf
7. www.patentoffice.nic.in/
8. http://www.biotechnology.gov.au/assets/documents/bainternetBA_IPManual20050401114445.pdf
9. http://www.bicpu.edu.in/ipr_ppt/15/kulkarni.pdf
10. *Commercializing Successful Biomedical Technologies, 2008, Shreefal S. Mehta, Cambridge University Press*
11. *Handbook Of Bioentrepreneurship, 2008 , Patzelt, Holger; Brenner, Thomas, Springer*
12. *Entrepreneurship And Business Of Biotechnology, Prof S N Jogdand, Himalaya Publisher*
13. *Entrepreneurship Development, 2003, S Anil Kumar, New Age International (P) Ltd. Publishers*
14. *Entrepreneurship For Everyone: A Student Textbook, 2009, Robert Mellor, Sage Publication Ltd*

SEMESTER- IV

Research Project and Thesis: MBT401

16 Credit

Seminar Presentation: MBT 402

4 Credit

Lab Courses M.Sc. Biotechnology

(4 Semester PG Degree Course)

(Choice Based Credit System)

Department of Biotechnology

Jamia Millia Islamia, New Delhi

SEMESTER- I

Lab Course-I (Code: MBT-106)

4 Credits

Max M.

100

1. Concepts of Buffers and their preparation
2. Isolation & Purification of genomic DNA from bacteria
3. Isolation & Purification of plasmid DNA
4. Agarose gel electrophoresis of chromosomal & plasmid DNA
5. Restriction Digestion of chromosomal & plasmid DNA
6. Isolation of DNA fragment from agarose gel
7. Primer designing and Polymerase chain reaction of selected gene
8. Protein extraction, estimation and purification from mammalian/bacterial/plant cells
9. Identification of specific protein in the unknown cell extract using western blotting
10. Analysis of induced protein expression in bacterial system by SDS-PAGE.
11. Demonstration of Protein purification techniques using crude protein extract of mammalian/bacterial/plant cells
 - i) Gel filtration chromatography
 - ii) Ion- exchange chromatography
 - iii) Affinity chromatography
12. Determination of Allelic and Genotypic frequencies.
13. Transformation of given Plasmid in E coli DH5 alpha and BL-21 cells.
14. Isolation of RNA from animal tissue/mammalian cells
15. The estimation of DNA by diphenylamine
16. Estimation of RNA by orcinol method

17. Isolation of PBMCs through Ficoll density gradient centrifugation
18. Differentiation of monocytes into macrophages
19. To check the purity of macrophages through FACS. (CD14/CD3/CD4)
20. Quantification of antigen through ELISA
21. Detection of antigen/antibody through Double immunodiffusion (Ouchterlony double diffusion)

SEMESTER- II

100

1. To prepare LB Broth and LB Agar
2. Isolation of pure culture by streak plate and spread plate technique
3. Quantification of viable counts through serial dilution from soil/water
4. To study the microbial interaction through models
5. To perform antibiotic sensitivity assay
6. To perform indole test for identification of bacteria
7. To perform MR-VP, citrate, catalase, urease and methyl-reductase tests for identification of bacteria
8. To grow fungi in Sabouraud agar and study their morphology
9. Study of Biphasic and normal growth curve
10. Induced expression of a heterologous protein (GST/GFP) in bacterial cells, followed by comassie staining or fluorescent microscopy.
11. Restriction Digestion and demonstration of the effect of DNA methylation on restriction digestion of Lambda DNA.
12. DNA ligation of lambda DNA HindIII digest with T4 DNA ligase
13. TA cloning of a purified PCR product.
14. Demonstration of site directed mutagenesis using XL Blue plasmid and blue white colony formation, selection and screening of recombinant clones.
15. To perform Thawing of provided cell culture.
16. To perform passaging of provided cell culture.
17. To determine viability of cells by Trypan Blue Method
18. To perform transient transfection in cell lines.
19. To analyze the expression of given gene in transient transfection system by immunoblotting
20. Tissue fixation and processing for histology
21. Section cutting and preparation of slides
22. Hematoxylin-Xylene Staining for histopathology
23. Tissue Immunostaining (IHC) for the detection of location of signaling protein in the tissues
24. Protein isoelectric focusing
25. Extraction, precipitation, solubilization and estimation of proteins
26. Measuring time course of an enzyme
27. Effect of varying enzyme concentration
28. Estimation of K_m and V_{max} for an enzyme
29. Effect of temperature on enzyme activity
30. Effect of pH on enzyme activity
31. Enzyme inhibition
32. Temperature stability of enzymes
33. pH stability of enzymes

SEMESTER- III

Lab Course-III (Code: MBT-307)

Credits- 04
Max M. 100

1. Isolation of amylase producing bacteria from soil by serial dilution using starch as a carbon source.
2. Growth curve analysis of *E. coli* using Luria Bertini broth.
3. Isolation of protease producing micro-organisms from garden soil by serial dilution using casein as a carbon source.
4. Isolation of lactic acid bacteria from yogurt and fermentation of lactic acid using different carbon sources.
5. Alcohol fermentation by *Sacharomyces cerevisiae* using different simple and complex carbon sources. Preparation of protoplast culture media and in vitro culturing of protoplasts.
6. Isolation, purification and characterization of protoplasts.
7. Preparation of artificial seeds loaded with growth promoters.
8. Isolation of chloroplast and thylakoids from plants.
9. Separation of photosynthetic pigment complexes by Blue Native-PAGE.
10. Estimation of Dissolved Oxygen in different water samples
11. Estimation of Biological Oxygen Demand and sag curve analysis in water samples
12. Study of stress related parameters (cysteine or proline) under abiotic stress (2 experiments)
13. Determination of microbial load and confirmation analysis in collected water samples
14. Analysis of plant growth under metal stress and its remediation potential (phytoremediation exp.)
15. Isolation of DNA from blood by phenol chloroform method
16. To study the Reverse-transcriptase-PCR and its significance
17. To study the PCR-RFLP, restriction digestion
18. To perform the DNA finger printing using different samples
19. Cytotoxic potential of anti-cancer drugs/plant extracts/ natural compounds through MTT assay
20. Isolation of RNA from cell line and real-time PCR for a particular gene
21. To identify a fragment of DNA in the unknown sample through Southern blotting
22. Immunohistochemistry for checking differential expression of cancer markers
23. Synthesis of silver nanoparticles
24. Characterization of synthesized nanoparticles
25. Antimicrobial activity of nanoparticles

Paper Details

S. No.	Paper Type Core/CBCE/ SEC/AECC	Paper Code	Title of Paper	Credit	M. Marks (Internal Assessment)	M. Marks (University Exam)
1.	Core	PBT 101	Research Methodology & Biotechniques	4	25	75
2.	Core	PBT 102	Research Project, Review & Annotated Bibliography	4		100
3.	Core	PBT 103	Genomics	4	25	75
4.	CBCE	PBT 104	Molecular Medicine & Industrial Biotechnology	4	25	75

Syllabus for Paper: Research Methodology & Biotechniques

UNIT-I: Biophysical and Biochemical Techniques

Chromatography: Principle, normal and reverse phase liquid chromatography, ion exchange, molecular exclusion, affinity chromatography, HPLC, GC, ICP-MS ; Electrophoresis Techniques: principle, Support media (agarose and polyacrylamide gels), agarose gel electrophoresis of DNA and RNA, southern and northern transfer, PFGE, Native PAGE, SDS-PAGE ; Centrifugation Techniques: Principle of sedimentation, centrifugation, ultracentrifugation, analytical centrifugation, preparative centrifugation, general applications of centrifugation; Spectrophotometry Techniques: theory and applications of CD, UV-VIS, IR, Fluorescence, Atomic absorption spectroscopy, FRET and its application.

UNIT-III: Genetic engineering, Immunology and Molecular Biology Techniques

Extraction of DNA, cellular screening, Polymerase Chain Reaction, DNA sequencing, DNA synthesis, bacterial transformation, molecular hybridization, FISH, Chromosomal banding and painting, Karyotyping, cloning techniques, r DNA Expression techniques; Preparation of culture media, types of culture media, Culture of micro-organisms, Culture in liquid medium, Culture in solid medium, Sterilization, Dilution technique for plate count, Enumeration techniques. Immunohistochemistry, Monoclonal antibody production.

UNIT-II: Histology and Microscopic Techniques and Radio-isotopes Techniques

Fixation of tissue, cell culture, Magnification and resolution of microscopes, components of light microscope, Theory and principles of microscopy, light, dark field, fluorescence microscopy, TEM, SEM, confocal microscopy, microtomy, ultramicrotomy, freeze fracturing, flow cytometry; Radioactivity and radioisotopes, rate of decay, units of radioactivity, specific activity, Detection and measurement of radioactivity Cerenkov counting and autoradiography, Applications in biological sciences - Analytical, diagnostics and metabolic studies, Safety aspects of radioactive handling, alternatives to radio-labeling.

UNIT-IV: Research Methods, Biostatistics and Bioinformatics

Introduction to applications of statistics in biology, Introduction to applications of Collection of data, Measures of dispersion, Simple correlation, Regression analysis, Tests of significance-F-test, paired and unpaired t-test, Chi-square test and its applications, Analysis of variance (ANOVA), Types of biological data, Biological Databases: Nucleic acid and protein sequence and protein structure databases, Bioinfo tools DNA sequence analysis (DSA), Sequence annotations and sequence analysis - Phylogeny of gene (blast, fasta, HMMer) and residue conservation. Primer design and T_m Calculation, DNA Restriction pattern analysis.

Paper – **II** Genomics

Unit I.

Organization of genomes:

Introduction: genome, genomics, omics and importance, general features, C-value paradox, gene identification, gene prediction rules and softwares: genome databases; annotation of genome. Genome diversity: taxonomy and significance of genomes-bacteria, yeast, *Caenorhabditis*, *Homo sapiens*, *Arabidopsis*, etc. synthetic genomes and their applications.

Unit II.

Mapping genomes:

Genetic mapping- i) Cross breeding and pedigree analysis, ii) DNA markers- RFLPs, SSLPs, SNPs. Physical mapping- restriction mapping, RAPD, Fluorescent in situ hybridization, Radiation hybrid mapping and sequence tagged site mapping.

Unit III.

Genome projects:

The Human genome projects, HapMap Project, the 1000 genome project, the ENCODE project. Structural genomics: assembly of a contiguous DNA sequence- shotgun method, clone contig method, and whole- genome shotgun sequencing. Understanding a genome sequence: locating the genes in a genome sequence, determining the functions of individual genes and by studying the activity of a protein coded of an unknown gene

Unit VI.

Functional genomics:

Determining functions of individual genes: computer analysis experimental approaches; case study- annotation of the *Saccharomyces*. RNAi, gene targeting, knock out mice; functional annotation by sequence comparison. DNA microarrays. Structural genomics, pharmacogenomics, drug detoxification genes, evolution of chromosomes and genomes. Comparative genomics, molecular phylogenetics, mitochondrial DNA analysis.

Pre-Ph.D Syllabus Paper III

Medical and Industrial Biotechnology

Unit-I

Gene Therapy Strategies: History and scope of gene therapy, Types of gene therapies; Somatic and germ lines, Gene replacement and gene addition, In vivo, ex vivo and in vitro gene therapies. Gene therapy vectors: Viral vectors: Retrovirus, Adenovirus, Adeno-associated virus, Lentivirus, Herpes virus, Nonviral vectors; Naked DNA, Liposomes and lipoplexes, Transposon. Gene editing methods: Cre-Lox system, Zn-finger nuclease, TALEN, CRISPR-Cas9.

Unit-II

Gene Therapy for Human Diseases: Gene therapies for Hemophilia B, β -Thalassemis and Sickle cell disease, Cystic fibrosis, Duchenne muscular dystrophy, Inherited neurological disorders, Inherited retinal disorders, Cancer Immunotherapy, Tyrosinemia, Severe combined immunodeficiency syndrome (SCID), Gene therapy of nonheritable disorders, recent advancement in gene therapy.

Unit-III

Industrial Biotechnology Systems: Selection of microorganisms: Genetic manipulation and potential problems of genetic engineering, preservation of microorganisms. Rationale for the design of vectors for the over expression of recombinant proteins in microorganisms: selection of suitable promoter sequences, ribosome binding sites, transcription terminator, fusion protein tags, Purification tags, protease cleavage sites and enzymes, inducible expression systems. Over expression model systems: *E. coli*, Yeast, Baculovirus, *Agrobacterium tumefaciens*, oral vaccines

Unit-IV

Product and Processes in Industrial Biotechnology: Industrial production of lactic acid, vinegar, insulin, alcohol, baker's yeast, antibiotics, enzymes. Fermented foods: Milk, cheese, meat, alcoholic beverages, breads and Single Cell Proteins (SCP). Controlling food spoilage: aseptic handling, low-temperature, high-temperature, dehydration, chemical-based preservation, radiation, osmotic pressure. Food-borne diseases: Food borne infections, intoxications. Biosensors, biopesticides, Petroleum microbiology.

Recommended Books:

1. Microbiology by Prescott, Harley, Klein (Mc.Graw Hill).
2. Microbiology by Michael J. Pelczar, JR., E.C.S. Chan, Noel R. Krieg (Tata Mc.-Graw Hill).
3. Genome by TA Brown