COURSE OUTLINE BRIEFS

DEPARTMENT OF BIOTECHNOLOGY

SARGODHA UNIVERSITY
Pathway to Progress

FACULTY OF SCIENCES

OVERVIEW

Biotechnology is an interdisciplinary science, which is overlapping botany, zoology, microbiology, bioinformatics, biochemistry, pharmacy, molecular biology, genetics, and agriculture, forensic and medical science. It is fundamental and applied science that provides foundation on which the understanding of the natural and material world depends.

The department – established in 2013 – offers PhD, MPhil & BS programs designed to meet the ever-growing needs in the field of biological science. A number of research projects of inter-disciplinary nature, funded by the Higher Education Commission of Pakistan and the University's Office of Research, Innovation and Commercialization, are being run by experienced faculty in collaboration with national and international institutions.

The department has highly qualified faculty including four PhD qualified members, three HEC approved supervisors and a number of visiting scientists and research associates. In the perspective of growing trends of value-addition and knowledge-based economy, the faculty is conducting research at the forefronts of their disciplines, such as industrial enzymes, insect molecular biology, metabolic disorders, and infectious diseases.

Academic Programs Offered

1. BS Biotechnology
2. MPhil Biotechnology
3. PhD Biotechnology

BS Biotechnology

Eligibility: At least 45% marks in FSc or equivalent.
Duration: 04 Year Program (08 Semesters)
Degree Requirements: 137 Credit Hours

Semester-1

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

Semester – 2

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

Semester – 3

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

Semester – 4

Course Code	Course Title	Credit Hours
BIOT-5108	Animal Physiology	3(2+1)

BIOT-5109	Ecology, Biodiversity and Evolution - II	3(2+1)
	Any subject from list of Social Sciences	3(3+0)
BIOT-5110	Molecular Biology	3(3+0)
CHEM-5103	Organic Chemistry	4(3+1)

Semester –5

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

Semester – 6

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

Semester – 7

Course Code	Course Title	Credit Hours
BIOT-6123	Research Methodology and Skills Enhancement	3(3+0)
BIOT-6124	Environmental Biotechnology	3(2+1)
BIOT-6125	Health Biotechnology	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	3(3+0)

Semester – 8

Course Code	Course Title	Credit Hours
BIOT-6126	Industrial Biotechnology	3(2+1)
BIOT-6127	Food Biotechnology	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	3(3+0)

BIOT-61xx	Seminar II	1(1+0)

MPhil Biotechnology

Eligibility: MA/MSc/BS 4-Year or equivalent (16 years of Education) in the relevant field or equivalent degree from HEC recognized institution with at least second Division or CGPA 2.00 out of 4.00.
Duration: 02 Year Program (04 Semesters)
Degree Requirements: 30 Credit Hours

Semester-1

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

Semester-2

Sr. No.	Name of Courses	Credit Hours
1	Elective V	3(3+0)
2	Elective VI	3(3+0)
3	Elective-VII	3(3+0)
4	Elective-VIII	3(3+0)

Semester 3-4

	Dissertation	6(0-6)

BS
BIOTECHNOLOGY

URCE-5101 GRAMMAR 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
2. Noun and its types
3. Pronoun and its types
4. Adjective and its types
5. Verb and its types
6. Adverb and its types
7. Prepositions and its types
8. Conjunction and its types
9. Phrases and its different types
10. Clauses and its different types
11. Sentence, parts of sentence and types of sentence
12. Synthesis of sentence
13. Conditional sentences
14. Voices
15. Narration
16. Punctuation
17. Common grammatical errors and their corrections

Recommended Texts

1. Eastwood, J. (2011). *A basic English grammar*. Oxford: Oxford University Press.
2. Swan, M. (2018). *Practical English usage* (8th ed.). Oxford: Oxford University Press.

Suggested Readings

1. Thomson, A. J., & Martinet, A. V. (1986). *A practical English grammar*. Oxford: Oxford University Press
2. Biber, D., Johansson, S., Leech, G., Conrad, S., Finegan, E., & Quirk, R. (1999). *Longman grammar of spoken and written English*. Harlow Essex: MIT Press.
3. Hunston, S., & Francis, G. (2000). *Pattern grammar: A corpus-driven approach to the lexicalgrammar of English*. Amsterdam: John Benjamins.
4.

URCP-5106 **Pakistan Studies** **2(2+0)**

The course is designed to acquaint the students of BS Programs with the rationale of the creation of Pakistan. Pakistan studies curriculum is the name of a curriculum of academic research and study that encompasses the culture, demographics, geography, history, and politics 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 endeavors to develop and progress in the contemporary world. For this purpose, the foreign policy objectives and Pakistan's foreign relations with neighboring and other countries are also included. This curriculum has been developed to help students analyze 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. Contextualizing Pakistan Studies
2. Geography of Pakistan: Geo-Strategic Importance of Pakistan
3. Freedom Movement (1857-1947)
4. Pakistan Movement (1940-47)
5. Muslim Nationalism in South Asia
6. Two Nations Theory
7. Ideology of Pakistan
8. Initial Problems of Pakistan
9. Political and Constitutional Developments in Pakistan
10. Economy of Pakistan: Problems and Prospects
11. Society and Culture of Pakistan
12. Foreign Policy Objectives of Pakistan and Diplomatic Relations
13. Current and Contemporary Issues of Pakistan
14. Human Rights: Issues of Human Rights in Pakistan

Recommended Texts

1. Kazimi, M. R. (2007). *Pakistan studies.* Karachi: Oxford University Press.
2. Sheikh, Javed Ahmad (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. 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. Calculus, originally called infinitesimal calculus or "the calculus of infinitesimals", is the mathematical study of continuous change, in the same way that geometry is the study of shape and algebra is the study of generalizations of arithmetic operations. 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, Harmonic progression
18. Binomial Theorem: Introduction to mathematical induction
19. Binomial theorem with rational and irrational indices.
20. 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)**

This course provides foundation and basic level knowledge of physical chemistry to under graduate students. This foundation course covers introduction of physical chemistry along with its application for learning principles of physico-chemical phenomenon. This offer complementary approaches to the fundamental understanding of chemical systems. Students will acquire knowledge to enable themselves to understand the elementary mathematics, physical state of matter, atomic structure, chemical thermodynamics, kinetic theory of gases, collision theory of reactions, fundamental principles and laws of thermodynamics, chemical equilibria and chemical kinetics and 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. Students will also be introduced about basics of electrochemistry. The general goal of learning this physical chemistry course is to obtain a vision of matter-energy relationship in physical and chemical systems.

Contents

1. Elementary Mathematics: Logarithmic, exponential and trigonometric functions, differentiation of elementary functions, methods of differentiation and integration
2. Physical States of Mater: Gases, Liquids and Solids
3. Atomic Structure: De Brogile equation. Schrodinger wave equation, solution for particle in 1D box.
4. Chemical Thermodynamics: laws of thermodynamics, Spontaneous and non-spontaneous processes.
5. Chemical Equilibrium: Law of Mass Action, equilibrium constant, and LeChaterlier's Principle.
6. Solutions: composition, ideal and non-ideal solutions. Raoult's law. Colligative properties,
7. Chemical Kinetics: Zero, first and second order reaction, Arrhenius equation, activation energy,
8. Electrochemistry: Conductance, Kohlrausch's law and its applications

Physical Chemistry Lab

1. Determination of surface tension and Parachor value by stalagmometer and percentage composition.
2. Determination of viscosity and Rhechor value of liquids from viscosity measurement.
3. Determination of refractive index and molar refractivity by refractometer.
4. Determination of heat of solution by solubility method,
5. Determination of boiling point and lowering of freezing point

Recommended Texts

1. Atkins, P., Paula, J., and Keeler, J. (2017). *Atkins' Physical Chemistry* (11th ed.), Oxford: Oxford University Press.
2. Kuhn, H. Försterling, H. Waldeck, D.H. (2009). *Principles of Physical Chemistry* (2nd ed.), New Jersey: Wiley Publisher.

Suggested Readings

1. Akhtar, M.N. and Nabi, G. (2006). *Texts Book of Physical Chemistry*. Lahore: Ilmi Kitab Khawna,.
2. Das, R.C., and Behera, B. (2003). *Experimental Physical Chemistry*. Delhi: Tata McGraw Hill.

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 Texts

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 Texts

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.

URCE-5102 Language Comprehension & 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).

Contents

1. Listening skills
2. Listening to isolated sentences and speech extracts
3. Managing listening and overcoming barriers to listening
4. Expressing opinions (debating current events) and oral synthesis of thoughts and ideas
5. Pronunciation skills
6. Recognizing phonemes, phonemic symbols and syllables, pronouncing words correctly
7. Understanding and practicing stress patterns and intonation patterns in simple sentences
8. Comprehension skills
9. Reading strategies, summarizing, sequencing, inferencing, comparing and contrasting
10. Drawing conclusions, self-questioning, problem-solving, relating background knowledge
11. Distinguishing between fact and opinion, finding the main idea, and supporting details
12. Texts organizational patterns, investigating implied ideas, purpose and tone of the text
13. Critical reading, SQ3R method
14. Presentation skills, features of good presentations, different types of presentations
15. Different patterns of introducing a presentation, organizing arguments in a presentation
16. Tactics of maintaining interest of the audience, dealing with the questions of audience
17. Concluding a presentation, giving suggestions and recommendations

Recommended Texts

1 Mikulecky, B. S., & Jeffries, L. (2007). *Advanced reading power: Extensive reading, vocabulary building, comprehension skills, reading faster*. New York: Pearson.

2 Helgesen, M., & Brown, S. (2004). *Active listening: Building skills for understanding*. Cambridge: Cambridge University Press.

Suggested Readings

1 Roach, C. A., & Wyatt, N. (1988). *Successful listening*. New York: Harper & Row.

2 Horowitz, R., & Samuels, S. J. (1987). *Comprehending oral and written language*. San Diego: Academic Press.

URCI-5105 **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 Muhammadﷺ. The learning of the Qur'an and Sunnah guides the Muslims to live peacefully.

Contents

1. Study of the Qur'an (Introduction to the Qur'an, Selected verses from *Surah Al-Baqarah, Al-Furqan, Al-Ahzab, Al-Mu'minoon, Al-An'am, Al-Hujurat, Al-Saff*)
2. Study of the Hadith (Introduction to Hadith literature, Selected Ahadith (Texts and Translation)
3. Introduction to Qur'anic Studies
4. Basic Concepts of Qur'an
5. History of Quran
6. Basic Concepts of Hadith
7. History of Hadith
8. Kinds of Hadith
9. Uloom –ul-Hadith
10. Sunnah & Hadith
11. Seerat ul-Nabi (PBUH), necessity and importance of Seerat, role of Seerah in the development of personality, Pact of Madinah, Khutbah Hajjat al-Wada' and ethical teachings of Prophet (PBUH).
12. Legal Position of Sunnah
13. Islamic Culture & Civilization
14. Characteristics of Islamic Culture & Civilization
15. Historical Development of Islamic Culture & Civilization
16. Comparative Religions and Contemporary Issues
17. Impact of Islamic civilization

Recommended Texts

1. Hassan, A. (1990). *Principles of Islamic jurisprudence*. New Dehli: Adam Publishers.
2. Zia-ul-Haq, M. (2001). *Introduction to al-Sharia al-Islamia*. Lahore: Aziz Publication.

Suggested Readings

1. Hameedullah, M. (1957). *Introduction to Islam*. Lahore: Sh M Ashraf Publisher.
2. Hameedullah, M. (1980). *Emergence of Islam*. New Dehli: Adam Publishers.
3. Hameedullah, M. (1942). *Muslim conduct of state.* Lahore: Sh M Ashraf Publisher.

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. Anton, H. (2005). *Calculus: a new horizon*. New Jersey: John Wiley.

CHEM-5102 Inorganic Chemistry 4(3+1)

This course covers a range of general topics of inorganic chemistry. It will provide a useful supplement to the advanced courses specified in the department. This course aims to enable the students to achieve the advance knowledge about the key introductory concepts of chemical bonding, acid-base chemistry, and properties of the representative and transition elements, as well as using this knowledge for qualitative and quantitative analysis of inorganic compounds during laboratory work. Learning objectives emphasized in CHEM 5102 involve developing an understanding of basic principles of inorganic chemistry. It develop critical thinking skills enabling students to solve chemistry problems that incorporate their cumulative knowledge. Students learned in class to modern chemistry techniques which give them opportunities to upgrade their knowledge about advanced inorganic concepts. The essence of this course is to develop study skills that students need to succeed in university-level chemistry courses and preparation of students for professional positions in chemistry.

Contents

1. Periodic Table and Periodicity of Properties: Modern Periodic Table
2. Acid Base Equilibria: Acids and bases, relative strengths of acids, pH, pKa, pKb. Hard/soft acid
3. Chemical Bonding: Nature of a bond, hybridization, Valence Bond Theory (VBT), The Concept of Resonance, Molecular Orbital Theory (MOT), Valence Shell Electron Pair Repulsion (VSEPR) theory.
4. Chemistry of p-Block and d-Block Elements
5. Chemistry of Elements: Separation Techniques: General introduction and Applications
6. Introduction to Analytical Techniques in Inorganic Chemistry:
7. Chemical Industries: Metallurgy of Al, Cr and U, fertilizers (Urea and Phosphate fertilizers) Cement and Sugar.

Inorganic Chemistry Lab

1. Qualitative Analysis; four radicals (cations and anions) for salt mixture.
2. Chromatographic separation of cations determination of total hardness of water using EDTA.
Estimation of copper (Iodometrically).
4. Determination of ferricyanide using KI solution. Determination of chloride by Mohr's methods
5. Estimation of chloride ions using adsorption (Fluorescein) indicator.
6. Percentage determination of ferric ions in ferric alum using KMnO4 solution.
7. Determination of purity of commercial potassium oxalate using KMnO4 solution.

Recommended Texts

1. Iqbal, M. Z. (2015). *Texts Book of Inorganic Chemistry.* Lahore: Ilmi Kitab Khana, Revised Edition.
2. Lee, J.D. (1996). *Concise Inorganic Chemistry.* 5th Edition, Chapman and Hall, UK.

Suggested Readings

1. Graham, H., and Man, H. (2000). *Chemistry in Context* 5th Edition. Scotland: Thomas Nelson Ltd.
2. Skoog, D. A., West, D.M., and Holler, F.J. (1994). *Analytical Chemistry* (6th ed.), Philadelphia: Saunders College Publications.

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 Texts

1. Vrema, 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 Texts

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.

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

Academic writing is a formal, structured and sophisticated writing to fulfill 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: Texts, 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
10. Paragraph and Essay Writing
11. Letters
12. Official Writing
13. Technical and Scientific Reports
14. Issues in scientific writing (plagiarism, authorship, ghostwriting, reproducible research)
    How to do a peer review; and how to communicate with the lay public

Recommended Texts

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: Routledge
4. Bovee, C.L. et.al (2002). *Business communication today*. India: Pearson Education
5. Burton, S.H. (2000). *Mastering practical writing*. London: Palgrave

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 include Word, Power Point, and 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.
2. Fuller, F., & Larson, B. (2015). Computers: Understanding technology, Introductory. USA: Paradigm Publishing.

Suggested Readings

1. O'Leary, T.J., & O'Leary, L.I. (2017). *Computing Essentials 2017.* USA: McGraw Hill

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, Linkage and crossing over.

Recommended Texts

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.

Recommended Texts

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 Texts

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

Tortora, G.J., & Funke, B.R. (2016). *Microbiology: An introduction.* (12th Ed.). UK: Pearson

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

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 Homeostasis, 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 Texts

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

Suggested Readings

1. Kent, G.C., & Miller, S. (2001). *Comparative anatomy of vertebrates.* New York: 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 Texts

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

SOCI-5101 **General Sociology-I** **3 (3+0)**

Sociology is the study of society, patterns of social relationships, social interaction, and culture that surrounds everyday life. It is a social science that uses various methods of empirical investigation and critical analysis to develop a body of knowledge about social order and social change. Subject matter can range from micro-level analyses of society to macro-level analyses .The course is designed to introduce the students with basic sociological concepts and to get familiarity with the overall discipline. The focus of the course shall be on basic concepts like scope and significance of Sociology, How Sociology is related as well as distinct from other social sciences. It focuses on the constituent parts of the society i.e. social systems and structures, socio-economic changes and social processes. This will also give an understanding of the Culture, elements of culture and the relationship of culture and personalities. The course will provide due foundation for further studies in the field of sociology.

Contents

1. Introduction to Sociology: The Science of Society, Scope and significance
2. Fields of Sociology: Sociology and other Social Sciences
3. Social interaction and social structure: The Nature and Basis of Social Interaction
4. Social Processes: Social structure Status, Roles, Power and Authority, Role Allocation
5. Culture: Meaning and nature of culture, Elements of culture: Norms, values beliefs, sanctions
6. Culture and Socialization, Transmission of Culture, Cultural Lag, Cultural Variation
7. Cultural Integration, Cultural Evolution, Cultural Pluralism, Culture and personality
8. Socialization & personality: Socialization, Agents of socialization
9. Personality: components of personality
10. Deviance and social control: Deviance and conformity
11. Mechanism and techniques of social control, Agencies of social control
12. Social organization: Definition, meaning and forms, Social groups; Functions of groups
13. Social Institutions: forms, nature and inter-relationship
14. Community: definition and forms (Urban and rural).
15. Social Institutions: Structure and functions of Institutions
16. Family, Religion, Education, Economy and political institution

Recommended Texts

1. Giddens, A. (2018). *Sociology* (11thed.).Cambridge: Polity Press.
2. Macionis, J. J. (2016). *Sociology* (16th ed.). New Jersey: Prentice-Hall.

Suggested Readings

1. Anderson, M. & Taylor, F. H. (2014). *Sociology the essentials* (8th ed.). Massachusetts: Cengage Learning.
2. Schaefer, T. R. (2012). *Sociology* (13th ed.). New York: McGraw Hill College.
3. Henslin, M. J. (2011). *Sociology: A down to earth approach* (11th ed.). Australia: Pearson

PSYC-5101 Introduction to Psychology (Minor) 3 (3+0)

This course has been designed to ensure an effective orientation of students towards the discipline of psychology so that they may come to appreciate the diversity of the subject and its pragmatic significance. This course provides an introduction to the concepts and theories of psychology and to their application to real life situations. Topics include history, research methods, sensation, perception, consciousness, stress and coping, learning, memory, motivation and emotions. Main objectives of the course include making students familiar with the essentials features of human personality; to inculcate a sense of personal relevance of Psychology as a subject with the potential of gaining better insight into one's own self and others. Upon the successful completion of course students will have an introductory knowledge of selected areas of basic psychological enquiry and they will be able to: differentiate between scientific and non-scientific information about human behaviors and mental processes, describe major developments and research methods used in psychology; Explain psychological processes involved in sensation, perception, learning, memory, motivation, emotion, states of consciousness and health.

Contents

1. Introduction to Psychology: definition of psychology, goals of psychology, major schools of thought in psychology, major fields of psychology
2. Basic research methods in psychology: survey research, experimental research, case study method
3. Biological basis of behavior: brain and nervous system, structure and function of major brain areas, neurotransmitters and their functions
4. Sensation and perception: difference between sensation and perception, principles of perception, role of perception in human cognition
5. Motivation and emotion: concept & theories of motivation and emotion
6. Learning: definition of learning, types of learning (i) classical conditioning (ii) operant conditioning, (iii) observational learning
7. Memory and intelligence: definition and stages of human memory, types of memory, concept of intelligence, basic theories of intelligence
8. Personality development: concept & theories; tips to improve personality
9. Health and stress and coping, stress, health, and coping in the workplace, effective measure to deal with stress and ways to cope.
10. Application of psychology in our social lives

Recommended Texts

1. Weiten, W. (2017). *Psychology: themes and variations* (10th ed.). Boston: Cengage Learning.
2. Nolen-Hoeksema, S. & Hilgard, E. R. (2015). *Atkinson and Hilgard's introduction to psychology* (16th ed.). New Dehli: Cengage Learning.

Suggested Readings

1. Flanagan, C., Berry, D., Jarvis, M. & Liddle, R. (2015). *AQA psychology.* London: Illuminate Publishing - Cheltenham.
2. Coon, D., Mitterer, J. O. & Martini, T. S. (2018*). Introduction to psychology: Gateways to mind and behavior* (15th ed.). Boston: Cengage Learning

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

Molecular Biology is the study of biological 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 underlie these changes and how cells handle this at the molecular level account for how changes in the genome can result in the different genetic diseases, including cancer diseases and transposable elements 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 Texts

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

CHEM-5103 Organic Chemistry 4(3+1)

The students will acquire knowledge about the basic concepts of organic chemistry, chemistry of hydrocarbons, functional groups and the mechanism of organic reactions. It will be useful for the qualitative analysis and synthesis of organic compound. Understanding and knowledge of new and advanced field of organic and also significances the importance of application of advanced techniques. This course is a foundation course for Organic Chemistry major courses of higher semester. The main objectives emphasized in this course involve developing an understanding of basic principles of organic chemistry. It develops critical thinking skills enabling students to solve general chemistry problems that incorporate their cumulative knowledge. Students learned in class to advanced organic chemistry concepts which give them opportunities to upgrade their knowledge about advanced organic concepts. The essence of this course is to develop study skills that students need to succeed in university-level chemistry courses and preparation of students for professional positions in the field of synthesis chemistry.

Contents

1. Basic concepts: atomic, molecular and hybrid orbitals: multiple localized and delocalized bonds.
2. Introduction to spectroscopy with special reference to the infrared,ultraviolet/visible spectroscopy.
3. Hydrocarbons: classification of hydrocarbons. Nomenclature. Methods of preparation,
4. Stereoisomerism: conformational analysis of ethane and butane. Optical isomerism, optical activity.
5. Alkyl halide: nomenclature, method of preparation and chemical reaction
6. The hydroxyl group and ether: nature of hydroxyl group in phenol and alcohol.
7. Alcohol: classification and nomenclature, preparation method and chemical reaction
8. Ether: preparation and reactions.
9. The carbonyl group: nature and its reactivity, nomenclature of aldehyde and ketone, Carboxylic acid anhydrides, acid halides, acid amides, esters including glycerides. Introduction to amino acid.
10. Nitrogen compounds: amines; classification, nomenclature, preparation and chemical reactions.

Organic Chemistry Lab.

1. Qualitative organic analysis; systematic identification of organic compounds containing group like COOH, OH, NH2, C=O.
2. Purification techniques viz solvent extraction distillation and recrystallization, etc.
3. Preparation of simple organic compounds viz, Ethyl benzoate, benzoic acid, tri-bromophenol, aspirin, nitrobenzene.

Recommended Texts

1. Younas, M. (2006). *Organic Spectroscopy*. Lahore: A. H. Publisher.
2. Vogel, A. I. (1996). *A Texts Book of Practical Organic Chemistry*. New Jersey: Prentice Hall.

Suggested Readings

1. Kemp, W. (1990). *Organic Spectroscopy*. London: Macmillan.
2. Chughtai, F. A. (1995). *Organic Reactions*, Lahore: Majid Book Depot.

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. Analytical chemistry studies and uses instruments and methods used to separate, identify, and quantify matter. In practice, separation, identification or quantification may constitute the entire analysis or be combined with another method. Separation isolates analysts. 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 Texts

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 Texts

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 Texts

1. Walker, J.M., & Rapley, R. (2008). *Molecular biomethods handbook: Methods in molecular biology*, 2nd Ed.). New Jersey, USA: Humana Press.

2. Bartlett, J.M.S., & Stirling, D. (2008). *Methods in Molecular Biology, PCR Protocols.* (2nd Ed.). New Jersey, 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 Texts

1. Kuby, J. (2006). *Immunology.* (6th Ed.). New York: WH Freeman
2. Abbas, A.K., & Lichtman, A.H. (2010). *Basic immunology: Functions and disorders of the immune system*. (3rd Ed.). Philadelphia: Saunders Publisher

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.). New Jersey: Wiley-Blackwell.

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 example: 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 Texts

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: Markazi Kutub Khana

Suggested Readings

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

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 Texts

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.

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 Texts

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 Jersey, 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, and 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, Microbiological mining
7. Biofuels and use of microbes in petroleum industry
8. Plant-microbe interactions, Bio-fertilizers
9. Biopesticides, composting, Antimicrobials
10. 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 Texts

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 Biotechnology: 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.

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 Texts

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. Mills, L.S. (2012). *Conservation of Wildlife Populations: Demography, Genetics, and Management*. (2nd Edition). Hoboken, USA: Wiley-Blackwell.
3. 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 genetic 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 Texts

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.

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 elaborated. 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/signalling 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 Texts

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.

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 instruments, what are some good laboratory practices, which should be followed strictly to avoid the biohazards. International rules and risks related to genetically modified organisms, awareness regarding genetic information will also be discussed. Euthanasia 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 Texts

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

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.

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 valuable 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 Texts

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

Suggested Readings

1. Kothari, C.R. (2004). *Research Methodology: Methods and Techniques*. (2nd Edition). New Delhi: New Age International Publishers.

2. Durrani, S.A. (2004). *Technical Writing*. Islamabad, Islamabad: 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 plays an important role in the well-being of human and all other species living on the earth. This course will 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 disturbed 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 Texts

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

Suggested Readings

1. Evans, G.M. and Furlong, J.C. (2010). *Environmental Biotechnology Theory and Application*. (2nd Edition). Hoboken, New York: Wiley-Blackwell.
2. Srinivas, T. (2008). *Environmental Biotechnology*. (1st Edition). New Delhi: 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. Introduction 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 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).
8. Drug delivery systems; blood transfusion and grafting techniques
9. Pharmacogenetics; gene therapy; biopharmaceuticals from plants; stem cell technology

Recommended Texts

1. Pongracz, J. and Keen, M. (2009). *Medical Biotechnology*. (1st Edition) . Haryana: Elsevier Health Sciences.
2. Schacter, B.Z. (2005). *Biotechnology and Your Health: Pharmaceutical Applications*. New York: 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: Nova Science Publication.
2. Dogramatzis, (2010). *Health care Biotechnology*. (1st Edition). Boca Raton, USA: CRC Press.

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 uses the biotechnological approaches involving the microorganisms to generate various products at production scale. This subject will help to enhance the knowledge of students about the microorganism that are commonly used in industry, nutritional requirements of these industrial microorganism and the various types of media which can be used to fulfill these nutritional requirements. Screening of valuable 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 microorganism at industrial scale, purification and extraction of fermented products, role of proteins produced by industrial microorganisms as food products, biocatalyst and bio insecticides will be explained.

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 Texts

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

Suggested Readings

1. Shara, L.A. (2009). *Industrial Biotechnology*. (1st Edition). New York: Nova Science Publishers.
2. Singh, R. and Ghosh, S. (2004). *Industrial Biotechnology*. New Delhi: Global Vision Publishing House.
3. Prasad, N.K. (2012). *Downstream Process technology, A New Horizon in Biotechnology*. Delhi: 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. Food technology is a branch of food science that deals with the production processes that make foods. Early scientific research into food technology concentrated on food preservation. Nicolas Appert's development in 1810 of the canning process was a decisive event. 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.

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 Texts

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

Suggested Readings

1. Belitz, H.D. (2009). *Food Chemistry*. (4th Edition). New York: Springer.

2. Nielsen, S.S. (2010). *Food Analysis*. (4th Edition). New York: Springer.

3. Singh, R.P. (2008). *Introduction to Food Engineering*. (4th Edition). New York: 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 requirements 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, soma clonal variations, regeneration of plants, micro propagation 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, and 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 Texts

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. Lanza, R., Langer, R., Vacanti, J.P., Atala, A. (2000). *Principles of Tissue Engineering*. (2nd Edition). New York, USA: Academic Press.
2. 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.

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 diseases
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 Texts

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 excipients 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 Texts

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.

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. screening 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 bio peptides like somatotropin, synthetic gonadotropin-releasing hormone in animal health, production and use of monoclonal antibodies 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 embryos 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
6. Gene transfer through embryo microinjection
7. Ethical and social issues in animal biotechnology.

Recommended Texts

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, 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, metabolites 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 Texts

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.

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 principles. 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 Texts

1. Metcalf and Eddy. (2003). *Wastewater Engineering: Treatment, Disposal, and Reuse*. (4th Edition). New York, USA: McGraw-Hill.
2. Maier. (1999). *Environmental Microbiology*. New York, USA: Academic Press.

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.

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 and 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, ingerprinting techniques
4. Plant breeders' and Farmers' rights, Plant variety protection
5. History of plant tissue culture/genetic engineering
6. Preparation and storage of culture media, Contamination issue and tests, Explant sources, Culture initiation, and types
7. Vector design and construction, Media manipulations
8. Plant biotechnology data collection and management
9. Developments and issues in plant biotechnology

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 Texts

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.

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 bio pesticides due to their benefits over conventional chemical fertilizers and pesticides. This course will cover types and function of biofertilizers and biopesticides, the nutritional requirements and media available for the growth of microorganisms, media preparation to fulfill the nutritional requirements 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 Texts

1. Suri, S. (2011). *Biofertilizer and Biopesticide*. Delhi, India: APH Publishing Corporation.
2. Maier. (1999). *Environmental Microbiology*. New York, USA: Academic Press.

Suggested Readings

1. Board, N. I. I. R. (2004). *The Complete Technology Book on Bio-fertilizer and Organic Farming*. Delhi: 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 students to the nanoparticles which can be used in medical, agriculture and industrial applications, quantum dots, nano tubes, nano rods. They will also explore the natural biological assembly at nanoscale and nanometric biological assemblies and their applications, nanobionics and applications of nano-biotechnology in cosmetics, agriculture and waste treatment. Moreover, the issues related to the nano-biotechnology and future prospective 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 Texts

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), Amplified fragment length polymorphisms (AFLP), DNA sequencing, blotting techniques, Enzyme-linked immunosorbent 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 principles behind these techniques commonly use in molecular diagnostics.

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, *in situ* hybridization
9. Molecular cytogenetics.

Practicals

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

Recommended Texts

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. Brown, T.A. (2016). *Gene Cloning and DNA Analysis*. (7th Edition). Hoboken, USA: Wiley-Blackwell.

BIOT-6139 Biosensors 3(3+0)

The purpose 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 Texts

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: John Wiley & Sons.
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. Pathogenies 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
6. Animal and plant viruses; propagation
7. Detection and quantification of viruses
8. Pathogenesis and immune response of viral infections
9. Laboratory diagnosis of viral diseases
10. Vaccines and antiviral drugs
11. Epidemiology; tumor viruses
12. Viral vectors and gene therapy;
13. Emerging viruses
14. Specific aspects of selected viral diseases

Recommended Texts

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.

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 labelling techniques
13. Use of radioisotopes as diagnostic and therapeutic tools.

Recommended Texts

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, Green 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 analyze 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 Texts

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 assessment 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 requirements, 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 Texts

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

1. Shailendra, S. (2007). *A text Book of Enzymes*. Karnataka, India: Campus Book International.
2. 3. Walsh, G. (2005). *Protein Biochemistry and Biotechnology*. Hoboken, USA: John Wiley and Sons.

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.

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.

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.
4. Look at different types of DNA which might be useful in a forensic case.
5. How it is examined in the laboratory and we will also analyse these DNA profiles generated in the laboratory.
6. How genetics has changed over the years and the effects that this has had to forensic investigation
7. How future advances in genetics might affect future criminals and investigations.

Recommended Texts

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 Texts

1. Sharma, H.C. (2009). *Biotechnological Approaches for Pest Management and Ecological Sustainability*. Hamsphire, United Kingdom: Talor and Francis.
2. Group.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.
2. Houck, M.M., and Siegel, J.A. (2017). *Fundamentals of Forensic Science*. New York, USA: Academic Press.

URCC-5110 Citizenship Education and Community Engagement 3 (1+2)

In recent years, community engagement has become a central dimension of governance as well as policy development and service delivery. However, efforts to directly involve citizens in policy processes have been bedeviled by crude understandings of the issues involved, and by poor selection of techniques for engaging citizens. This course will provide a critical interrogation of the central conceptual issues as well as an examination of how to design a program of effective community engagement. This course begins by asking: Why involve citizens in planning and policymaking? This leads to an examination of the politics of planning, conceptualizations of "community" and, to the tension between local and professional knowledge in policy making. This course will also analyze different types of citizen engagement and examine how to design a program of public participation for policy making. Approaches to evaluating community engagement programs will also be a component of the course.

Contents

1 Introduction to Citizenship Education and Community Engagement: Orientation
2 Introduction to Active Citizenship: Overview of the ideas, Concepts, Philosophy and Skills
3 Identity, Culture and Social Harmony: Concepts and Development of Identity
4 Components of Culture and Social Harmony, Cultural & Religious Diversity
5 Multi-cultural society and inter-cultural dialogue: bridging the differences, promoting harmony
6 Significance of diversity and its impact, Importance and domains of inter-cultural harmony
7 Active Citizen: Locally active, Globally connected
8 Importance of active citizenship at national and global level
9 Understanding community, Identification of resources (human, natural and others)
10 Human rights, Constitutionalism and citizens' responsibilities: Introduction to human rights
11 Universalism vs relativism, Human rights in constitution of Pakistan
12 Public duties and responsibilities
13 Social Issues in Pakistan: Introduction to the concept of social problem, Causes and solutions
14 Social Issues in Pakistan (Poverty, Equal and Equitable access of resources, unemployment)
15 Social Issues in Pakistan (Agricultural problems, terrorism & militancy, governance issues)
16 Social action and project: Introduction and planning of social action project
17 Identification of problem, Ethical considerations related to project
18 Assessment of existing resources

Recommended Books

1. Kennedy, J. K., & Brunold, A. (2016). *Regional context and citizenship education in Asia and Europe*. New York: Routledge Falmer.
2. Macionis, J. J., & Gerber, M. L. (2010). *Sociology*. New York: Pearson Education

Suggested Books

1. British Council. (2017). *Active citizen's social action projects guide.* Scotland: British Council
2. Larsen, K. A., Sewpaul, V., & Hole, G. O. (Eds.). (2013). *Participation in community work: International perspectives.* New York: Routledge

MPhil
BIOTECHNOLOGY

BIOT-7101 **Metabolic Pathways in Plants** **3(3+0)**

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

Contents

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

Recommended Texts

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

Suggested Readings

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

BIOT-7102 **Signal Transduction** **3(3+0)**

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

Contents

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

Recommended Texts

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

Suggested Readings

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

BIOT-7103 Biotechnology Law & Regulations 3(3+0)

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

Contents:

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

Recommended Texts

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

Suggested Readings

1 Guide, N. I. H. (1996). *Revised Guide for the Care and Use of Laboratory Animals*. Rockville-Maryland, USA: National Academies Press.

BIOT-7104 Recombinant DNA Technology 3(3+0)

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

Contents

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

Recommended Texts

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

Suggested Readings

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

BIOT-7105 General & Medical Genetics 3(3+0)

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

Contents

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

Recommended Texts

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

Suggested Readings

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

BIOT-7106 Molecular Basis of Plant Development 3(3+0)

This course provides a comprehensive introduction on major groups of plants; the structure of 'higher plants. Higher plants display a variety of architectures that are defined by the degree of branching, intermodal elongation, and shoot determinacy. Studies on the model plants of Arabidopsis thaliana and tomato and on crop plants such as rice and maize have greatly strengthened our understanding on the molecular genetic bases of plant architecture, one of the hottest areas in plant developmental biology. Protective systems, absorbing systems, supporting systems, Photosynthesis systems, Storage 'systems, 'Transporting' systems. More specifically, this course introduces the Alternative development strategies: Embryonic development of somatic cells and pollen grains, abnormal growth. This course will cover various aspects of plant growth and development at the molecular level and recent advances in understanding molecular mechanisms of gene regulation in plants. The course emphasis will be on current literature to understand how the tools of genetics, molecular biology and genomics are being used to understand plant development. At the end of this course, students will be able to understand different parts of plants and their functions.

Contents:

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

Recommended Texts

1. Fahn, A. (2001). *Plant Anatomy*. (4th ed.). Butterworth, USA: Pergamon Press
2. Fosket, D. E. (2012). *Plant growth and development: A molecular approach.* UK: Elsevier.

Suggested Readings

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

BIOT-7107 **Regulation of Gene Expression** **3(3+0)**

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

Contents

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

Recommended Texts

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

Suggested Readings

1. Articles Published in *Nature Review Immunology*

BIOT-7108 Biological Safety and Risk Management 3(3+0)

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

Contents

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

Recommended Texts

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

Suggested Readings

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

BIOT-7109 **Biochemistry I** **3(3+0)**

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

Contents:

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

Recommended Texts

1. Nelson, D. L., Cox, M. M.(2017). *Lehninger Principles of Biochemistry* (7th ed.). USA: WH Freeman Publishers.
2. Voet, D., Voet, J. G., Pratt, C.W. (2016). *Fundamentals of Biochemistry* (5th ed.). Hoboken, USA: John Wiley & Sons.

Suggested Readings

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

BIOT-7110 **Biochemistry II** **3(3+0)**

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

Contents

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

Recommended Texts

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

Suggested Readings

1. Vasudevan, D. M. and Sreckumer, S. (2001). *Textsbook of Biochemistry (for medical students)* (3rd ed.). New-Delhi, India: Jaypee Brothers Medical Publishers. Pvt. Ltd.
2. Mckee, T., Mckee, J. R. (2003). *Biochemistry, the molecules of life* (3rd ed.). New-York, USA: McGraw-Hill.

BIOT-7111 **Cell Biology I** **3(3+0)**

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

Contents

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

Recommended Texts

1. Gunning, B. E. S., Steer, M. W. (1975). *Plant Cell Biology.* Edward Arnold, London UK: Blackwell Scientific Publications.
2. Lodish, H. F. (2008). *Molecular cell biology.* USA: WH Freeman Publishers.

Suggested Readings

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

BIOT-7112 **Cell Biology II** **3(3+0)**

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

Contents:

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

Recommended Texts

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

Suggested Readings

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

BIOT-7113 **Molecular Biology** **3(3+0)**

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

Contents

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

Recommended Texts

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

Suggested Readings

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

BIOT-7114 **Bioinformatics** **3(3+0)**

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

Contents

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

Recommended Texts

1. Ramsden, J. (2009). *Bioinformatics: An Introduction.* London, Uk: Verlag-Springer Publisher.
2. Edwards, D., Stajich, J., Hansen, D. (2009). *Bioinformatics: Tools and Applications.* New-York, USA*:* Verlag-Springer publisher.

Suggested Readings

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

BIOT-7115 **Virology** **3(3+0)**

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

Contents

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

Recommended Texts

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

Suggested Readings

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

BIOT-7116 Analytical & Mechanistic Enzymology 3(3+0)

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

Contents

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

Recommended Texts

1. Kyte, J. (2007). *Structure in protein chemistry.* New-York, USA: Garland Science.
2. Sheehan, D. (2000). *Physical Biochemistry: principles and applications.* Chichester, Uk: John Wiley & Sons.

Suggested Readings

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

BIOT-7117 Protein Chemistry & Enzymology 3(3+0)

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

Contents

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

Recommended Texts

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

Suggested Readings

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

BIOT-7118 Insect Molecular Biology and Viruses 3(3+0)

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

Contents

1. Introduction to Insect Biology
2. Insects as model for molecular biology
3. Classification of insects using molecular biological technique/ DNA barcoding
4. Insects as a vector of plants disease
5. Insect as a vector of animal disease
6. Defense mechanisms of insects and its molecular biology
7. Classifications of insect viruses
8. Classification of Insect parasites and polydnaviruses
9. Use of insects and viruses to study Gene structure of baculovirus
10. construction of expression vectors
11. To study functional genomics Gene silencing
12. Biological control using insect viruses
13. Modern Insect control strategies
14. Recent research articles

Recommended Texts

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

Suggested Readings

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

BIOT-7119 Biostatistics & Laboratory Mathematics 3(3+0)

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

Contents

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

Recommended Texts

1. Stephenson, F. H. (2003). *Calculations in molecular biology and biotechnology – A guide to mathematics in the laboratory.* San Diego, USA: Academic Press.
2. Chap T. Le (2003). *Introductory Biostatistic. Hoboken,* New Jersey, USA: John Wiley & Sons.

Suggested Readings

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

BIOT-7120 Bioprocess Technology 3(3+0)

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

Contents

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

Recommended Texts

1. Subramanian, G. (2012). *Biopharmaceutical production technology,* Vol. 2. Bergisch Gladbach, Germany: Wiley-VCH.
2. El-Mansi, Demain, B., & Allman, A. R. (2006). *Fermentation Microbiology and Biotechnology* (2nd ed.). USA: Taylor & Francis, CRC Press.

Suggested Readings

1. Hutkins, R. W. (2006). *Microbiology and Technology of Fermented Foods.* Chicago, USA: Blackwell Publishers.
2. Heinzle, E., Biwer, A. P., & Cooney, C. L. (2006). *Development of Sustainable Bioprocesses: Modeling and Assessment.* New Jersey, USA: John Wiley & Sons.

BIOT-7121 **Biophysics** **3(3+0)**

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

Contents

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

Recommended Texts

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

Suggested Readings

1. Pattabhi, V., Gautham, N. (2002). *Biophysics.* Pangbourne, UK: Alpha Science International Science.

BIOT-7122 Biopharming in Plants: Principles and Techniques 3(3+0)

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

Contents

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

Recommended Texts

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

Suggested Redings

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

BIOT-7123 **Protein Engineering** **3(3+0)**

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

Contents:

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

Recommended Texts

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

Suggested Readings

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

BIOT-7124 Bioremediation and biodegradation 3(3+0)

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

Contents

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

Recommended Texts

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

Suggested Readings

1. Wackett, L. P., & Hershberger, C. D. (2001). *Biocatalysis and Biodegradation: Microbial Transformation of Organic Compounds.* Washington DC, USA: ASM Publishers.

BIOT-7125 Research Methods in Biotechnology 3(3+0)

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

Contents

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

Recommended Texts

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

Suggested Readings

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

BIOT-7126 **Immunology** **3(3+0)**

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

Contents

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

Recommended Texts

1. Paul, W. E. (2008). *Fundamental Immunology*. Philadelphia, USA: Lippincot Williams and Wilkins.
2. Chapel, H., Haeney, M., Misbah, S., & Snowden, N. (2006). *Essentials of Clinical Immunology.* Hoboken, New-Jersey, USA: Blackwell Publishers.

Suggested Readings

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

BIOT-7127 Agriculture Biotechnology 3(3+0)

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

Contents:

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

Recommended Texts

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

Suggested Readings

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

BIOT-7132 Microbial enzyme Technology 3(3+0)

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

Contents

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

Recommended Texts

1. Shukla, Pratyoosh, Pletschke, Brett I. (2013). *Advances in enzyme biotechnology*. New-Delhi, India:Springer.
2. Pandey, A., Webb, C., Fernandes, M., Larroche, C. (2006). *Enzyme Technology*. New-York, USA:Verlac-Springer.

Suggested Readings

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

BIOT-7135 **Fermentation Technology** **3(3+0)**

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

Contents

1. Introduction to fermentation technology
2. Fermentations and Microbial types
3. Solid state fermentation submerged fermentation
4. Batch fermentation and continuous fermentation
5. Control and regulation of microbial growth in fermentation
6. Machanism of mass transfer
7. Mass transfer across gas/liquid and solid/liquid phase boundaries
8. Fermenter design: Fermenter configuration
9. Fermenter design; Aeration, agitation and process control
10. Batch fermentation
11. Continuous fermentation
12. Control and regulation of microbial growth in fermentation
13. Measurement of Temperature, dissolved oxygen
14. Aeration, agitation and process control, Ammonia and other variables
15. Data analysis,Industrial application of fermentation
16. Recent research articles

Recommended Texts

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

Suggested Readings

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

BIOT-7136 **Applied Biostatistics** **3(3+0)**

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

Contents

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

Recommended Texts

1. Bluman, A. G. (2018). *Elementry Statistics A Step By Step Approach* (10th ed.). New-York, USA: Mac Graw Hill.
2. Baldi, B. (2008). *The Practice of Statistics in the Life Sciences*. New-York, USA: W. H. Freeman publisher.

Suggested Readings

1. Daniel, W. W. (2009). *Biostatistics: A Foundation for Analysis in the Health Sciences* (9th ed.). Hoboken, New-Jersey, USA: John Wiley & Sons, Inc.

BIOT-7137 Advanced Analytical Techniques 3(3+0)

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

Contents

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

Recommended Texts

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

Suggested Readings

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

REVISED CURRICULUM

Ph.D. Program

IN

BIOTECHNOLOGY

DEPARTMENT OF BIOTECHNOLOGY

UNIVERSITY OF SARGODHA

(2018)

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RATIONALE

Biotechnology refers to the employment of various types of "technology" to use, exploit, modify or improve existing biological processes for a specific purpose; its overarching goal is to enhance the quality of human life - be it directly or indirectly - by producing and/or developing effective pharmaceuticals, bioenergy, disease-resistant and high-yield crops as well as animals, and microbes for remediation in an efficient, cost-effective and ethically responsible manner. The field has already shown immense promise and further innovations are certain to culminate in dramatic improvements in existing technologies and outcomes. Biotechnology is the next wave of change that is likely to be as sweeping and invasive as that brought about by information technology.

The developed countries are focusing to expand and capitalize on biotechnology. America is leading the biotechnology industry; having reached the mark of US$ 72 Billion in 2009 it expected to grow at the cumulative annual growth rate (CAGR) of 7% to reach approximately US$ 95 Billion by the end of this year. Cutting edge work is also going on in the United Kingdom, Germany, Korea, China and Japan. According to the new research report, "Asia Pacific Biotechnology Market (2008-2012)", the Asia-Pacific biotech market is projected to grow at a CAGR of around 16% during 2010 – 2012. Japan and China are dominating biotech industry at the regional forefront, while higher growth rates have been expected in emerging markets like Malaysia, India, and Singapore. Pakistan has recently initiated investment on the applications of biotechnology, especially in agriculture for developing insect-resistant and high yield crops, vaccine production, textile, leather and chemical industries, health, bioinformatics and environmental biotechnology. The Government of Pakistan has invested over US$ 20 million in biotechnology research and hundreds of scientists are working in more than 31 public and private sector biotechnology research centers. There are various funding mechanisms now in place to support research and development in different disciplines of biotechnology. Many international institutions including Asian Development Bank, Islamic Development Bank, World Bank, USAID, Rockefeller Foundation and Australian Centre for International Agriculture Research also provide financial assistance for selected biotech projects.

With remarkable advancements in agriculture, biomedical research and pharmaceutical industry, biotechnology has become a major discipline which is likely to play an increasingly significant role in improving the economies of different countries, and especially those

which are developing. Pakistan must do its utmost to impart quality education in this exciting and promising field to its undergraduate and graduate students. The proposed Biotechnology curriculum has been developed with immense enthusiasm, passion and responsibility. It is anticipated that its successful implementation in all institutions across Pakistan will culminate in the production of well-trained post graduates who are much sought after by educational institutions and corporations within Pakistan and abroad.

STANDARDIZED FORMAT FOR Ph.D. IN BIOTECHNOLOGY

Sr. No.	Category	No. of courses	Credit Hours
1.	Course work	6	18

2.	Thesis/Dissertation		
	Total		

- Duration 3-5 years
- Number of courses per semester 3-5

LIST OF ELECTIVE COURSES

1. BIOT-901 Advances in Microbial Genetics
3(3-0)

2. BIOT-902 Advances in Animal Biotechnology
3(3-0)

3. BIOT-903 Advances in Immunology
3(3-0)

4. BIOT-904 Frontiers in Molecular Biology (Journal Club)
3(3-0)

5. BIOT-905 Advances in Genomics
3(3-0)

6. BIOT-906 Advances in Proteomics
3(3-0)

7. BIOT-907 Recent trends in Molecular Diagnostics
3(3-0)

8. BIOT-908 Applications of Nano-biotechnology
3(3-0)

9. BIOT-909 Modern Biotechnology: Principles & Applications
3(3-0)

10. BIOT-910 Recent trends in Biochemical Engineering
3(3-0)

11. BIOT-911 Metabolic Engineering and Biofuels
3(3-0)

12. BIOT-912 Advances in Insect Molecular Biology and Viruses
3(3-0)

13. BIOT-915 Advances in Environmental Biotechnology
3(3-0)

14. BIOT-916 Advances in Plant Tissue Culture
3(3-0)

15. BIOT-917 Advances in Biosensor Technologies
3(3-0)

16. BIOT-918 Biotechnology of Nonrenewable Resources
3(3-0)

17. BIOT-919 Advances in Pharmacogenomics
3(3-0)

18. BIOT-920 Molecular Systematics
3(3-0)

19. BIOT-921 Advances in Protein Chemistry
3(3-0)

20. BIOT-922 Advances in Cell and Molecular Biology
3(3-0)

21. BIOT-923 Advances in Fungal Biotechnology
3(3-0)

22. BIOT-924 Advances in Microbiology
3(3-0)

23. BIOT-925 Advances in animal cell Culture
3(3-0)

24. BIOT-926 Advances in Molecular Genetics
3(3-0)

25. BIOT-927 Genomics, Proteomics & Bioinformatics
3(3-0)

26. BIOT-928 Advances in Plant Biotechnology
3(3-0)

27. BIOT-929 Medical Biochemistry
3(3-0)

28. BIOT-930 Cellular Signaling
3(3-0)

29. BIOT-931 Advances in Health Biotechnology
3(3-0)

30. BIOT-932 Advances in Vaccine Research
3(3-0)

31. BIOT-933 Advances in Industrial Biotechnology
3(3-0)

32. BIOT-934 Structural Biology
3(3-0)

33. BIOT-935 Advanced Recombinant DNA Technology
3(3-0)

34. BIOT-936 Advance Techniques in Molecular Biology
3(3-0)

35. BIOT-937 Advances in Bioprocess Technology
3(3-0)

36. BIOT-938 Enzyme Technology
3(3-0)

37. BIOT-939 Applied Biostatistics
3(3-0)

38. BIOT-940 Advanced Analytical Techniques
3(3-0)

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

SCHEME OF STUDIES FOR PH.D. DEGREE IN BIOTECHNOLOGY

FIRST SEMESTER

Sr. No.	Name of Courses	Credit Hours
1	Elective-I	3(3-0)
2	Elective-II	3(3-0)
3	Elective-III	3(3-0)
	Total	**9**

Second Semester

Sr. No.	Name of Courses	Credit Hours
1	Elective-IV	3(3-0)
2	Elective-V	3(3-0)
3	Elective-VI	3(3-0)
	Total	**9**

Thesis **Research**

DESCRIPTION OF PHD COURSES

NOTE: Latest Edition of Books shall be used.

BIOT-901 ADVANCES IN MICROBIAL GENETICS 3(3-0)

Microbial genetics, Gene fusions, Yom Kippur, Lambda overview, Genetics retreat, Pathway analysis, Repression, Temperate bacteriophage, Bacterial signal transduction, Insertions elements and transposons, Gene function in prokaryotic microorganisms, Mechanisms of genetic recombination. Yeast cell type & signal transduction, Cell cycle genetics, Cytoskeleton genetics, Proteomics, Recombination mechanisms, DNA repair

Recommended Books

1. Latest review articles in Nature reviews genetics
2. Stephen McGrath and Douwe van Sinderen (2007) Bacteriophage: Genetics and Molecular Biology. Caister Academic Press

BIOT-902 Advances in Animal Biotechnology 3(3-0)

Latest books published in last five years will be followed to teach recent advancements in the field of biotechnology. Presentation and group discussion of latest, high impact research and review articles in Biotechnology research

Recommended Books

1. Biotechnology in Animal Husbandary, Renaville R., Bunny A (Eds) 2001, Springer, USA.
2. Animal Biotechnology, Sirivastava A.X et al. 2005, Oxford and BH Publishing Company.

BIOT-903 ADVANCES IN IMMUNOLOGY 3(3-0)

Presentation and group discussion of latest, high impact research and review articles in Molecular Immunology research.

Recommended Books:

1. Cellular and Molecular Immunology, Abul K Abass, 2008 Elsevier USA.
2. Case Studies in Immunology, Jonathon Brostoff et al. 5th Edition, 2007. Elsevier ,
3. Rapid Review Microbiology and Immunology, Ken S. Rosanthal, 2011, Elsevier.

BIOT-904 FRONTIERS IN MOLECULAR BIOLOGY (JOURNAL CLUB) 3(3-0)

Molecular Biology of RNA (types, structure, synthesis, transcription), Post-transcriptional modifications (RNA processing, editing, export etc.), Regulation of gene expression (transcription factors, gene activation silencing etc.), Molecular Biology of Proteins (types, structure, synthesis, translation), Post-translational modifications (glycosylation, phosphorylation, methylation, etc.), Molecular mechanisms of cellular communication, Bioinformatics (genomics, proteomics, metabonomics), Applications of molecular biology in agriculture, medicine and physiology, student presentation of latest research articles on selected topics.

Recommended Books

1. Advances in Molecular Biology Rajender Singh ALP Books, 2009
2. Tom Strachan and Andrew Read (2010) Human Molecular Genetics. 4th edition
3. Molecular Biology of the Cell Alberts, Bruce; Johnson, Alexander; Lewis, Julian; Raff, Martin; Roberts, Keith; Walter, New York and London: Garland Science; c2002
4. The Cell - A Molecular Approach Cooper, Geoffrey M. Sunderland (MA): Sinauer Associates, Inc.; c2000
5. Molecular Cell Biology Lodish, Harvey; Berk, Arnold; Zipursky, S. Lawrence; Matsudaira, Paul; Baltimore, David; Darnell, James E. New York: W. H. Freeman & Co.; c2007
6. Latest Articles from Nature Reviews Molecular Biology

BIOT-905 ADVANCES IN GENOMICS 3(3-0)

Organization and Structure of the Genomes, Characterization of the Genes, Physical Mapping of the Genes, Genetic Mapping of the Genes, Transcript Mapping, Structural Variation in the Genomes. Group Discussions.

Recommended Books:

1. Lewin (2010) Genes X
2. Tom Strachan and Andrew Read (2010) Human Molecular Genetics. 4th edition

BIOT-906 ADVANCES IN PROTEOMICS 3(3-0)

Protein Structure, Protein Folding, Protein Purification, Protein Sequencing, Protein Engineering, DNA-Protein Interaction, Protein-Protein Interaction, Introduction to Protein Bioinformatics (structure-function relationship, ORF and annotation, literature search (PubMed), Major Protein Resources {ExPASy (Swiss-PROT), BRENDA, ProtParam, Protscale, PIR, PBD, ncbi.nlm.nih.gov (entrez), InterProScan, Dotlet, ClustalW, PSIPRED, CN3D, What-IF}, Retrieving Protein Sequences, Protein chemistry on computers, Predicting Physio-chemical Properties of a protein, Comparing Protein sequences to other sequences, Data mining tool (BLASTing), Comparing Protein Sequences by Dotlet&ClustalW, Finding domains in a protein using InterProScan, Predicting secondary structure with PSIPRED, Homology modeling using Swiss model first approach

Recommended Books

1. Bioinformatics for Dummies by J-M Claverie & C Notredame, Wiley Publishing Inc. New York 2003
2. Physical Biochemistry: principles and applications by D Sheehan, Wiley and Sons Ltd. UK 2000
3. Fundamentals of Biochemistry by Donald Voet, Judith G. Voet and Charlotte W. Pratt
4. Proteomics: introduction to methods and applications AgnieszkaKraj, Jerzy Silberring John Wiley & Sons, 2008

BIOT-907 RECENT TRENDS IN MOLECULAR DIAGNOSTICS 3(3-0)

Overview of human genetic diseases: types of mutations; single gene and polygenic disorders; autosomal and sex-linked recessive and dominant inheritance; chromosomal abnormalities, Molecular techniques: PCR and non-PCR amplification, types of probe, gene expression analysis (real time PCR) and proteomics (e.g. use of MALDI-TOF), *in situ* hybridization (ISH) and flouresence*in situ* hybridization (FISH), cytogenetics and pre-natal diagnosis, linkage markers, Detection of specific mutations in hereditary genetic diseases and cancers, Detection of infectious diseases (viral, bacterial, fungal, protozoan) by molecular methods, Prenatal diagnosis and family screening procedures and outcomes, Analyte receptor interactions, Detection of atoms and small molecules, Antibody-based techniques including ELISA, immunohistochemistry, nephelometry, Future impact on pathology.

Recommended Books

1. Wiliam B. Coleman (2006) Molecular diagnostics; for the clinical laboratorian. 2nd edition. Humana Press
2. David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Fundamentals of Molecular Diagnostics
3. Lela, Maribeth L. (2007) Molecular Diagnostics: Fundamentals, Methods, & Clinical Applications. F.B. Davis company

BIOT-908 APPLICATIONS OF NANO-BIOTECHNOLOGY 3(3-0)

This course will explore latest research articles on therapeutic applications of Biochemistry and Molecular Biology research. Specifically, new concepts in drug design, combinatorial chemistry, Biochemical conjugates, Nanobioconjugates, Gene therapeutics, Targeted delivery, Safety and efficacy of experimental drugs, bioethics.

Recommended Books

1. Experimental Therapeutics, Author: Martin Wilkins Publisher: Taylor & Francis Group 2003
2. Cancer Medicine Kufe, Donald W. editors. Hamilton (Canada):BC Decker Inc.; c2003

3. Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine By: Alexander Battler, Jonathan Leor Publisher: Springer 2005
4. Gene Therapy and Gene Delivery Systems By: David V. Schaffer, Weichang Zhou Publisher: Springer 2006

BIOT-909 MODERN BIOTECHNOLOGY: PRINCIPLES & APPLICATIONS 3(3-0)

Principles of Biotechnology; Issues and concerns about Biotechnology; Applications of Biotechnology: Health Care, Production of proteins for pharmaceutical and other specialized purposes, Molecular Diagnostics, DNA fingerprinting, Antibiotics, vaccines, Biosensors, gene therapy; Environmental Biotechnology; Waste treatment and pollution prevention, bioremediation, biofuel production from waste. Agriculture & Live-Stock Products: Biofertilizers: Crop Improvement, Becontree of Noxious Plants and Animals. Process Applications: Biotechnology of raw-ore processing (sulfides; carbonates and silicates bioleaching), Accumulation of metals by microbial cells, Biopulping; Biofuels, Microbial Enhanced Oil Recovery; Food Processing: Production of beer, wine, cheese, bread, SCP, cities acid and amino acids; Industrial & Enzyme Technology: Enzyme characterization and kinetics, traditional industries and associated enzymes .Future perspectives of Biotechnology for example: safety of GM crops, etc.

Recommended Books

1. Helen Kreuzer and Adrianne Massey (2005) Biology and Biotechnology: Science, Applications, and Issues. ASM Press
2. Bernard Ollivier (2005) Petroleum Microbiology. ASM Press
3. Mahmoud Ghannoum (2004). Microbial Biofilms. ASM Press
4. Bernard R. Glick and Jack J. Pasternak (2003) Molecular Biotechnology: Principles & Applications of Recombinant DNA, 3rd Edition. ASM Press
5. Judith A. Scheppler, Patricia E. Cassin, and Rosa M. Gambier, (2000). Biotechnology Explorations: Applying the Fundamentals. ASM Press

BIOT-910 RECENT TRENDS IN BIOCHEMICAL ENGINEERING 3(3-0)

Microorganisms in chemical and biochemical synthesis, Fermentation Process Control, Dissolved Oxygen Measurement and Mixing, Gas and Liquid System: Aeration and Agitation, Growth Kinetics, Design of Bioreactors and Operations, Down Stream Processing, Material and Elemental Balance, Bioprocess Scale-up, Enzyme Kinetics & Immobilization (Simple enzyme kinetics, enzyme reactor, inhibition, other influences, and experiments, Product Purification & Recovery

Recommended Books

1. Ghasem Najafpour. (2006).Biochemical Engineering and Biotechnology. Elsevier Science
2. Michael L. Shuler and FikretKargi, Prentice Hall, (2001). Bioprocess Engineering, Basic Concepts, 2nd Edition, ISBN: 0-13-081908-5

BIOT-911 METABOLIC ENGINEERING AND BIOFUELS 3(3-0)

Definition of Biofuels, biomass and bioenergy, bioresources, biofuels classification, energy crises, importance and application of biofuels, environment and biofuels, world energy scenario, leading countries using biofuels, advances in biofuels research, University-Industry linkage, biofuels feed stock. Introduction of biodiesel as a fuel, history, international applications and production, environmental impacts, systematics of oil seeds plants, classification, edible and non-edible oil seeds, cultivation, systematic research trends, concept of free fatty acids, feed stock selection, transesterification, types, oil seed processing, quality control of biodiesel, phytochemical screening of biodiesel, biodiesel blends, American Standard Testing Methods (ASTM) and EN (European Nations) standards, fuel properties, viscosity, specific gravity, density, flash, cloud, pour points, centane index and number, distillation, sulfur contents, acid values, biodiesel byproducts, glycerin and soap analysis, methanol recovery, implementation in engine, efficiency performance and consumption, biodiesel emissions, economics of biodiesel, marketing, supply chain, systematics of biodiesel yielding plant species of Pakistan, future of biofuels technology.

Recommended Books

1. Dhillon, D. S., R. K. Tyagi, S. Saxena and A. Agrawal. 2004. Plant Genetic Resources: Oilseed and Cash Crops. India.
2. Lele, S. 2005. Biodiesel and Jatropha Cultivation. Bharat Printers, Jodhpur, India.
3. Mendez. M. C. 2006. "Feasibility Study of a biodiesel production plant form oil seeds". University of Strathclyde, Department' of Mechanical Engineering

BIOT-912 Advances in Insect Molecular Biology and viruses 3(3-0)

New advancement in insect molecular biology and insect virus relationship, Insects: model for molecular biology, Classification of insects using molecular biological technique/ DNA barcoding, Insects as a vector of plants and animal diseases, Defense mechanisms of insects and its molecular biology, Classification of insect viruses, Insect parasites and polydnaviruses, Gene structure of baculovirus and construction of expression vectors, Use of insects and viruses to study functional genomics, Gene silencing, Biological control using insect viruses, Modern Insect control strategies: use of biological toxins and microorganisms.

Recommended Books

1. Crampton, J. M., Beard, C. B., & Louis, C. (1997). *The molecular biology of insect disease vectors: a methods manual*. Chapman & Hall Ltd.
2. Gilbert, L. I. (2012). *Insect molecular biology and biochemistry*. Academic Press.
3. Vodovar, N., & Saleh, M. C. (2012). Of insects and viruses: the role of small RNAs in insect defence. *Advances in insect physiology*, *42*, 1.
4. Schoonhoven, L. M., Van Loon, J. J., & Dicke, M. (2005). *Insect-plant biology*(No. Ed. 2). Oxford University Press.
5. Hall, J. C. (2003). Genetics and molecular biology of rhythms in Drosophila and other insects. *Advances in genetics*, *48*, 1-280.
6. Ashburner, M. (1989). *Drosophila. A laboratory handbook*. Cold Spring Harbor Laboratory Press.
7. Martignoni, M. E., & Iwai, P. J. (1986). A catalog of viral diseases of insects, mites, and ticks.

8. Carter, W. (1962). Insects in relation to plant disease. *Insects in relation to plant disease*.
9. Jarvis, D. L. (1997). Baculovirus expression vectors. In *The baculoviruses* (pp. 389-431). Springer US.

BIOT-913 ADVANCES IN FERMENTATION TECHNOLOGY 3(3-0)

Fermentations Introduction, Microbial Types, Fermentation Processes: Solid state fermentation, submerged fermentation, Batch fermentation and continuous fermentation, Control and regulation of microbial growth in fermentation, Mass and Energy Transfer: Mechanism of mass transfer, mass transfer across gas/liquid and solid/liquid phase boundaries. Fermenter Design: Fermenter configuration, aeration, agitation and process control. Measurement of temperature, dissolved oxygen, ammonia and other variables, Data Analysis, Industrial application of fermentation.

Recommended Books

1. K.K. MachveManglam (2009) Fermentation Technology Publications
2. El-Mansi, Bryce Demain and A. R. Allman, (2006) Fermentation Microbiology and Biotechnology, 2nd Ed. CRC Press.
3. GhasemNajafpour. (2006).Biochemical Engineering and Biotechnology. Elsevier Science
4. Mukhopadhyay, S. N., (2001) Process Biotechnology Fundamentals. Viva books. New Delhi, India.
5. Allen, L, Bennett, J. W, Geoffrey, M. G (2001) Advances in Applied Microbiology. Academic Press.
6. Demain, A. L. and Solomon, N. A. (2000) Manual of Industrial Microbiology and Biotechnology. AMS press USA.

BIOT-914 ADVANCES IN AGRICULTURE BIOTECHNOLOGY 3(3-0)

Plant breeding; Cell and tissue culture; Plant transformation; methods of Transformation in plants including competence, electroporation, microinjection, Particle gun and agrobacterium; methods for assessing transformation, Transgenic crops for herbicide, pest, fungal, bacterial and viral resistance. Transient and stable expression systems, viruses as expression vectors; genetically modified organisms; Biosafety guidelines.

Recommended Books

1. Hartman, H. T., D. E. Kester, F. T. Davies, Jr.,and R. L. Geneve. 2002. Plant propagation principles and practices. 7th ed. Prentice Hall, Englewood Cliffs, USA.
2. Fahn, A. 2001. Plant Anatomy, 4th Edition, Butterworth, Heinemann Ltd.
3. Fosket, D. E. 1998. Plant Growth and Development: A Molecular Approach. Academic press, San Diego.

BIOT-915 ADVANCES IN ENVIRONMENTAL BIOTECHNOLOGY 3(3-0)

Waste treatment: waste water treatment; Solid waste treatment; activated sludge processing, landfill, Biodegradation of pollutants: degradation of chemical pollutants, e.g., petroleum hydrocarbons, pesticides, coordinated hydrocarbons and industrial dyes etc. Bioremediation, biotransformation (e.g. heavy metals), Molecular approaches for environmental management: importance of genetic exchange in degradation of xenobiotics, tracking of genes in environment, Transport of pathogens through soil and aquifers and their detection methods, Biosafety: Regulation, Release of GMOs, possible risk assessment measurement of genotoxicity. Toxicity of degraded products.

Recommended Books

1. Christon Hurst, Ronald Crawford, Jay Garland, David Lipson, Aaron Mills and Linda Stetzenbach (2007) Manual of Environmental Microbiology. 3rd Ed. Blackwell Publishers
2. Ronald M. Atlas, (2005) Bioremediation: Applied Microbial Solutions for Real World Environmental Clean-up. ASM Press

3. Patrick K. Jjemba (2004) Environmental Microbiology: Principles and Applications. Sciences Publishers USA
4. Laqrence P. Wackett (2001) Biocatalysis and Biodegradations: Microbial Transformation of Organic Compounds. ASM Press
5. Derek R. Lovley (2000) Environmental Microb-Metal Interactions. ASM Press
6. Christopher F. Faster and D. A John Wase, John Wase (2004) Environmental Biotechnology. John Willey & Sons.
7. Ralph Mitchell (1993) Environmental Microbiology. John Wiley & sons Inc.

BIOT-916 ADVANCES IN PLANT TISSUE CULTURE 3(3-0)

Techniques for rapid clonal propagation in vitro, techniques for production of disease-free plants. Understand the in vitro technologies on the application of seedling production and breeding in Horticultural plants. Introduction, Plant tissue laboratory and aseptic techniques, Preparation and composition of nutrient media, Mass micropropagation of healthy plants, Callus and cell culture, Somaclonal variation, Experiments in plant tissue culture, Presentation from selective scientific papers.

Recommended Books

1. Arditti, J. and R. Ernst. 1992. Micropropagation of orchids. Wiley, New York, USA.
2. Bhojwani, S. S. and M. K. Razdan. 1996. Plant tissue culture : theory and practice, a revised edition. Elsevier Science, Netherlands.
3. Chawla, H. S. 2002. Introduction to plant biotechnology, 2nd ed. Science, India, USA.
4. de Jong, J. 1990. Integration of in vitro techniques in ornamental plant breeding. Plant Breeding Research, Wageningen, Netherlands.
5. Debergh, P. C. and R. H. Zimmerman. 1990. Micropropagation : technology and application. Kluwer Academic, Netherlands.
6. Dodds, J. H. and L. W. Roberts. 1985. Experiments in plant tissue culture. 2nd ed. Cambridge University, New York, USA.
7. Hartman, H. T., D. E. Kester, F. T. Davies, Jr.,and R. L. Geneve. 2002. Plant propagation principles and practices. 7th ed. Prentice Hall, Englewood Cliffs, USA.

BIOT-917 ADVANCES IN BIOSENSORS TECHNOLOGIES 3(3-0)

Biosensor introduction and background; Classification of biosensors, Optical biosensors in bioprocess technology; Optical transducers and measurement principles, Optical biosensors; advantages and disadvantages, Enzyme based (bioactivity) sensors, Bioaffinity sensors, Electrochemical DNA biosensors, Biosensors for in situ measurements, Flow injection analysis, Examples of FIA-systems used for on line bioprocess monitoring, Current and potential applications and difficulties with biosensor applications (Biomedical, Environmental, monitoring microbial processes etc.), Recent trends and Future perspectives, Economics and market for biosensors; Development cost of a biosensor, Cost reduction methods, Commercially available biosensors

Recommended Books

1. Frances, S. L. & Taih, C. R. 2008. Optical Biosensors. Today and Tomorrow, 2nd Edn, Elsevier Science.
2. Sadana, A. 2001. Engineering Biosensors, Kinetics and design applications. A. Sadana Academic press.
3. Freitag, R. 1996. Biosensors in Analytical Biotechnology. Academic Press R. G. Landes Company.
4. Scheller, F. & Schimid, R. D. 1991. Biosensors: Fundamentals, Technologies and Application. VCH Weinheim, New York.

Recommended Articles

1. Velasco-Garcia, M. N. 2009. Optical biosensors for probing at the cellular level: A review of recent progress and future prospects. *Semin Cell Dev Biol* 20, 27–33.
2. Kerman, K., Kobayashi, M. & Tamiya, T. 2004. Recent trends in electrochemical DNA biosensor technology. *Measurement Science & Technology* 15, R1-R11.
3. Mehrvar, M. & Abdi, M. 2004. Recent developments, characteristics and potential applications of electrochemical biosensors. *Analytical Science* 20, 1113– 126.
4. Rodriguez-Mozaz, S., Marco, M., Lopez de Alda, M. J., et al. 2004. Biosensors for environmental applications: Future development trends. *Pure Appl Chem* 76, 723–752.

BIOT-918 BIOTECHNOLOGY FOR NON RENEWABLE RESOURCES 3(3-0)

Biomining and biodesulphurisation, Biomining-past, present and future, Industrial leaching methods, Chemical bioleaching, Microbial bioleaching-direct mechanism, Indirect mechanism, Microbiological desulphurisation of fossil fuels, Environmental impacts, Acid mine drainage-generation and effects, Remediation of AMD-bulk purification, Metal removal, Acid rains. Metal tolerance, Introduction, Habitats, The organisms, Heavy metal tolerance (Extracellular complexation, Extracellular precipitation and crystallization, Transport-related mechanisms of resistance, Intracellular compartmentation and detoxification, Metal transformations, Morphological changes), Genetic aspects of heavy metal resistance in bacteria, Genetic aspects of yeast metallothionein, Commercial aspects, Future prospects. Downstream Processing of Metals, Introduction, Conventional methods, Biosorption/bioaccumulation of heavy metals and its mechanism, Types of biosorbents, Methods to enhance biosorption potential, Modeling of biosorption/bioaccumulation-equilibrium, Kinetic modeling, Commercial aspects-industrial potential, Development of bioresins, Scale up studies, Future prospects.

Recommended Books

1. Rawlings, D. E. & Johnson, D. B. 2007. Biomining. Springer.
2. Volesky, B. 2003. Sorption and Biosorption. CRC Publishers.
3. Horikoshi, & Grant W. D. 1998. Extremophiles-Microbial life in extreme environments. John Wiley & Sons.
4. Edwards, C. 1991. Microbiology of Extreme Environments. Open University Press, UK. K.
5. Ehrlich, H. L. & Brierley, C. L. 1990. Microbial Mineral Recovery. McGraw-Hill Publishing Company.
6. Volesky. 1990. Biosorption of Heavy Metals. Volesky, CRC Publishers.
7. Herbert, R. A. & Codd, G. A. 1986. Microbes in Extreme Environments. Society for General Microbiology publication by Academic Press.

Recommended Articles

1. Ivanov, I. P. 2007. Main trends in the biotechnological processing of coals: A review. *Solid Fuel Chemistry* 4, 3-10.

2. Clark, M. E., Batty, J. D., Buuren, C. b. V., et al. 2006. Biotechnology in minerals processing: Technological breakthroughs creating value. *Hydrometallurgy* 83, 3-9.
3. John, J. & Kilbane. 2006. Microbial biocatalyst developments to upgrade fossil fuels. *Curr Opin Biotechnol* 17, 305-314.

BIOT-926 Advances in Molecular Genetics

3(3-0)

Course Contents

The Logic of genetic analysis. Model organisms and their genomes (*Saccharomyces cerevisiae, Caenorhabditis elegans, Drosophila melanogaster, Arabidopsis thaliana, Mus musculus*), Genes and mutants, identifying mutants. Forward and reverse genetic analysis. Producing mutations, Classifying mutants, targeted gene knockouts. Complementation tests, genetic screens, connecting a phenotype to a DNA sequence, finding mutant phenotypes for cloned genes. Genome-wide mutant screens, identifying genes to be mutated, screening for mutant phenotypes, disrupting and perturbing genes. Gene activity, molecular analysis of gene Expression, RNA expression analysis of mutant gene, protein expression analysis of mutant gene. Assays of gene expression, analysis of gene activity using mutants. Interpreting mutant phenotype, conditional mutations. Gene interactions, using one gene to find more genes, suppressors mutations, synthetic enhancers.

Recommended Books

1. Advanced Genetic Analysis: Genes, Genomes and Networks in Eukaryotes by Philip Meneely. Oxford University Press, 2009.
2. Introduction to Genetic Analysis [9th Edition] by Anthony J.F. Griffiths, Susan, R. Wessler, Richard, C. Lewontin and Sean, B. Carroll. W.H. Freeman, 2007.
3. Genetics: Analysis and Principles by Robert, J. Brooker. McGraw-Hill Science, 2008.

BIOT-927 Genomics, Proteomics & Bioinformatics 3(3-0)

Genomes, genome anatomies. Understanding the genome sequences, SNPs and QTLs, Genome mapping. Development of genetic maps and markers. Map based cloning of the genes. Genome scale cloning strategies. Identification of Specialized Genes. Expression profiling for relative gene expression studies. Mass genomic expression analysis (Real time PCR and microarray). Proteomics approach for target recognition, identification and analysis of proteins through LC/MS/MS and MALDI-TOF. Applications of bioinformatics in biology and the software tools for molecular analysis. Introduction to databases, data search and utilities including translation, multiple alignment, identification of specific motifs, signal peptides. Protein structure and functional characterization, expressed sequence tag (EST) analysis. Optimization of gene expression and synthetic gene construction. Statistical software in genome mapping.

Recommended Books

1. Genomes [3rd Edition] by Brown, T.A. Garland Science: New York, 2006.
2. Separation Methods in Proteomics by Smejkal, G.B. and Lazareu, A. CRC Press, Taylor and Francis Group USA, 2006.
3. Proteomics Today: Protein Assessment and Biomarkers using Mass Spectrometry, 2D Electrophoresis and Microarray Technology by Hamdan, M. and Righetti, P.G. John Wiley and Sons, Inc., USA, 2005.
4. Discovering Genomics, Proteomics and Bioinformtics by Campbell, A.M. and Heyer, L.J. Pearson Education Ptv. Ltd. Singapore, 2004.
5. Bioinformatics and Functional Genomics by Jonathan Pevsner. Wiley-Blackwell, UK. 2009.

BIOT-928 Advances in Plant Biotechnology 3(3-0)

Genetic engineering of plant for abiotic tolerance (drought, temperature and salinity), and genetic engineering of plants for herbicide tolerance. Different proteins of plant and non-plant origin with insecticidal activities and their engineering in plants for control of insects. Genetic engineering of plants against important viral, bacterial and fungal pathogens. Expression of multiple genes in transgenic plants. Generation of marker free transgenic plants and tissue-specific expression of transgenes. Biosafety of crops and rules related to biosafety

of crops. RNA Interference (RNAi) technology and its applications in engineering novel traits of agronomic importance.

Recommended Books/Articles

1. Batista, R. & Oliveira, M. M. 2009. Facts and fiction of genetically engineered food. *Trends in Biotechnology* 27, 277-286.
2. Chua, N. H. & Tingey, S. V. 2006. Plant biotechnology: looking forward to the next ten years. *Curr Opin Biotechnol 17*, 103-104.
3. Halford, N. 2006. Plant Biotechnology. John Wiley & sons.
4. Agrios, G. N. 2005. Plant Pathology, 5th edn, Elsevier Acdemic Press.
5. Schoonhoven, L. M., Joop, J. A., Loon, V. et al. 2005. Insect-Plant Biology. Oxford University Press.
6. Christon, P. & Klee, H. 2004. Handbook of Plant Biotechnology, Two-volume set. John Wiley & Sons.

BIOT-929 Medical Biochemistry 3(3-0)

Bioenergetics and Oxidative Metabolism, Function of the Gastrointestinal Tract in Digestion and Absorption of Food, Vitamins, Minerals and Nutrition, Anaerobic Metabolism of Glucose in the Red Cell, Carbohydrate Storage and Synthesis in Liver and Muscle, The Tricarboxylic Acid Cycle, Oxidative Metabolism of Lipids in Liver and Muscle, Biosynthesis and Storage of Fatty Acids in Liver and Adipose Tissue, Biosynthesis of Cholesterol in Liver, Lipids and Lipoproteins, Glucose Homeostasis and Energy Metabolism, Metabolism in kidney and liver, Biochemical Endocrinology, Signal Transduction, and Neurochemistry.

Recommended Books/Articles

1. Murphy, R. C & Johnson, K. M. 2008. Cholesterol, Reactive Oxygen Species, and the Formation of Biologically Active Mediators. *J Biol Chem* 283, 15521-15525.
2. Tontonoz, P. & Spiegelman, B. M. 2008. Fat and beyond: the diverse biology of PPARgamma. *Annu Rev Biochem* 77,289-312.

3. Cox, M & Nelson, D. L. 2006. Lehninger Principles of Biochemistry.
4. Devlin, T. M. 2006. Textbook of Biochemistry with Clinical Correlations.
5. Baynes, J. 2005. Medical Biochemistry, 2nd edn, Marek Dominiczak.

BIOT-930 CELLULAR SIGNALING

3(3-0)

The purpose of this course is to advance the knowledge of students for the signaling of cells which is very important mechanism for the understanding of signaling pathways. Signaling pathways play a very major role in the brief understanding of the physiology and pathology or living organisms. This course will also include the topics e.g. mechanism of signal transduction, global cell regulatory programs, cell-cell communications, receptors involved in the cellular signal transduction. Signal types will also be elaborated. Moreover, signaling pathways, lipid signaling, heterotrimeric G-protein coupled signaling, nuclear receptors and drug metabolism will also be the part of this course. Protein dynamics. Intracellular messenger substances, protein kinases, MAP kinases. Trans-membrane receptors. Intracellular signaling. redox signaling. Cell surface enzymes. Regulation of cell cycle, apoptosis, malfunction, tumerogenesis/cancer. Insulin signaling, Trans-membrane receptors, Ion channels and the molecular networks of abiotic stress signaling.

Content

1. The machinery of signal transduction, global cell regulatory programs, cell-cell communications
2. Types of signals, signal transduction, receptors for cell signals, signaling pathways,
3. Lipid signaling
4. Heterotrimeric G-protein coupled signaling, nuclear receptors and drug metabolism
5. Protein dynamics, Intracellular messenger substances, protein kinases, MAP kinases
6. Trans-membrane receptors, Intracellular signaling, redox signaling
7. Cell surface enzymes, Regulation of cell cycle, apoptosis, malfunction,
8. Insulin signaling, Trans-membrane receptors, Ion channels and the molecular networks of abiotic stress signaling.

Recommended Text

1. Ernst, J. M. (2001). *The Biochemistry of Cell Signalling.* New York, USA: Oxford University Press.
2. Gerhard, K. (2003). *Biochemistry of Signal Transduction and Regulation*. Hoboken, USA: Wiley-VCH.

Suggested Readings

1. Yang, Z. (2008). *Intracellular Signalling in Plants*. Hoboken, USA: Wiley-Blackwell, 2008.
2. Bradshaw, R.A. and Dennis, E.A. (2003). *Handbook of Cell Signaling*. New York, USA: Academic Press.
3. Bogre, L. and Beemster, G. (2008). *Plant Growth Signaling*. New York, USA: Springer.
4. Kumar, R. (2004). *Molecular Targeting and Signal Transduction*. Norwell, USA: Kluwer Academic Publishers.

BIOT-931 ADVANCES IN HEALTH BIOTECHNOLOGY

3(3-0)

Health biotechnology comes under the umbrella of biotechnology, it involves the use of living cells and cell materials to understand the physiological and pathological condition and produce pharmaceutical and diagnostic products that help treat and prevent human diseases. Health biotechnology 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 genetics, human genome organization, mechanism which causes changes in human genome, pathological mutation or polymorphism, mechanism by which body combat these changes (DNA repair), Genome mapping and genetic testing. 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, repetitive DNA and transposable elements will be also discussed.

Content

1. Introduction to classical genetics (Mendalian and non-mendalian pattern of inheritance)
2. Human genome organization, Human multigene families and repetitive DNA, transposable elements
3. Instability of human genome: mutation and DNA repair
4. Physical and transcript mapping
5. Genetic mapping of Mendelian characters: Recombinants and non-recombinants
6. Genetic markers, Two point and multipoint mapping
7. Genetic mapping of complex characters: Parametric and non-parametric linkage analysis
8. Association and linkage, Linkage disequilibrium, Strategies for complex disease mapping
9. Human Genome Projects, genetic and physical mapping of the human genome, Model organism and other genome projects
10. Identifying human disease genes: Strategies in identifying disease genes, position-independent strategies,
11. Positional candidate strategies, confirming a candidate gene.
12. Genetic testing in individuals and populations: Gene tracking, Population screening, DNA profiling
13. Gene therapy and its ethical issues

Recommended Text

1. Strachman and Read. (2003). *Human Molecular Genetics*. Hoboken, USA: Wiley-Liss Publishers.

Suggested Readings

1. Julia, E., Richards, R. and Hawleg S. (2005). *The Human Genome*. (2nd Edition). Oxford, United Kingdom: Elsevier Academic Press.
2. Lewis, R. (2003). *Human Genetics. Concepts and Applications*. (5th Edition). New York, USA: McGraw Hill.

BIOT-932 ADVANCES IN VACCINE RESEARCH

3(3-0)

A vaccine is a biological preparation that provides active acquired immunity to a particular infectious disease. A vaccine typically contains an agent that resembles a disease-causing microorganism.This is

the advanced course specially designed to promote the knowledge of vaccine development and research which is much needed area of biotechnology. This course will enlighten the students about the various concepts of immunity: resistance, inflammation, phagocytosis, vaccines, attenuation, antigen, antibody, antigen-antibody reactions. This course will include the details of aforementioned topics e.g. types of immunity, condition of antigenicity, chemical basis of antigenic specificity, antigenic determinants, haptens, adjuvants, nature of antibody, immunoglobulins, site and theories of antibody formations, rate of antibody formation, heterogenecity, Antigen-Antibody reactions: valence of antigen and antibody, cross reaction. Concept of homologous and heterologous reactions, serologic reactions, role of serology in diagnosis of disease, immunoelectrophoresis, radioimmunoassay, fluorescent tagged antibody and Blood group of man will also be part of this course.

Content

1. Concept of immunity and resistance, inflammation, phagocytosis
2. Kinds of immunity, vaccines, attenuation, antigen,
3. Condition of antigenicity, chemical basis of antigenic specificity
4. Antigenic determinants, haptens, adjuvants
5. Antibody, nature of antibody, immunoglobulins, site and theories of antibody formations
6. Rate of antibody formation, heterogenecity
7. Antigen-Antibody reactions: valence of antigen and antibody, cross reaction
8. Concept of homologous and heterologous reactions
9. Serologic reactions, role of serology in diagnosis of disease
10. Immunoelectrophoresis, radioimmunoassay
11. Fluorescent tagged antibody
12. Blood group of man: A, B, O. and other practical application of knowledge of blood groups.

Recommended Books

1. Arrhenius, S. (2008). *Immunochemistry*. Charliston, USA: BiblioBazaar.
2. Burns, R. (2005). *Immunochemical Protocols*. Totowa, USA: Humana Press.

Suggested Readings

1. Chatterjea, M. N. (2002). *Textbook of Medical Biochemistry*. New Delhi, India: Jaypee Brothers.
2. Talwar, G. P. (2003). *Textbook of biochemistry and Human Biology*. New Delhi, India: Prentice-Hall of India.
3. Garrett, Reginald, H., Grisham, Charles, M. (2002) *Principles of Biochemistry with a Human Focus*. Belmont, USA: Brooks Cole Publishing.
4. Berg, J. M., Tymoczko, J. L. (2002). *Biochemistry*. New York, USA: W. H. Freeman.

BIOT-933 **ADVANCES IN INDUSTRIAL BIOTECHNOLOGY**

3(3-0)

The purpose of this course is to advance the knowledge of students for industrial biotechnology. Main focus of this course is on the practical applications of this emerging field of industrial biotechnology. This subgroup of biotechnology is providing very useful and easily applicable solutions to the problems of human. This course will discuss about the major problem of pollution and the solutions provided by the industrial biotechnology. This course will also include the biodegradation of xenobiotic chemicals; ethanol and related fermentations, fermentation for the production of pharmaceutical products including antibiotics, hormones and vaccines. The recent literature published in the renowned journals related to the biopharmaceuticals will also be discussed in the class to emphasize the importance of this course and its applications. Moreover, the industrial production processes will also be elaborated along with their advantages and disadvantages. Microbial and metal leaching will also be explained.

Content

1. Water pollution and effluent treatment
2. Biodegradation of xenobiotic chemicals; ethanol and related fermentations
3. Production of industrial enzymes
4. Fermentation for the production of pharmaceutical products including antibiotics, hormones, vaccines
5. Production of other chemicals of industrial importance
6. Microbial metal leaching
7. Industrial production processes

Recommended Books

1. Voet, D., Voet, J.G., Pratt, C.W. (1999). *Fundamentals of Biochemistry*. Hoboken, USA : John Wiley and Sons.
2. Lehninger, A. L., Nelson, D.L., Cox, M.M. (2000). *Principles of Biochemistry*. (3rd Edition). New York, USA : Worth Publishers.

Suggested Readings

1. Zubay, G. (1998). *Biochemistry*. (4th Edition). Iowa, Canada: Brow Dubuque.
2. Stryer, L. (2000). *Biochemistry*. (5th Edition). New York, USA: W.H. Freeman and Co.
3. Murray, R.K., Grammer, D.K., Mayes, P.A., Rodwell, V. W. (2000). *Harper's Biochemistry*. (25th Edition). New York, USA : Appleton and Lange.
4. Atlas, R.M. (1997). *Principles of Microbiology*. (2nd Edition). Dubuque, USA : W.C. Publishers.

BIOT-934 STRUCTURAL BIOLOGY 3(3-0)

This course will focus on the structural basis of function of macromolecules in a cell by providing an introduction to: the biophysical and biochemical properties of macromolecules; the physico-chemical basis of structure-function relationships and how structures of macromolecules and macromolecular assemblies are determined. Impact of structural biology in enhancing our mechanistic knowledge of broad range of cellular processes will be emphasized through case studies using example of individual proteins to large macromolecular complexes such as viruses. The theory and practical application of various techniques used in structural characterization of proteins such as circular dichroism, Fourier-transform infrared, fluorescence and nuclear magnetic resonance spectroscopy, calorimetric technique and X-ray crystallography will be discussed in detail to make the understanding of students about these techniques more better and sound. Various bioinformatic tools will be used to predict the structures of protein (secondary structure, threading, homology modeling etc.). Moreover, the structural biology of membrane proteins along with membrane dynamics, structural and functional insights into membrane transport: passive and active will also come under the umbrella of this course.

Content

1. Introduction to structural biology and its importance in the study of proteins
2. Theory of techniques used for structural characterization of proteins
3. Circular dichroism, Fourier-transform infrared
4. Fluorescence and nuclear magnetic resonance spectroscopy
5. Calorimetric technique and X-ray crystallography
6. Protein structure prediction using bioinformatics tools
7. Structural biology of membrane proteins
8. Membrane dynamics
9. Membrane proteins; their types and classification
10. Structural and functional insights into membrane transport: passive and active

Recommended Books

1. Nelson, D.L. and Cox, M.M. (2008). *Lehninger Principles of Biochemistry*. (5th Edition). New York, USA: W.H. Freeman and Co.
2. Voet, D., Voet, J.G., Pratt, C.W. (2008). *Principles of Biochemistry*. (3rd Edition). Hoboken, USA : John Wiley and Sons.

Suggested Readings

1. Messerschmidt, A. (2007). *X-Ray Crystallography of Biomacromolecules: A Practical Guide*. (1st Edition). Hoboken, USA: Wiley VCH.
2. Stephen, B.A. (2000). *Membrane Transport - A Practical Approach*. New York, USA: Oxford University Press.

BIOT-935 ADVANCED RECOMBINANT DNA TECHNOLOGY 3(3-0)

This course is designed to familiarize the student with methods employed to produce recombinant products. The lectures will cover fundamental aspects of the recombinant DNA methodologies used in the laboratory as well as some commercial applications of the techniques. Moreover, new advancement in Recombinant DNA Technology, Importance and application of DNA recombinant technology in industrial, agricultural, biomedical and environmental biotechnology with comprehensive theoretical know how to generate macromolecules of desired characters for transgenesis will also be discussed in class. This course will also include the theoretical knowledge of the various techniques used in genetic engineering including nucleic acid isolation (especially DNA), cleavage of DNA by restriction enzyme after generating a restriction enzyme map, cloning and selection of the transformant, protein expression, gel electrophoresis, polymerase chain reaction, DNA sequencing, and related techniques. Along with these topics, a brief introduction of restriction endonucleases, DNA modifying enzymes, Cloning vectors, synthesis of new DNA molecules, gene libraries and cDNA cloning will be given to the students.

Content

1. Advancement in Recombinant DNA Technology
2. Importance & application of DNA recombinant technology in industrial, agricultural, biomedical & environmental biotechnology
3. Synthesis of macromolecules of desired characters by transgenesis
4. Different approaches to isolate nucleic acids, cleavage of DNA
5. Genetic Maps, Restriction endonucleases, DNA modifying enzymes
6. Cloning vectors and its types, Making new DNA molecules, Gene libraries & cDNA cloning
7. Competency and different means of introducing DNA into Prokaryotes & Eukaryotes
8. Reporter Genes; Identification and screening of recombinant DNA molecules
9. Marker free recombination
10. Gateway cloning

Recommended Books

1. Brown, T.A. (2010). *Gene Cloning and DNA Analysis: An Introduction*. (6th Edition). Oxford, United Kingdom: Blackwell Sciences Ltd
2. Glick, B.R., Pasternak, J.J. (2003). Molecular *Biotechnology: Principles & Applications of Recombinant DNA*. (3rd Edition). Washington, USA: ASM Press.

Suggested Readings

3. Teresa, T. and Shirely, B. (2002). *Biotechnology DNA Protein: a laboratory project in molecular biology*. Boston, USA: McGraw Hill.
4. Kreuzer, H. and Massey, A. (2001). *Recombinant DNA and Biotechnology*. (2nd Edition). Washington, USA: ASM Press.
5. Joseph, S. and David, R.W. (2001). *Molecular cloning. A laboratory Manual*. (3rd Edition). New York, USA: Cold Spring Harbor Laboratory Press.
6. Old, R. W. and Primrose S. C. (2006). *Principles of Gene Manipulations*. (6th Edition). Oxford, United Kingdom: Blackwell Science.

BIOT-936 ADVANCE TECHNIQUES IN MOLECULAR BIOLOGY 3(3-0)

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. Advanced theoretical knowledge of numerous molecular biology techniques, including DNA and RNA isolation, PCR, Regular and nested PCR, RT- PCR, Multiplex PCR, Real time PCR, Agarose gel electrophoresis, Pulse field electrophoresis, Two-dimensional gel electrophoresis, Polyacrylamide gel electrophoresis etc. In parallel to this, hybridization and signal detection methods, design and detection of short RNA, DNA sequencing, fundamentals of microarray and Microarray technologies, gene expression analysis techniques, genomic libraries, methods of cDNA library development/screening, southern, northern and western hybridization, ELISA, molecular markers and advanced genome editing techniques e.g. CRISPER-Cas technology will also be discussed in detail. 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 professional practice in areas related to molecular biology.

Content

1. Introduction to central dogma, DNA, RNA, Protein
2. DNA and RNA Isolation, Purification and Quantitation,
3. Gel Electrophoresis and its types
4. Polymerase Chain Reaction and its types
5. Probe labeling, Hybridization and Signal Detection Methods, Southern, northern and western hybridization
6. Design and detection of short RNA, DNA sequencing
7. Fundamentals of microarray and Microarray technologies, Gene expression analysis techniques
8. Genomic libraries, Methods of cDNA library development/screening
9. ELISA, Molecular Markers
10. Gene regulation, Principles of RNAi and siRNA techniques
11. Genome editing techniques: CRISPER-Cas9

Recommended Books

1. Brown, T.A. (2010). *Gene Cloning and DNA Analysis: An Introduction*. (6th Edition). Oxford, United Kingdom: Blackwell Sciences Ltd.
2. Miesfeld, R. and John, L.A. (1999). *Applied Molecular Genetics*. Hoboken, USA: Willey and Sons, Inc.

Suggested Readings

1. Stewart Jr., N.C. (2008). *Plant Biotechnology and Genetics: Principles, Techniques and Applications.* Hoboken, USA: Wiley-Interscience.
2. Twyman, R.M. (2005). *Advanced Molecular Biology*. Oxfordshire, United Kingdom: Taylor and Francis.
3. Joseph, S. and David, R.W. (2001). *Molecular cloning. A laboratory Manual*. (3rd Edition). New York, USA: Cold Spring Harbor Laboratory Press.
4. John M. S. and Stirling, B.D. (2008). *Methods in Molecular Biology,* (2nd Edition). Totowa, USA: Humana Press Inc.

BIOT-937 **ADVANCES IN BIOPROCESS TECHNOLOGY**

3(3-0)

Study of the engineering concepts for biological conversion of raw materials to food, pharmaceuticals, fuels, and chemicals. Emphasis is placed on enzyme kinetics and technology, bioreaction kinetics, design, analysis, and control of bioreactors and fermenters, and downstream processing of bioreaction products. This course is for the students who have basic knowledge of industrial processes and bioprocess technology. This course will advance their understanding of current advances in the subject area including growth kinetics of the reactions which will convert the raw materials to food, pharmaceuticals, fuels, and chemicals. This course will also give insight into the cultures, bioreactors, productivity of various culture types, chemostat theory, critical dilution rate and applications of continuous and batch cultures. The coure will advance the understanding about fermentation mediums and inoculum of microorgaisms for the production of useful products. Economic Aspects of the Bioprocesses and New techniques and advancement in Bioprocess technology will also be studies.

Content

1. Growth Kinetics: Growth in batch and continuous cultures
2. Factors affecting the growth rates
3. Biomass production and yields
4. Continuous culture, hemostat theory, critical dilution rate, productivity, applications of continuous cultures
5. Fermentation medium: inoculum, dissolved oxygen tension
6. Bioreactors and its types, Scale-up theory, Oxygen transfer and shear effects in bioreactors
7. Transport phenomena (Mass, Heat)
8. Down-Stream Processing
9. Economic Aspects of the Bioprocesses
10. New techniques and advancement in Bioprocess technology

Recommended Books

1. Subramanian, G. (2007). *Bioseparation and Bioprocessing: A Handbook*. (2nd Edition). Hoboken, USA: John Wiley & Sons.
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. Hutkins, R.W. (2006). *Microbiology and Technology of Fermented Foods*. Hoboken, USA: Wiley-Blackwell Publishers
2. Heinzle, E., Biwer, A.P., Cooney, L.C. (2006). *Development of Sustainable Bioprocesses: Modeling and Assessment*. Hoboken, USA: John Wiley & sons.
3. Shuler, L.M. and Kargi, F. (2001). *Bioprocess Engineering; Basic Concepts*. (2nd Edition), New Dehli, India: Prentice Hall of India.

BIOT-938 ENZYME TECHNOLOGY 3(3-0)

The course on enzyme technology will provide advanced information on the fundamental aspects and current perspectives in enzyme technology to the students of biotechnology who will work in industry and academia in future. This course will provide information about the use of enzyme technology as an important tool for biotechnological processes, including food, feed, fuels, textiles, paper, energy and environmental applications. Enzyme kinetics, enzyme activation/inhibition, enzyme engineering and the use of various technologies for the characterization of enzymes including Polyacrylamide gel electrophoresis of enzymes and its various modified technologies will be discussed in detail. The search for improvements in existing enzyme-catalyzed processes dictates the need to update information on various enzyme technologies. This course will also give a snapshot of current practice and research in the area of enzyme technology. Industrial application of enzymes will be mainly focused to emphasize the importance of this course.

Content

1. Enzyme discovery; Enzyme classification and nomenclature
2. Enzyme biochemistry; Isoenzymes, Allosteric enzymes, multienzyme complexes and multifunctional enzymes
3. Up-stream processing of enzymes; Enzyme recovery and purification by fractional precipitation and Fast Protein Liquid chromatography
4. Physiochemical and thermodynamic properties of enzymes
5. Kinetics and thermodynamics of enzyme stability, Enzyme Inhibition/Activation
6. Catabolite repression and feed back inhibition
7. Characterization of enzymes, enzyme engineering, Ribozyme and catalytic antibodies
8. Protein sequencing by Edman Degradation
9. Industrial application of enzymes (amylases, cellulases, proteases, glucoamylase, lipase etc.)

Recommended Books

3. Shailendra, S. (2007). *A text Book of Enzymes*. Karnataka, India: Campus Book International.
4. Nelson, D.L. and Cox, M.M. (2008). *Lehninger Principles of Biochemistry*. (5th Edition). New York, USA: W.H. Freeman and Co.

Suggested Readings

1. Price, N. C. and Stevens, L. (2005). *Fundamentals of Enzymology*. (3rd Edition). New York, USA: Oxford University press.
2. Walsh, G. (2005). *Protein Biochemistry and Biotechnology*. Hoboken, USA: John Wiley and Sons Ltd.
3. Purich, D. L. (2002). *Enzyme Kinetics and Mechanism: Detection and Characterization of Enzyme Reaction*. *Methods in Enzymology series*. New York, USA: Academic press.
4. Eisenthal, R. & Danson, M. J. (1992). *Enzyme Assays: A Practical Approach. Practical Approach Series*. New York, USA: Oxford University press.

BIOT-939 APPLIED BIOSTATISTICS

3(3-0)

The subject covers basic statistical knowledge and its application in biotechnology. Statistics and experimental design are important tools for the biotechnologist and should be used when planning and conducting experiments as well as during the analysis and interpretation of results. This course will provide a survey of data and data types, specific topics including tools for describing central tendency and variability in data, methods for performing inference on population means and proportions via sample data, statistical hypothesis testing and its application to group comparisons, issues of power and sample size in study designs, and random sample and other study types. This course will provide some applied concepts important to the statistical analysis of data obtained from biotechnological experiments, and illustrates the application of common statistical procedures to analyse binomial, count, and continuous data for experiments with different treatment factors as well as identifying trends of dosage treatment factors. This course will enable the students of biological sciences to analyse their experimental data by making hypothesis and checking the hypothesis by using suitable statistical test. This course will emphasis on interpretation and concepts.

Content

1. Types of data and methods of data collection.
2. Types of studies: observational and experimental
3. Types of variables with example of each,
4. Descriptive and inferential statistics; central tendency and dispersion, hypothesis test, Type I and II error
5. Statistical software e.g. SPSS
6. Normality analysis
7. Parametric and Non parametric tests e.g. Student T-Test, Man-Whitney U Test
8. General linear model test, Post hoc tests and their presentation in results (Duncons multiple range test, Tukey's test, LSD, Bonferroni test).
9. Association analysis
10. Simple linear regression and multiple linear regression
11. Understand how to construct and interpret a two-way contingency table,
12. Calculate the expected cell count and the chi-square statistic (goodness of fit test and homogeneity test)
13. Odds ratio and Risk Rate, Logistic regression, survival analysis and Kaplan Meier test.

Recommended Books

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

Suggested Readings

1. Norman, G.R. and Streiner, D.L. (2000). *Biostatistics: The Bare Essentials*. B.C. Decke Inc.
2. Quinn, G.P. and Keough, M.J. (2002). *Experimental Design and Data Analysis for Biologists*. Cambridge, UK: Cambridge University Press.
3. Campbell, R.C. (1989). *Statistics for Biologists*. Cambridge, UK: Cambridge University Press.

BIOT-940 ADVANCED ANALYTICAL TECHNIQUES

3(3-0)

This course will provide the students with advanced knowledge in analytical techniques. This will include a detailed theoretical background and a critical understanding of the laboratory-based techniques they will apply during their research projects. The course will build on the Foundations course by delivering a more in depth examination of the specific analytical techniques relevant to their research projects. After completing this course, students will be able to: 1) explain the theoretical aspects of key analytical techniques and instruments used in biological sciences, including but not limited to electron microscopy, X-ray diffraction, mass spectrometry and spectroscopy, 2) strategically plan analytical campaigns to apply to different types of samples and research objectives, including selection of the most appropriate technique/instrumentation for the students' research project, 3) Undertake the correct sample preparation and characterization prior to analysis by the chosen techniques or instruments, 4) Design an analytical work-flow to acquire data and achieve the research objectives of their project.

Content

1. Spectroscopy and its types e.g. UV Spectroscopy, Quantitative Infrared Spectroscopy etc.
2. Direct Potentiometry, Spectro fluorimetry: Determination of Fluid Volumes by Dye Dilution Techniques
3. TLC: Drug Monitoring Techniques
4. Column Techniques: Separation of Transition Metal Cations,
5. Chromatography and its types
6. Principles of IR-spectrometry and its use for compound identification; understanding of the working mechanism of the basic components of spectrometric and mass-spectrometric instrumentation
7. Amino acid sequencers, Blotting Apparatus, Centrifuges, DNA Sequencers
8. Bioreactors, Electroporation Instrument, Isoelectric Focusing Apparatus
9. Lyophilized, Microarray Technology, Microscopy, Microtomy
10. Nuclear Magnetic Resonance Instrument; principles and application.

Recommended Books

1 Rouessac, F. and Rouessac, A. (2000). *Chemical Analysis: Modern instrumentation, Methods and Techniques*. Hoboken, USA: John Wiley & Sons.

2 Skoog, D.A., Holler, F.J., Nieman, T.A. (1997). *Principles of Instrumental Analysis* (5th Edition). Belmont, USA: Brooks Cole Publishing.

Suggested Readings

1. Chan, C.C., Lee, Y.C., Lam, H. Zhang, X.M. (2005). *Analytical Methods validation and Instrument Performance verification*. (1st Edition), Hoboken, USA: John Wiley & Sons.
2. Sharma, B.K. (2005). *Instrumental Method of Chemical Analysis*. (1st Edition), Meerut, India: Meerut Goel Publishing House.