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

Annexure-A

REVISED SCHEME OF STUDIES
&
CURRICULUM
BS BIOTECHNOLOGY
(Semester / Term System)
(2019)

BioTechnology

DEPARTMENT OF BIOTECHNOLOGY
UNIVERSITY OF SARGODHA
SARGODHA

INCHARGE
Department of Biotechnology
University of Sargodha

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Mission Statement of BS Biotechnology Program

The mission of the BS Biotechnology Program is to build concepts of biotechnology through high quality teaching, practices and research to develop leading biotechnologists for industry, academia and research organizations.

Program's Objectives:

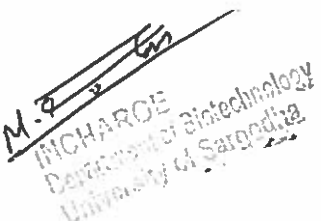
Objectives of BS Biotechnology program

The objectives of this program are:

1. To inculcate basic knowledge and advancements in biotechnology.
2. To develop practical, research and communication skills.
3. To equip students with knowledge and skills for better planning and management of Biotechnological resources, environment, health, medicine, agriculture and entrepreneurship in the country.
4. To provide students a professional learning experience.
5. To prepare students for effective role in industry, academia and research organizations.
6. To develop the analytical approach for solving professional problems.
7. To pursue higher studies in any well-reputed international university.

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

1. Comprehensive biotechnology curriculum comparable to national and international standards.
2. Peer review of curriculum and its continuous updating.
3. Conducive environment for teaching and discussion.
4. Emphasis is on imparting skills that can enable students to collect information, data and its proactive utilization to learn and solve the biological problems.
5. Expand infrastructure for study, research/Practical understanding through experiments and research.
6. Seek collaboration with industry and research organizations.
7. Character building of students through encouragement in various curricular and co-curricular activities in the light of Islamic values and principles.



STANDARDIZED FORMAT
FOR BS (4 YEAR) IN BIOTECHNOLOGY

STRUCTURE

Sr. No.	Categories	No. of courses	Credit Hours
1.	Compulsory courses	9	24
2.	General courses	8	27
3.	Discipline-specific Foundation courses	13	39
4.	Major courses	14	38
5.	Electives within the major	3	9
	Total	47	**137**

- Duration — 4 years
- Semesters — 8
- Semester duration — 16-18 weeks
- Total numbers of credit hours — 137
- Course load per semester — 15-18 Credit hours
- Number of courses per semester — 5-6
- Eligibility — At least 45% in F.Sc. (Pre-medical or equivalent Science discipline)

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LAYOUT FOR BS (4-YEAR) IN BIOTECHNOLOGY

Compulsory Courses (C)		General Courses (G)	
9 courses		8 courses	
24 Credit hours		27 Credit hours	
Subject	**Cr. hr.**	**Subject**	**Cr. hr.**
1. English I:Grammer	3(3+0)	1. Physical Chemistry	4(3+1)
2. English II:Language Comprehension &Presentation skills	3(3+0)	2. Inorganic Chemistry	4(3+1)
		3. Organic Chemistry	4(3+1)
		4. Ecology, Biodiversity and Evolution - I	3(3+0)
3. English III:Academic Writing	3(3+0)	5. Ecology, Biodiversity and Evolution - II	3(2+1)
		6. Animal Physiology	
4. Mathematics – I: Pre Calculas	3(3+0)	7. Two courses of social sciences: *	3(2+1)
5. Bio-Mathematics		a) Social Sciences I	3(3+0)
6. Introduction to Information and Communication Technologies	3(3+0) 3(2+1)	b) Social Sciences II	3(3+0)
7. Pakistan Studies			
8. Islamic Studies	2(2+0)		
9. Biosafety and Bioethics	2(2+0)		
	2(2+0)		
	24		27

* These courses will be offered from the lists of Social Sciences courses given below:

Lists of Social Sciences courses

1. Principles of Marketing 3(3+0)
2. Mass Communication 3(3+0)
3. Economics 3(3+0)
4. Introduction to Sociology 3(3+0)
5. Environmental Policy 3(3+0)
6. Introduction to Psychology 3(3+0)
7. Fine Arts 3(3+0)
8. Introduction to Political Science 3(3+0)
9. International Affairs 3(3+0)
10. Public Administration 3(3+0)

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Discipline-specific Foundation Courses (F)		Major Courses (M)		Elective Courses within the major	
13 courses		14 courses		3 courses	
39 Credit hours		38 Credit hours		9 Credit hours	
Subject	**Cr. hr.**	**Subject**	**Cr. hr.**	**Subject**	**Cr. hr.**
1. Cell Biology	3(2+1)	1. Bioinformatics	3(1+2)	Elective - I	3(3+0)
2. Microbiology	3(2+1)	2. Principles of Biochemical Engineering	3(2+1)	Elective - II	3(3+0)
3. Classical Genetics	3(3+0)			Elective - III	3(3+0)
4. Analytical Chemistry and instrumentation	3(2+1)	3. Agriculture Biotechnology	3(2+1)		
		4. Genomics and Proteomics	3(3+0)		
5. Molecular Biology	3(3+0)	5. Research Methodology and skills enhancement	3(3+0)	(These courses will be selected from the list of Elective courses)	
6. Introduction to Biotechnology	3(3+0)	6. Environmental Biotechnology	3(2+1)		
7. Biochemistry-I	3(2+1)	7. Health Biotechnology	3(3+0)		
8. Biochemistry-II	3(2+1)	8. Recombinant DNA Technology	3(2+1)		
9. Methods in Molecular Biology	3(2+1)	9. Industrial Biotechnology	3(2+1)		
10. Immunology	3(3+0)	10. Food Biotechnology	3(3+0)		
11. Probability and Biostatistics	3(3+0)	11. Seminar I	1(1+0)		
		12. Seminar II	1(1+0)		
12. Microbial Biotechnology	3(2+1)	13. Research Project / Internship OR Special Paper - I *	3(3+0)		
13. Genetic Resources and Conservation	3(3+0)	14. Research Project / Internship OR Special Paper - II *	3(3+0)		
	39		38		9

* Students securing CGPA of 3.0/4.0 after sixth semester will be given option of Research project while students with CGPA of less than 3.0/4.0 after sixth semester or those from having CGPA of 3.0/4.0 but not opting for Research project will have to select Two (02) Special papers from given lists in lieu of Reseach.

SCHEME OF STUDIES FOR 4-YEAR BACHELOR OF SCIENCE (BS) DEGREE IN BIOTECHNOLOGY

Year-1: Semester – I

Course Code	Subject	Credit Hours
URCE-5191	Grammer (C)	3(3+0)
URCP-5196	Pakistan Studies (C)	2(2+0)
MATH-5101	Mathematics – I: Pre Calculus	3(3+0)
CHEM-5101	Physical Chemistry (G)	4(3+1)
BIOT-5101	Introduction to Biotechnology (F)	3(3+0)
BIOT-5102	Biochemistry-I (F)	3(2+1)
	Total	**18**

Year 1: Semester – II

Course Code	Subject	Credit Hours
URCE-5192	Language Comprehension and Presentation Skills (C)	3(3+0)
URCI-5195	Islamic Studies / Ethics (C)	2(2+0)
MATH-6151	Bio Mathematics	3(3+0)
CHEM-5102	Inorganic Chemistry (G)	4(3+1)
BIOT-5103	Cell Biology (F)	3(2+1)
BIOT-5104	Biochemistry-II (F)	3(2+1)
	Total	**18**

Year 2: Semester – III

Course Code	Subject	Credit Hours
URCE-5193	Academic Writing (C)	3(3+0)
ICTC-5201	Introduction to information and communication Technologies (C)	3(2+1)
	Any subject from list of Social Sciences (G)	3(3+0)
BIOT-5105	Classical Genetics (F)	3(3+0)
BIOT-5106	Ecology, Biodiversity and Evolution - I (G)	3(3+0)
BIOT-5107	Microbiology (F)	3(2+1)
	Total	**18**

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Year 2: Semester – IV

Course Code	Subject	Credit Hours
BIOT-5108	Animal Physiology (G)	3(2+1)
BIOT-5109	Ecology, Biodiversity and Evolution - II (G)	3(2+1)
	Any subject from list of Social Sciences (G)	3(3+0)
BIOT-5110	Molecular Biology (F)	3(3+0)
CHEM-5103	Organic Chemistry (G)	4(3+1)
	Total	**16**

Year 3: Semester – V

Course Code	Subject	Credit Hours
BIOT-6111	Analytical Chemistry and Instrumentation(F)	3(2+1)
BIOT-6112	Bioinformatics (M)	3(1+2)
BIOT-6113	Methods in Molecular Biology (F)	3(2+1)
BIOT-6114	Immunology (F)	3(3+0)
BIOT-6115	Probability and Biostatistics (F)	3(3+0)
BIOT-6116	Principles of Biochemical Engineering (M)	3(2+1)
	Total	**18**

Year 3: Semester – VI

Course Code	Subject	Credit Hours
BIOT-6117	Recombinant DNA Technology (M)	3(2+1)
BIOT-6118	Microbial Biotechnology (F)	3(2+1)
BIOT-6119	Genetic Resources and Conservation (F)	3(3+0)
BIOT-6120	Agriculture Biotechnology (M)	3(2+1)
BIOT-6121	Genomics and Proteomics (M)	3(3+0)
BIOT-6122	Biosafety and Bioethics (C)	2(2+0)
	Total	**17**

Year 4: Semester – VII

Course Code	Subject	Credit Hours
BIOT-6123	Research Methodology and Skills Enhancement (M)	3(3+0)
BIOT-6124	Environmental Biotechnology (M)	3(2+1)
BIOT-6125	Health Biotechnology (M)	3(3+0)
BIOT-xx	Seminar I	1(1+0)
BIOT-61xx	Elective – I	3(3+0)
BIOT-61xx	Research Project / Internship OR Special Paper - I (M)	3(3+0)
	Total	**16**

Year 4: Semester – VIII

Course Code	Subject	Credit Hours
BIOT-6126	Industrial Biotechnology (M)	3(2+1)
BIOT-6127	Food Biotechnology (M)	3(3+0)
BIOT-61xx	Elective II	3(3+0)
BIOT-61xx	Elective - III	3(3+0)
BIOT-61xx	Research Project / Internship OR Special Paper - II (M)	3(3+0)
BIOT-61xx	Seminar II (M)	1(1+0)
	Total	**16**

* Research project will be offered on the basis of merit to students securing CGPA of 3.0/4.0 after completion of 6th semester and facilities available in the field of specialization. Remaining students shall have to opt two special papers, one from each list (I and II) in lieu of Research.

TOTAL CREDIT HOURS: **137 in 08 semesters (4 Years)**

LIST OF ELECTIVE/SPECIAL PAPER COURSES

		Cr. hr.
1. BIOT-6128	Cell and Tissue Culture	3(2+1)
2. BIOT-6129	Marine Biotechnology	3(3+0)
3. BIOT-6130	Molecular Biology of Insects and Insect Viruses	3(3+0)
4. BIOT-6131	Pharmaceutical Biotechnology	3(3+0)
5. BIOT-6132	Animal Biotechnology	3(3+0)
6. BIOT-6133	Fungal Biotechnology	3(3+0)
7. BIOT-6134	Water and Waste water Treatment	3(2+1)
8. BIOT-6135	Plant Biotechnology	3(2+1)
9. BIOT-6136	Biofertilizers And Biopesticides	3(3+0)
10. BIOT-6137	Nano-biotechnology	3(3+0)
11. BIOT-6138	Molecular Diagnostics	3(2+1)
12. BIOT-6139	Biosensors	3(3+0)
13. BIOT-6140	Virology	3(3+0)
14. BIOT-6141	Radiobiology	3(3+0)
15. BIOT-6142	Biofuels and Biorefineries	3(3+0)
16. BIOT-6143	Fermentation Biotechnology	3(2+1)
17. BIOT-6144	Enzymology	3(2+1)
18. BIOT-6145	Forensic DNA Typing	3(3+0)
19. BIOT-6146	Biotechnology for Pest Management	3(3+0)
20. BIOT-6147	Seminar I	1(1+0)
21. BIOT-6148	Seminar II	1(1+0)

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

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SEMESTER - I

URCE-5191 **English – I: Grammer** **3(3+0)**

The course introduces the students to the underlying rules to acquire and use language in academic context. The course aims at developing grammatical competence of the learners to use grammatical structures in context in order to make the experience of learning English more meaningful enabling the students to meet their real life communication needs. The objectives of the course are to, reinforce the basics of grammar, understand the basic meaningful units of language, and introduce the functional aspects of grammatical categories and to comprehend language use by practically working on the grammatical aspects of language in academic settings. After studying the course, students would be able to use the language efficiently in academic and real life situations and integrate the basic language skills in speaking and writing. The students would be able to work in a competitive environment at higher education level to cater with the long term learners' needs.

Contents

1. Parts of Speech
    a. Types and uses of nouns
    b. Types and uses of pronouns
    c. Types and uses of verbs
        i. Finite verbs (action, modal, helping, transitive n intransitive)
        ii. Non-finite verbs (infinitives, participles, gerunds)
    d. Types and uses of adverbs
    e. Types and uses of adjectives
    f. Types and uses of prepositions
    g. Types and uses of conjunctions
    h. Use of article
2. Common grammatical errors and their corrections
3. Sentence structure
4. Types and functions of sentences
5. Types and functions of phrases
6. Types and functions of clauses
7. Synthesis of sentences
8. Conditional sentences
9. Voice and change of voice
10. Direct and indirect narration and Punctuation

Pre-requisite: Nil

Recommended Text

1. Eastwood, J. (1999). *A basic English grammar* (3rd ed). UK: Oxford University Press.
2. Eastwood. J. (2002). *Oxford Guide to English Grammar*. UK: Oxford University Press

Suggested Readings

1. Richards, V. T. & Eston, E. E. (2007). *Analysing the Grammar of English* (3rd ed)., Washington, D. C, USA; Georgetown University Press.
2. Azar, B. S. (2016). *Understanding and using English Grammar* (5th ed). Canada: Pearson.
3. Swan, M. (2016). *Practical English Usage (4th ed)*. Oxford University Press.
4. Thomson, A. J., & Martinet, A. V. (1986). *A Practical English Grammar*. OUP.
5. Biber, D., Johansson, S., Leech, G., Conrad, S., Finegan, E., & Quirk, R. (1999). *Longman Grammar of Spoken and Written English* (Vol. 2). MIT Press.
6. Hunston, S., & Francis, G. (2000). *Pattern Grammar: A corpus-driven approach to the lexical grammar of English* (Vol. 4). Amsterdam: John Benjamins.

URCP-5196 **Pakistan Studies** **2(2+0)**

The course is designed to acquaint the students of BS Programs with the rationale of the creation of Pakistan. The students would be apprised of the emergence, growth and development of Muslim nationalism in South Asia and the struggle for freedom, which eventually led to the establishment of Pakistan. While highlighting the main objectives of national life, the course explains further the socio-economic, political and cultural aspects of Pakistan's endeavours to develop and progress in the contemporary world. For this purpose, the foreign policy objectives and Pakistan's foreign relations with neighbouring and other countries are also included. This curriculum has been developed to help students analyse the socio-political problems of Pakistan while highlighting various phases of its history before and after the partition and to develop a vision in them to become knowledgeable citizens of their homeland.

Contents

1. Introduction to the Course
2. Geography of Pakistan: Geo-Strategic Importance of Pakistan
3. Freedom Movement and Pakistan Movement
4. Nationalism in South Asia and Two Nations Theory
5. Ideology of Pakistan
6. Initial Problems of Pakistan
7. Political and Constitutional Developments in Pakistan
8. Economy of Pakistan
9. Society and Culture of Pakistan
10. Foreign Policy Objectives of Pakistan
11. Current and Contemporary Issues of Pakistan
12. Human Rights: Issues of Human Rights in Pakistan

Pre-Requisite: Nil

Recommended Text

1. Kazimi, M. R. (2009). *A Concise History of Pakistan*. Karachi: Oxford University Press.
2. Sheikh, Javed Ahmed. (2004).*Pakistan's Political, Economic and Diplomatic Dynamics*. Lahore: Kitabistan Paper Products.

Suggested Readings

1. Hayat, Sikandar. (2016). *Aspects of Pakistan Movement*. Islamabad: National Institute of Historical and Cultural Research.
2. Kazimi, M. R. (2009). *A Concise History of Pakistan*. Karachi: Oxford University Press.
3. Sheikh, Javed Ahmed. (2004). *Pakistan's Political, Economic and Diplomatic Dynamics*. Lahore: Kitabistan Paper Products.
4. Talbot, Ian. (1998). *Pakistan: A Modern History*. London: Hurst and Company.

MATH-5101 **Mathematics – I: Precalculus** **3(3+0)**

The goal of this course is to prepare students for first-year Calculus. Helping students gain proficiency in their understanding and ability to utilize real-valued functions, the primary tool in Calculus, accomplishes this goal. Students are presented a broad set of 'function tools', including a general understanding of function properties together with a 'library' of commonly used functions. It is intended that students become skilled at recognizing the different families of functions and the primary properties that set each apart, are able to apply the general function properties to each type of function, and are able to use the special set of algebraic skills associated with each. Students are also expected to become adept in utilizing and interpreting the results from graphing calculators, as an important investigative tool.

Contents

1. Preliminaries: Real-number system
2. complex numbers
3. Introduction to sets
4. Set operations
5. Functions, types of functions.
6. Matrices: Introduction to matrices
7. Types of matrices
8. Matrix inverse, Determinants
9. System of linear equations
10. Cramer's rule
11. Quadratic Equations: Solution of quadratic equations
12. Qualitative analysis of roots of a quadratic equations
13. Equations reducible to quadratic equations
14. Cube roots of unity
15. Relation between roots and coefficients of quadratic equations.
16. Sequences and Series: Arithmetic progression
17. Geometric progression
18. Harmonic progression
19. Binomial Theorem: Introduction to mathematical induction
20. Binomial theorem with rational and irrational indices.
21. Trigonometry: Fundamentals of trigonometry, trigonometric identities.

Recommended Texts

1. Dolciani, M. P., Wooton, W., Beckenback, E.F., Sharron, S. (1978). *Algebra 2 and trigonometry*. Boston: Houghton & Mifflin.
2. Nauman, K. (2019). *Basic mathematics-I: algebra and trigonometry* (2nd ed.). Lahore: Al-Hassan Pub.

Recommended Readings

1. Kaufmann, J. E. (1994). *College algebra and trigonometry* (3th ed.). Boston: PWS-Kent Pub. Co.
2. Swokowski, E. W. (1993). *Fundamentals of algebra and trigonometry* (8th ed.). Boston: PWS-Kent Pub. Co.

CHEM-5101 **Physical Chemistry** **4(3+1)**

The subject physical chemistry covers basic scientific knowledge and its application in the field of biotechnology. Students will acquire knowledge to enable themselves to understand the fundamental principles and laws of thermodynamics and chemical equilibria and to investigate the physical properties of ideal/non-ideal binary solutions. Students will also be able to study the rates of reactions and perform related calculations.

Contents

1. Elementary Mathematics:
2. Physical States of Mater: Gases Liquids, Solids
3. Atomic Structure:
4. Chemical Thermodynamics
5. Chemical Equilibrium
6. Solutions
7. Chemical Kinetics
8. Electrochemistry

Physical Chemistry Lab (Cr. 01)

1. Determination of surface tension and Parachor value by stalagmometer.
2. Determination of percent composition of liquid solutions from surface tension measurement.
3. Determination of viscosity and Rhechor value of liquids from viscosity measurement.
4. Determination of percent composition of liquid solutions viscometrically.
5. Determination of refractive index and molar refractivity by refractometer.
6. Determination of percent composition of liquid solutions by refractive index measurements.
7. Determination of heat of solution by solubility method.
8. Determination of heat of neutralization of an acid with a base.
9. A kinetic study of acid hydrolysis of ethyl acetate.
10. Kinetic study of saponification of ethyl acetate.
11. Determination of molecular weight of a compound by elevation in boiling point. (Ebullioscopic method).
12. Determination of molecular weight of a compound by lowering of freezing point (The Cryoscopic methods).
13. Determination of equilibrium constant of KI – I2 KI3.
14. Conductometric titration of strong acid and strong base.

Recommended Text

1. Akhtar, M.N. & Ghulam Nabi, (2006) "Text Book of Physical Chemistry" Ilmi Kitab Khawna, Lahore.
2. Bhatti, H.N. and K. Hussain, (2005) "Principles of Physical Chemistry"; Carvan Book House, Lahore.
3. Das, R.C. and B. Behera, (2003) "Experimental Physical Chemistry". Tata McGraw Hill, Delhi.
4. Shaheen, M. A., Jilani (2016) Manual of Practical Chemistry Vol. I. Jilani Notes, Sargodha.

Suggested Readings

1. Chaudhry, G.R. (2016) Text Book of Physical Chemistry. 2nd Edition. New Kitab Markaz. Aminpur Bazar, Faisalabad, Pakistan, .
Maron S. H. and Jerome, B. (1995) "Fundamentals of Physical Chemistry" Macruthan Publishing co. Inc. New York.

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BIOT-5101 Introduction To Biotechnology 3(3+0)

To acquaint students with the basic concepts and significance of biotechnology as it stands today. The subject covers basic scientific knowledge and its application in biotechnology. The course also deals with the major elements of the global significance of biotechnology, the categories of biotechnology processes and products, and in the context of "traditional" vs "modern" biotechnology processes. The key developments in the history of biotechnology and the enabling technologies - fermentation, downstream processing; recombinant methods, analysis and automation, genomics, proteomics, metabolomics will be discussed to provide tools and basic knowledge in order to understand biotechnology. The emerging areas of biotechnology, for example Agricultural Biotechnology. Protein, Forensic Biotechnology. Bioremediation. Aquatic Biotechnology, Regulatory agencies and issues that impact Biotechnology industry will be discussed as well. In addition to that, a provocative and issues in Biotechnology. genetically modified food. genetic testing. embryos for research/human cloning, ethical/legality/social questions & dilemmas will be incorporated.

Contents

1. Biotechnology- definition and history
2. Foundations of biotechnology and interdisciplinary pursuit
3. Branches and/or applications of biotechnology in medicine and diagnostics
4. Applications of biotechnology in Agriculture (crop yield, resistance against biotic and abiotic factors, food, livestock, fisheries, etc.)
5. Production of biotechnological products, transgenics, microbial etc.
6. Application of biotechnology in environment
7. Applications of biotechnology in industry etc.
8. Safety in biotechnology
9. Public perception of biotechnology
10. Biotechnology and ethics
11. Use of modern biotechnology
12. Biotechnology and the developing world

Recommended Text

1. Thieman, W.J. & Palladino, M.A. (2014). *Introduction to biotechnology.* Edinburgh Gate UK : Pearson Education Limited.
2. Daugherty. E. (2012). *Biotechnology: Science for the New Millennium*, 1st Edition, Revised, USA: Paradigm Publication,.

Suggested Readings

1. Smith. J.E. (2012). *Biotechnology*. 5th Edition. UK: Cambridge University Press.
2. Nicholl, T.S.D. (2012). *An Introduction to Genetic Engineering*, 2nd Edition. UK: Cambridge University Press .
3. Ratlegde, C. and Kristiansen. B. (2006). *Basic Biotechnology.* 2nd Edition. UK: Cambridge University Press.
4. Thomas. J.A. and Fuchs. R.L. (2002). *Biotechnology and Safety Assessment*, 3rd Edition, UK: Academic Press.

BIOT-5102 **BIOCHEMISTRY – I** **3(2+1)**

The subject aims to provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis, and to enable the students to acquire a specialised knowledge and understanding of selected aspects by means of series of lectures and lab experiments. Through this course the students would be able to acquire fundamental knowledge of the molecules of life (also knowns as biomolecules) such as nucleic acids, carbohydrates, proteins and fatty acids, as well as their function in the context of a living cell as they provide the body with energy. The students will also become familiar with the biochemical functions of water and buffer inside the cell The students will also be able to recognize the different classes of enzymes and coenzymes and their role in the biological processes in the body . The students will also get knowledge about hormones in terms of their structure, function and role in regulating the metabolism.

Contents

1. Introduction to biochemistry
2. Water, pH, buffers, and biochemical composition of cells
3. Carbohydrates - structure and classification
4. Proteins - overview with emphasis on their composition and structure
5. Classification and function of proteins
6. Lipids - structure, classification and biological significance
7. Enzymes - properties, nomenclature, classification
8. Factors affecting enzyme activity including inhibitors and potentiators,
9. Basic kinetics, derivation of K_m and V_{max}; coenzymes and vitamins
10. Nucleic acids - structure and function.

Practicals

Standard laboratory operating and safety procedures, Preparation of laboratory solutions, buffers and pH determination; qualitative and quantitative tests for carbohydrates, proteins and lipids; enzyme assays and the effect of pH, temperature and other factors on enzyme activity.

Recommended Text

1. Nelson, D.L. and Cox, M. M., (2012). *Lehninger principles of biochemistry*, 6th Edition. New York: W.H. Freeman.
2. Hames, D. and Hooper, N., (2006). *Instant notes biochemistry*, 3rd Edition, USA: Taylor & Francis Group.

Suggested Readings

1. Berg, J., Tymoczko, J. and Stryer, L., (2006) . (Eds). *Biochemistry*; 6th Edition, New York: W.H. Freeman and Company.
2. Voet, D. and Voet, T.G., (2008). *Biochemistry*, 4th Edition, New York: John Wiley & Sons.
3. Murray, *et al.*, (2012). *Harper's ilustrated Biochemistry*, 29th Edition. New York: McGraw-Hill Medical Publishing.
4. Ferrier, D.R., (2013). *Lippincott's Biochemistry*, 6thEdition. USA: Lippincott Williams & Wilkin Publishing Company.

SEMESTER - II

URCE-5192 English –II: Language Comprehension And Presentation Skills 3(3+0)

The course aims at developing linguistic competence by focusing on basic language skills in integration to make the use of language in context. It also aims at developing students' skills in reading and reading comprehension of written texts in various contexts. The course also provides assistance in developing students' vocabulary building skills as well as their critical thinking skills. The contents of the course are designed on the basis of these language skills: listening skills, pronunciation skills, comprehension skills and presentation skills. The course provides practice in accurate pronunciation, stress and intonation patterns and critical listening skills for different contexts. The students require a grasp of English language to comprehend texts as organic whole, to interact with reasonable ease in structured situations, and to comprehend and construct academic discourse. The course objectives are to enhance students' language skill management capacity, to comprehend text(s) in context. to respond to language in context. and to write structured response(s).

Listening Skills

1. Recognizing different phonemes
2. Recognizing syllables
3. Listening to isolated sentences
4. Listening to small speech extracts
5. Managing listening (attending. understanding, remembering, evaluating, and responding)
6. Barriers to listening and their remedies
7. Expressing opinions (debating current events)
8. Oral synthesis of thoughts and ideas
9.

Pronunciation Skills

1. Pronouncing English phonemes
2. Recognizing phonemic symbols
3. Pronouncing words correctly
4. Understanding and practicing stress patterns
5. Practicing intonation patterns in simple sentences
6. Conflict resolution through panel discussion
7.

Comprehension Skills

1. Reading strategies
2. Critical Reading (SQ3R Method)
3. Summarizing
4. Sequencing
5. Inferencing
6. Comparing and contrasting
7. Drawing conclusions
8. Self-questioning
9. Relating background knowledge

10. Distinguishing between fact and opinion
11. Finding the main idea, important facts, and supporting details
12. Comprehending text organization patterns
13. Investigating implied ideas in a text
14. Purpose and tone of the text

Presentation Skills

1. Features of good presentations
2. Different types of presentations
3. Different patterns of introducing a presentation
4. Organizing arguments in a presentation
5. Tactics of maintaining interest of the audience
6. Concluding a presentation
7. Giving suggestions and recommendations while ending of a presentation
8. Dealing with the questions of audience
9. Listening to recorded presentations

Pre-Requisite: Nil

Recommended Text

1. Worthington, D. Fitch-Hauser, M. (2018). *Listening: Processes, Functions, and Competency* (2nd ed). Routledge.

2. Siddons, S. (2008). *The Complete Presentation Handbook*. Kogan Page Ltd

3. Mikulecky, B. S. & Jeffry, L.(2007). *Advanced Reading Power: extensive reading, vocabulary building, comprehension skills, reading faster*. Pearson

4. Hancock, M. (2012). *English Pronunciation in Use* (2nd ed). Cambridge

Suggested Readings

1. Mandel, S. (2000). *Effective Presentation Skills*. Thomson Learning
2. *Reading Comprehension Skills and Strategies*. (2002). The Edge
3. Dorothy, E.Z. & Rumisek, L.A. (2003). *College Writing: from Paragraph to Essay*. McMillan
4. Helgesen, M., Brown, S., & Brown, S. (1994). *Active listening: Building skills for understanding*. Cambridge University Press.
5. Opitz, M. F., & Zbaracki, M. D. (2004). *Listen hear!: 25 effective listening comprehension strategies*. Heinemann Educational Books.
6. Liang, L. A., & Galda, L. (2009). Responding and comprehending: Reading with delight and understanding. *The Reading Teacher*, *63*(4), 330-333.
7. Hughes, S., & Harwood, N. (2010). Materials to develop the speaking skill. *English language teaching materials: Theory and practice*, 207-224.

URCI-5195 **Islamic Studies** **2(2+0)**

Islamic Studies engages in the study of Islam as a textual tradition inscribed in the fundamental sources of Islam: Qur'an and Hadith, history and particular cultural contexts. The area seeks to provide an introduction to and a specialization in Islam through a large variety of expressions (literary, poetic, social, and political) and through a variety of methods (literary criticism, hermeneutics, history, sociology, and anthropology). It offers opportunities to get fully introductory foundational bases of Islam in fields that include Qur'anic studies, Hadith and Seerah of Prophet Muhammad (PBUH), Islamic philosophy, and Islamic law, culture and theology through the textual study of Qur'an and Sunnah. Islamic Studies is the academic study of Islam and Islamic culture. It majorly comprises of the importance of life and that after death. It is one of the best systems of education, which makes an ethical groomed person with the qualities which he/she should have as a human being. The basic sources of the Islamic Studies are the Holy Qur'an and Sunnah or Hadith of the Holy Prophet Muhammad ﷺ. The learning of the Qur'an and Sunnah guides the Muslims to live peacefully

Contents

1. قرآن مجید کی مندرجہ ذیل آیات کا ترجمہ و تشریح کریں
   i. البقرہ :آیات284,285,286(ایمانیات)
   ii. آل عمران:آیات190,191(تفکرو تدبر)
   iii. المومنون:آیات1-11(صفات مومنین)
   iv. الفرقان:آیات 63-77(موضوع آداب معاشرت)
   v. الاحزاب :آیات 6,21,40,57,58(تخصصات نبوی)
   vi. الحجرات:آیات1-18(موضوع آداب نبوی ﷺ،معاشرتی احکام)
   vii. الحشر:آیات 19,20(فکر آخرت،عظمت قرآن)
   viii. الصف:آیات 1-4(تفکر وتدبر بشارت بعثت ختم المرسلین،دعوت اور اقامت دین)
2. منتخب احادیث کا ترجمہ و تشریح(۱۵ احادیث)
3. منتخب ابواب سیرۃ النبی ﷺ اور اسلامی تہذیب و معاشرت

Recommended Text (1-2 only)

1. نعمانی، شبلی، سید سلیمان ندوی، سیرۃ النبی ﷺ، لاہور:آر زیڈ پیکجز، ۱۴۰۸ھ
2. تعلیمات اسلام ڈاکٹر محمد شہباز منج

Suggested Readings (Maximum 3-4)

1. الجامع الصحیح، ابو عبداللہ محمد بن اسماعیل البخاری، بیروت : دارلکتب العربی، ۱۴۲۵ھ
2. الجامع الصحیح ، ابو الحسنین مسلم بن حجاج القشیری،بیروت: دارالکتاب العربی، ۲۰۰۴ء
3. نعمانی، شبلی، سید سلیمان ندوی، سیرۃ النبی ﷺ، لاہور:آر زیڈ پیکجز، ۱۴۰۸ھ
4. بیکل،محمد حسین، حیاتِ محمد ﷺ،مترجم :مولانا محمد وارث کامل ، لاہور:مکتبہ کاروان، ۱۹۷۱ء

MATH-6151 Bio-Mathematics 3(3+0)

Calculus is the mathematical study of continuous change. It has two major branches, differential calculus and integral calculus. Both branches make use of the fundamental notions of convergence of infinite sequences and infinite series to a well-defined limit. Modern calculus is considered to have been developed in 17th century .A course in calculus is a gateway to other, more advanced courses in mathematics devoted to the study of functions and limits, broadly called mathematical analysis. Calculus is used in every branch of the physical sciences, actuarial science, computer science, medicine, demography, and in other fields. It allows one to go from rates of change to the total change or vice versa, and many times in studying a problem we know one and are trying to find the other. This course aims to provide students with the essential concepts of biomathematics and how these can be employed for analyzing real data.

Contents

1. Real-number line
2. Functions and their graphs
3. Solution of equations involving absolute values
4. Inequalities
5. Limits and Continuity: Limit of a function
6. Left-hand and right-hand limits
7. Continuity
8. Continuous functions.
9. Derivatives and their Applications: Differentiable functions
10. Differentiation of polynomial
11. Rational and transcendental functions
12. Derivatives
13. Integration and Definite Integrals: Techniques of evaluating indefinite integrals
14. Integration by substitution
15. Integration by parts
16. Change of variables in indefinite integrals
17. Application and importance of calculus for biotechnology; the exponential growth curve and growth equation

Recommended Texts

1. Thomas, G. B. and Finney, A. R. (2005). *Calculus*. USA : Addison-Wesley, Reading.
2. Nauman, K. (2019). Basic-mathematics-I: algebra-and-trigonometry (2nd ed.). Lahore: Al-Hassan Pub.

Suggested Readings

1. Helfgott, M. and Moore, D. (2011). *Introductory calculus for the natural sciences*. USA: Create Space Independent Publishing Platform.
2. Neuhauser, C. (2010). *Calculus for biology and medicine*. Prentice Hall.
3. Anton, H. (2005). *Calculus: a new horizon*. John Wiley.
4. Kumar, A. (2011). Mathematics for Biologist (1st ed.). Alpha Science. International.

CHEM-5102 **Inorganic Chemistry** **4(3+1)**

Students will acquire knowledge about the key introductory concepts of chemical bonding, acid-base chemistry, and properties of p-block elements as well as using this knowledge for qualitative and quantitative analysis of inorganic compounds during laboratory work.

Contents

1. Periodic Table and Periodicity of Properties
2. Acid Base Equilibria
3. Chemical Bonding
4. Chemistry of p-Block Elements
5. Chemistry of d-Block Elements
6. Separation Techniques
7. Introduction to Analytical Techniques in Inorganic Chemistry
8. Chemical Industries

Inorganic Chemistry Lab (Cr. 01)

1. Qualitative Analysis; four radicals (cations and anions) for salt mixture.
2. Chromatographic separation of cations
3. Determination of total hardness of water using EDTA.
4. Estimation of manganese (II) using EDTA.
5. Estimation of copper (iodometrically).
6. Determination of thiosulphate ion (Iodometrically).
7. Determination of ferricyanide using KI solution.
8. Determination of chloride by Volhard"s and Mohr"s methods.
9. Estimation of chloride ions using adsorption (Fluorescein) indicator.
10. Estimation of bromide ions using adsorption (Eosin) indicator.
11. Estimation of percentage of ferrous ions in the Mohr"s salt using $KMnO_4$.
12. Percentage determination of ferric ions in ferric alum using $KMnO_4$ solution.
13. Determination of purity of commercial potassium oxalate using $KMnO_4$ solution.
14. Estimation of ferrous ions using $K_2Cr_2O_7$ solution

Recommended Text

1. Bhatti, H.N. and Nasir, B.A. (2000). Modern Inorganic Chemistry, 1st Edition. The Carvan Book House, Lahore.
2. Graham, H and Man, H. (2000). Chemistry in Context 5th Edition. Thomas Nelson Ltd. U.K..
3. Shaheen, M. A., Jilani (2016). Manual of Practical Chemistry Vol.II, Jilani Notes, Sargodha.

Suggested Readings

1. Iqbal, M.Z., (1998).Text Book of Inorganic Chemistry". Ilmi Kitab Khana, Revised Edition.
2. Chaudhry, G. R., (2001).Text Book of Inorganic Chemistry, 2nd Edition; New Kitab Markaz, Faisalabad, Pakistan.
3. Albert, C.F., Wilkinson G. and Gaus, P.L. (1995). Basic Inorganic Chemistry, 3rd Edition, John Wiley & Sons, Inc. NY.

BIOT-5103 **Cell Biology** **3(2+1)**

This course will introduce to foundation theories, concepts and practices in biology. Cell biology is study of the structure and function of prokaryotic and eukaryotic cells. In this course we will focus on Eukaryotic cells (Animals, Plants) 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 integration of cells into tissues. We will also cover important cellular processes such as cell cycle regulation as mitosis and meiosis, signal transduction, functions of different compartments and the overall structure/ultrastructure of cells. The isolation, structure, location, and functions of different cellular organelles will be discussed including Endoplasmic Reticulum, Golgi complex/Golgi apparatus, Lysosomes, Mitochondria, power house of cell, Microbiodies, Nucleus, as well as visualized by electron microscopy. The development of critical thinking processes and proficiency in scientific reading and writing will be emphasized throughout the course.

Contents

1. Introduction to cell theory including historical perspective
2. Overview of membrane structure and chemical constituents of the cell
3. Function, isolation and molecular organization of cellular organelles specifically the endoplasmic reticulum DNA replication in prokaryotes and eukaryotes
4. Lysosome, micro-bodies Post transcriptional processing (e.g., RNA splicing, alternative splicing, editing).
5. Mitochondrial ultra-structure and function
6. Composition and structure of membranes
7. recombination and transposable elements
8. Skin sensors of heat and cold, skin sensors of mechanical stimuli, sonar, smell, taste and vision in vertebrates
9. Membrane receptors and transport mechanisms
10. Structure and function of chromosomes: cell cycle
11. Nucleus, Mitosis and Meiosis
12. Cell movement - structure and function of cytoskeleton, centriole
13. Cilia and flagella

Recommended Text

1. Verma, P.S., (2005). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology.Multicolor Edition, India: Chand and Company Ltd.

2. Lodish, *et al.*, (2012). Molecular Cell Biology, 7th Edition. New York: W.H. Freeman.

Suggested Readings

1 Karp., (2002). *Cell and Molecular Biology*, 3rd Edition. New York: John Wiley & Sons.
2 Alberts, et al., (2009). *Essential Cell Biology*, 3rd Edition. New York: Garland Publishers.
3. Cooper, G.M. and Hausman, R.E., (2009). *The Cell: A Molecular Approach*, 5th Edition. USA: Sinauer Associates, Inc.

BIOT-5104 **Biochemistry – II** **3(2+1)**

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 and lab experiments. Special emphasis will be placed on, but not limited, to the biochemical basis of metabolism including the biosynthesis and breakdown of lipids, amino acids, nucleic acids and some important special products derived from amino acids. Through this course the students will also be able to integrate and evaluate biochemical and physiological concepts and mechanisms related to normal healthy states to diseases or pathologic states.

Contents

1. Introduction to metabolism and basic aspects of bioenergetics and biochemical thermodynamics (endergonic and exergonic reactions)
2. Phosphoryl group transfer and ATP production, Metabolism, oxidation-reduction
3. Carbohydrate metabolism and regulation (glycolysis, glycogenolysis; gluconeogenesis; pentose phosphate pathway). Citric acid cycle (reactions, energetics and control)
4. Electron transport chain, oxidative phosphorylation, shuttle mechanisms
5. Lipid metabolism (energy yield from fatty acid oxidation, ketone bodies, acyl glycerol, compound lipids, cholesterol)
6. Photosynthesis; Calvin Cycle
7. Metabolism of nitrogenous compounds (amino acid synthesis, catabolism, purine and pyrimidine synthesis), Nucleic acid metabolism and control
8. Urea cycle and Integration of metabolism

Practicals

Basic biochemical methods such as iodine test for polysaccharides, fermentation of sugars by Baker's yeast; isolation of amylose and amylopectin from starch; extraction of glycogen from liver; acid and enzymatic hydrolysis of glycogen; extraction and estimation of lipids from plant tissue/seed and lipid separation from different tissues; fractionation by thin layer chromatography (TLC).

Recommended Text

1. Nelson, D. L. and Cox, M. M., (2012). *Lehninger Principles of Biochemistry*, 6th Edition. New York: W.H. Freeman .
2. Hames, D. and Hooper, N., (2006). *Instant Notes on Biochemistry*, 3rd Edition, USA: Taylor & Francis Group.

Suggested Readings

1 Berg, J., Tymoczko, J. and Stryer, L., (2006). (Eds), *Biochemistry*. 6th Edition. New York: W.H. Freeman and Company.
2 Voet, D. and Voet, T.G., (2008). *Biochemistry*. 4th Edition. New York: John Wiley & Sons.

SEMESTER - III

URCE-5193 **English – Iii: Academic Writing** **3(3+0)**

Academic writing is a formal, structured and sophisticated writing tofulfill the requirements for a particular field of study. The course aims at providing understanding of writer's goal of writing (i.e. clear, organized and effective content)and to use that understanding and awareness for academic reading and writing. The objectives of the course are to make the students acquire and master the academic writing skills. The course would enable the students to develop argumentative writing techniques. The students would be able to the content logically to add specific details on the topics such as facts, examples and statistical or numerical values. The course will also provide insight to convey the knowledge and ideas in objective and persuasive manner. Furthermore, the course will also enhance the students' understanding of ethical considerations in writing academic assignments and topics including citation, plagiarism, formatting and referencing the sources as well as the technical aspects involved in referencing.

Contents:

1. Academic vocabulary
2. Quoting, summarizing and paraphrasing texts
3. Process of academic writing
4. Rhetoric: Persuasion and identification
5. Elements of Rhetoric: Text, author, audience, purposes, setting
6. Sentence structure: Accuracy, variation, appropriateness, and conciseness
7. Sentence Skills (choice of verbs, passive structures and nominalisations)
8. Appropriate use of active and passive voice
9. Types of writing
    a. Persuasive
    b. Argumentative
    c. Analytical
    d. Comparing and contrasting
    e. Explaining cause and effect
    f. Commentaries, and opinion pieces
    g. Personal Profiles
10. Paragraph and Essay Writing
    a. Organization and structure of paragraph and essay
    b. Logical reasoning
    c. Transitional devices (word, phrase and expressions)
    d. Development of ideas in writing
11. Letters
    a. Of Invitation
    b. Of Regrets
    c. Of Sales/persuasive letters
12. Official Writing
    a. Joining/leaving reports
    b. Notifications
    c. Meeting notices
    d. Minutes of meeting

13. Technical and Scientific Reports
    a. Styles of documentation (MLA and APA)
    b. In-text citations
    c. Plagiarism and strategies for avoiding it
14. Issues in scientific writing (plagiarism, authorship, ghostwriting, reproducible research)
    1. How to do a peer review; and how to communicate with the lay public

Pre-Requisite: Nil

Recommended Text

1. Brannan, B. (2003). *A Writer's workshop: Crafting paragraph, building essays*. New York, USA: McGraw Hill
2. Wong, L. (2002). *Paragraph essentials: A writing guide*. Boston: Houghton Mifflin

Suggested Readings

1. McCarthy, M., & O'Dell, F. (2016). *Academic vocabulary in use: Vocabulary reference and practice* (2nd ed). Cambridge: Cambridge University Press
2. Aristotle. (2007). *On Rhetoric: A theory of civic discourse* (2nd ed). New York: OUP
3. Bailey, S. (2014). *Academic Writing: A handbook for international students*. New York, USA: Routledge
4. Bovee, C.L. et.al (2002). *Business communication today*. India: Pearson Education
5. Burton, S.H. (2000). *Mastering practical writing*. London: Palgrave
6. Canagarajah, A.S. (2013). *Critical academic writing and multilingual students*. USA: University of Michigan Press
7. Johnson-Sheehan, R., & Charles, P. (2010). *Writing today*. New York: Pearson
8. Kennedy, X.J., Kennedy, M.D., & Holladay, S.A. (1999). *The Bedford guide for college writer*. Bedford: St. Martin's
9. Maimon, E.P., & Peritz, J.H. (2003). *A Writer's resource: A handbook for writing and research*. NY: McGraw Hill
10. Silvia, P.J. (2007). *How to write a lot: A practical guide to productive academic writing*. USA: American Psychological Association.
11. Swales. J. M., & Feak, C. B. (2004). *Academic writing for graduate students: Essential tasks and skills* (Vol. 1). Ann Arbor, MI: University of Michigan Press.

M. [illegible]

ICTC-5201 Introduction To Information & Communication Technologies 3(2+1)

The course introduces students to information and communication technologies and their current applications in their respective areas. Objectives include basic understanding of computer software, hardware, and associated technologies. They can make use of technology to get maximum benefit related to their study domain. Students can learn how the Information and Communications systems can improve their work ability and productivity. How Internet technologies, E-Commerce applications and Mobile Computing can influence the businesses and workplace. At the end of semester students will get basic understanding of Computer Systems, Storage Devices, Operating systems, E-commerce , Data Networks, Databases, and associated technologies. They will also learn Microsoft Office tools that includes Word, Power Point, Excel. They will also learn Open office being used on other operating systems and platforms. Specific software's related to specialization areas are also part of course.. Course will also cover Computer Ethics and related Social media norms and cyber laws.

Contents

1. Basic Definitions & Concepts
2. Hardware: Computer Systems & Components, Storage Devices. Number Systems
3. Software: Operating Systems, Programming and Application Software,
4. Introduction to Programming
5. Databases and Information Systems Networks
6. Data Communication
7. The Internet, Browsers and Search Engines
8. Email Collaborative Computing and Social Networking
9. E-Commerce
10. IT Security and other issues
11. Use of Microsoft Office tools (Word, Power Point, Excel) or other similar tools depending on the operating system.
12. Other IT tools/software specific to field of study of the students if any

Recommended Book

1. Vermaat, M.E., Sebok, S.L., Freund. S.M., Campbell, J.T., & Frydenberg, M. (2018). *Discovering Computers 2018: Digital technology, data and devices.* UK: Cengage

Suggested Readings

1. O'Leary, T.J., & O'Leary, L.I. (2017). *Computing Essentials 2017.* USA: McGraw Hill
2. Fuller, F., & Larson, B. (2015). Computers: Understanding technology, Introductory. USA: Paradigm Publishing

BIOT-5105 **Classical Genetics** **3(3+0)**

To acquaint students with classical aspects of genetics. An introduction to the principles of genetics, including topics from classical Mendelian concepts to the contemporary molecular biology of the gene. Upon successful completion of this course, students should be able to demonstrate the following competencies: (1) an understanding of the central theories and methodologies that define the field of genetics and its various sub disciplines (traditional, molecular, and population genetics) and the ability to use the vocabulary that embodies this knowledge; (2) an understanding that science is a continual process of investigation and interpretation and that scientific knowledge progresses via the support and rejection of competing hypotheses. collective decisions that are based on empirical evidence and logical interpretation using inductive and deductive reasoning; (3) the ability to develop a scientifically informed position on some of the bioethical and social issues related to the practice and application of genetics research.

Contents

1. Classical Mendelian genetics
2. Monohybrid crosses
3. Dominance, recessiveness.
4. Codominance and semidominance
5. Principle of independent assortment;
6. Dihybrid and trihybrid ratios;
7. Gene interactions; epistasis and multiple alleles
8. ABO blood type alleles and Rh factor alleles in humans
9. Probability in Mendelian inheritance
10. Structure of chromosomes
11. Organization of genes and genomes;
12. Nucleic acid function; DNA as warehouse of genetic information
13. Experimental evidence that DNA is genetic material
14. Sex determination
15. Linkage and crossing over.

Recommended Text

1 Snustad, D.P.. & Simmons, M.J. (2008). *Principles of Genetics.* (5th Ed.). New York: John Willy & Son

2 Klug, W.S. and Cumming, M.R. (2008). *Concepts of Genetics.* (9th Ed.). USA: Prentice Hall

Suggested Readings

1 Pierce, B. (2004). *Genetics: A conceptual approach.* (2nd Ed.). New York: W.H. Freeman

2 Brooker, R.. (2011). *Genetics: Analysis and principles.* (4th Ed.). USA: McGraw-Hill..

3 Pierce, B.A. (2011). *Genetics: A conceptual approach.* (4th Ed.) New York: W.H. Freeman Publisher

BIOT-5106 **Ecology, Biodiversity & Evolution – I** **3(3+0)**

This course aims to introduce students to the fundamentals of ecology, biological diversity and evolution – key areas that are pertinent to modern day biology. The course also aims to provide an introduction to the properties of life and cells leading to genetic and biological diversity. The objective of this course is to describe the molecular and structural unity of life and to explain how the diversity of living things is generated and perpetuated, and exemplify this diversity among and within life's three domains. After going through this course the students would be able to enhance their knowledge of biological diversity with emphasis on variation leading to natural selection. The course also describes the basic properties of populations and interactions among different types of organisms within an ecosystem. The course also demonstrates the fundamental processes underlying adaptive evolution, speciation and extinction, population growth and regulation, species coexistence, and maintenance of biodiversity.

Contents

1 An Introduction to ecology and the biosphere,
2 What Determines the distribution of life on earth
3 Factors that influence earth's climate.
4 Principal terrestrial and aquatic biomes
5 Energy flow and nutrient cycling in ecosystems
6 Population ecology, Population growth and regulation community ecology
7 Community Interactions
8 Ecosystems and restoration ecology
9 Conservation biology and global change
10 Conserving earth's biodiversity
11 Importance of biodiversity
12 Major threats to biodiversity
13 Factors effecting biodiversity
14 Sustainability essential for a healthy future, causes and consequences of extinction.
15 Impact of environment on loss of genetic diversity and speciation; *in situ* and *ex situ* conservation.

Recommened Books

1. Audesirk, T., Audesirk, G., Byers, B.E. (2017). Biology: *Life on earth.* (11th Ed). New Jersey. USA: Pearson Hoboken
2. Campbell, N.A. (2016). *Biology.* (11th Edition). California,.USA: Benjamin/Cummings Publishing Company

Suggested Readings

1 Aston, et al. (2004). *Ecological Genetics: Planning and application.* UK: Blackwell Science
2 Costa, L.G., & Eaton, D.L. (2006). Gene-Environment interactions: Fundamentals of ecogenetics. (1st Ed.). NJ: John-Wiley & Sons
3 Louis, P., & Pojman, L.P. (2007). *Environmental ethics: Readings in theory and application.* (5th Ed.). Belmont: Wadsworth Publishing

BIOT-5107 **Microbiology** **3(2+1)**

This course aims to familiarize students with fundamentals of prokaryotic and eukaryotic microbial life including viruses. In this course students will learn about culturing of bacteria, nutritional requirements of microbes and control of microbes. Students will also learn about the importance of microbes in our life. The course also describes how microorganisms are used as model systems to study basic biology, genetics, metabolism and ecology. This course will also help to student about knowledge of antibiotics and their mode of action. Students learning this course will be able to complete a substantial research project related to microbiology; seek and employ insights from others in implementing the project; evaluate a significant challenge or question faced in the project in relation to core concepts, methods or assumptions in microbiology; and describe the effects of learning outside the classroom on his or her research or practical skills.

Contents

1. Overview and history of microbiology including microbial diversity (Archaea, bacteria, fungi,algae, protozoa)
2. Nutrition and growth of microbes
3. Metabolism of microbes
4. Cultivation of microbes
5. Viruses
6. Control of microorganisms: Sterilization and disinfection,
7. Antimicrobial agents
8. Antibiotics, antibiotic resistance and susceptibility
9. Antifungal and antiviral agents; cell death
10. Symbiosis, Carbon, nitrogen, sulfur and phosphorus cycles
11. Microbiology of soil, Microbiology of freshwater and seawater.

Practicals

Sterilization techniques; culturing of bacteria in liquid and on solid medium: Gram-staining of bacteria; colony and cell morphology; bacterial cell count and growth curves; biochemical tests.

Recommended Text

1. Plczer, M.J., Chan, E.C.S., & Krieg, N.R. (2008). *Microbiology*. (5th Ed.). New Dehli: Tata McGraw Hill Publisher
2. Talaro, K.P. (2009). *Foundations in Microbiology: Basic principles*. (7th Ed.). NY: McGraw Hill Publisher

Suggested Readings

1 Tortora, G.J., & Funke, B.R. (2016). *Microbiology: An introduction*. (12th Ed.). UK: Pearson
2 Alcamo, I.E. (2016). *Fundamentals of Microbiology*. (9th Ed.). USA: Jones and Bartlett Publishers
3 Cappuccino, J.G., & Sherman, N. (2016). *Microbiology: A laboratory manual*. (10th Ed.). UK: Pearson Education

SEMESTER – IV

BIOT-5108 **Animal Physiology** **3(2+1)**

The major aims of this course are to provide students with a basic understanding of the fundamental processes and mechanisms that serve and control the various functions of the body.To familiarize students with the principles and basic facts of Animal Physiology and with some of the laboratory techniques and equipment used in the acquisition of physiological data. The emphasis will be on mammalian physiology but there will be some coverage of other vertebrate taxa. The course will focus on organ-system physiology, however, cellular and molecular mechanisms will be discussed in order to present a current view of physiological principles. Furthermore, emphasis will be placed on nervous, muscular, cardiovascular, respiratory, renal, digestive, and endocrine physiology. Where appropriate, basic chemical and physical laws will be reviewed in order to enhance and to promote student understanding. This course provides comprehensive introduction to students on Homerostasis, Biomembranes, Skins, Physiology of Muscles and skeletons etc.

Contents

1. Introduction. Homeostasis. Biomembranes.
2. Skins. Physiology of Muscles and Skeletons: protection, support and movement
3. The Nervous System: spinal and cranial nerves, neurons, membrane potentials and nerve transmission; senses and sensory receptors
4. Endocrine Glands and their Hormone Messengers, Chemistry of hormones and mechanism of hormone action, Hormonal system of invertebrates and vertebrates
5. Cardiac physiology; introduction to cardiac cycle, vertebrate & invertebrate. Cardiovascular system; introduction, solute exchange, blood pressure. of vertebrates and invertebrates
6. Immune and Lymphatic Systems of vertebrates, Respiratory system; introduction, gas exchange & transport, control, Nutrition and the Digestive System
7. Urine, Reproduction in Animals. Extra renal osmoregulatory organs, Fluid and acid-base balance; Metabolic fates of nutrients in heterotrophs.

Practicals

Dissection of frog and study of digestive, reproduction, arterial, venous and respiratory system. Blood cells. Dissection of pigeon and study of its various systems. Dissection of mouse and study of various systems. Study of Nervous tissue (brain) of Mammals.

Recommended Text

1. Richard. W., Gordon, A., & Margaret, A. (2004). *Animal Physiology.* (1st Ed.). NY: Mc Graw Hill Inc
2. Guyton. (2001). *Text book of medical physiology.* (9th ed.). NY: Mc Graw Hill Inc

Suggested Readings

1. Kent, G.C., & Miller, S. (2001). *Comparative anatomy of verebrates.* NY: McGraw Hill Inc
2. Campbell, N.A. (2016). *Biology.* (11th Ed.). California: Benjamin/Cummings Publishers. Inc

BIOT-5109 **Ecology, Biodiversity & Evolution – II** **3(2+1)**

This course is a continuation of Ecology, Biodiversity & Evolution – I and offers advanced concepts in these areas. The student will be given a chance to build a clear understanding of the scope of biological diversity and the phylogenetic relationships that underlie the organization of major groups of organisms. In this course, the students will study the directional and random forces that lead to adaptation within populations, speciation between populations, and quantum differences between major groups. By the end of the course, students will be familiar with the major groups of plants, including when they arrived on earth and how they are related to one another. Students will also learn basic ecological theory and begin to use these principles in understanding and proposing solutions to the major environmental problems facing the biosphere. Diversity of animal kingdoms and evolution of seed plants will also be covered in this module.

Contents

1 History of life, The Origin of Species, how do new species Form, models of speciation;
2 Phylogeny and the Tree of Life, construction of phylogenetic trees on basis of morphology and molecular markers
3 What are molecular clocks, Diversity of protists, Plant diversity
4 Major groups of plants, Colonization of plants on land
5 Evolution of seed plants, Major adaptations in plants, domestication and improvement of crops
6 Diversity of animal kingdom: Invertebrates and Vertebrates.

Practicals

Types of Ecosystems, Pond freshwater ecosystem; vegetation profile; grassland, rangeland and forest; biotic and abiotic factors of grassland, rangeland and aquatic ecosystem including methods of sampling; analysis of plant communities by different methods and decomposition of leaf litter by organisms. Collection of various plant groups, Shape and structure of different classes plants and animals by light microscopy; Collection of selected animal groups.

Recommended Text

1 Audesirk, T., Audesirk, G., & Byers, B.E. (2017). *Biology: Life on earth.* (11th Ed.). New Jersey, USA: Pearson Hoboken
2 Campbell, N.A., (2016). *Biology*: (11th Ed.). California: Benjamin/Cummings Publishing Company, Inc

Suggested Readings

1 Costa, L.G., & Eaton, D.L. (2006). *Gene-Environment interactions: Fundamentals of ecogenetics.* (1st Ed.). NJ: John-Wiley & Son
2 Louis, P., & Pojman, L.P. (2007). *Environmental ethics: Readings in theory and application.* (5th Ed.). Belmont: Wadsworth Publishing..
3 Miller, S. A., & Harley, J.P. (2011). *Zoology*. (5th Ed.). USA: The McGraw-Hill

BIOT-5110 **Molecular Biology** **3(3+0)**

Molecular Biology is the study of bi ological systems at the molecular level. Molecular Biology deals with nucleic acids and proteins and how these molecules interact within the cell to promote proper growth, division and development. It is large and ever changing discipline. In this course, students will acquaint with the chemistry and biology of nucleic acid structure (DNA, RNA) and the mechanics of replication, transcription, post transcription modification, translation, post translational modifications in prokaryotes (particularly bacteria) and eukaryotes. The central goal is understanding the gene regulation at all levels both in prokaryotes and eukaryotes. In this course, students will account for causes for DNA damages and genetic changes and explain the different mechanisms that underly 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 will be also discussed.

Contents

1. Introduction to molecular biology and history
2. Structure and function of DNA
3. Chromatin and structure of chromosomes
4. Protein structure and function
5. DNA replication in prokaryotes and eukaryotes
6. Transcription in prokaryotes and eukaryotes
7. Post transcriptional processing (e.g., rna splicing, alternative splicing. editing).
8. Translation
9. Post-translational processing in eukaryotes
10. Protein folding, targeting and turnover
11. DNA damage and repair
12. Recombination and transposable elements
13. Signaling and control of gene regulation in prokaryotes
14. Signaling and control of gene regulation in eukaryotes

Recommended Text

1 Alberts, B., et al. (2007). *Molecular biology of the cell.* (5th ed.). NY: Garland Science
2 Lodish, H., et al. (2012). *Molecular cell biology.* (7th ed.). NY: W.H. Freeman

Suggested Readings

1 Berg, J.M., et al. (2006). *Biochemistry.* (6th Ed.). New York: W.H. Freeman
2 Schleif, R. (1993). *Genetics and molecular biology.* (7th Ed.). UK: The Johns Hopkins University Press

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CHEM-5103 **Organic Chemistry** **4(3+1)**

The course will acquire knowledge about basic concepts of organic chemistry, chemistry of hydrocarbons and functional groups and the mechanism of organic reactions. Such information will be useful for qualitative analysis and synthesis of organic compounds.

Contents

1. Basic Concepts
2. Hydrocarbons
3. Stereoisomerism
4. Alkyl Halides
5. The Hydroxyl group and Ethers
6. Phenols
7. The Carbonyl Group
8. Carboxylic Acids and their Derivatives
9. Nitrogen Compounds: Amines

Physical Chemistry Lab (Cr. 01)

1. Qualitative Organic Analysis: Systematic identification of organic compounds containing groups containing groups like COOH, OH, NH_2 and C=O.
2. Purification techniques viz solvent extraction.
3. Purification techniques viz distillation..
4. Purification techniques viz Recrystallization.
5. Preparation of Ethyl benzoate,
6. Preparation of Benzoic acid.
7. Preparation of Tribromophenol.
8. Preparation of Aspirin &
9. Preparation of Nitrobenzene.

Recommended Text

1. Younas, M. (2006). *Text book of organic chemistry*. Lahore. Pakistan: Ilmi Kutab Khana
2. Rehman. A. (2006).*Text book of organic chemistry*. Lahore, Pakistan: Caravan Book House
3. March, J. (2006). *Advanced organic chemistry*. (8th Ed.). New York: Wiley .
4. Younas, M. (2006). *Organic spectroscopy*. Lahore: A. H. Publisher
5. Solomons, T. W. G. (2016). *Fundamentals of organic chemistry*. (12th ed.). New York: Wiley
6. Rehman, A. (2006). *Experimental organic chemistry*. Lahore: The Caravan Book House

Suggested Readings

1 Pine, S.H. (1987). *Organic chemistry*. New York: McGraw-Hill

2 Sykes. P. (1999). *A guide book to mechanism in organic chemistry*. New Dehli: Prentice Hall

Solomons. T.W.G. (2016). *Fundamentals of organic chemistry*. New York: Wiley

SEMESTER – V

BIOT-6111 **Analytical Chemistry And Instrumentation** **3(2+1)**

This course gives an introduction to analytical chemistry and an overview of important analytical methods and their range of application within detection of inorganic and organic compounds. Important analytical quantitative techniques from classical methods, electrochemical methods, spectrochemical / spectrophotometric methods, and separation techniques are reviewed. The course also includes risk assessment of chemical experiments, important steps and procedures in analytical chemistry, and evaluation/interpretation of results. The course gives an overview of important use of selected classical and instrumental chemical quantitative analytical methods and a short introduction to their basic theory. As a part of this course, a project work is also to be carried out; relevant topics will be announced at semester start. There will be an excursion at the end of the semester.

Contents

1. Introduction to various analytical techniques;
2. Principles and applications of various types of chromatography including paper, thin layer. gel filtration, ion-exchange, affinity, high performance liquid chromatography (HPLC). gas chromatography,
3. GC-MS and LC–MS; Spectroscopy types including nuclear magnetic resonance (NMR),
4. Visible, ultraviolet, luminescence, flame, atomic absorption. fluorescence, emission and inductively coupled plasma emission spectroscopy (ICPMS);
5. Principles and applications of flow cytometry; Introduction to X-ray diffraction;
6. General analytical instrumentations and methods of fractionation and characterization of proteins and nucleic acids including dialysis, ultra-filtration, lyophilisation, ultracentrifuge and amino acid analyzer.

Practicals

Separation of biomolecules by paper, column and thin layer chromatography; determination of molecular weight of proteins by gel filtration; identification of sugars, proteins, electrolytes etc. by UV/Visible spectrophotometer; determination of sodium and potassium content in blood serum by flame photometer and mineral analysis of plant tissues using atomic absorption spectrophotometer.

Recommended Books

1. Boyer, R.F. (2016). *Biochemistry laboratory: Modern theory and techniques.* (2nd Ed.). New Dehli: Prentice Hall, .
2. Wilson, K. (2016). *Principles and techniques of biochemistry and molecular biology.* (7th Edition). UK: Cambridge University Press .

Suggested Readings

1. Chung, C., et al. (2005). *Analytical methods validation and instrument performance verification.* (1st Ed.). New York: John Wiley & Sons
2. Sharma, B.K. (2005). *Instrumental method of chemical analysis.* (1st Ed.). India: Meerut Goel Publishing House

BIOT-6112 **Bioinformatics** **3(1+2)**

Bioinformatics is defined broadly as the study of the inherent structure of biological information. The objective of the course is to introduce students to the rapidly evolving field of bioinformatics. The term "bioinformatics" often means different things to different scientists, and the goal of this course is not to cover all those things. The main objective of this course is to familiarize the students with biological data mining from online databases and the use of various bioinformatics tools for extracting and processing biological data. After completing this course, the students will gain an understanding of the computational challenges (and their solutions) in the analysis of large biological data sets; they will also understand how some of the commonly used bioinformatics tools work, how to use these tools effectively, and how to read and evaluate the research articles in the field.

Contents

1 Introduction; bio-computing
2 Biological databases - types and retrieval of nucleic acid (or genomic) or protein sequence information
3 Sequence alignment - pairwise, multiple
4 Phylogenetics; *in silico* identification of protein motifs and domains
5 Structural bioinformatics of proteins and RNAs including protein modeling and prediction of their interactions with other proteins and small molecules
6 Identification of genes and promoter regions within genomes; networks
7 Strategies for whole genome sequencing and assembly

RECOMMENDED DATABASES AND TOOLS

NCBI, PDB, EcoCyc, DDBJ, SWISS-PROT, TIGR, KEGG etc.
Bioedit, Repeatmasker. PHRED, PHRAP, BLAST, Prosite/BLOCKS/PFAM. CLUSTALW, Emotif, RasMol, Oligo, Primer3, Molscript, Treeview, Alscript, Genetic Analysis Software, Phylip, MEGA4.0 etc.

Recommended Text

1 Claverie, J.M., & Notredame, C. (2014). *Bioinformatics for Dummies.* (4th Ed.). USA: Wiley Publishing.
2 Xiong, J. (2016). *Essential Bioinformatics.* (3rd Ed.). UK: Cambridge University Press.

Suggested Readings

1 Mathura, V., & Kangueane, P. (2016). *Bioinformatics: A concept-based introduction.* USA: Springer.
2 Mount, D.W. (2001). *Bioinformatics Sequence and Genome Analysis.* (4th Ed.). USA: Cold Spring Harbor Laboratory Press.
3 Sperschneider, V. (2016). *Bioinformatics: Problem solving paradigms.* USA: Springer.

BIOT-6113 **Methods In Molecular Biology** **3(2+1)**

This course is designed to identify the fundamental aspects of molecular biology techniques and to apply the principles of molecular methods in a design in order to sense, study or control a biological system. This introductory course will explore the process of doing scientific research in a molecular biology lab. Students will learn numerous techniques in the lab, including DNA isolation, PCR, gel electrophoresis etc. This course is intended for the students with little or no experience in a molecular biology lab, and it will prepare these students for the more advanced molecular lab courses and training. The aim of the course is that the students should assimilate a substantial theoretical basis to understand the key experimental techniques used in modern molecular biology research. Students will also be equipped with theoretical and practical basis for further academic studies or professional practice in areas related to molecular biology.

Contents

1. Solution dilutions, Sterilization techniques,
2. DNA/RNA extraction techniques.
3. Horizontal, vertical, pulse field, denaturing gradient gel electrophoresis;
4. Analysis of proteins by native and SDS-PAGE; 2-D gels;
5. Polymerase chain reaction (PCR) – Types of PCR (inverse, touch-down, nested, hemi-nested, pit stop,
6. Multiplex, reverse transcriptase, RACE, Real-time qPCR, Applications of PCR; Detection of mutations and/or SNPs;
7. Analysis of nucleic acids by gel electrophoresis
8. Enzyme-linked immunosorbant assay; Southern, Western, Northern blotting.
9. Biosensors, Transducers.

Practicals

Preparation of stock and working solutions; isolation of nucleic acids and their quantification; restriction digestion of DNA and preparation of restriction maps; gel electrophoresis, agarose and polyacrylamide gels; polymerase chain reaction (PCR); preparation of chemically competent cells; transformation of bacteria with plasmid DNA.

Recommended Text

1. Walker, J.M., & Rapley, R. (2008). *Molecular biomethods handbook: Methods in molecular biology*; 2nd Ed.). NJ, USA: Humana Press.
2. Bartlett, J.M.S., & Stirling, D. (2008). *Methods in Molecular Biology, PCR Protocols.* (2nd Ed.). NJ, USA: Humana Press Inc

Suggested Readings

1. Griffiths, A.J.H., Wessler, S.R., Carrol, S.B., & Doebley, J. (2015). *Introduction to genetic analysis*. (11th Ed.). USA: W. H. Freeman and company
2. Wink, M. (2011). *An Introduction to molecular biotechnology: Fundamentals, methods, and applications.* (2nd Ed.). USA: Wiley Blackwell
3. Wilson, K., & Walker, J. (2010). *Principles and techniques of biochemistry and molecular biology.* (7th Ed.). UK: Cambridge University Press

BIOT-6114 **Immunology** **3(3+0)**

The purpose of this course is to acquaint students with the basic principles of innate and adaptive immune systems. The multiple roles, functions of immune system, and its consisting of cells and the relation of how this lead to diseases. The course will consider both innate and adaptive immunity and include the structure and function of key receptors including immunoglobulin, T cell receptors and innate pattern recognition receptors. The mechanisms of antibody formation and molecular aspects of cellular immunity including T and B cell interactions and lymphocytes memory formation, will be emphasized, and connections to modern biomedical science will be highlighted. These will include presentations and discussions on autoimmunity, immunity against major microbial pathogens (viruses, bacteria, parasites) transplantation and tumor immunology. Different types of Vaccines including traditional and modern vaccine and their importance as protection from different viral and bacterial pathogen. Types of allergies and how they affect human life.

Contents

1. Overview of the immune system as the body's main defense mechanism.
2. Elements of innate and acquired immunity
3. Cells and organs of the immune system.
4. Properties of antibodies and antigens together with their structure.
5. Antibody function and interactions
6. Monoclonal and polyclonal antibodies.
7. Genetics of antibody structure and diversity
8. Expression of immunoglobulin genes.
9. Major Histocompatibility complex.
10. T-cell and B-Cell.
11. Complement system
12. Hypersensitivity
13. resistance and immune response to infectious diseases
14. Cell-mediated effector response, leukocyte migration and inflammation
15. Vaccine, Traditional vaccines, Modern Vaccines
16. Autoimmunity
17. Transplantation immunology

Recommended Text

1. Kuby, J. (2006). *Immunology*. (6th Ed.). New York: WH Freeman

Suggested Readings

1. Janeway, C.A., et al. (2001). *Immunobiology. The immune system in health and disease.* (5th Edition). New York, Garland Science Publisher
2. Anderson, W.L. (1999). *Immunology*. (1st Ed.). NJ: Wiley-Blackwell.
3. Abbas, A.K., & Lichtman, A.H. (2010). *Basic immunology: Functions and disorders of the immune system*. (3rd Ed.). Philadelphia: Saunders Publisher

BIOT-6115 **Probability And Biostatistics** **3(3+0)**

The subject covers basic statistical knowledge and its application in biotechnology. Statistics and experimental design are important tools for the plant biotechnologist and should be used when planning and conducting experiments as well as during the analysis and interpretation of results. This chapter provides some basic concepts important to the statistical analysis of data obtained from plant tissue culture or biotechnological experiments, and illustrates the application of common statistical procedures to analyze binomial. count, and continuous data for experiments with different treatment factors as well as identifying trends of dosage treatment factors. For eg: A drug is given to animals or humans to see whether the changes produced are due to the drug or by chance or to compare the action of two different drugs. And to find the relative potency of new drug with respect to a standard drug. To test usefulness of sera and vaccine in the field.

Contents

1. Frequency distribution
2. exercise frequency distribution,
3. Measures of central tendency and measures of location.
4. Measures of dispersion,
5. Statistical hypothesis and significance,.
6. Null and alternative hypothesis, confidence interval,
7. Tests involving normal distribution
8. Tests involving student's t-distribution
9. F-distribution, Analysis of Variance (ANOVA)
10. Chi-square test, tests of independence and contingency tables
11. LSD test, experimental designs
12. Complete Randomized Design (CRD)
13. Randomized Complete Block Design, sequence Analysis
14. Latin Square Design, Markov chains and Models and their application, Profile HMMs, Probabilistic approaches to phylogeny

Recommended Text

1 Chernick, M.R., & Friis, R.H. (2003). *Introductory biostatistics for the health sciences: Modern applications including bootstrap.* (1st Ed.). USA: Wiley Interscience.
2 Chaudhry, S.M. (2005). *Introduction to statistical theory.* (6th Ed.). Lahore, Pakistan: MarkaziKutubKhana

Suggested Readings

1 Mann, P.S. (2010). *Introductory Statistics.* (7th Ed.). NJ: John Wiley & Sons.
2 Freund, J. E., & Perles, M.B. (2005). *Modern elementary statistics.* (12th Ed.). USA: Pearson Publishers

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BIOT-6116 **Principles of Biochemical Engineering** **3(2+1)**

To acquaint the students with the fundamentals of biochemical engineering. The objective of this course is to introduce the basic concepts of biomolecule and the cell function and how they are applied to bioreactor analysis and its design. The students will also be able to develop a clear picture of what enzymes are, what their function is and the mechanistic models describing their function in biochemical reactions. Through this course, the students will grasp knowledge about the mechanisms and energetics of metabolic pathways in the cell and the various patterns and calculations involved in describing cell growth. This course focuses on the interaction of chemical engineering, biochemistry, and microbiology. Mathematical representations of microbial systems are featured among lecture topics. Kinetics of growth, death, and metabolism will also be covered during this course. Continuous fermentation, agitation, mass transfer, and scale-up in fermentation systems, and enzyme technology round out the subject material.

Contents

1 Introduction to microorganisms and biological molecules
2 Principles of enzyme catalysis; methods of enzyme and cell immobilization; enzyme kinetics
3 Internal mass transfer effect on immobilized growth: Stoichiometry models of microbial growth; structured model, of microbial growth
4 Bioreactors - continuous stirred tank bioreactors, plug-flow and packed bed bioreactors, imperfect mixing
5 Fed batch bioreactors, gas liquid mass transfer in bioreactors, power requirement for bioreactor, sterilization and heat transfer in bioreactors
6 Introduction to bioproduct recovery
7 Biological product manufacturing, Economic analysis of bioprocesses, Case study: penicillin.

Practicals

Unstructured microbial growth with application of Monod model; inhibition kinetics and nutrient uptake rate; methods of immobilization via binding and physical retention; yield coefficient and stoichiometry; production of enzymes by structured and segregated models; bioreactor design and analysis (batch, fed-batch and continuous); enzyme catalysis in the CSTR; packed bed and plug flow bioreactor; rheology of fermentation broth; mixing and gas-liquid mass transfer, heat transfer, media and bioreactor sterilization techniques; techno-economic analysis of a typical bioprocess.

Recommended Text

1 Katoh, S., et al. (2015). *Biochemical egineering: A textbook for engineers, chemists and biologists.* (2nd ed.). Germany: Wiley-VCH.
2 Najafpour, G. (2015). *Biochemical engineering and biotechnology.* (2nd Ed.). USA: Elsevier Science

Suggested Readings

1 Douglas. S.C.. & Blanch, H.W. (1997). *Biochemical engineering.* (2nd Ed.). USA: CRC Publishers.
2 Katoh, S.. & Yoshida, F. (2009). *Biochemical engineering: A textbook for engineers, chemists and biologists*. Germany: Wiley-VCH.

SEMESTER – VI

BIOT-6117 **Recombinant DNA Technology** **3(2+1)**

To acquaint the students with basic techniques and tools used in gene manipulation and its practical uses. This subject is aimed to introduce the student to the wide range of methodologies that are commonly known as Recombinant DNA Technology. These methodologies, most of them developed at the end of the last century, are one of the pillars of modern biotechnology and the students will become familiar with these methodologies during course of this module. The general objective of this courses is to provide a solid basis allowing the student to apply these methodologies when designing biotechnological processes. After completing this course, the students will have a knowledge about the main cloning vectors, main characteristics of vectors and how to use them in the different strategies for the cloning of DNA fragments. It will also familiarize students with the application of recombinant DNA Technology in various fields such as agriculture, health, industry, environment and basic research.

Contents

1 Introduction and History of Recombinant DNA technology
2 DNA modifying enzymes, restriction endonucleases, restriction mapping
3 Vectors and their types, cloning vectors including plasmids, bacteriophages, cosmids
4 YAC vectors, shuttle and expression vectors; tumor inducing (Ti) plasmids; transformations
5 Cloning strategies, expression of recombinant proteins and their purification by affinity chromatography; Expression in prokaryotes and eukaryotes, Site-directed mutagenesis, genomic and cDNA libraries, chromosome walking
6 Sequencing strategies; Application of recombinant DNA Technology (agriculture, health, industry, environment and basic research).

Practicals

DNA and plasmid isolation. Preparation of restriction maps, designing expression constructs, Transformation techniques, Blotting techniques.

Recommended Text

1. Griffiths, A. J. H., Wessler, S. R., Carrol, S. B. and Doebley, J. (2020). *Introduction to Genetic Analysis*. (12th Edition). New York, USA: W. H. Freeman and company.
2. Brown, T.A. (2016). *Gene Cloning and DNA analysis*. (7th Edition). Hoboken, USA: Wiley-Blackwell Publishing.

Suggested Readings

1 Primrose, S.B. and Twyman, R.M. (2006). *Gene Manipulation and Genomics*. (6th Edition). New Jersy, USA: Blackwell Publishing.
2 Watson, J.M., Caudy, A.A., Meyers, R.A. and Witkowski, J.A. (2007). *Recombinant DNA: Gene and Genomes*. (3rd Edition). New York, USA:W.H. Freeman and Company.

BIOT-6118 **Microbial Biotechnology** **3(2+1)**

To acquaint students with how modern methods may be employed to enhance the characteristics of microbes that are commonly used in various industries including food, agriculture and pharmaceutical. This module will take an in-depth look at how microbes and their metabolic pathways and products can be used in biotechnology. The module will be particularly concerned with microbial biotechnology, covering for example, genetic modification of microbes, exploitation of microbes in various industries, in agriculture, in energy sector and in medicine. This course covers the technological application that uses microbiological systems, microbial organisms, or derivatives thereof, to make or modify products or processes for specific use. The lectures start with how microbial diversity is useful to mankind. It also explains the significant role of microbes in vaccine production, plant microbe interactions, development of microbial insecticides, production of microbial polysaccharides and polymers. This module will also allow students to develop their own interests in other aspects of biotechnology.

Contents

1. Issues and scope of microbial biotechnology
2. Genetically modified microorganisms
3. Microbes as tools for microbiological research
4. Biotechnological potential of microbes
5. Significance of microorganisms in food production, fermentation, pharmaceutical and other industries
6. Vaccine development and production
7. Microbiological mining
8. Biofuels and use of microbes in petroleum industry
9. Plant-microbe interactions
10. Bio-fertilizers
11. Biopesticides, composting
12. Antimicrobials
13. Significance of microbial biotechnology in the economic development of Pakistan.

Practicals

Isolation and screening of potential microbes from different environmental sources; lab scale production of bacterial enzymes; lab-scale production of alcohol by yeast; the use of microbes in bioleaching; use of microbes in microbial enhanced oil recovery.

Recommended Text

1. Kumar, P., Patra. J.K., Chandra, P. (2018). *Advances in Microbial Biotechnology: Current Treands and Future Prospects*. (1st Edition). New York. USA: Apple Academic Press.
2. Glick: B.R. Pasternak, J. J.. Patten, C.L. (2009). *Molecular Biotechmology: Principles and Applications of Recombinant DNA*. (4th Edition) Washington,USA: ASM Press.

Suggested Readings

1. Goodsell, D.S. (2004). *Bionanotechnology: Lessons from Nature*. Hoboken, USA: John Wiley & Sons.
2. Ray. R.C. (2005). *Microbial Biotechnology in Agriculture and Aquaculture*. Plymouth. USA: NBN International.
3. Kreuzer. H. and Massey, A. (2005). *Biology and Biotechnology Science. Applications. and Issues*. (1st Edition). Washington.USA: ASM Press.

4. Harding, S.E. (2010). *Biotechnology and Genetic Engineering Reviews*. (1st Edition). Nottingham, The Netherlands: Nottingham University Press.

BIOT-6119 **Genetic Resources And Conservation** **3(3-0)**

The subject covers basic scientific knowledge about genetic resources, their importance and application. Plant material conservation to ensure food security around the world and especially with reference to Pakistan will be discussed. Endangered animal species around the globe will be discussed. Plant and animal species of Pakistan in danger of extinction will be discussed in details. Causes of extinction and strategies for conservation of endangered animal species will be discussed. Biodiversity and its importance in the preservation of ecosystem will also be discussed. Laws and legislation regarding conservation of endangered species will be discussed. All relevant examples will be given and experiences will be shared. Future prospects of these conservation strategies will be discussed. All relevant ethical and legal issues will also be discussed. After studying this subject, students will be able to understand the importance of genetic resources, their preservation and use for the betterment of mankind. They will also be aware of all the national and international organizations and their efforts for the conservation of genetic resources.

Contents

1. Introduction to genetic resources and their significance
2. Plant genetic resources – utilization
3. Plant genetic resources opportunities and constraints
4. Strategic role of plant genetic resources in achieving global food security and sustainable agriculture
5. Overview of wild and domesticated genetic resources of Pakistan
6. Genetic diversity in endangered species
7. Genotype-environment interactions, gene pools and genetic boundaries
8. Genetic drift, inbreeding, migration and gene flow
9. Introduction to extinction and its causes
10. Threatened animal and plant species
11. Conservation of genetic resources through mapping of existing biological diversity
12. Assessing conservation status, management strategies
13. Laws and treaties of conservation, quarantine regulations
14. Future prospects of genetic conservation.

Recommended Text

1. Kamau, E.C. Winter, G., (2009). *Genetic Resources, Traditional Knowledge and the Law: Solutions for Access and Benefit Sharing*. (1st Edition). London, United Kingdom: Earthscan Publication Ltd.
2. Primack, R.B. (2010). *Essentials of Conservational Biology*. (5th Edition). Sunderland, USA: Sinauer Associates Inc.

Suggested Readings

1. Primack, R.B. (2012). *A Primer of Conservational Biology*. (5th Edition). Sunderland, USA: Sinauer Associates Inc.
2. Virchow, D. (1999). *Conservation of Genetic Resources: Costs and Implications for a Sustainable Utilization of Plant Genetic Resources for Food and Agriculture*. New York, USA: Springer.

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3. Mills, L.S. (2012). *Conservation of Wildlife Populations: Demography, Genetics, and Management*. (2nd Edition). Hoboken, USA: Wiley-Blackwell.
4. Frankham, R. (2010). *Introduction to Conservation Genetics*. (2nd Edition). Cambridge, United Kingdom: Cambridge University Press.

BIOT-6120 Agriculture Biotechnology 3(2+1)

This course is 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 that can be used to improve the plants for better growth, production and resistance form diseases. This course will also give basic knowledge to the students related to the egentic markers involved in the plant modification and tracking the desired phenotypic characteristic. Moreover. this course will also acquaint students with techniques and skills employed for producing transgenic crops (Genetically modified organisms), their evaluation and commercialization which is very important for making the laboratory knowledge available to the farmer. This course will also introduce the students to the biofertilizaer and biopesticides, which are proving great alternatives to the poisonous chemical fertilizers and pesticides. The ethical and moral concerns regarding the transgenic crops and their use as food, use of biofertilizers and biopesticides along with their future perspectives will also be elaborated.

Contents

1. Agriculture biotechnology and its applications in crop improvements
2. Cell and plant tissue culture methodology; improvement of plants via plant cell culture
3. Plant molecular biomarkers; direct and indirect methods of plant and animal transformation: gene gun method of transformation
4. *Agrobacterium* mediated transformation, chloroplast transformation and polyethylene glycol (PEG) mediated transformation
5. Transgenic crops with herbicide, biotic and abiotic stress resistance; problems related to transgenic plants
6. Genetically modified organisms (GMOs); field evaluation and commercialization of GMOs; possible effects of releasing GMOs into the environment
7. Biofertilizers, biopesticides and their types; non-symbiotic nitrogen fixers; present and future prospects of biofertilizers.

Practicals

Preparation of Murashige and Skoog medium and stocks of macronutrients, micronutrients, and hormones; selection of ex-plant, medium preparation and callus induction; culturing *Agrobacterium* and using it to infect plant callus; selection of transformants; regeneration of plantlets and acclimatization; plant DNA extraction and PCR for detecting introduction of foreign DNA into plants.

Recommended Text

1. Qaim, M. (2010). *Agricultural Biotechnology in Developing Countries: Towards Optimizing Benefits for Poor*. New York, USA: Springer
2. Kempken, F. (2010). *Genetic Modification of Plants: Agriculture, Horticulture and Forestry (Biotechnology in Agriculture and Forestry)*. New York, USA: Springer.

Suggested Readings

1. Slater, A. (2008). *Plant Biotechnology: The Genetic Manipulation of Plants*. (2nd Edition). New York, USA: Oxford University Press.
2. Altman, A. (2011). *Plant Biotechnology and Agriculture: Prospects for the 21st Century*. (1st Edition). New York, USA: Academic Press.
3. Herren, R.V. (2012). *Introduction to Agricultural Biotechnology: An Agricultural Revolution*. (2nd Edition). Boston, USA: Cengage Learning.

BIOT-6121 **Genomics And Proteomics** **3(3+0)**

The overarching goal of this course is to provide students with a thorough overview of both the theoretical and experimental aspects of structural and functional genomics as well as proteomics. Proteomics complements genomics and is useful when scientists want to test their hypotheses that were based on genes. Even though all cells of a multicellular organism have the same set of genes, the set of proteins produced in different tissues is different and dependent on gene expression. This course will introduce the students to the genetics, organization of genome and various practical approaches to know the sequence of genes/genome. Moreover, Gene expression and the biologicals systems which interfere with the gene expression will also be discussed. Proteins and their role in cell signaling will be aloborated. By the end of this course, each student will be familiar with the terminology, underlying principles and strategies, and the technical methodology involved in genomics and proteomics.They will be able to compare and contrast the strengths and limitations of these technologies.

Contents

1. Organization and structure of genomes
2. Genetic mapping (RFLP, microsatellite, SNP)
3. High-resolution physical mapping (STS, EST)
4. Flow cytometry; somatic cell and radiation hybrids
5. Artificial chromosomes in bacteria and yeast
6. Hierarchical and whole genome shotgun sequencing
7. DNA sequencing strategies - manual and automated sequencing, pyrosequencing
8. Solexa, Helicos, Roche 454, real-time and nanopore sequencing;
9. Sequence assembly, obstacles and solutions
10. Estimating gene number – over-prediction and under-prediction, homology searches, exon prediction programs, integrated gene-finding software packages; structural variation in the genome and its applications
11. Microarray and RNA interference; proteomics; cellular communication/signaling pathways; protein-protein interactions and validation - yeast two hybrid system
12. Affinity purification-mass spectrometry (AP-MS), tandem affinity purification (TAP) tagging, fluorescence resonance energy transfer (FRET) and co-immunoprecipitation.

Recommended Text

1. Strachan, T. and Read, A.P. (2010). *Human Molecular Genetics*. (4th Edition). New York, USA: Garland Science.
2. Saccone, C. and Pesole, G. (2003). *Handbook of Comparative Genomics: Principles and Methodology*. (1st Edition). Hoboken, UAS: Wiley-Liss.

Suggested Readings

1. Town, C. (2002). *Functional Genomics*. (1st Edition). New York, USA: Springer.
2. Krebs, J.E., Golstein, E.S., Kilpatrick, S.T. (2010). *Lewin's GENES X*. (10th Edition). Middlesex, USA: Jones and Bartlett Publishers.
3. Al-Rubeai, M. and Fussenegger, M. (2010). *Systems Biology (Cell Engineering)*. (1st Edition). New York, USA: Springer.

BIOT-6122 **Biosafety and Bioethics** **2(2+0)**

This course will explore a rich content on prevention, standards and ethical principles which provide a basic awareness about biological integrity, focusing both on ecology and human health. We will discuss what actually the biosafety is? What are the major biohazards related to laboratory chemicals and intruments, what are some good laboratory practices, which should be followed strickly to avoid the biohazards. International rules and risks related to genetically modified organisms, awareness regarding genetic information will also be discussed. Euthanaisa is an important topic to discuss as it is under debate and many countries support this concept. Hence, the ethical issues regarding euthanasia will be discussed in detail. In addition to this, an important knowledge regarding ethical and moral concerns associated with patenting, benefit sharing and knowledge about role of national bioethics committees will also be delivered. Emerging cloning technologies as well as major biosafety levels/standards will be also be incorporated to enhance the understanding of students regarding biosafety.

Contents

1. Introduction to Biosafety
2. Definition
3. Concept
4. Uses and abuses of genetic information
5. Biohazards
6. Good laboratory practices
7. Risks related to genetically modified organisms (GMO)
8. International rules and regulations for biosafety and GMOs
9. Introduction to bioethics
10. Ethical issues related to GMOs
11. Euthanasia
12. Reproductive and cloning technologies
13. Transplants and eugenics
14. Patenting
15. Commercialization and benefit sharing
16. Role of national bioethics committees
17. Biosafety guidelines from a national perspective

Recommended Text

1. Krishna. V.S. (2007). *Bioethics and Biosafety in Biotechnology*. New Delhi, India: New Age International Publishers.
2. WHO (2006). *Laboratory Biosafety Manual*. (3rd Edition). New Delhi, India: AITBS Publishers and Distributors. (Available online free of cost)

Suggested Readings

1. Pakistan Environmental Protection Agency. (2005) National Biosafety Guidelines. (*Available online*)
2. The laboratory Biosafety Guidelines.3rd edition. USA: WHO.

3. BioTrad, and Access and benefit Sharing: From Concept to Practice. (A handbook for policymakers and regulators). Switzerland: UUNTCD.
4. The Oxford Handbook of Bioethics

SEMESTER – VII

BIOT-6123 Research Methodology and Skills Enhancement 3(3+0)

This course will familiarize students with various methods and tools used for conducting research and latest trends in the field of biotechnology through reading and understanding scientific literature. Introducing the students to various different types of manuscripts and the methods/steps involved in preparing a good scientific manuscripts, different online tools to find the articles related to the research topic, fetching the valueable information from articles, designing research projects, methods to collect data and interpretation of that data to come to the concluding point. This course will also help the students in learning the important skills to present their scientific knowledge in an effective way by using different techniques like posters and presentations, which are common method used in scientific community to share their knowledge. Introduction and importance of intellectual property rights will also be elaborated to improve the knowledge of students about patenting and securing their research, avoiding the unethical academic practices (Plagiarism) and its severe consequences.

Contents

1. Introduction; unethical academic practices (plagiarism)
2. Need of research and research types
3. Extraction and review of literature
4. Identifying a research problem and formulating a hypothesis
5. Designing a study; data collection, interpretation and analysis
6. Writing a research report, project, thesis and/or research article or review
7. Preparing posters
8. Making scientific presentations
9. Intellectual property.

Recommended Text

1. Bryman. A. (2001). *Social Research Methods*. (2nd Edition). New York, USA: Oxford University Press.
2. Awan, J.A. (2003). *Scientific Presentation*. Faisalabad, Pakistan: Unitech Communication.

Suggested Readings

1. Kothari, C.R. (2004). *Research Methodology: Methods and Techniques*. (2nd Edition). New Delhi, India: New Age International Publishers.
2. Durrani. S.A. (2004). *Technical Writing*. Islamabad, Pakistan: Higher Education Commission.
3. Kumar. R. and Kindersley. D. (2010). *Research Methodology: A Step by Step Guide for Beginners*. (3rd Edition). Ventura. USA: SAGE Publications.

BIOT-6124 **Environmental Biotechnology** **3(2+1)**

As environment palys an important role in the well being of human and all other species living on the earth. This course witll help the students to learn about the various factors of the environment and ways in which biotechnology is helping in improving/conserving the environment. The factors which disturbe the environmental balance e.g. different types and sources of pollution, methods/tools which can be used to measure pollution levels and help in reducing pollution burden will also be discussed in detail. Role of genetic manipulations and different strategies which can be used for genetic manipulation of living organisms for the betterment of environment, role of biodegradation and biotransformation of hazardous chemicals in reducing the pollution and improving the environment for species including human will also be the part of this course. To further emphasize the importance of environmental biotechnology, students will also be introduced to the various products of environmental biotechnology which are being used to improve the environment.

Contents

1. Introduction to environmental biotechnology; fundamentals of biological interventions
2. Genetic manipulation strategies in environmental biotechnology
3. Pollution indicators and pollution control strategies
4. Bioreactors
5. Domestic waste water treatment; industrial effluent treatment; sludge treatment
6. Contaminated land and bioremediation
7. Phytoremediation; landfills and composts
8. Concept of integrated environmental biotechnology
9. Biodegradation and biotransformation of hazardous chemicals
10. Products of environmental biotechnology.

Practicals

Biodegradation of environmental pollutants by microorganisms; bacteriology of drinking water; microscopic studies of water specimens collected from various locations; field survey of polluted areas and field study for pollution indicators (e.g., plants, microorganisms and air).

Recommended Text

1. Vallero D. (2015). *Environmental Biotechnology: A Biosystems Approach.* (2nd Edition). New York. USA: Academic Press
2. Chatterji A.K. (2011). *Introduction to Environmental Biotechnology.* (3rd Edition). Delhi. India: Prentice-Hall of India

Suggested Readings

1.Fluker, M.H. (2010). *Environmental Biotechnology*. Boca Raton. USA: CRC Press.
2. Evans. G.M. and Furlong, J.C. (2010). *Environmental Biotechnology Theory and Application.* (2nd Edition). Hoboken. USA: Wiley-Blackwell.
3. Srinivas. T. (2008). *Environmental Biotechnology*. (1st Edition). New Delhi. India: New Age International Publishers.

BIOT-6125 **Health Biotechnology** **3(3+0)**

The purpose of this course is to acquaint students with biotechnology in healthcare including diagnostic tools, immunization and therapeutics. The course will emphasize the understanding of the molecular basis of the disease and role of molecular and genetic markers in the disease onset, progression and diagnosis. Various mutations and polymorphisms involved in the disease, infectious agents and their associated pathologies and importance of active and passive immunization to combat these pathologies. Different types of Vaccines including traditional and modern vaccine and their importance as protection from different viral and bacterial pathogen. Emerging needs for organ transplantation. causes of organ failure and problems associated with organ transplantation. Students will also be familiarized with the importance of animals as disease models, organ and food providers. Indtroduction to the traditional and modern treatment methods, role of pharmacogenetics, gene therapy, stem cell technology and various drug delivery systems in treating a disease will also also be explained.

Contents

1. Introduction to health biotechnology;
2. Social acceptance of medical biotechnology;
3. Molecular basis of disease; molecular and genetic markers
4. Detection of mutations and infectious agents; active and passive immunization
5. Vaccines (live, killed, recombinant DNA vaccines, subunit vaccines, DNA vaccines, edible vaccines).
6. Organ transplantation;
7. Applications of transgenic animals (animal models of diseases, farming and enhancement of farm animals).
6. Drug delivery systems; blood transfusion and grafting techniques
7. Pharmacogenetics; gene therapy; biopharmaceuticals from plants: stem cell technology

Recommended Text

1. Pongracz, J. and Keen, M. (2009). *Medical Biotechnology*. (1st Edition) . Haryana, India: Elsevier Health Sciences.
2. Schacter. B.Z. (2005). *Biotechnology and Your Health: Pharmaceutical Applications*. New York. USA: Chelsea House Publishers.

Suggested Readings

1. Bustillo. L.G.T. and Pena, I.G. (2012). *Biotechnology: Health, Food, Energy and Environment Applications (Biotechnology in Agriculture, Industry and Medicine)*. New York. USA: Nova Science Publication.
2. Dogramatzis. (2010). *Health care Biotechnology*. (1st Edition). Boca Raton. USA: CRC Press.

SEMESTER – VIII

BIOT-6126 **Industrial Biotechnology** **3(2+1)**

The main aim of biotechnology is to improve and ease the life of human and industry is playing an important role in producing various valuable products for the betterment of mankind and make their work easier and quicker. Industrial biotechnology use the biotechnological approaches involving the miroorganisms to generate various products at production scale. This subject will help to enhace the knowledge of students about the microorganism that are commonly used in industory, nutritional requirments of these industrial microorganism and the various types of media which can be used to fullfill these nutritional requirments. Screening of valueable strains of microorganism and their culture collections, importance of fermentation technology and various types of fermenters which can be used for the growth of these miroorganims at industrial scale, purification and extraction of fermented products, role of proteins produced by industrial miroorganisms as food products, biocatalyst and bioinsecticides will be explained. Moreover, the use of industrial microorganism in the production of vaccine and antibiotics will also be the focus of this course.

Contents

1. Industrial biotechnology – introduction and scope
2. Microorganisms commonly used in industry; media and nutritional requirements of industrial organisms
3. Screening for productive strains and strain improvement; culture collections
4. Fermentation and fermenters; extraction of fermented products; production of beer, wines, spirits and vinegar
5. Use of single cell proteins as food products; biocatalysts; microbial insecticides
6. Production of metabolites: organic acids and amino acids
7. Vaccines and antibiotic production

Practicals

Isolation of *lactobacillus* from dairy products, fruit juices. etc.; fermentation of different sugars by bacteria (or other microorganisms); identification of proteases/ amylases producing bacteria; extraction of hydrolytic crude enzymes from microbes; effect of environmental factors (e.g., pH, temperature, salt, etc.) on activity of crude enzymes.

Recommended Text

1. Watson K. (2016). *Industrial Biotechnology*. (Vol 1 & 2). Delhi. India: Atithi Medical Book Ltd.
2. Hazare et al (2014). *Handbook of Food and Industrial Biotechnology*. Florida, USA: CRC Publishers.

Suggested Readings

1. Shara, L.A. (2009). *Industrial Biotechnology*. (1st Edition). New York, USA: Nova Science Publishers.
2. Singh, R. and Ghosh, S. (2004). *Industrial Biotechnology*. New Delhi, India: Global Vision Publishing House.
3. Prasad, N.K. (2012). *Downstream Process technology, A New Horizon in Biotehnology*. Delhi. India: PHI Learning Ltd.

BIOT-6127 **Food Biotechnology** **3(3+0)**

Food biotechnology is a process scientists use to enhance the production, nutritional value, safety, and taste of foods. The purpose of this course is to acquaint students with the role of microorganisms in food and the food industry in addition to principles of enzymology, and food engineering. The course emphasizes modern techniques in food microbiology, biotechnology and food analysis. Course focused on recent developments and applications of modern genetics as well as enzyme, cell, tissue, and organ-based biological processes to produce and improve foods, food ingredients, and functional foods. Other areas of strong interest are fermentation to improve foods, food ingredients, functional foods, and food waste remediation. The course is beneficial to develop an in depth knowledge of food science, and food processing and composition, focusing on biotechnology applied to food.

Contents

1. Food composition
2. Probiotics
3. Fermented foods
4. Food enzymes
5. Colors and additives
6. Overview of metabolic engineering of bacteria for food ingredients
7. Techniques used for production of food ingredients by microbes
8. Genetic modification of plant starches for food application
9. Biotechnological approaches to improve nutritional quality and shelf life of fruits and vegetables
10. Microbial food spoilage and food borne diseases; detection and control of food borne bacterial pathogens
11. Food safety and quality control; international aspects of quality and safety assessment of food derived by modern biotechnology.

Practicals

Pure culture study of fermented products such as yogurt, bread, pickles, acetic acid etc.; isolation and handling of microbial flora of fermented products as *Lactobacilli, Saccharomyces, Aspergillus, Acetobacter* etc.; preparation of fermented products using pure cultures; effect of pH on the microbial flora of different fermented products.

Recommended Text

1. Joshi, V.K. (2012). *Food Biotechnology*. (1st Edition) . Delhi, India: I K International Publishing House.
2. Campbell-Platt, G. (2009). *Food Science and Technology*. (1st Edition). Hoboken, USA: Wiley-Blackwell.

Suggested Readings

1. Belitz, H.D. (2009). *Food Chemistry*. (4th Edition). New York, USA: Springer.
2. Nielsen, S.S. (2010). *Food Analysis*. (4th Edition). New York, USA: Springer.
3. Singh, R.P. (2008). *Introduction to Food Engineering*. (4th Edition). New York, USA: Academic Press.

ELECTIVE/SPECIAL PAPER COURSES

BIOT-6128 **Cell and Tissue Culture** **3(2+1)**

The aim of this course is to provide students with a thorough understanding of the importance of cell, tissue and organ culture and its application in life sciences. This course provides students with a sound, practical, and theoretical knowledge of key techniques to perform cell culture. Topics include cell and tissue culture, nutritional requirments of different cells/tissues, preparation of media for culturing, various types of cell cultures (on solid media or in suspensions), the growth environment, routine maintenance of cell cultures, cryopreservation, transfection, somaclonal variations, regeneration of plants, micropropagation and cell counting. Other topics include cloning techniques, suspension culture, serum-free culture, evaluation of cryopreserved cells, extraction of DNA from mammalian cells, and use of multi-well plates in cell culture, animal cells for bioassays and bioproducts, design and operation of animal cell culture bioreactors for therapeutic protein production, growth environment, Stem cell culture. Upon completion, students should be able to demonstrate the knowledge and skills required to initiate, maintain, and manipulate cells in culture.

Contents

1. Plant cell and tissue culture: requirements for *in vitro* cultures; culture facilities
2. Sterile techniques; media preparation and handling; callus cultures; cell suspension cultures; protoplast culture; haploid cultures, organ culture; meristem culture for virus elimination
3. Embryo culture and embryo rescue; regeneration of plants and micropropagation; somaclonal variation
4. Industrial uses of plant cell culture; tissue culture in genetic engineering and biotechnology.
5. Mammalian cell culture: origin and principles of cell culture
6. Qualitative characteristics of cell cultures; cell counting and analysis
7. Cryopreservation; cell banking and subculture (variety of different systems).
8. Primary cell culture techniques; development of immortalized cell line; detection of microbial contaminants
9. Animal cells for bioassays and bioproducts
10. Design and operation of animal cell culture bioreactors for therapeutic protein production: growth environment; Stem cell culture

RECOMMENDED TEXT

1. Setlow, J.K. (2000). *Genetic Engineering: Principles and Methods*. Norwell, USA: Kluwer Academic Publishers.
2. Nicholl, D.S.T. (2002). *An Introduction to Genetic Engineering*. (2nd Edition). Cambridge, United Kingdom: Cambridge University Press.

Suggested Readings

1. Razdan, M.K. (2003). *Introduction to Plant Tissue Culture*. (2nd Edition). New York, USA: Intercept.
2. Lanza, R., Langer, R., Vacanti, J.P., Atala, A. (2000). *Principles of Tissue Engineering*. (2nd Edition). New York, USA: Academic Press.

3. Punia, M.S. (1999). *Plant Biotechnology and Molecular Biology: A Laboratory Manual*. London, United Kingdom: Scientific Publishers.

BIOT-6129 **Marine Biotechnology** **3(3+0)**

Marine biotechnology is the creation of products and processes from marine organisms through the application of biotechnology, molecular and cell biology, and bioinformatics. This course will acquaint students with recent advancements in the field of marine biotechnology and how molecular techniques may be applied for studying marine organisms. Main focus of this course is to provide the basic knowledge about the marine microorganisms, marine microflora, phytoplankton, role of marine microbes in the global carbon cycling. This course will also provide the insight to the genomic organization of marine organisms which will help in assessing the beneficial characteristics of marine organisms and genetic manipulation of marine organism for their improvement. Moreover, aquaculture techniques for the production of beneficial marine organisms as source of food and primary and secondary metabolites, recent progress in the discovery of drugs and enzymes from the marine sources will also be discussed with the students to emphasize the importance of marine biotechnology.

Contents

1. Introduction to marine microorganisms
2. Introduction to marine biotechnology
3. Marine flora/phytoplankton
4. Aquaculture techniques
5. Marine microbes of biotechnological importance
6. Primary and secondary metabolites (e.g., antibiotics, organic acids, toxins, etc).
7. Role of marine microbes in global carbon cycling
8. Genomics of marine organisms
9. Recent progress in discovery of drugs and enzymes from marine sources.

Recommended Books

1. Gale, Y.L. (2010). *Marine Biotechnology I (Advances in Biochemical Engineering Biotechnology)*. New York, USA: Springer.
2. Gale, Y.L. (2010). *Marine Biotechnology II (Advances in Biochemical Engineering Biotechnology)*. New York, USA: Springer.

Suggested Readings

1. Johansen, M.N. (2011). *Microalgae: Biotechnology, Microbiology and Energy*. New York, USA: Nova Science Pub Inc.
2. Buchholz, R. (2012). *Microalgae Biotechnology*. Boston, USA: Walter De Gruyter Inc.
3. Gale, Y.L. (2010). *New Developments in Marine Biotechnology*. New York, USA: Springer.
4. Kim, S.K. (2011). *Handbook of Marine Microalgae: Biotechnology and Applied Physiology*. (1st Edition). Hoboken, USA: Wiley.

BIOT-6130 **Molecular Biology of Insects and Insect Viruses** **3(3+0)**

Insects are very important for human health and the bio balance of our planet. On one side, they are useful by playing an important role in maintaining the balance in nature, while on other side, they are also harmful, such as the invasion of locusts. It is very important to study the molecular biology of insects and the viruses which infect the insects to dig their beneficial roles. The purpose of this course is to familiarize the students to the molecular biological of insects and insect viruses. For insect viruses, the baculovirus as well as other insect viruses and their use in insect pest control and as an efficient expression vector for expression of foreign genes will be studied. Furthermore, this course will also include some other topics: classification of insect viruses, Insect parasites and polydnaviruses, use of insects and viruses to study functional genomics, biological control using insect viruses. Students will also be provided with the knowledge of tools necessary to express foreign genes of their own interest using the baculovirus expression vector systems.

Contents

1. Insects: model for molecular biology
2. Classification of insects using molecular biological technique/ DNA barcoding
3. Insects as a vector of plants and animal diseses
4. Defense mechanisms of insects and its molecular biology.
5. Classification of insect viruses
6. Insect parasites
7. Polydnaviruses
8. Gene structure of baculovirus and construction of expression vectors
9. Use of insects and viruses to study functional genomics
10. Biological control using insect viruses.

Recommended Text

1. Crampton, J.M., Beard, C.B., Louis, C. (1997). *The Molecular Biology of Insect Disease Vectors: A Methods Manual*. London, United Kingdom: Chapman & Hall Ltd.
2. Gilbert, L.I. (2012). *Insect Molecular Biology and Biochemistry*. New York, USA: Academic Press.

Suggested Readings

1. Schoonhoven, L.M., Van Loon, J.J., Dicke, M. (2005). *Insect-Plant Biology*. New York, USA: Oxford University Press.
2. Hall, J.C. (2003). *Genetics and Molecular Biology of Rhythms in Drosophila and Other Insects*. (1st Edition). New York, USA: Academic Press.
3. Jarvis, D. L. (1997). *Baculovirus Expression Vectors*. New York, USA: Springer.

BIOT-6131 **Pharmaceutical Biotechnology** **3(3+0)**

Pharmaceutical biotechnology is an emerging field in the pharmaceutical industry owing to its many benefits over the conventional pharmaceutics. This course will familiarize the students to the basic differences between the biopharmaceutical and pharmaceutical, general process of drug development, properties of effective drug. In the drug development process, each step starting from the selection of lead molecule to the purification of biopharmaceutical and its final packing will be elaborated in details to make the students able to understand all the precautionary measures taken at each step and the hurdles (contaminations) that can make the production of biopharmaceutical a challenging task. Various technologies like genomics, proteomics, structural genomics etc. which help in the selection of lead molecule will be discussed. Moreover, the methods/test conducted at various stages of drug testing. role of excepients and various polymers which are commonly used in pharmaceutical industry to improve the drug characteristics/activity and controlled drug release systems will also be explained. Furthermore, legal and regulatory issues associated with the biopharmaceuticals will also be discussed.

Contents

1. Introduction and basic concepts of pharmaceutical biotechnology
2. Properties of an effective drug: drug development process; selection of a lead molecule from available pool
3. Lab scale studies, pilot scale studies and clinical trials (Phase I, II and III).
4. Drug toxicity; impact of genomics and other related technologies on drug discovery
5. Use of DNA and protein microarrays in identification of disease targets and for monitoring effectiveness of drugs
6. Pharmacogenomics; plants and microorganisms as sources of drugs
7. Polymers: classification, polymerization and characterization
8. Controlled drug release system and its advantages and disadvantages over conventional release methods; legal and regulatory issues.

Recommended Text

1. Kayser, O. (2012). *Pharmaceutical Biotechnology: Drug Discovery and Clinical Application*. (2nd Edition). Hoboken, USA: Wiley-Blackwell.
2. Walsh, G. (2007). *Pharmaceutical Biotechnology: Concepts and Applications*. (1st Edition). Hoboken, USA: Wiley.

Suggested Readings

1. Ende, D.J. (2010). *Chemical Engineering in the Pharmaceutical Industry: R & D to Manufacturing*. (1st Edition). Hoboken, USA: Wiley.
2. Subramanian. G. (2012). *Biopharmaceutical Production Technology*. (1st Edition). Hoboken. USA: Wiley-VCH.
3. Crommelin. *et al*., (2007). *Pharmaceutical Biotechnology: Fundamentals and Applications*. (3rd Edition). London. United Kingdom: Informa Healthcare.
4. Kokate. C. (2012). *Textbook of Pharmaceutical Biotechnology*. Amsterdam. Netherlands: Elsevier.

BIOT-6132 **Animal Biotechnology** **3(3+0)**

The purpose of this course is to acquaint students with techniques for engineering transgenic animals and embryonic micromanipulations. Importance of animals as providers of food and non-food items, improving the characteristics of animals by genetic manipulations using various different techniques e.g. transformation, transfection, microinjection etc.screeening of transgenic animals at DNA or protein levels will be included in this course. Along with these, this course will also include the biotechnological techniques in animal breeding, different animal breeding strategies, role of synthetic biopeptides like somatotropine, synthetic gonadotropin-releasing hormone in animal health, production and use of monoclonal anitibodies in diagnosis of animal diseases and as therapeutic agents to treat the disease. role of cytokines and their potential use in diagnosis of microbial infections. Furthermore, introduction to micromanipulation, various techniques used for micromanipulation of farm animal embyos for increasing the animal number will also be discussed.

Contents

1. Introduction and history of transgenic animals
2. Role of synthetic peptides/proteins in animal health
3. Use of monoclonal antibodies as a diagnostic/therapeutic agents
4. Cytokines and their potential therapeutic value as applicable to the diagnosis of microbial infections
5. Micromanipulations of farm animal embryos
5. Use of biotechnological techniques in animal breeding strategies
7. Gene transfer through embryo microinjection
6. Ethical and social issues in animal biotechnology.

Recommended Text

1. Freshney, I.R. (2010). *Culture of Animal Cells: A Manual of Basic Techniques and Specialized Application.* (6th Edition). Hoboken, USA: Wiley-Blackwell.
2. Masters, J.R. (2000). *Animal Cell Culture.* (3rd Edition). New York, USA: Oxford University Press.

Suggested Readings

1. Barnum, S. (2004). *Biotechnology: An Introduction.* (Updated Edition (with Infotrac)). Belmont, USA: Brooks Cole Publishing.

2. Tourte, Y. and Catherine, T.C. (2005). *Genetic Engineering and Biotechnology: Concepts, Methods, and Agronomic Applications*. New Delhi, India: Science Publishers.

3. Houdebine, L.M. (2003). *Animal Transgenesis and Cloning.* (1st Edition). Hoboken, USA: John Wiley and Sons.

BIOT-6133 **Fungal Biotechnology** **3(3+0)**

Fungi are a critical component of the diversity and function of terrestrial ecosystems. They regulate decomposition rates, facilitate plant nutrient uptake and have a profound impact on agriculture, economics and human affairs. The goal of this course is to provide an introduction to the key components of mycology(study of fungi), including ecology, physiology, genetics and diversity. The course will also cover major groups of fungi and their key morphological features and lifecycles. Laboratories are intended to give hands-on experience with the diverse range of fungal organisms covered in lectures. The basic biology of fungi, including growth, structure, genetics, diversity, the commercial uses of fungi and their importance as model organisms. Also discusses the interactions between fungi and plants and fungi and humans. Moreover, metobiltes which are produced by fungi and play an important role in medical, agricultural and industrial biotechnology would also be discussed. Light will be shed on the role of biotechnology in control of pathogenic fungi and applications of fungal biotechnology in various other fields.

Contents

1. Introduction to mycology; production techniques used in fungal biotechnology
2. Metabolites produced by fungi
3. Utilization of fungi in medical and agricultural biotechnology
4. Industrial uses of fungi including food manufacturing
5. Bio-deterioration and biodegradation
6. Biotechnology and the control of pathogenic fungi
7. Current applications of fungal biotechnology
8. Screening of fungal metabolites; mycotoxins.

Practicals

Fungal morphology; identification of fungi; sexual and asexual reproductive structures of fungi; DNA extraction from hyphae and zoospores; molecular techniques for detecting genetic variations among different fungi.

Recommended Text

1. Rai, M. (2009). *Advances in Fungal Biotechnology*. New Delhi, India: I.K. International Pvt. Ltd.
2. Prakash, A. (2008). *Fungi in Biotechnology*. Delhi, India: CBS publishers.

Suggested Readings

1. Sati, S.C. (2007). *Recent Mycological Research: Fungal Biotechnology*. New Delhi, India: I.K. International Publishing House.
2. Rai, M. (2009). *Advances in Fungal Biotechnology*. New Delhi, India: I.K. International Publishing House.
3. Arora D.K. (2003). Handbook of Fungal Biotechnology. (2nd Edition). Boca Raton. USA: CRC Press.
4. Tkacz, J.S. and Lange, L. (2004). *Advances in fungal Biotechnology for Industry, Agriculture and Medicine*. (1st Edition). New York, USA: Springer.

BIOT-6134 **Water and Waste Water Treatment** **3(2+1)**

This course is an overview of various approaches to protecting water quality with an emphasis on fundamental principals. In this course, sources and characteristics of drinking and waste water, theory and conceptual design of systems for treating industrial wastewater and drinking water will be discussed, as well as reactor theory, process kinetics, and models. As industrial effluents (industrial waste water) is the major source of water pollution, hence, treatment process of industrial effluent, its various modifications and recycling technology will be discussed in detail. Physical, chemical, and biological processes will also be presented, including sedimentation, filtration, biological treatment, disinfection, sludge processing etc. Many biology based solutions are presented to solve the issues of waste water, so the role and characterization of microorganisms helpful in waste water treatment along with waste management will be studied. Finally, there will be discussion on engineered, natural or combination processes for wastewater treatment, their benefits and drawbacks.

Contents

1. Water and wastewater sources and characteristics
2. Drinking water treatment process
3. Industrial effluent treatment process; novel treatment processes and recycling technology
4. Theory and application of commonly used processes; sedimentation, coagulation, filtration, disinfection, gas transfer, activated sludge, trickling filters, oxidation ponds, sorption, and sludge stabilization and disposal
5. Process combinations to produce treatment systems
6. Role of microorganisms in waste treatment;
7. Utilization and management of waste
8. Microbial characterization.

Practicals

Designing individual aerobic and anaerobic unit processes; physicochemical characteristics of drinking water and waste water; analytical analysis of drinking and waste water for detecting heavy metals and minerals.

Recommended Text

1. Metcalf and Eddy. (2003). *Wastewater Engineering: Treatment, Disposal, and Reuse.* (4th Edition). New York, USA: McGraw-Hill.

Suggested Readings

1. Bitton, G. (2011). *Wastewater Microbiology.* (4th Edition). Hoboken, USA: Wiley-Blackwell.
2. Csuros, M. and Csuros, C. (1999). *Microbiological Examination of Water And Wastewater.* (1st Edition). Boca Raton, USA: CRC Press.
2. Maier. (1999). *Environmental Microbiology.* New York, USA: Academic Press.

BIOT-6135 **Plant Biotechnology** **3(2+1)**

This course will provide comprehensive introduction on plant biotechnology, detection of pathogenic microbes in plants, molecular markers etc. More specifically, this course introduces Plants derived pharmaceuticals. This course will also give experimental insight into the basic and advanced techniques used in genetic engineering of plants. Moreover, the theory of this course will cover all the important topics starting from the history of plant biotechnology to the fingerprinting techniques and use of RNAi and genome editing in crops. Role of molecular markers and marker assisted selection of plants, rights of breeders anf farmers, plant variety protection, patenting of plants or plant products, genetic engineering techniques used in plant biotechnology to improve the phenotypic characteristics, growth and production of plants, vectors used in plant genetic engineering, culturing of plant tissues. green house and field growth of genetically manipulated plants, plant databases and storage of plant tissues also comes under the umbrella of this course.

Contents

1. Introduction in Plant Biotechnology, history and general information
2. PCR application in plants and Detection of Pathogenic microbes in plants
3. Molecular Markers and Marker-assisted selection, Use of molecular tools to access genetic diversity among closely related plant species
4. Fingerprinting techniques
5. Plant breeders' and Farmers' rights, Plant variety protection, Convention of biodiversity and Patenting.
6. History of plant tissue culture/genetic engineering, Plant tissue culture media components, nutrients, phytohormones, carbohydrate sources, gelling agents, antibiotic
7. Preparation and storage of culture media, Contamination issue and tests, Explant sources, Culture initiation, and types
8. Vector design and construction. Vector components, *Agrobacterium*-mediated transformation. Monocot vs dicot protocols. Binary vectors. *Agrobacterium* culture / co-cultivation. Floral dip vs. other target tissues, Microprojectile bombardment-mediated transformation, Direct DNA delivery methods and parameters,Microcarrier preparation. Selection and regeneration of transgenic plants
9. Media manipulations, Subculture and selection screenable marker assays, Regeneration and transplanting, Molecular, genetic and expression assays, Greenhouse and field growth of transgenic plants,
10. Plant biotechnology data collection and management, Databases, Experimental design and analysis, Data summary and interpretation
11. Developments and issues in plant biotechnology, RNAi and VIGS, Plants derived pharmaceuticals. Impact on cropping systems, Novel applications and Risk assessment/management.

Practicals

Sterilization techniques. Genomic DNA extraction and quatification. PCR using a 2-step PCR protocol, universal degenerated oligonucleotide primers to isolate specific chromosomal regions. DNA sequencing and use of GenBank to compare with known sequences. Plant tissue culture media components. Explant isolation. Culture initiation. Sub-culturing. Bacterial culture growth. *Agrobacterium* culture growth. Arabidopsis/Maize transformation. Target tissue preparation. Microcarrier coating. Biolistic DNA delivery. Selection of callus sectors. GUS. GFP assays.

Transgenic seedling screens, Transplanting of regenerants, DNA isolation and assays, Southern blot interpretation, PCR assays.

Recommended Text

1. Christou, P. and Klee, H. (2004). *Handbook of Plant Biotechnology*. Hoboken, USA: John Wiley and Sons, Inc.
2. Chawla, H.S. (2010). *Introduction to Plant Biotechnology*. (3rd Edition). Boca Raton, USA: CRC Press.

Suggested Readings

1. Slater, A. (2008). *Plant Biotechnology: The Genetic Manipulation of Plants*. (2nd Edition). New York, USA: Oxford University Press.
2. Miglani, G.S. (2013). *Gene Expression*. Oxfor, United Kingdom: Alpha Science Intl Ltd.

BIOT-6136 **Biofertilizers And Biopesticides** **3(3+0)**

Biofertilizers are defined as preparations containing living cells of microorganisms that help crop plants' uptake of nutrients by their interactions in the rhizosphere when applied through seed or soil. They accelerate certain microbial processes in the soil which augment the extent of availability of nutrients in a form easily assimilated by plants. As an alternative to chemical pesticide, a biopesticide consists of naturally occurring or genetically engineered microorganisms (such as bacteria) and pose less risk to the environment. This course aim to acquaint students with techniques and skills employed for production and using biofertilizers and biopesticides due to their benefits over conventional chemical fertilizers and pesticides. This course will cover types and function of biofertilizers and biopesticides, the nutritional requirments and media available for the growth of microorganisms. media preparation to ful fill the nutriotional requirments of microorganisms, disease and insect interaction, plant and microorganism interactions, characterization of useful microbial strains, compare and contrast the biofertilizers and biopesticides with traditional chemical fertilizers and pesticides, barriers to the use of biofertilizers and biopesticides.

Contents

1. Introduction to Biofertilizers, Types of biofertilizers
2. Media preparation and staining techniques
3. Advantages of biofertilizers over chemical fertilizers
4. Preparation of carrier based biofertilizers
5. Introduction to Biopesticides
6. Types of biopesticides and their function
7. Benefits and Barriers to Biopesticide Use
8. Successfully Using Biopesticides
9. Disease and Insect Control Products,
10. Safety Review
11. Mass scale production,
12. Scale up and formulation.

Recommended Text

1. Suri, S. (2011). *Biofertilizer and Biopesticide*. Delhi, India: APH Publishing Corporation.

Suggested Readings

1. Board. N. I. I. R. (2004). The Complete Technology Book on Bio-fertilizer and Organic Farming. National Institute of Industrial Research.
2. Deshmukh, A.M., Khobragade, R.M. and Dixit P.P. (2007). *Handbook of Biofertilizers and Biopesticides*. Oxford. United Kingdom: Oxford Book Company.

BIOT-6137 **Nano-Biotechnology** **3(3+0)**

The nano-biotechnology course is an interdisciplinary course that describes an emerging discipline dedicated to the generation of products, devices for biotechnology and bioengineering applications through integration of biology, chemistry, engineering and state-of-the-art nanotechnology, starting at the molecular level. The goal of this course is to ignite student's interests in this field by exposing them to diverse amazing projects. Students will gain abilities to integrate their multidisciplinary knowledge and skills into the interdisciplinary research project designs. This course aim to acquaint students with key integrative technologies and use of nanoparticles in biological systems. This course will introduce the studenst to the nanoparticals which can be used in medical, agriculture and industrial applications, quatum dots, nano tubes, nano rods. They will also explore the natural biological assembly at nanoscale and nanometric biological assemblies and their applicatioons, nano bionics and applications of nano-biotechnology in cosmetics, agriculture, waste treatment. Moreover, the issues related to the nano-biotechnology and future prospectives will also be discussed

Contents

1. Introduction; interface between nanotechnology and bionanotechnology
2. Manipulating molecules
3. Carbon fullerenes and nanotubes
4. Non-carbon nanotubes and fullerene-like materials
5. Quantum dots; nanowires, nanorods and other nanomaterials
6. Magnetic nanoparticles
7. Natural biological assembly at the nanoscale
8. Nanometric biological assemblies (complexes).
9. Nanobionics and bio-inspired nanotechnology
10. Applications of biological assemblies in nanotechnology
11. Medical, cosmetics, agriculture, water and other applications of nanobiotechnology
12. Future prospects of nanobiotechnology
13. Use of nanotechnology for diagnosing and curing disease.

Recommended Text

1. Gazit, E. (2007). *Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology*. (1st Edition). London. United Kingdom: Imperial College Press.
2. Renugopalakrishnan, V. and Lewis, R.V. (2006). *Bionanotechnology: Proteins to Nanodevices*. New York. USA: Springer.

Suggested Readings

1. Prinz, F.B., Smith, R.L., Greco R.S. (2004). Nanoscale Technology In Biological Systems. Boca Raton, USA: CRC Press.
2. Mirkin, C.A. and Niemeyer, C.M. (2007). *Nanobiotechnology II: More Concepts and Applications*. Hoboken, USA: John Wiley & Sons.
3. Niemeyer C.M. and Mirkin, C.A. (2004). *Nanobiotechnology*. (1st Edition). Hoboken, USA: Wiley-VCH.

BIOT-6138 **Molecular Diagnostics** **3(2+1)**

This course will give a comprehensive introduction to the basic principles of the rapidly growing field of molecular diagnostics. Beginning with an overview of essentials and unique terminologies, the course addresses many direct and amplified nucleic acid test methods involving various basic molecular biology/biotechnology techniques like Polymerase chain reaction (PCR), restriction fragment length polymorphisms (RFLP), Ampifies fragment length polymorphisms (AFLP), DNA sequencing, blotting techniques. Enzyme-linked immunosorbant assays (ELISA), and advance molecular biology technology techniques like Immunofluorescence staining and immunohistochemistry, micro-arrays, *in situ* hybridization, molecular cytogenetics etc. Specimen handling, and the clinical applications, advantages, and disadvantages of molecular diagnostics will also be covered. Most importantly, the principles behind molecular diagnostics will be presented in detail, providing the students with strong foundation for future exploration and study in molecular diagnostics. Moreover, experimental insight into these techniques will give the students more comprehensive understanding of the basic principals behind these techniques commonly use in molecular diagnositics.

Contents

1. Introduction and applications of molecular diagnostics techniques in agriculture and forensic sciences
2. Polymerase chain reaction (PCR)
3. Detection of mutations and single nucleotide polymorphisms (SNPs) by restriction fragment length polymorphisms (RFLPs)
4. DNA sequencing
5. Blotting techniques (e.g., Southern, Northern and Western).
6. Enzyme-linked immunosorbant assays (ELISA).
7. Immunofluorescence staining and immunohistochemistry
8. Micro-arrays
9. *in situ* hybridization
10. Molecular cytogenetics.

Practicals

ELISA; PCR.Visits to various diagnostic, pathology laboratories and/or research institutes.

Recommended Text

1. Debnath. M., Prasad, G.B.KS., Bisen, P.S. (2010). *Molecular Diagnostics: Promises and Possibilities*. New York, USA: Springer.
2. Wilson, D.D. (2008). *Manual of Laboratory and Diagnostic Tests*. New York, USA: McGraw-Hill publisher.

Suggested Readings

1. Buckingham. L. (2007). *Molecular Diagnostics Fundamentals, Methods, and Clinical Applications*. (1st Edition). Philadelphia, USA: F.A. Davis Publisher.

2. Walker, J.M. and Rapley, R. (2005). *Medical Biomethods Handbook*. New York, USA: Humana Press.
3. Brown, T.A. (2016). *Gene Cloning and DNA Analysis*. (7th Edition). Hoboken, USA: Wiley-Blackwell.

BIOT-6139 **Biosensors** **3(3+0)**

The purose of this course is to acquaint students with fundamentals of sensors that are capable of specifically detecting minute quantities of various individual biomolecules or those displayed on cellular or viral surfaces. This course will introduce the students to the highly interdisciplinary field of biosensors. After an overview of the fundamental principles, the course will introduce various strategies to apply the scientific theory and mechanisms to practical issues such as immunoassays, detection of DNA mutation or environmental toxin, metabolic activity, an *in-vivo* neuronal signal monitoring. The students will be exposed to recent publications that highlight key advances in this field and learn how various chemical, biological and engineering concepts used in synergy to achieve state-of the-art sensing of important biological molecules. Emphasis will be placed on active participation by students, including literature presentations, critical evaluation of articles, concise technical writing and in-depth discussion. After studying this course, students will be able to distinguish common and different challenges of major electrochemical biosensor applications, mark critical design and selection decisions with respect to the target application and practical limitations.

Contents

1. Introduction; miniaturization and microsystems including sensing by optical techniques
2. Field-effect transistors
3. Ion-selective and enzyme-sensitive electrodes
4. Biological signals and their types
5. Amperometric biosensors based on redox enzymes
6. Potentiometric biosensors and enzyme field effect transistors (ENFET).
7. Thermal biosensors;
8. Optical biosensors based on redox enzymes
9. Indirect affinity sensors
10. Optical and electrical antibody-based biosensor
11. Direct affinity detection using surface plasmon resonance
12. Piezoelectric biosensors.

Recommended Text

1. Villadsen, J., Nielson, J., Liden. G. (2003). *Bioreaction Engineering Principles*. (2nd Edition). Norwell. USA: Kluwer Academic.
2. El-Monsi, E.M.T., Bryce. C.F.A., Demain, A.L., Allman, A.R. (2011). *Fermentation Microbiology and Biotechnology*. (3rd Edition). Boca Raton. USA: CRC Press.

Suggested Readings

1. Bone, S. and Zaba. B. (1992). *Bioelectronics*. (1st Edition). Hoboken. USA: Wiley.
2. Hall. E.A.H. (1991). *Biosensors*. Hoboken, USA: John Wiley & Sons.
3. Koryta. J. (1993). *Ions, Electrodes and Membranes*. (2nd Edition). Hoboken. USA: John Wiley & Sons.

BIOT-6140 **Virology** **3(3+0)**

This course is designed to introduce the students to the field of virology. This course will give them knowledge of the components of viruses, their replication schemes, structure and genetics of viruses, and how the various types of animal and plant viruses infect, replicate in host cells and immune system respond to these viruses.Pathogenis of viruses, diagnosis of viral infections and role of vaccines and antiviral drugs against these viruses is also a part of this course. This course will give the students foundational knowledge to understand methods used to prevent viral infection and spread. Upon completion of this course students will be able to understand the cumulative and integrative nature of virology as a discipline.They will have solid knowledge of viral infection and replication schemes and how those are exploited to develop drugs to prevent/treat viral infection or used as a tool to treat and cure other diseases.

Contents

1. Historical perspective
2. General properties of viruses
3. Classification and nomenclature
4. Virus structure and assembly
5. Replication cycle and genetics of viruses
5. Animal and plant viruses; propagation
6. Detection and quantification of viruses
7. Pathogenesis and immune response of viral infections
8. Laboratory diagnosis of viral diseases
9. Vaccines and antiviral drugs
10. Epidemiology; tumor viruses
11. Viral vectors and gene therapy;
12. Emerging viruses
13. Specific aspects of selected viral diseases

Recommended Text

1. Flint, S.J., Racaneillo, V.R., Raal, G.F., Skalka, A.M., Enquist, L.W. (2009). *Principles of Virology*. Washington,USA: ASM Press..
2. Lal, S. (2007). *The Biology of Emerging Viruses*. Hoboken, USA: Wiley-Blackwell.

Suggested Readings

1. Wagner, E.K., Hewlett, M.J., Bloom, D.C., Camerini, D. (2007). *Basic Virology*. (3rd Edition). Hoboken, USA: Wiley-Blackwell.
2. Flint, S.J. (2009). *Principles of Virology*. (3rd Edition). New York, USA: AMS Press.

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BIOT-6141 **Radiobiology** **3(3+0)**

Radiobiology is mainly concerned with the effects of ionizing radiation on organisms and the applications in biology of radiological techniques. This course is designed to acquaint students with use of radiation and radioactive materials in agriculture, health and basic research. This course will cover all the basic and advance topics related to radiobiology including: types and sources of radioisotopes with major emphasis on the radioisotopes used in medical and biological processes, types and sources of radiations, introduction and physics of radioactive substances, influences of radiations on living cells, effect of different exposure times of radiations on living cells, exposure and radiation dose-effect, molecular basis of cellular effects, cell radiation sensitivity, radiation therapy used in medical or biological procedures, radiation protection, safety measures and treatment of radiation injuries, fundamental aspects and relationship of imaging physics and radiobiology including current regulation and recommendations in radiation biology, Radiological technologies and labeling techniques; use of radioisotopes as diagnostic and therapeutic tools.

Contents

1. Introduction to radiobiology
2. Radioisotopes and types and sources of radiation
3. Physics of radioactive substances
4. Effects of radiation on living cells
5. Exposure and radiation dose-effect
6. Molecular basis of cellular effects
7. Cell radiation sensitivity
8. Radiation therapy
9. Radiation protection, safety measures and treatment of radiation injuries
10. Fundamental aspects and relationship of imaging physics
11. Radiobiology including current regulation and recommendations in radiation biology
12. Radiological technologies and labeling techniques
13. Use of radioisotopes as diagnostic and therapeutic tools.

Recommended Text

1. Wambersie, A. (2007). *Introduction to Radiobiology*. New York, USA: Tylor and Francis.
2. Nias. A.H.W. (2007). *Introduction to Radiobiology*. New York, USA: Academic Press.

Suggested Readings

1. Washington. C.M. (2009). *Principles and Practice of Radiation Therapy*. Haryana, India: Elesvier Health Sciences.
2. Der Kogel, A.V. and Joiner, M. (2009). *Basic Clinical Radiobiology*. (4th Edition). London, United Kingdom: Hodder Arnold Publication.
3. Forshier. C.M. (2008). *Essentials of Radiation, Biology and Protection*. (2nd Edition). Boston. USA: Cengage Learning.

BIOT-6142 **Biofuels and Biorefineries** **3(3+0)**

This course is designed to acquaint students with the sources of biomass and their extraction and processing for common use. This course will shed light on types and sources of biofuels, agroindustrial byproducts and biodegradable materials, genomics of biofuels, metabolic engineering, introduction to the biorefineries (a facility that processes biological material to produce fuel (such as ethanol and biodiesel), electricity, and commercially useful chemicals), biobased industrial products, Grenn biorefineries which will use the waste material from agriculture and forests, Lingo-cellulosic feedstock biorefinery, whole-crop biorefinery based on wet/dry milling and products from whole-crop biorefinery. On successful completion of this course students will be able to: 1) Identify the range of biomass resources available for liquid biofuels production, 2) Evaluate a range of technologies available for biofuels production from biomass and analyse the potential for future reduction in costs through technological development, 3) Explain the main theoretical concepts and practical implementation associated to biofuels engineering systems, 4) Get familiar with the concept of biorefinery and critically evaluate the potential of biorefining processes.

Contents

1. Biofuels - introduction, types and sources
2. Agroindustrial byproducts
3. Biodegradable materials
4. Genomics of biofuels
5. Metabolic engineering
6. Biorefineries
7. Biobased industrial products
8. Basics of green biorefineries; agriculture, forestry and primary refinery raw material
9. Lingo-cellulosic feedstock biorefinery
10. whole-crop biorefinery based on wet/dry milling
11. Products from whole-crop biorefinery
12. Fundamental sugar platform and syngas platform.

Recommended Text

1. Kumar, S. and Sani, R.K. (2017). Biorefining of Biomass to Biofuels: Opportunities and Perception. New York. USA: Springer.
2. Eckert, C. and Trinh, C. (2016). Biotechnology for Biofuels production and optimization. Amsterdam. Netherlands: Elsevier.

Suggested Readings

1. Kamm, *et al.*, (2006). *Biorefinery-Industrial Processes and Products Status Quo and Future Directions*. Hoboken. USA: Wiley-VCH.
2. Verts *et al.*, (2010). *Biomass to Biofuels: Strategies for Global Industries*. (1st Edition). Hoboken. USA: Wiley.
3. Lee, S. and Shah, Y.T. (2012). *Biofuels and Bioenergy: Processes and Technologies (Green Chemistry and Chemical Engineering)*. (1st Edition). Boca Raton. USA: CRC Press.
4. Jose. S. and Bhasker, T. (2015). *Biomass and Biofuels: Advanced Biorefineries for Sustainable Production and Distribution*. Boca Raton. USA: CRC Press.

BIOT-6143 **Fermentation Biotechnology** **3(2+1)**

This course is designed to familiarize the students with theoretical and experimental biotechnological techniques used for fermentation. This course will give basic understanding of the fermentation technology, microorganisms which can be used in fermentation, isolation and characterization of those microorganisms, improvement of microbial strains through genetic manipulation. Moreover, this course will also explain about the methods for the assesment of the nutritional requirments of selected microorganisms and media preparation to fulfill the nutritional requirments of microbes. Micrbobial growth in different types of cultures, importance of sterilization in microbial cell culturing, methods and kinetics of sterilization, role of various filters in sterilizations, fluid rheology, Newtonian & non-Newtonian factors effecting K_La in fermentation vessel are also part of this course. Students will also learn about the different types of bioreactors for the culturing of free and immobilized cells, aeration and agitation requirments, downstream processing for product recovery. Examples of various products of fermentation biotechnology and their applications will also be shared to emphasize the importance of this course.

Contents

1. Overview of fermentation technology: definition, economics, applications
2. Strain development and improvement: isolation of microorganisms – plating
3. Criteria for selection and improvement through genetic engineering
4. Growth requirement of various organisms and media preparation
5. Stoichiometry of microbial growth: preparation of inoculum
6. Microbial growth kinetics in batch culture; continuous culture; sterilization
7. Modes & kinetics of sterilization, design of batch and continuous sterilization process, air sterilization & theory of fibrous filters; fluid rheology: classification
8. Newtonian & non-Newtonian factors effecting K_La in fermentation vessel;
9. Design of bioreactors and configuration for free and immobilized cells; waste treatment;
10. Tissue engineering for plant and animal cell cultures; aeration and agitation; product recovery; scaling-up of fermentation process

Practicals

Initiation of a bacterial/plant or animal cell/tissue culture in a simple conical flask or in a fermenter depending on availability and its handling according to the techniques introduced in theory as sterilization, media formulation, growth kinetics, product recovery etc.

Recommended Text

1. Doran, P.M. (2012). *Bioprocess Engineering Principles*. (2nd Edition). New York, USA: Academic Press.
2. McNeil, B. (2009). *Practical Fermentation Technology*. Hoboken, USA: John Willey & Sons

Suggested Readings

1. El-Monsi, E.M.T., Bryce, C.F.A., Demain, A.L., Allman, A.R. (2007). Fermentation Microbiology and Biotechnology. Boca Raton, USA: CRC Press.
2. Shuler, M.L. and Kargi, F. (2002). *Bioprocess Engineering: Basic concept*. Delhi, India: Prentice Hall of India.

BIOT-6144 **Enzymology** **3(2+1)**

The purpose of this course is to acquaint students with enzyme structure, nomenclature and classification, provide understanding of methods used for enzyme purification and characterization. Furthermore, this course will cover a wide range of topics including history of enzymes, classification of enzymes, enzyme properties, mechanism and kinetics of enzyme catalyzed reaction, regulation of enzyme activities, enzyme Inhibition (Reversible and Irreversible: competitive, uncompetitive and non competitive inhibitors), factors affecting the enzyme activities e.g. temperature, pH and substrate concentration, mechanism of multi-substrate reaction, chemical modes of enzymatic catalysis, binding modes of enzymatic catalysis, production and purification of enymes, characterization of enzymes by using various techniques e.g. Polyacrylamide gel electrophoresis of enzymes (Native PAGE, SDS-PAGE, SDS-DR-PAGE, TUG-PAGE, Urea PAGE, Isoelectric focusing, Capillary electrophoresis), Enzyme engineering (Chemical modification, Enzyme immobilization, Site directed mutagenesis, Proteolytic nicking); Ribozyme and catalytic antibodies; Protein sequencing by Edman Degradation, Industrial application of enzymes (amylases, cellulases, proteases, glucoamylase, lipase, galactosidase etc).

Contents

1. Enzyme discovery; Enzyme classification and nomenclature
2. Enzyme biochemistry (Amino acid and protein structures
3. Forces that maintain protein structures); Isoenzymes, Allosteric enzymes, Multienzyme complexes and multifunctional enzymes
4. Up-stream processing of enzymes; Enzyme recovery and purification by fractional precipitation and Fast Protein Liquid chromatography
5. Physiochemical and thermodynamic properties of enzymes (effect of temp, substrate & pH); 6. Kinetics and thermodynamics of enzyme stability; Enzyme Inhibition/Activation (Kinetic mechanism: competitive, uncompetitive and non-competitive); Catabolite repression and feed back inhibition.
7. Polyacrylamide gel electrophoresis of enzymes (Native PAGE, SDS-PAGE, SDS-DR-PAGE, TUG-PAGE, Urea PAGE, Isoelectric focusing, Capillary electrophoresis).
8. Enzyme engineering (Chemical modification, Enzyme immobilization, Site directed mutagenesis, Proteolytic nicking); Ribozyme and catalytic antibodies; Protein sequencing by Edman Degradation.
9. Industrial application of enzymes (amylases, cellulases, proteases, glucoamylase, lipase, galactosidase etc);

Practicals

Enzyme kinetics, effect of different factors on enzyme activity, enzyme denaturation, purification and characterization techniques e.g. column chromatography

Recommended Text

1. Shailendra, S. (2007). *A text Book of Enzymes*. Karnataka, India: Campus Book International.

Suggested Readings

1. Nelson, D.L and Cox, M.M. (2006). *Lehninger Principles of Biochemistry*. (4th Edition). New York, USA: W.H. Freeman and Company.
2. Price, N.C. and Stevens, L. (2005). *Fundamentals of Enzymology*. (3rd Edition). New York, USA: Oxford University Press.
3. Walsh, G. (2005). *Protein Biochemistry and Biotechnology*. Hoboken, USA: John Wiley and Sons.

BIOT-6145 **Forensic DNA Typing** **3(3+0)**

DNA profiling is renowned as a technique that is used in forensic investigations to match criminals against samples obtained from crime scenes DNA Analysis Forensic DNA typing has evolved over time by developing analytical methods for smaller and smaller fragments that, at the same time, are increasingly variable in the human population The purpose of this course is to familiarize the students to the importance of DNA in criminal investigations. This course will revise the basics of DNA and its inheritance patterns which will help the students to understand the results of forensic DNA typing specially the DNA markers which are mainly used in DNA typing. This course will focus on the methods of current forensic DNA typing emphasizing on short tandem repeats (STRs), new genetic markers and new technologies. Furthermore, this course will also explain the process of DNA testing from different types of samples through DNA extraction, DNA quantitation, DNA amplification, and statistical interpretation. This course will also introduce the studets to the role of different DNA types in the forensic investigations, the evolutionary changes of DNA which can affect the forensic investigations, ethical concerns in retaining DNA profiles and the issues involved when people use a database to search for close relatives.

Contents

1. Introduction to genetics, describing what DNA is and the basics of inheritance.
2. Introduction to forensic science.
3.To examine how DNA and genetics can be utilised in a criminal investigation.
3. Look at different types of DNA which might be useful in a forensic case.
4. How it is examined in the laboratory and we will also analyse these DNA profiles generated in the laboratory.
5. How genetics has changed over the years and the effects that this has had to forensic investigation
6. How future advances in genetics might affect future criminals and investigations.

Recommended Text

1. Shewale, J.G., and Liu. R.H. (2017). *Forensic DNA Analysis: Current Practices and Emerging Technologies*. Boca Raton, USA: CRC Press.
2. Koblinsky, L., Liotti, T.F., and Oeser-Sweat, J. (2015). *DNA: Forensic and Legal Applications*. Hoboken, USA: Wiley.

Suggested Readings

1. Butler, J.M. (2017). *Fundamentals of Forensic DNA Typing*. New York, USA: Academic Press.
2. Butler, J.M. (2016). *Advanced Topics in Forensic DNA Typing: Methodology*. New York. USA: Academic Press.
3. Houck. M.M., and Siegel. J.A. (2017). *Fundamentals of Forensic Science*. New York, USA: Academic Press.
4.Butler. J.M. (2015). *Forensic DNA typing: Biology, Technology, and Genetics of STR Markers*. New York. USA: Academic Press.

BIOT-6146 **Biotechnology for Pest Management** **3(3+0)**

Due to increasing problems occurring from massive applications of pesticides, such as insect resistance to pesticides, the use of biotechnological tools to minimize losses from insect pests has become inevitable. This course explores how the modern tools of biotechnology can be used in pest management for sustainable crop production, the biosafety of transgenic crops, and environmental conservation, issues ranging from host plant resistance to insect pests to the application of molecular approaches for pest management. It will also discuss phenotyping transgenic plants, mapping populations for insect resistance, physico-chemical and molecular markers associated with insect resistance, the potential of insect-resistant transgenic crops for pest management, and the use of biotechnological tools for diagnosing insects and monitoring insect resistance to insecticides. In this course students will also study about the issues related to gene flow, resistance to transgenes and selection markers, the biosafety of food derived from genetically engineered plants, and the potential application of molecular tools for solving some of the intricate pest problems in the future.

Contents

1. Examine how bioassay techniques can be used to evaluate mapping populations and the bio-efficacy of transgenic plants for pest management.
2. Presents an in-depth analysis of the interaction of transgenic plants with non-target organisms in the environment.
3. Discusses issues related to the biosafety of food, feed, and forage derived from genetically modified crops.
4. Covers the consequences of gene flow and the development of resistance to the transgene and selection markers.
5. Biotechnology applications for the improvement of bio-pesticides and the discovery of new insecticide molecules.

Recommended Text

1. Sharma, H.C. (2009). *Biotechnological Approaches for Pest Management and Ecological Sustainability*. Hamsphire, United Kingdom: Talor and Francis Group.
2. Mukerji, K.G., Chamola, B. P., Upadhyay, R.K. (2012). *Biotechnological Approaches in Biocontrol of Plant Pathogens*. New York, USA: Springer.

Suggested Readings

1. Abrol, D.P. (2014). *Integrated Pest Management*. New York, USA: Academic Press.

Note: ***Courses from other Departments***

- Details of courses from other departments may be developed by the concerned DEPARTMENT according to their Selection of Courses as recommended by their Board of Studies.
- Elective/ special papers may be offered from the given list depending upon department's resources