




UNIVERSITY OF SARGODHA
OFFICE OF THE REGISTRAR
(ACAD BRANCH)

NOTIFICATION

On the recommendations of Academic Council made in its 1/2020 meeting held on 18.06.2020, the Syndicate in its 1/2020 meeting held on 27.07.2020 approved the revised curricula of the following programs for implementation w.e.f Fall 2019.

- i. BS in Biotechnology (Semester / Term System) (Annex-'A')
- ii. M.Phil in Biotechnology (Annex-'B')


(WAQAR AHMAD)
Additional Registrar (General)

No. SU/Acad/24/773

Dated: 03.10.2024

Distribution:

- Chairman, Department of Biotechnology
- Controller of Examinations
- Director Academics

C.C:

- Dean, Faculty of Science
- Director, QEC
- Additional Registrar (Affiliation & Registration)
- Secretary to the Vice-Chancellor
- PA to Registrar
- Notification File

**REVISED SCHEME OF STUDIES &
CURRICULUM
M.Phil BIOTECHNOLOGY**

(2019)



**DEPARTMENT OF BIOTECHNOLOGY
UNIVERSITY OF SARGODHA
SARGODHA**

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RAISED SCHEDULE OF FEES &
CURRICULUM
IN THE BACHELOR'S DEGREE

1974

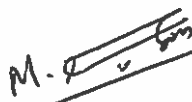


THE DEPARTMENT OF BIODIVERSITY
UNIVERSITY OF BANGALORE
BANGALORE

1974

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Department of Biotechnology
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Mission Statement of the Department

The Department of Biotechnology offers four year BS, two years M.Phil and 3 years PhD programs in Biotechnology. The Department at University of Sargodha has an extensive loyalty to generate and propagate knowledge. The Department has a mission to coach students/scholars to critically and objectively analyze issues related to the well beings of our society. To improve the educational progression and the scholarly character and profile of the Department, members of the faculty engage in teaching and research and offer their expertise.

Mission Statement of M.Phil Program

M.Phil program of studies is planned to produce Biotechnologists well versed in theoretical and experimental knowledge and its applications through analytical skills (both qualitative and quantitative) in their specific areas where original research is an important factor throughout the globe.

Program's Objectives:

Objectives of M.Phil in Biotechnology

The objectives of this program are:

1. To impart knowledge about the major disciplines of Biotechnology. It will enable the students to understand the principles of organizations and inter-relationships in the biological systems.
2. To teach different methods of exploration, investigation, organization of data and its utilization in practical life.
3. To train students for advanced studies and specialization on recently emerging technological and multidisciplinary fields such as Genetic Engineering, Molecular Biology, Cell biology, Immunology, Probiotics etc. After completing the degree / students will be able to apply their knowledge to their respective fields effectively.
4. To equip students with knowledge and skills for better planning and management of Biotechnological resources, environment, health, medicine, agriculture and entrepreneurship in the country.
5. To develop the scientific culture and demonstrate professional skills in teaching / research/ managerial positions in wide range of professions in national and international organizations.
6. Through a combination of lecture content and lab exercises, the students will learn the scientific method.
7. To provide rigorous training in the selected field of Biotechnology.
8. To develop students' abilities to think about biotechnology clearly and critically and to carry out independent research and ultimately commercializing it.
9. To produce biotechnologists those have profound knowledge of different biological specializations and are in direct contact with industry.
10. To generate an intellectually stimulating atmosphere among graduate students and faculty.
11. To prepare manpower with better understanding of economic issues both at national and international level.
12. Scholars and researchers having thoughtful manifestation about the resources and better techniques of their efficient allocation among the required ends of society.

Main elements of the strategic plan to achieve program mission and objectives:

1. Along with establishing and strengthening the theoretical knowledge base, importance is provided to inculcating the experimental skills in students.
2. Focus is on imparting knowledge, skills and attitudes pertinent with the field.

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3. Emphasis is on imparting skills that can enable students to collect information, data and its proactive utilization to learn and solve the biological problems. _
4. Teaching pertinent research methods on the highest level.
5. Classroom presentation and seminars are encouraged for capacity building of students.
6. Special emphasis on the comprehensive personality development of the learners.
7. Character formation of students through encouragement in various curricular and co-curricular activities in the light of Islamic values and principles.

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SCHEME OF STUDIES FOR M. PHIL DEGREE IN BIOTECHNOLOGY
FIRST SEMESTER—

Sr. No.	Name of Courses	Credit Hours
1	Elective I	3(3+0)
2	Elective II	3(3+0)
3	Elective III	3(3+0)
4	Elective IV	3(3+0)

Second Semester

Course Code	Name of Courses	Credit Hours
1	Elective V	3(3+0)
2	Elective VI	3(3+0)
3	Elective-VII	3(3+0)
4	Elective-VIII	3(3+0)

Thesis Research

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LIST OF ELECTIVE COURSES

1.	BIOT-7101	Metabolic Pathways In Plants	3(3+0)
2.	BIOT-7102	Signal Transduction	3(3+0)
3.	BIOT-7103	Biotechnology Law & Regulations	3(3+0)
4.	BIOT-7104	Recombinant DNA Technology	3(3+0)
5.	BIOT-7105	General & Medical Genetics	3(3+0)
6.	BIOT-7106	Molecular Basis of Plant Development	3(3+0)
7.	BIOT-7107	Regulation of Gene Expression	3(3+0)
8.	BIOT-7108	Biological Safety and Risk Management	3(3+0)
9.	BIOT-7109	Biochemistry I	3(3+0)
10.	BIOT-7110	Biochemistry II	3(3+0)
11.	BIOT-7111	Cell Biology I	3(3+0)
12.	BIOT-7112	Cell Biology II	3(3+0)
13.	BIOT-7113	Molecular Biology	3(3+0)
14.	BIOT-7114	Bioinformatics	3(3+0)
15.	BIOT-7115	Virology	3(3+0)
16.	BIOT-7116	Analytical & Mechanistic Enzymology	3(3+0)
17.	BIOT-7117	Protein Chemistry & Enzymology	3(3+0)
18.	BIOT-7118	Insect Molecular Biology and Viruses	3(3+0)
19.	BIOT-7119	Biostatistics & Laboratory Mathematics	3(3+0)
20.	BIOT-7120	Bioprocess Technology	3(3+0)
21.	BIOT-7121	Biophysics	3(3+0)
22.	BIOT-7122	Biopharming in Plants: Principles and Techniques	3(3+0)
23.	BIOT-7123	Protein Engineering	3(3+0)
24.	BIOT-7124	Bioremediation and biodegradation	3(3+0)
25.	BIOT-7125	Research Methods in Biotechnology	3(3+0)
26.	BIOT-7126	Immunology	3(3+0)
27.	BIOT-7127	Agriculture Biotechnology	3(3+0)
28.	BIOT-7128	Molecular Evolution	3(3+0)
29.	BIOT-7129	Molecular Basis of Plant Breeding	3(3+0)
30.	BIOT-7130	Bioethics, Biosecurity, Biosafety & Dual Use Education	3(3+0)
31.	BIOT-7131	Methods In Molecular Biology	3(3+0)
32.	BIOT-7132	Microbial Enzyme Technology	3(3+0)

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33.	BIOT-7133	Forensic Sciences	3(3+0)
34.	BIOT-7134	Medicinal Plant Biotechnology	3(3+0) - -
35.	BIOT-7135	Fermentation Technology	3(3+0)
36.	BIOT-7136	Applied Biostatistics	3(3+0)
37.	BIOT-7137	Advanced Analytical Techniques	3(3+0)

The courses from the attached list can be taken depending upon the resources of the department.


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DESCRIPTION OF MPhil COURSES

NOTE: Latest Edition of Books shall be used.

BIOT-7101

Metabolic Pathways in Plants

3(3+0)

Plants are sessile organisms that must respond dynamically to environmental signals. Key to their response and survival is the intricate network of metabolic pathways that result in the differential accumulation of metabolites. This course will familiarize students with the fundamentals of plant metabolomics research. Metabolomics is presented in relation to plant development, nutrition, and response to stress, among other topics. Course goals include a critical evaluation of a current topic in plant metabolomics and how metabolomics technology can enhance their own research objectives. Prerequisites: Graduate student status or consent of instructor. This course provides comprehensive introduction to intermediary metabolism of lipids, proteins and nucleic acids. one carbon pool, digestion and absorption of food, detoxification and immune system, blood and other body fluids. More specifically, the course introduces concepts of Enzymes, co-enzymes, bioenergetics, the hormones and the plants pigments, Composition of vitamins, Renal function, acid base balance, electrolytes and water balance.

Contents

- 1 Enzymes which includes Coenzymes and Bioenergetics.
- 2 Introduction to intermediary metabolism of Lipids, Proteins and Nucleic acids,
- 3 One carbon pool: Digestion and absorption of food,
- 4 Detoxification and immune system.
- 5 Blood and other body fluids,
- 6 Chemistry of Respiration and gas transport,
- 7 Renal function, acid-base balance, electrolytes and water balance,
- 8 Composition of Urine and the vitamins,
- 9 Composition and metabolism of specialized tissues.
- 10 Nutritional aspects of Proteins, Carbohydrates, Lipids, the hormones and plant pigments.

Recommended Text

- 1 Schwender, J., Junker, B. H. (2009). *Plant metabolic networks* (3rd ed.). Dordrecht: Springer.

Suggested Readings

1. Murray, R. K., Granner, D. K., Mayes, P. A., & Rodwell, V. W. (2003). *a LANGE medical book. Harper's Illustrated Biochemistry* (26th ed). New York, America: McGraw-Hill Companies, Inc.

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BIOT-7102

Signal Transduction

3(3+0)

This course provides comprehensive introduction to classification of hormones and growth regulators, Phyto-hormones, agrochemicals and biosynthetic pathways of plants hormones. Cells in multicellular organism communicate with each other and internally by a complex network of signaling pathways that regulate cellular process such as growth, differentiation, migration, survival. The basic concept of general growth and development will be introduced, treating how specific plant organs develop as the plant grows from an embryo to a flowering plant. How does the cell cycle and growth control contribute to plant development and how is cell cycle and growth controlled, how are cell walls and metabolism integrated into development How do stresses impact on growth and development and what kind of molecular mechanisms underlie these processes This course also introduces concepts on the role of hormones in agriculture, horticulture and tissue culture. Students will understand the strengths and limitations of various experimental approaches for studying signal transduction. Students will be able to apply knowledge for assay of plant hormones. Study of recent research articles will be also helping to enhance their knowledge of research area.

Contents

- 1 Phyto-hormones,
- 2 Agrochemicals,
- 3 Classification of Hormones,
- 4 Growth regulators,
- 5 Biosynthetic pathways for Plant hormones.
- 6 Methods of assay of plant hormones,
- 7 Physiological functions of plants hormones,
- 8 Biochemical functions of plant hormones,
- 9 Role of hormones in Agriculture,
- 10 Horticulture, Tissue culture.
- 11 Phytohormones and stress phenomenon,
- 12 Mechanization of phytohormone action,
- 13 Hormones and gene expression, Recent research articles

Recommended Text

- 1 Schneider, E. A. and Wightman, F. (1978). *Auxins. In Phytohormones and related compounds: A comprehensive treatise*. Amsterdam: Elsevier/North-Holland Biomedical Press.
- 2 Phillips, I. J. D. and Wareing, P.F. (1981). *Growth and differentiation in plants* (3rd Ed). Pergamon

Suggested Readings

- 1 Scott, T.K. (1984). *Hormonal regulation of development II*. Springer-Verlag Berlin Heidelberg.

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BIOT-7103

Biotechnology Law & Regulations

3(3+0)

This course provides comprehensive introduction to bioethics, National bioethics committees and the role, use of human tissues/embryos, use of animals for experimentation and animal rights, the concepts of Intellectual property, patent law, trademarks, copyrights, trade secrets, licensing and patent litigation. The course discusses the ethical issues arising from developments in biotechnology in the fields of human, plant, animal, and microbial genetics. Potential problems facing individuals and communities at regional, national, and global levels, issues like the impact of biotechnology on environment, health, and food will be explored. Additionally, the course covers the basic legal notions in the conduct of biomedical research with human subjects, patents, licensing, exclusive rights, and corporate laws and their compatibility with Human Rights code. The students will be exposed to the standards used to assure safety and efficacy of biotechnological products from production facility licensing to industry regulation by Good Manufacturing Practice and Quality System regulation.

Contents:

- 1 Bioethics, National bioethics committees and the role,
- 2 Use of Human tissues/ embryos/ animals for experimentation and animals' rights,
- 3 Individual and organizational responsibility in R & D,
- 4 commercial aspects of biotechnology,
- 5 Gene therapy,
- 6 Cloning,
- 7 Biomaterials in the medical and health sector,
- 8 Farming and crop modification in the agricultural,
- 9 Society concerns: Intellectual property,
- 10 Privacy, government and industrial regulation, liability, ethics, and policy responses,
- 11 Key issues in Intellectual property and patent law,
- 12 how they influence the development and commercialization of advances in the field of biotechnology,
- 13 Key issues in Intellectual property, patent law, trademarks, copyrights, trade secrets, licensing and patent litigation.

Recommended Text

- 1 Jusoh, S. (2006). *Biotechnology law and regulation: the ASEAN perspective*. Cameron May.
- 2 Wellons, H. B., Ewing, E. S., & Cople, R. (2007). *Biotechnology and the Law*. American Bar Association.

Suggested Readings

- 1 Guide, N. I. H. (1996). *Revised Guide for the Care and Use of Laboratory Animals*. NIH GUIDE, 25.

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BIOT-7104

Recombinant DNA Technology

3(3+0)

This course provides a comprehensive introduction on importance and application of DNA recombinant technology in industrial, agricultural, biomedical and environmental biotechnology with comprehensive theoretical knowledge how to generate macromolecules of desired characters for transgenesis. The main goal of the course is to provide an advanced and rigorous training about a diversity of recombinant DNA techniques, both basic and advanced. So, at the end of the module the student will have achieved a solid knowledge of different techniques involving the manipulation of recombinant DNA currently used in research laboratories as well as profits and limitations. Students will be able to understand the methodological procedures and identify current instrumental tools based on recombinant DNA technology to address key issues in many research areas, such as structure of DNA, the structure and function of chromatin, the evaluation of the expression and regulation, replication, transcription, translation and subcellular localization of proteins, etc.

Contents

- 1 Importance & application of DNA recombinant technology in Industrial, Agricultural, Biomedical, Environmental and theoretical knowledge how to generate transgenesis,
- 2 Different approaches to isolate nucleic acids,
- 3 Cleavage of DNA,
- 4 Genetic maps,
- 5 Restriction endonucleases,
- 6 Competency and different means of introducing DNA in Prokaryotes,
- 7 Competency and different means of introducing DNA in Eukaryotes,
- 8 Gene libraries,
- 9 cDNA cloning,
- 10 DNA modifying enzymes,
- 11 Cloning vectors, various types,
- 12 Reporter genes,
- 13 Identification and screening of recombinant DNA molecules.

Recommended Text

- 1 Brown, T. A. (2016). *Gene cloning and DNA analysis: an introduction*. John Wiley & Sons.
- 2 Bernard R., Glick, & Pasternak, J. J. (2003). *Molecular Biotechnology: Principles & Applications of Recombinant DNA* (3rd ed.).

Suggested Readings

- 1 Thiel, T., Bissen, S., & Lyons, E. M. (2002). *Biotechnology: DNA to protein: a laboratory project in molecular biology*. McGraw-Hill.

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BIOT-7105

General & Medical Genetics

3(3+0)

This course provides comprehensive introduction on a review of human disease with a genetic component, relating phenotype to genotype wherever possible, from monogenic disorders to complex, multifactorial diseases. More specifically, this course introduces developmental genetics, Cancer genetics, Immunogenetics, Animal models of genetic disease, Gene therapy, Genetic counseling. The overall goal of this course is to provide students with the knowledge and understanding of the scientific principles that are the basis of current approaches to the diagnosis and management of disease. The application of these scientific principles and knowledge to the practice of medicine, including the development of life long learning and problem solving skills, is emphasized. Learning from both basic science and clinical disciplines teach the fundamental principles of genetics. At the end of this course, students will be expected to be able to recognize patterns of inheritance, recognize the genetic and environmental contribution to multifactorial conditions and diagnosis of disease.

Contents

- 1 A review of human disease with a genetic component, relating phenotype to genotype wherever possible,
- 2 Multifactorial diseases,
- 3 Chromosomal basis of heredity and Genetic variation in individuals and populations,
- 4 Autosomal dominant and recessive inheritance,
- 5 Sex-linked and mitochondrial inheritance,
- 6 Genetics of Developmental genetics,
- 7 Cancer genetics,
- 8 Immunogenetics and Animal models of genetic disease.
- 9 Chromosomal basis of disease.
- 10 Biochemical genetics.
- 11 Disorders of metabolism.
- 12 Risk factor calculation, Epigenetics, Cancer genetics,
- 13 Hereditary mechanisms not linked to DNA sequence (genomic imprinting).

Recommended Text

- 1 Turnpenny, P. D., Ellard, S. (2007). *Emery's elements of medical genetics* (13th ed.).

Suggested Readings

1. Robin, N. H. (2008). *Medical genetics: its application to speech, hearing, and craniofacial disorders*. Plural Publishing.

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BIOT-7106

Molecular Basis of Plant Development

3(3+0)

This course provides a comprehensive introduction on major groups of plants; The structure of 'higher plants. Protective systems, absorbing systems, supporting systems, Photosynthesis systems, Storage 'systems, 'Transporting' systems. More specifically, this course introduces the Alternative development strategies: Embryonic development of somatic cells and pollen grains, abnormal growth. This course will cover various aspects of plant growth and development at the molecular level and recent advances in understanding molecular mechanisms of gene regulation in plants. The course emphasis will be on current literature to understand how the tools of genetics, molecular biology and genomics are being used to understand plant development.

Contents:

- 1 The major groups of plants, The structure of 'higher plants - The cell, meristems; simple tissue; complex tissues and tissue systems,
- 2 Protective systems, absorbing systems, Supporting systems, Photosynthesis systems, Storage 'systems,
- 3 'Transporting' systems: Secretory systems, Excretory systems, Aerating systems and Movement systems of positional perception, Intra-organism communication systems,
- 4 Concept of plant growth and development from an organism perspective: Seed to seedling: Seed germination, seedling growth,
- 5 Seedling to adult plant Primary vegetative body of the Plant,
- 6 Growth and Differentiation of the shoot, leaf and root; Secondary body of the plant
- 7 Floral evocation and development of the floral meristem formation of floral organs,
- 8 Microsporogenesis and formation of the male gametophyte,
- 9 Megasporogenesis and formation of the embryo sac,
- 10 Seed and Fruit formation,
- 11 Alternative development strategies: Embryonic development of somatic cells, Pollen grains and abnormal growth,
- 12 The vascular cambium, secondary xylem. Secondary phloem, periderm, Excretory systems,
- 13 Aerating systems, Movement systems of positional perception.
- 14 Intra-organism-communication-systems.

Recommended Text

- 1 Fahn, A. (2001). *Plant Anatomy*. (4th ed.). Butterworth. Heinemann Ltd.
- 2 Fosket, D. E. (2012). *Plant growth and development: A molecular approach*. Elsevier.

Suggested Readings

- 1 Kozolowski, T.T. (1994). *Growth and Development of Trees*. Vols. I and II. New York, America: Academic Press.

BIOT-7107

Regulation of Gene Expression

3(3+0)

This course provides a comprehensive introduction on transcriptional regulation of gene expression and Post-transcriptional regulation of gene expression. More specifically, this course introduces on Studying gene expression by using cultured cells, Reporter genes, transgenic animals, gene targeting, Knock out mutations. The participants in this course will discuss selected topics dealing mainly with regulatory mechanisms that control gene expression by RNA polymerase II in eukaryotes. Topics will include assembly of the initiation complex; roles of transcription factors, co-activators and *cis*-acting regulatory elements; promoter escape; mechanisms that control elongation and termination of transcription; chromatin control of transcription; regulatory RNAs; and chromosome conformation. The course will be structured so as to have an introductory lecture on a specific topic in one class followed by the next class being a participatory discussion of pre-assigned research papers in which all students will have prepared themselves to present any of the individual figures from the assigned papers.

Contents

- 1 Nucleosome structure,
- 2 Histone modification,
- 3 Chromatin remodeling in gene activation,
- 4 Epigenetic regulation,
- 5 Regulation of gene expression at Transcriptional level,
- 6 Post transcriptional level,
- 7 Roles of transcription factors,
- 8 Regulation of gene expression at protein level,
- 9 Studying gene expression by using cultured cells,
- 10 Co-activators and *cis*-acting regulatory elements,
- 11 Promoter escape,
- 12 Reporter genes,
- 13 Transgenic animals,
- 14 Gene targeting,
- 15 Knock out mutations,
- 16 Research articles.

Recommended Text

- 1 Lewin (2010). *Genes X* (10th ed.). Jones and Bartlett Publishers.
- 2 Strachan, T., Read, A. (2010). *Human Molecular Genetics* (4th ed.). Garland Science.

Suggested Readings

- 1 Articles Published in *Nature Review Immunology*

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BIOT-7108

Biological Safety and Risk Management

3(3+0)

Over the past years, the approach for bio risk management has markedly evolved. From checking compliance with prescribed requirements, the focus has shifted to management systems with protection measures designed in relation to the risks identified in a detailed assessment. Against this background, people responsible for bio risk management in an organization are challenged to cope with an increasing complexity and diversity of questions. This course provides a comprehensive review of all the essential elements of biorisk management, strengthening biosafety practitioners to build their own approach. This course provides a comprehensive introduction on Modern biotechnology and its social implications, biomedical research and bioethics. Introduction to biosafety and biohazards, Risk factors and risk groups, laboratory borne infections and toxins, risk controls. More specifically, this course introduces Raising awareness about professional in implementing the conventions; to build up a strong culture of awareness and compliance with bio-standards for life sciences and biotechnology students at university level.

Contents

- 1 Modern biotechnology and its social implications.
- 2 Biomedical research and bioethics,
- 3 Introduction to biosafety and biohazards,
- 4 Risk factors and risk groups, Biological waste disposal and recycling,
- 5 Safety and benefits of genetic testing,
- 6 Laminar flow hoods and biological safety cabinets, Risk factors and risk groups,
- 7 Experimentation on/using Human embryos, Stem cell research, Use of animals and GMOs, Genetically modified food and biosafety,
- 8 Indigenous knowledge and patenting, Commercialization and benefit sharing,
- 9 To have a first-hand knowledge about the awareness level of dual use education and Capacity building of University teachers for curriculum development,
- 10 Laboratory borne infections and toxins, risk controls, Commercialization and benefit sharing,
- 11 To build up a strong culture of awareness and compliance with bio-standards for life sciences and biotechnology students at university level.

Recommended Text

- 1 Chalmer, M. (2004). *Cross-Cultural biotechnology*. Rowma & Littlefield Polishers.
- 2 Poppy, G., Wilkinson, M. (2005). *Gene Flow from GM Plants*. Blackwell Science Publications.

Suggested Readings

- 1 Karp, G. (2002). *Cell and Molecular Biology: Concepts & Experiments* (3rd ed.). John Wiley Sons. Inc. N.Y.

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BIOT-7109

Biochemistry I

3(3+0)

The subject aims to provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of selected aspects by means of series of lectures and lab experiments. This course will provide a comprehensive introduction to the students that would be to acquire fundamental knowledge of the molecules of life such as nucleic acids, carbohydrates, Glycoprotein and Glycolipids as informational as well as their function in the context of a living cell. Small organic molecules function in energy production and creating building blocks for the components of cells and can also be used to perturb the functions of proteins directly. Delineating the structure, chemical properties and function of relevant carbohydrates as Monosaccharide, Disaccharides and Polysaccharides. Delineate glycolysis, glycogen metabolism, citric acid cycle.

Contents:

- 1 Carbohydrates and glycobiology,
- 2 Carbohydrates: Monosaccharides,
- 3 Disaccharides and Polysaccharides,
- 4 Glycoproteins and Glycolipids,
- 5 Nucleic acid Structure,
- 6 Nucleic acid chemistry,
- 7 Genome alterations and new products of Biotechnology,
- 8 The composition and architecture of membranes,
- 9 Membrane dynamics and Solute transport across membranes,
- 10 Delineate glycolysis, glycogen metabolism, citric acid cycle,
- 11 Delineating the structure, chemical properties and function of relevant carbohydrates as Monosaccharide, Disaccharides and Polysaccharides
- 12 Lectins, selectins, oligosaccharide-bearing hormones,
- 13 Storage lipids, structural lipids in membranes,
- 14 lipids as signals,
- 15 Cofactors, and pigments.

Recommended Text

- 1 Nelson; D. L., Cox, M. M.(2017). *Lehninger-Principles of Biochemistry* (7th ed.).
- 2 Voet, D., Voet, J. G., Pratt. C.W. (2016). *Fundamentals of Biochemistry* (5th ed.). Wiley.

Suggested Readings

- 1 Metzler, D. E. (2003). *Biochemistry*. Volume 1 and 2. Elsevier Academic press.
- 2 Murray. R. K., Granner. D. K., Mayes, P. A., & Rodwell. V.W. (2003). *Harper's illustrated Biochemistry* (26th ed.). McGraw Hill Inc.

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BIOT-7110

Biochemistry II

3(3+0)

This course is a continuation of principles of Biochemistry - I and aims to familiarize students with the key concepts of intermediary metabolism of proteins, nucleic acids, carbohydrates and lipids. The course also aims to provide knowledge on the principles of thermodynamics and their applications in bioenergetics. This subject will provide an advanced understanding of the core principles and topics of metabolism and to enable students to acquire a specialised knowledge and understanding of selected aspects by means of series of lectures. This course provides a comprehensive introduction on Bioenergetics, metabolic pathways, digestion and absorption of food, detoxification and immune system, Acid base balance, electrolyte, water balance. More specifically, this course introduces nutritional aspects of proteins, carbohydrates and lipids, the hormones, the plant pigments, the chemistry of respiration and gas transport. Compare and contrast the sequence of reactions that take place during photosynthesis (for plants and cyanobacteria) with the electron transport chain.

Contents

- 1 Bioenergetics and Metabolic pathways.
- 2 Digestion and absorption of food,
- 3 Detoxification and immune system and blood and other body fluids,
- 4 Chemistry of Respiration and gas transport,
- 5 Renal function Disaccharides,
- 6 Acid-base balance, electrolytes and water balance,
- 7 Composition of urine and composition,
- 8 Metabolism of specialized tissues,
- 9 Nutritional aspects of Proteins,
- 10 Carbohydrates,
- 11 Lipids,
- 12 The hormones and the plant pigments

Recommended Text

- 1 Murray, R. K., Granner, D. K., Mayes, P. A., & Rodwell, V. W. (2003). *Harper's illustrated Biochemistry* (26th ed.). McGraw Hill Inc.
- 2 Champe, P. C., & Harvey, R. A. (1994). *Biochemistry. Lippincott's illustrated Review*. J. B. Lippincott's Co.

Suggested Readings

- 1 Vasudevan, D. M. and Sreckumer. S. (2001). *Textbook of Biochemistry (for medical students)* (3rd ed.). Jaypee Brothers Medical Publishers. Pvt. Ltd.
- 2 Mckee, T., Mckee, J. R. (2003). *Biochemistry: the molecules of life* (3rd ed.). MacGraw Hill Co.

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BIOT-7111

Cell Biology I

3(3+0)

This course will acquaint students with features of eukaryotic cells (Animals, Plants), functions of different compartments and the overall structure/ultrastructure of cells (especially Endoplasmic Reticulum, Golgi complex, Lysosomes, Mitochondria as well as Mitosis and Meiosis as visualized by electron microscopy. This course provides comprehensive introduction on Basic chemical and physical concepts, Membrane structure and function, Storage and expression of genetic information, Biogenesis, traffic and functions of cellular membrane systems. More specifically, this course introduces Evolution of cells and genetics of cell organelles, formation of specialized cells. Cancer cells and growth control. At Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles and will be apply to their knowledge of cell biology to selected examples of changes or losses in cell function. These can be including responses to environmental or physiological changes or alternations of cell function brought about by mutation.

Contents

- 1 Basic chemical and physical concepts of Membrane structure and function,
- 2 Storage and expression of genetic information,
- 3 Biogenesis, traffic and functions of cellular membrane systems,
- 4 Structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles,
- 5 Reception and transduction of environmental information,
- 6 Cellular interactions and the extra cellular matrix,
- 7 Cytoskeleton and cellular motility,
- 8 Structure/ultrastructure of cells
- 9 Cell cycle and cell division,
- 10 Evolution of cells and genetics of cell organelle,
- 11 Formation of specialized cells. Cancer cells and growth control.

Recommended Text

- 1 Gunning, B. E. S., Steer, M. W. (1975). *Plant Cell Biology*. Blackwell Scientific Publications.
- 2 Lodish, H. F. (2008). *Molecular cell biology*. W. H. Freeman.

Suggested Readings

- 1 Kleinsmith, L. J., Kish, V. M. (2002). *Principles of Cell and Molecular Biology*. Harper Collins College Publishers.

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BIOT-7112

Cell Biology II

3(3+0)

The focus of Cell Biology is the study of the structure and function of the cell. In this course we will focus on Eukaryotic cell biology and will cover topics such as membrane structure and composition, transport, and trafficking; the cytoskeleton and cell movement; the breakdown of macromolecules and generation of energy; and the integration of cells into tissues types of prokaryotic cells. We will also cover important cellular processes such as cell cycle regulation, signal transduction. Throughout the semester we will attempt to relate defects in these various cellular processes to human diseases to help gain a better understanding for what happens when cells don't work as they should. This course will provide basic and comprehensive understanding of cell structure and function. During this course, also discuss the molecular composition of cellular components and organelles and how these molecules and their interactions ultimately dictate cell structure and function.

Contents:

- 1 Introduction to Cell theory,
- 2 Cell structure and functions,
- 3 Cell chemistry,
- 4 Types of cells: Prokaryotic cells, Viruses, Bacteria,
- 5 Types of cells: Prions & viroids,
- 6 Endoplasmic reticulum, lysosome,
- 7 Mitochondria, chloroplast,
- 8 The nucleus,
- 9 Mechanism of cell signaling, protein folding,
- 10 Protein aggregation,
- 11 Protein degradation,
- 12 Structure and function of cytoskeleton,
- 13 The cell cycle, Mitosis, Meiosis,
- 14 Cell cycle regulation,
- 15 signal transduction

Recommended Text

- 1 Alberts, B., Johnson, A. (2006). *Molecular Biology of the Cell* (4th ed.). Garland Science.
- 2 Lodish, Berk, Zipursky, (2000). *Molecular Cell Biology* (4th ed.). W.H. Freeman.

Suggested Readings

1. Karp, G. (2010) *Cell Biology* (6th ed.). Wiley Desktop.
2. Karp, G. (2010). *Cell and Molecular Biology: Concepts and experiments* (6th ed.). John Wiley & Sons.

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BIOT-7113

Molecular Biology

3(3+0)

The course should give advanced knowledge of the structure and function of genetic material (DNA and RNA) in prokaryotes and eukaryotic cells, advanced and extended knowledge and skills in molecular biological methodology. In this course, students will know about the chemistry and biology of nucleic acid structure and the mechanism of DNA replication, transcription, post transcription modification, translation, post translational modifications in prokaryotes and eukaryotes. This course deals with nucleic acids and proteins and how these molecules interact within the cell to promote growth, division and development. The central goal understands the gene regulation at all levels both in prokaryotes and eukaryotes. In this course, students will account for causes of DNA damages, genetic changes and explain the different mechanisms that underlie these changes and how cells handle this at the molecular level account for how changes in the genome can result in the different genetic diseases, including cancer diseases and transposable elements.

Contents

- 1 Molecular Biology of RNA (Types, structure), Synthesis and Transcription of RNA,
- 2 Post transcriptional modifications (RNA processing, Editing, export etc),
- 3 Molecular Biology of DNA (Types, structure),
- 4 Synthesis and Transcription of DNA,
- 5 Post transcriptional modifications (DNA processing, Editing, export etc),
- 6 Causes of DNA damages, genetic changes and explain the different mechanisms that underlie these changes
- 7 Regulation of gene expression (Transcription factors, Gene activation silencing etc),
- 8 Gene regulation at all levels both in prokaryotes and eukaryotes
- 9 Chemistry and biology of nucleic acid structure
- 10 Molecular Biology of Proteins,
- 11 Type, structure, Synthesis, translation of Protein
- 12 Post-translational modifications (Glycosylation, Phosphorylation, methylation, etc),
- 13 Applications of molecular biology in Agriculture,
- 14 Medicine and physiology.

Recommended Text

- 1 Singh. R. (2009). *Advances in Molecular Biology*: ALP Books.
- 2 Lodish, Berk, H., Zipursky, A., Matsudaira, S.L., Baltimore, P., Darnell, D., & James, E. (2007). *Molecular Cell Biology*. New York, America: W. H. Freeman & Co.

Suggested Readings

- 1 Strachan, T., Read, A. (2010). *Human Molecular Genetics* (8th ed.). Garland Science.
- 2 Latest Articles from *Nature Reviews Molecular Biology*

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BIOT-7114

Bioinformatics

3(3+0)

This course provides a comprehensive introduction on application of computational tools to the analysis of genome and their gene products, Amino acids and their properties, Protein secondary and tertiary structure prediction, classification and super folds, more specifically, course introduces on prediction of protein structure from sequencing data. Bioinformatics is the science of storing, extracting, organizing, analyzing, interpreting and using information. The approaches to the discipline of bioinformatics incorporate expertise from the biological sciences, computer science and mathematics. The major in bioinformatics is designed for students interested in molecular biology and genetics, information technologies and computer science. Bio informaticists are involved in the analysis of the human genome, identification of targets for drug discovery, the study of structural and functional relationships, and molecular evolution. At the end of this course, students will be able to use existing software effectively to extract information from large databases and to use this information in computer modeling.

Contents:

- 1 Approach to biological Phenomena from conceptual viewpoint of Physical sciences and Molecular to organismic level of biological hierarchical structure,
- 2 Application of computations tools to the Analysis of genome and their gene products,
- 3 Amino acids and their properties,
- 4 Protein secondary and tertiary structure prediction classification and super folds,
- 5 A case study proteases-function and mechanism, Simple sequence analysis, use of hydropathy plots,
- 6 Introduction to sequence databases (ExPASy tools, Comparing sequences against sequence databases),
- 7 Predicting protein coding regions,
- 8 Prediction of protein structure from sequencing data, Genome sequencing projects,
- 9 Genome sequencing projects,
- 10 Bioinformatics and genome analysis,

Recommended Text

- 1 Ramsden, J. (2009). *Bioinformatics: An Introduction*. Springer
- 2 Edwards, D., Stajich, J., Hansen, D. (2009). *Bioinformatics: Tools and Applications*. Springer.

Suggested Readings

- 1 Pain, R. (2000). *Mechanism of protein folding*. Oxford University Press.
- 2 Baldi, P., & Brunak, S. (2001). *Bioinformatics: the machine learning approach*. MIT press.
- 3 Kanehisa, M. (2000). *Post-genome informatics*. OUP Oxford.
- 4 Baxevanis, A. S., Quellet, B. F. F. (2001). *Bioinformatics: a practical guide to the analysis of genes and proteins*. Wiley Interscience. A John Wiley & Sons.

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BIOT-7115

Virology

3(3+0)

The course will give an overview of medically important virus families, their replication strategies and mechanisms for development of viral infectious diseases. Topics will include taxonomy, replication strategies, pathogenicity and transmission of viruses and, additionally, diagnosis, prevention and treatment of viral diseases. Common human viral infections will be the focus of the course, and emphasis will be put on virus-host interactions as a key to understanding the diversity of viruses and viral diseases. This course provides comprehensive introduction on General approaches to laboratory diagnosis of viral diseases, Laboratory management and biosafety, Collection, transportation and processing of specimen, methods for the diagnosis of Herpes viruses Adenoviruses, Rota viruses, virus associated with rash disease. More specifically, this course introduces DNA amplification by PCR and DNA based detection systems, Interpretation of lab investigation. At the end of this course, students will be able to Compare, and contrast methods used for laboratory diagnosis of viral infections.

Contents:

- 1 History and introduction to general approaches to laboratory diagnosis of viral diseases,
- 2 Taxonomy, replication strategies, pathogenicity and transmission of viruses,
- 3 Diagnosis, prevention and treatment of viral diseases,
- 4 Multifactorial diseases,
- 5 Laboratory management and biosafety,
- 6 Collection, transportation and processing of specimen,
- 7 Methods for diagnosis of Herpes viruses,
- 8 Adenoviruses, Rota viruses,
- 9 Methods for diagnosis of Virus associated with rash disease,
- 10 Hepatitis viruses,
- 11 Enteroviruses,
- 12 Retro viruses, Pox viruses,
- 13 Orthomyxoviruses and Arboviruses,
- 14 Detection systems,
- 15 DNA amplification by PCR,
- 16 DNA based detection systems,
- 17 Interpretation of lab investigation,

Recommended Text

- 1 Kudesia, G., Wreghitt, T. (2009). *Clinical and Diagnostic Virology*. Cambridge University Press.
- 2 Etal, D. M. K. (2001). *Virology*. Macmillan Press.

Suggested Readings

- 1 Lamb, R., Malcom, A., Martin, E. D. (2001). *Fields Virology*. Lippincott, Williams & Wilkins.
- 2 Cann, A. J. (2000). *Virus Culture: A Practical Approach*. Oxford University Press.

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BIOT-7116

Analytical & Mechanistic Enzymology

3(3+0)

The course focuses on enzymes, nature, structure and function, the theories of enzyme kinetics, the mechanisms of enzyme catalysis, and the mechanisms of enzyme regulation in the cell. Chemical reactions within the cell rarely occur without the presence of a catalyst, known as an enzyme. The focus of this course is enzyme kinetics, the mechanisms of enzyme catalysis, and enzymatic regulation. The course starts with a review of the basic enzymatic concepts. Then, it moves to enzyme kinetics of single substrate reactions, enzyme inhibition and multi-substrate enzyme systems. The course continues with mechanisms of enzyme catalysis, active site studies, and the description of specific well-characterized enzymes. Because many enzymes play key regulatory roles in metabolism, the course concludes with mechanisms of enzyme regulation. At the end of, this course introduces fermentative production of industrial enzymes, Analytical applications of enzymes, Enzymes as biosensors as well as Clinical and therapeutic applications of enzymes.

Contents:

- 1 Enzymes, nature, structure and function,
- 2 Biological role of enzymes,
- 3 Their sources and biosynthesis,
- 4 enzyme turnover,
- 5 Multi-enzyme complexes
- 6 Mechanisms of enzyme reaction (Reversible changes, Irreversible changes),
- 7 Regulatory enzymes and the control of metabolic pathways,
- 8 Feedback inhibition, allosteric enzymes,
- 9 Industrial enzymes (types their sources, uses and applications),
- 10 Fermentative production of industrial enzymes,
- 11 Methods of immobilization and kinetics,
- 12 Properties of immobilized enzymes,
- 13 Uses of free and immobilized enzymes in industry,
- 14 Analytical applications of enzymes: Enzymes as biosensors.
- 15 Clinical and therapeutic applications of enzymes.

Recommended Text

- 1 Kyte, J. (2007). *Structure-in protein chemistry*. Garland Science.
- 2 Sheehan, D. (2000). *Physical Biochemistry: principles and applications*. UK: Wiley and Sons Ltd.

Suggested Readings

- 1 Articles Published in Nature Review Cell & Molecular Biology
- 2 kaKraj, A., Silberring, J. (2008). *Proteomics: introduction to methods and applications*. John Wiley & Sons.

BIOT-7117

Protein Chemistry & Enzymology

3(3+0)

Advanced course on protein structure and function, with special emphasis on research methodologies in protein chemistry and protein engineering. The course starts with a detailed overview of protein biosynthesis in eukaryotic cells (transcription + translation) as well as protein trafficking and post-translational modifications. Then the main core of the course involves protein chemistry methodologies, enzyme mechanisms, protein engineering, and the use of enzymes in biotransformations. This course provides comprehensive introduction on Basic structure of amino acids, biological function of amino acid variety, protein denaturation, protein folding, posttranslational modifications of proteins, purification and characterization of proteins. More specifically, this course introduces enzyme classification and EC code, Inactivation of enzymes, haemoglobin and myoglobin: cooperatively. At the end of this course, to provide general knowledge on protein structure and function as well as the experimental techniques in protein chemistry and protein engineering and also to develop the ability of to solve specific problems related to proteins and enzyme functions.

Contents:

- 1 Basic structure of amino acids,
- 2 Biological function of amino acid variety,
- 3 Protein structure (Primary structure, Secondary structure, determination secondary structure, Tertiary structure, Quaternary structure),
- 4 Protein denaturation, Protein folding,
- 5 Posttranslational modifications of proteins,
- 6 Purification and characterization of proteins,
- 7 The nature of catalysis,
- 8 Biocatalysts,
- 9 Enzyme classification and EC code,
- 10 Enzyme kinetics, the Henri-Michaelis-Menten (HMM) equation,
- 11 Competitive inhibition, Uncompetitive inhibition,
- 12 Non-competitive inhibition, Partially non-competitive inhibition,
- 13 Inactivation of enzymes,
- 14 Hemoglobin and myoglobin: cooperativity,

Recommended Text

- 1 Lundblad, R. L. (2006). *The evolution from protein chemistry to proteomics: basic science to clinical application*. CRC/Taylor & Francis.
- 2 Sheehan, D. (2000). *Physical Biochemistry: principles and applications*. UK: Wiley and Sons Ltd.

Suggested Readings

- 1 Articles Published in *Nature Review Cell & Molecular Biology*

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BIOT-7118

Insect Molecular Biology and Viruses

3(3+0)

The substantial costs of insect-associated viruses, ranging from honeybee decline to human, animal and plant disease, have driven investment in molecular research toward mitigation. Interest in insect viruses extends beyond these negative impacts however with biotechnological insect virus-based tools used to produce recombinant proteins, for gene therapy, vaccine production, and virus-induced gene silencing. This course provides comprehensive introduction on Insects: model for molecular biology, Classification of insects using molecular biological technique/ DNA barcoding, Insects as a vector of plants and animal diseases, Defense mechanisms of insects and its molecular biology, Classification of insect viruses etc. More specifically, this course introduces Biological control using insect viruses, Modern Insect control strategies. Use of insects and viruses to study gene structure of baculoviral and construction of expression vectors and related viruses will be discussed. At the end of this course, students will be able to techniques for DNA barcoding and can be techniques to developed recombinant vectors.

Contents:

- 1 Insects as model for molecular biology,
- 2 Classification of insects using molecular biological technique/ DNA barcoding,
- 3 Insects as a vector of plants and animal disease,
- 4 Defense mechanisms of insects and its molecular biology,
- 5 Classifications of insect viruses, Insect parasites and polydnviruses,
- 6 Use of insects and viruses to study Gene structure of baculovirus and construction of expression vectors,
- 7 To study functional genomics Gene silencing,
- 8 Biological control using insect viruses,
- 9 Modern Insect control strategies,

Recommended Text

- 1 Crampton, J. M., Beard, C. B., & Louis, C. (1997). *The molecular biology of insect disease vectors: a methods manual*. Chapman & Hall Ltd.
- 2 Gilbert, L. I. (2012). *Insect molecular biology and biochemistry*. Academic Press.

Suggested Readings

- 1 Schoonhoven, L. M., Van Loon, J. J., & Dicke, M. (2005). *Insect-plant biology* (2nd ed.). Oxford University Press.
- 2 Jarvis, D. L. (1997). *Baculovirus expression vectors*. In *The baculoviruses*. US: Springer.
- 3 Hall, J. C. (2003). *Genetics and molecular biology of rhythms in Drosophila and other insects*. *Advances in genetics*, 48, 1-280. Elsevier Publisher.

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BIOT-7119

Biostatistics & Laboratory Mathematics

3(3+0)

The discipline of biostatistics applies statistical theory and methodology to the biological sciences. Based in the mathematical sciences, biostatistics is concerned with developing an empirical basis for understanding biological mechanisms and for medical and health policy decisions that profoundly affect our lives. This course provides comprehensive introduction on Data collection, organization of data, Types of measurement: categorical, ordinal and quantitative, Types of studies: surveys, comparative studies, Frequency distributions, Comparison of mean, median and mode, Variance and standard deviation etc. More specifically, this course introduces Scientific notation and metric preferences, Calculations related to: Preparation of solutions, mixtures and media, Bacterial cell growth, Quantitation of nucleic acids, Protein measurements. At the end of this course, students will be able to design and analyzing studies to determine if new drugs and medical devices are safe and effective as well as designing and analyzing data from agriculture experiments to increase productivity and yield.

Contents:

- 1 Data collection and Organization of data
- 2 Variance and standard deviation
- 3 Probability concepts, Confidence intervals, Statistical inference
- 4 Types of measurement: Ordinal and Quantitative
- 5 Types of studies: Surveys, Comparative studies, Frequency distributions
- 6 Scientific notation and metric preferences
- 7 Calculations related to: Preparation of solutions, mixtures and media, Bacterial cell growth etc.
- 8 Hypothesis testing, Correlation and regression,
- 9 ANOVA, Analysis of microarray data
- 10 Linkage analysis in disease gene mapping, Risk factor calculation in genetic diseases
- 11 Use of selected software's for statistical data analysis
- 12 **Laboratory Mathematics:** Scientific notation and metric preferences,
- 13 Calculations related to: Preparation of solutions,
- 14 mixtures and media, Bacterial cell growth,
- 15 Quantitation of nucleic acids, Protein measurements, Centrifugation

Recommended Text

- 1 Stephenson, F. H. (2003). *Calculations in molecular biology and biotechnology – A guide to mathematics in the laboratory*. Academic Press.
- 2 Chap T. Le (2003). *Introductory Biostatistic*. John Wiley & Sons, Inc.

Suggested Readings

- 1 Cann, A.J. (2002). *Maths from Scratch for Biologist*. Wiley.
- 2 Dowdy, S., Wearden, S., & Chilko, D. (2011). *Statistics for research* (Vol. 512). John Wiley & Sons.

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BIOT-7120

Bioprocess Technology

3(3+0)

This course provides comprehensive introduction on Growth Kinetics: Growth in batch and continuous cultures; factors affecting the growth rates; biomass production and yields. Continuous cultures, chemostat theory, critical dilution rate, productivity, applications of continuous cultures etc. This course will provide students with an up-to-date knowledge of upstream and downstream processing technology. Spanning the production of biomolecules of relevance to both the pharmaceutical and industrial biotechnology sectors, and with a specific emphasis on mammalian and microbial cell biosystems, a key goal is to convey the integrated nature of modern bioprocess development. The emphasis will be on relating how market requirements influence the development and cost-effective optimization of biotechnology processes, stressing the multidisciplinary nature of this sector. Students who complete this course module will be equipped with a knowledge and understanding of mainstream bioprocess design heuristics so that they may engage productively within multidisciplinary process development teams.

Contents:

- 1 Fermentation medium, inoculum, dissolved oxygen tension Organization of data,
- 2 Growth Kinetics: Growth in batch and continuous cultures,
- 3 Factors affecting the growth rates,
- 4 Biomass production and yields,
- 5 Continuous cultures: Growth in batch and continuous cultures,
- 6 Chemostat theory, critical dilution rate, productivity,
- 7 Applications of continuous cultures,
- 8 Transport phenomena (Mass, Heat),
- 9 fluidized bioreactor, membrane bioreactor (hollow fiber & rotating membranes),
- 10 Scale-up theory. Oxygen transfer and shear effects in bioreactors,
- 11 Bioreactors: Stirred-tank bioreactor, Air-lift bioreactor,
- 12 Down-Stream Processing,
- 13 Economic aspects of the Bioprocesses,

Recommended Text

- 1 Subramanian, G. (2012). *Biopharmaceutical production technology*, 2 volume set (Vol. 2). John Wiley & Sons.
- 2 El-Mansi, Demain, B., & Allman, A. R. (2006). *Fermentation Microbiology and Biotechnology* (2nd ed.). CRC Press.

Suggested Readings

- 1 Hutkins, R. W. (2006). *Microbiology and Technology of Fermented Foods*. Blackwell Publishers.
- 2 Heinzle, E., Biver, A. P., & Cooney, C. L. (2006). *Development of Sustainable Bioprocesses: Modeling and Assessment*. John Wiley & sons.

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BIOT-7121

Biophysics

3(3+0)

Biophysics is the field that applies the theories and methods of physics to understand how biological systems work. Biophysics has been critical to understanding the mechanics of how the molecules of life are made, how different parts of a cell move and function, and how complex systems in our bodies, the brain, circulation, immune system, and others work. Biophysics is a vibrant scientific field where scientists from many fields including math, chemistry, physics, engineering, pharmacology, and materials sciences, use their skills to explore and develop new tools for understanding how biology all life works. This course provides comprehensive introduction on Molecular orbitals: the concepts, chemical binding; bond lengths, bond order, bond energies, spectroscopy, crystallography: importance of weak chemical interactions in a cell. Energy relations in cell kinetics parameters of the reaction in a cell. Theories of reaction rate etc. More specifically, this course introduces, physical structure and biological properties of bio membrane, (monolayer, multilayers) and nucleic acid.

Contents:

- 1 Molecular orbitals: The concepts,
- 2 Chemical binding; bond lengths, bond order, bond energies,
- 3 Spectroscopy,
- 4 Crystallography: Importance of weak chemical interactions in a cell,
- 5 Energy relations in cell kinetics parameters of the reaction in a cell,
- 6 Selected properties of macromolecules: Molecular weight, osmotic pressure,
- 7 Light scattering, diffusion,
- 8 Viscosity, surface tension,
- 9 Electrophoresis,
- 10 X-ray diffraction,
- 11 Theories of reaction rate. Fast chemical reactions,
- 12 Metal-ions in biological system,
- 13 Chain reaction, photochemical reactions,
- 14 Physical structure and biological properties of bio membrane, (monolayer, multilayers) and nucleic acid

Recommended Text

1. Ratne, B. D., Hoffman, A. S., Schoen, F. J., & Lemons, J. E. (1996). *Biomaterials Science: An Introduction to Materials in Medicine* (3rd ed.). Academic Press.

Suggested Readings

- 1 Pattabhi, V., Gautham, N. (2002). *Biophysics*, Alpha Science International Science.

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BIOT-7122

Biopharming in Plants: Principles and Techniques

3(3+0)

Biopharming involves the insertion into plant cells of foreign genes coding for medically important proteins, such as therapeutic proteins, monoclonal antibodies, and vaccines. One approach to biopharming is to insert the gene for a desired protein into the DNA of chloroplasts, membrane-bound organelles containing chlorophyll. Chloroplasts have their own circular set of genes that is distinct from the main genome in the cell nucleus. In the leaves of higher plants, each cell has as many as 100 chloroplasts, each of which contains up to 100 copies of the genome. Thus, by inserting a transgene into the chloroplast genome, one can greatly amplify the gene and produce large amounts of the corresponding protein. This course provides introduction on Chloroplast biogenesis and genome organization, Evolutionary symbiosis theory, Anatomical and physiological features of chloroplast etc. More specifically, this course introduces Transplastomic technology to improve plant traits, and large-scale production of therapeutic proteins, antibodies and edible vaccines.

Contents:

- 1 Chloroplast biogenesis and genome organization
- 2 Evolutionary symbiosis theory, Anatomical and physiological features of chloroplast
- 3 Chloroplast genome organization and its interaction with nuclear genome
- 4 Photosystem I and II assembly
- 5 Regulation of gene expression in planta, control of chloroplast gene expression
- 6 Transcriptional regulation: The reporter genes, Sequence elements in promote and its interaction with transcriptional factors, Compartmentalization in gene expression, Genome Engineering and Recombination systems
- 7 Advantages of chloroplast transformation, Construction of vectors, Homologous recombination,
- 8 Compartmentalization in gene expression, Transplastomic technology to improve plant traits,
- 9 Develop resistances against biotic and abiotic stress and to improve vigor development of male sterile and restorer lines,
- 10 Chloroplast as bioreactor, Metabolic engineering, Industrial products production e.g. Industrial enzymes and biodegradable plastic and other industrial products,
- 11 Large scale production of therapeutic proteins, Antibodies and edible vaccines.

Recommended Text

- 1 Jeon, K. W. (2005). *International Review of Cytology: A survey of cell biology*. Vol. 244. California, USA: Elsevier academic press
- 2 Pierce, B. A. (2003). *Genetics: A conceptual approach*. New York, USA: W. H. Freeman and company.

Suggested Readings

- 1 Marja, K., Caldentey O., & Barz, W. H. (2002). *Plant Biotechnology and Transgenic Plants Edited by Culinary and Hospitality Industry Publications Services*. Texas, USA:
- 2 Hartwell, L. (2000). *Genetics: from genes to genomes*. North America, USA: McGraw Hill.

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BIOT-7123

Protein Engineering

3(3+0)

Proteins are the workhorses of the cell. With different combinations of the 20 common amino acids, proteins have evolved with a staggering array of functions and capabilities including: the specific binding of ligands, catalysis of complex chemical reactions, functionality in extreme environments, transportation of valuable molecules, and the exhibition of diverse structural and material properties. Protein engineering holds the potential to transform the metabolic drug landscape through the development of smart, stimulus-responsive drug systems. Protein therapeutics are a rapidly expanding segment of Food and Drug Administration approved drugs that will improve clinical outcomes over the long run. This course provides a comprehensive introduction to protein engineering, Mutagenesis strategies and approaches, Engineering with unnatural amino acids analogues. Structure-function relationship and protein engineering. Various procedures/techniques used in protein engineering. More specifically, this course introduces Elucidation of protein engineering approaches: rational and random with examples such as protein engineering of the cytochrome P450 monooxygenase, aldolases and other industrial enzymes.

Contents:

- 1 Introduction to protein engineering
- 2 Mutagenesis strategies and approaches
- 3 Engineering with unnatural amino acids analogues.
- 4 Structure-function relationship and protein engineering
- 5 procedures/techniques used in protein engineering
- 6 Protein production in *Escherichia coli*, *Saccharomyces cerevisiae*
- 7 *Pichia pastoris* and cell free protein synthesis
- 8 Use of protein engineering in protein purification
- 9 Protein targeting/sorting, Protein Folding Protein folding mechanisms,
- 10 Folding and stabilization of recombinant proteins
- 11 Elucidation of protein engineering approaches: Rational and random with examples such as protein engineering of the cytochrome P450 monooxygenase, aldolases and other industrial enzymes.

Recommended Text

- 1 Nelson, D. L., Cox, M. M., & Lehninger, A. L. (2008). *Principles of biochemistry* (p. 245). New York, America: Freeman.
- 2 Robertson, D., & Noel, J. P. (2004). *Protein engineering*. Elsevier.

Suggested Readings

- 1 Drew, D., Newstead, S., Sonoda, Y., Kim, H., Von Heijne, G., & Iwata, S. (2008). *GFP-based optimization scheme for the overexpression and purification of eukaryotic membrane proteins in Saccharomyces cerevisiae*. *Nature protocols*, 3(5), 784-798.
- 2 Alberghina, L. (2003). *Protein Engineering in Industrial Biotechnology*. Harvard academic publishers.

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BIOT-7124

Bioremediation and biodegradation

3(3+0)

This course will present the basic principles of chemical and biological degradation of toxic chemicals and familiarize the students with the application of the remedial technologies in natural environments. Biodegradation is a microorganism-mediated decomposition of organic matter. Bioremediation is a technique applied by people to clean up organic matter and other substances by using microbes with the biodegradation process. The key difference between biodegradation and bioremediation is that biodegradation is a natural process that occurs in the environment while bioremediation is an engineered technique applied by humans to clean the environment. This course provides comprehensive introduction on poorly degradable organic compounds, character of synthetic compounds regarding Natural attenuation etc. More specifically, this introduces use of genetically engineered microorganisms (GEMs) for biodegradation/bioremediation of contaminants.

Contents:

- 1 Poorly degradable organic compounds
- 2 Character of synthetic compounds regarding Natural attenuation; persistence and recalcitrance towards biodegradation (xenobiotic)
- 3 The importance of microorganisms in metabolizing natural and synthetic organic compounds / xenobiotics), Isolation and identification of degradative bacteria,
- 4 Ecology of degradative bacteria, physiology and growth of degradative bacteria,
- 5 Studies of catabolic pathways: Metabolites, Enzymes and Genes involved,
- 6 Enhanced transformation of recalcitrant organic pollutants: nitro-aromatic compounds, Dyes, Chlorinated organics etc,
- 7 Molecular mechanisms of genetic adaptation to xenobiotic compounds: Gene transfer, Point mutations, Recombination and transposition,
- 8 Molecular tools to study genetic adaptation to such compounds in natural environments,
- 9 Potentials and limitations to evolve and use metabolic pathways, use of genetically engineered microorganisms (GEMs) for biodegradation/bioremediation of contaminants,
- 10 Mineralization of environmental pollutants via complete catabolic pathways,
- 11 Environmental factors influencing biodegradation and bioremediation processes

Recommended Text

- 1 Caister, E. D. (2007). *Microbial biodegradation; genomics and molecular biology*. Academic Press.
- 2 Vallero, D. A. (2004). *Environmental contaminants: assessment and control*. Elsevier Academic press.

Suggested Readings

- 1 Wackett, L. P., & Hershberger, C. D. (2001). *Biocatalysis and Biodegradation: Microbial Transformation of Organic Compounds*. Blackwell Publishing.

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BIOT-7125

Research Methods in Biotechnology

3(3+0)

As rapid advances in biotechnology occur, there is a need for a pedagogical tool to aid current students and laboratory professionals in biotechnological methods; Methods in Biotechnology is an invaluable resource for those students and professionals. Methods in Biotechnology engages the reader by implementing an active learning approach, provided advanced study questions, as well as pre- and post-lab questions for each lab protocol. A comprehensive review of current techniques in biotechnology research and applications, the development and use of some of the techniques are placed in historical context. Discussion covers techniques used in genomics, transcriptomics, and proteomics and the applications of these techniques. This course provides comprehensive detail on Central Dogma, DNA, RNA, Protein, Sterilization techniques, DNA and RNA isolation, purification and quantitation, Agarose gel electrophoresis, Pulse field electrophoresis, Two-dimensional gel electrophoresis, types of PCR and CRISPER/Cas, Talens etc., More specifically this course introduces Gene expression analysis techniques, and DNA finger printing.

Contents:

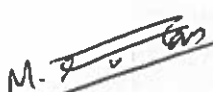
- 1 What is Molecular Biology, Central Dogma, DNA, RNA, Protein,
- 2 Stock solutions, Sterilization techniques,
- 3 DNA and RNA isolation, purification and quantitation,
- 4 Agarose gel electrophoresis, Pulse field electrophoresis, Two-dimensional gel electrophoresis, Polyacrylamide gel electrophoresis,
- 5 Fundamentals of PCR, Regular and nested PCR, Primer designing, RT-PCR, Multiplex PCR, Real time PCR: principle and different chemistries, Uses of PCR,
- 6 Probe labeling, Hybridization and Signal detection methods, Principles of RNAi and siRNA techniques, CRISPER/Cas, Talens etc.,
- 7 Design and detection of short RNA, DNA sequencing, Fundamentals of microarray and Microarray technologies,
- 8 Gene expression analysis techniques, Genomic libraries, Methods of cDNA library development/screening,
- 9 Southern, northern and western hybridization, ELISA, Molecular Markers, DNA finger printing,

Recommended Text

- 1 Brown, T. A. (2016). *Gene cloning and DNA analysis: an introduction*. (7th ed.). Oxford. Balckwell Sciences Ltd.

Suggested Readings

1. Stewart Jr, C. N. (2016). *Plant biotechnology and genetics: principles, techniques, and applications*. John Wiley & Sons.

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BIOT-7126

Immunology

3(3+0)

Immunology, the scientific study of the body's resistance to invasion by other organisms. In a medical sense, immunology deals with the body's system of defense against disease-causing microorganisms and with disorders in that system's functioning. Understanding immunology has allowed the prevention of infections by the use of vaccines, has helped the medical world develop the ability to transfuse blood making modern surgery possible, has allowed transplantation to become a reality, and has led to rational treatments for allergies and autoimmune diseases, and what are likely the first real cures for cancer. This course provides comprehensive introduction on Overview of the immune response: Introduction to infection and immunity, innate immune system, the adaptive immune system, cells of immune system, molecules of the immune system; antigens: Introduction to the antigen receptors, the B cell - receptor antibody, the T cell - receptor TcR etc. More specifically, this course introduces Immunity to Infection: The immediate defense systems, early and late immune responses.

Contents:

- 1 Overview of the immune response, Introduction to infection and immunity,
- 2 Innate immune system and adaptive immune system,
- 3 Cells of immune system,
- 4 Molecules of the immune system,
- 5 Antigens: Introduction to the antigen receptors, the B cell - receptor antibody, the T cell - receptor TcR,
- 6 Introduction to antigen processing and presentation,
- 7 Antibodies: Antibody structure and classes, Receptors for antibody and antibody,
- 8 Diversity, class switching and affinity maturation, B cell development,
- 9 Introduction to MHC molecules: MHC class I, MHC class II,
- 10 Receptors for antibody and antibody,
- 11 Diversity, class switching and affinity maturation, B cell development,
- 12 Cytokines.
- 13 Complement, Tolerance,
- 14 Interferon,
- 15 Immunity to Infection,
- 16 Vaccination,
- 17 Autoimmunity,
- 18 Tumor immunology,

Recommended Text

- 1 Paul, W. E. (2008). *Fundamental Immunology*. Philadelphia: USA: Lippincot Williams and Wilkins.
- 2 Haeney, M. (2006). *Essentials of Clinical Immunology*. Helen Chapel: Blackwell Publishers.

Suggested Readings

- 1 Walt, F. (2006). *Advances in Immunology*. USA: Academic Press.

BIOT-7127

Agriculture Biotechnology

3(3+0)

Agricultural Biotechnology is the use of new scientific techniques based on our understanding of DNA to improve crops and livestock that are not possible with conventional breeding alone. This can be achieved in part by modern molecular plant breeding techniques such as marker-assisted selection (MAS). A course designed to incorporate basic elements of science with a variety of technology applications that are used to modify living organisms. Areas of emphasis include basic science laboratory procedures, implementation of the scientific method of discovery, plant science. Agricultural Biotechnology covers the study of the concepts, methods and a range of tools employed to understand and manipulate the genetic make-up of organisms to increase the production or processing of agricultural products. This course provides comprehensive introduction on Plant breeding; Cell and tissue culture; Plant transformation; methods of transformation in plants including competence, electroporation, microinjection, Particle gun and *Agrobacterium*; methods for assessing transformation etc. More specifically, this course introduces Biosafety guidelines.

Contents:

- 1 Introduction to Plant breeding,
- 2 Cell and tissue culture,
- 3 Methods of transformation in plants including competence, electroporation,
- 4 Microinjection, Particle gun and *Agrobacterium*,
- 5 Methods for assessing transformation transgenic crops for herbicide,
- 6 Methods for assessing transformation transgenic crops pest,
- 7 Methods for assessing transformation transgenic crops fungal,
- 8 Methods for assessing transformation transgenic crops bacterial,
- 9 Methods for assessing transformation transgenic crops viral resistance,
- 10 Transient and stable expression systems,
- 11 Viruses as expression vectors,
- 12 Genetically modified organisms,
- 13 Biosafety guidelines,

Recommended Text

- 1 Hartman, H. T., Kester, D. E., Davies, F. T., Jr., & Genève, R. L. (2002). *Plant propagation principles and practices* (7th ed.). USA: Prentice Hall, Englewood Cliffs.
- 2 Fahn, A. (2001). *Plant Anatomy* (4th ed.). Butterworth, Heinemann Ltd.

Suggested Readings

- 1 Fosket, D. E. (1998). *Plant Growth and Development: A Molecular Approach*. San Diego: Academic press.

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BIOT-7132

Microbial enzyme Technology

3(3+0)

Enzyme technology broadly involves production, isolation, purification and use of enzymes (in soluble or immobilized form) for the ultimate benefit of humankind. In addition, recombinant DNA technology and protein engineering involved in the production of more efficient and useful enzymes are also a part of enzyme technology. Microbial enzymes find applications in many fields, including chemical, fermentation, agricultural, pharmaceuticals, and food production. Choosing the appropriate expression systems is important for the enzyme production rate, and bacteria, filamentous fungi, and yeasts have been used to express recombinant enzymes. This course provides comprehensive detail on Introduction to microbial enzymes, historical highlights of enzyme technology, selection of microbe for enzyme production, production of microbial enzymes by various methods. More specifically this course introduces strategies to improve properties of microbial enzymes, market value of enzymes, industrial uses of enzymes.

Contents:

- 1 Introduction to microbial enzymes,
- 2 Historical highlights of enzyme technology,
- 3 Classifications of enzymes
- 4 Common functions of enzymes
- 5 Recombinant DNA technology,
- 6 Protein engineering involved in the production of more efficient and useful enzymes
- 7 Selection of microbe for enzyme production,
- 8 Production of microbial enzymes by various methods,
- 9 Recovery of enzymes,
- 10 Purification of enzymes by various methods,
- 11 Reutilization of enzyme by mobilization,
- 12 Immobilization
- 13 Immobilization methods,
- 14 Characterization of enzymes,
- 15 Strategies to improve properties of microbial enzymes,
- 16 Market value of enzymes,
- 17 Industrial uses of enzymes,

Recommended Text

- 1 Shukla, Pratyosh, Pletschke, Brett I. (2013). *Advances in enzyme biotechnology*. Springer.
- 2 Pandey, A., Webb, C., Fernandes, M., Larroche, C. (2006). *Enzyme Technology*. Springer.

Suggested Readings

- 1 Kelly, J. W., Baldwin, T. O. (1991). *Application of Enzyme biotechnology*. Springer.
- 2 Fogarty W. M., Kelly C. T. (1990). *Microbial enzymes and Biotechnology* (2nd ed.). Springer.

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Fermentation is a metabolic process that produces chemical changes in organic substrates through the action of enzymes. In biochemistry, it is narrowly defined as the extraction of energy from carbohydrates in the absence of oxygen. Fermentation technology is the use of organisms to produce food, pharmaceuticals and alcoholic beverages on a large-scale industrial basis. The basic principle involved in the industrial fermentation technology is that organisms are grown under suitable conditions, by providing raw materials meeting all the necessary requirements such as carbon, nitrogen, salts, trace elements and vitamins. This course emphasizes the application of biological and engineering principles to problems involving microbial, mammalian, and biological/biochemical systems. This course provides comprehensive introduction to Fermentations, Microbial types, fermentation processes: Solid state fermentation, sub-merged fermentation, Batch fermentation and continuous fermentation. Control and regulation of microbial growth in fermentation etc. More specifically, This course introduces Industrial application of fermentation.

Contents:

- 1 Introduction to Fermentations and Microbial types,
- 2 Solid state fermentation sub-merged fermentation,
- 3 Batch fermentation and continuous fermentation,
- 4 Control and regulation of microbial growth in fermentation,
- 5 Mechanism of mass transfer,
- 6 Mass transfer across gas/liquid and solid/liquid phase boundaries,
- 7 Fermenter design: Fermenter configuration, Aeration, agitation and process control,
- 8 Batch fermentation and continuous fermentation,
- 9 Control and regulation of microbial growth in fermentation,
- 10 Measurement of Temperature, dissolved oxygen,
- 11 Aeration, agitation and process control, Ammonia and other variables,
- 12 Data analysis, Industrial application of fermentation,

Recommended Text

- 1 El-Mansi, Demain B., & Allman, A. R. (2006). *Fermentation Microbiology and Biotechnology* (2nd ed.). CRC Press.
- 2 Najafpour, G. (2006). *Biochemical Engineering and Biotechnology*. Elsevier Science.

Suggested Readings

- 1 Allen, L., Bennett, J. W., Geoffrey, M. G. (2001). *Advances in Applied Microbiology*. Academic Press.
- 2 Demain, A. L., & Solomon, N. A. (2000). *Manual of Industrial Microbiology and Biotechnology*. USA: AMS press.

BIOT-7136

Applied Biostatistics

3(3+0)

This course provides comprehensive introduction on Basic concepts: Stages of research, types of data and methods of data collection. Introduction to basic statistical concepts, including, study designs, the goals of research design with examples of the two basic types of studies: observational and experimental etc. More specifically, this course introduces Basic concepts: Stages of research, types of data and methods of data collection. Descriptive and inferential statistics through SPSS. The goals of research design with examples of the two basic types of studies. At the end of this course, students will be able to design and analysing studies to determine if new drugs and medical devices are safe and effective as well as designing and analyzing data from agriculture experiments to increase productivity and yield. Use of statistical techniques will enable students to analyse and presenting their research work in more appropriate and well-mannered and to understand their study results in a better way.

Contents:

- 1 Introduction to basic statistical concepts,
- 2 Study designs,
- 3 The goals of research design with examples of the two basic types of studies,
- 4 Types of variables with examples,
- 5 Importance of control group and randomization in a research study,
- 6 Descriptive and inferential statistics (How to enter data into statistical software (SPSS),
- 7 The goals of research design with examples of the two basic types of studies,
- 8 Checking normality in data,
- 9 Understanding the overall concept of transforming data,
- 10 Describe the overall shape, location, and spread of the distribution from a histogram,
- 11 Identify potential outliers or points that deviate from the overall pattern,
- 12 Displaying the relationship between two variables by a scatter plot and interpret,
- 13 Strength of association, identifying the difference between a response and explanatory variable,
- 14 Descriptive statistics, measures of central tendency and dispersion,
- 15 Data arrangement, Presentation in the form of table,
- 16 Selection of appropriate charts for presentation of qualitative and quantitative variables/data/results,
- 17 Inferential statistics, Selecting a proper statistical test,

Recommended Text

- 1 Bluman, A. G. (2018). *Elementary Statistics A Step By Step Approach* (10th ed.). Mac Graw Hill.

Suggested Readings

- 1 Daniel, W. W. (2009). *Biostatistics: A Foundation for Analysis in the Health Sciences* (9th ed.). John Wiley & Sons, Inc.
- 2 Baldi, B. (2008). *The Practice of Statistics in the Life Sciences*. W. H. Freeman publisher.

BIOT-7137

Advanced Analytical Techniques

3(3+0)

This course provides comprehensive introduction on UV Spectroscopy/Separations, Quantitative Infrared Spectroscopy, Flame Atomic Absorption Spectroscopy, Direct Potentiometry, Spectro fluorimetry: Determination of Fluid Volumes by Dye Dilution Techniques, TLC: Drug Monitoring Techniques, Column Techniques etc. The objective of this course is to provide an introductory survey of modern analytical instrumentation and techniques in the areas of spectroscopy, chromatography, and electroanalysis. Emphasis will be placed on the physical phenomena governing the operation of each instrument and the general components of each instrument. After completing the course, students should be versed in different chemical methods of analysis and able to identify a suitable instrument for a specific application in the laboratory. The laboratory is designed to provide hands-on experience using chemical instrumentation through a combination of experiments and demonstrations. Students should be able to describe the advantages and disadvantages of different instruments in terms of usability, sensitivity, cost, and other parameters with an emphasis on the complementarity of different techniques.

Contents:

- 1 Spectroscopy: UV Spectroscopy/Separations, Quantitative Infrared Spectroscopy
- 2 Flame Atomic Absorption Spectroscopy
- 3 Direct Potentiometry, Spectro fluorimetry: Determination of Fluid Volume
- 4 4. Principles of IR-spectrometry and its use for compound identification
- 5 5. Column Techniques: Separation of Transition Metal Cations
- 6 6. Gas Chromatography, High Performance Liquid Chromatography
- 7 Types of variables-with examples,
- 8 Importance of control group and randomization in a research study
- 9 Balances, Bioreactors, Electroporation Instrument, Isoelectric Focusing Apparatus
- 10 Centrifuges. DNA Sequencers,
- 11 Lyophilizer, Microarray Technology
- 12 Microtomy. Nuclear Magnetic Resonance Instrument, principles and application
- 13 Southern Blotting, Northern Blotting and Western Blotting

Recommended Text

- 1 Rouessac, F., & Rouessac, A. (2000). *Chemical Analysis: Modern instrumentation. methods and technique.* John Wiley & Sons.
- 2 Skoog, D. A., Holler, F. J., & Nieman, T. A. (1997). *Principles of Instrumental Analysis* (5th ed.). Brooks Cole.

Suggested Readings

- 1 de Loos-Vollebregt, M. T. C.. (2004).. *Spectro-metrische analyse-technieken*. 2004. Heron reeks - Bohn Stafleu Van Loghum.

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