




UNIVERSITY OF SARGODHA
OFFICE OF THE REGISTRAR
(ACAD BRANCH)

NOTIFICATION

On the recommendations of Academic Council made in its 16th (1/2023) meeting held on 02.01.2023, the Syndicate in its 61st (1/2023) meeting held on 27.01.2023 has approved the scheme of studies / syllabi of BS-Biochemistry and M.Phil-Biochemistry programs for implementation w.e.f. Fall 2023 (Annex-'A' & 'B').


(Asif Mehmood) 27/02/23.
Deputy Registrar (Acad)

No. SU/Acad/165

Dated: 27.02.2023

Distribution:

- Director, Institute of Chemistry
- Controller of Examinations

C.C:

- Director Academics
- Director, QEC
- Deputy Registrar (Affiliation)
- Deputy Registrar (Registration)
- Secretary to the Vice-Chancellor
- PA to Registrar
- Notification File

**SCHEME OF STUDIES &
CURRICULUM FOR
BS BIOCHEMISTRY AND MPhil
BIOCHEMISTRY
(2023)**



**INSTITUTE OF CHEMISTRY
UNIVERSITY OF SARGODHA
SARGODHA**

Fazal

Eligibility Criteria for Admission to BS Biochemistry and MPhil Biochemistry Programmes

Institute of Chemistry		
Institute of Chemistry	BS Biochemistry	<ul style="list-style-type: none"> • F.Sc. Pre-Medical • A Level – Biology Major
	MPhil Biochemistry	<ul style="list-style-type: none"> • BS/MSc Biochemistry • BS/MSc Chemistry (Specialization in Biochemistry) • BS/MSc Chemistry (Specialization in Organic and Physical with Biochemistry as a minor subject) * • BS/MSc Biotechnology * • BS/MSc Molecular Biology * • BS/MSc Microbiology * <p>* The student with this combination can apply for the admission but they have to take deficiency courses (if any) to complete degree requirements.</p>

Faint handwritten signature and stamp

Annexure

SCHEME OF STUDIES & CURRICULUM
BS BIOCHEMISTRY
(Semester / Term System)
(2023)



INSTITUTE OF CHEMISTRY
UNIVERSITY OF SARGODHA
SARGODHA

Fazal

INSTITUTE OF CHEMISTRY
UNIVERSITY OF SARGODHA
SARGODHA

**Scheme of Studies for BS-4 Years Program in Biochemistry (Semester/ Term system) w.e.f.
Fall 2023 & onwards sessions**

Summary:

BS-4 Years Biochemistry program comprises of 8 semesters with 139 credit hours. Outline of the courses is as under.

Semester I – IV

Botany and Zoology courses will be offered for the students who have entered in the program with Pre-Medical/Pre-engineering combination in F.Sc. or equivalent.

Semester-I:

Course Code	Course Title	Credits
BOTN-5101	Diversity of Plants	4(3-1)
CHEM-5101	Physical Chemistry	4(3-1)
CHEM-5201	Amino Acids, Proteins and Nucleic Acids	4(3-1)
URCP-5101	English I (Grammar)	3(3-0)
URCI-5105	Islamic Studies	2(2-0)
Total Credits		17(14-3)

Semester-II:

Course Code	Course Title	Credits
CHEM-5102	Inorganic Chemistry	4(3-1)
CHEM-5202	Carbohydrates and Lipids	4(3-1)
URCI-5102	English II (Language Comprehension & Presentation Skills)	3(3-0)
URCP-5106	Pakistan Studies	2(2-0)
ZOOL-5101	Animal Diversity-I	4(3-1)
Total Credits		17(14-3)

Semester-III:

Course Code	Course Title	Credits
BOTN-5103	Cell Biology, Genetics and Evolution	4(3-1)
CHEM-5103	Organic Chemistry	4(3-1)
CHEM-5203	Enzymes and vitamins	4(3-1)
URCP-5103	English III (Academic Writing)	3(3-0)
URCI-5109	Introduction to Information and Communication Technologies	3(3-0)
Total Credits		18(15-3)

Semester-IV:

Course Code	Course Title	Credits
BUSB-6152	Principles of Management	3(3-0)
CHEM-5204	Analytical Biochemistry	4(3-1)
CHEM-5205	Molecular Biology I	4(3-1)
ZOOL-5103	Animal Form and Function- I	4(3-1)
URCE-5104	English IV (Introduction to English Literature)	3(3-0)
Total Credits		18(15-3)

*Chemistry courses (semester I-IV) can be rotated with subject to availability of teacher in that specialized field.

Fair

Semester-V:

Course Code	Course Title	Credits
CHEM-6301	Basic Mathematics for Biochemists	2(2-0)
CHEM-6302	Microbiology and Industrial Fermentation	4(3-1)
CHEM-6303	Introduction to computers in Biochemistry	3(2-1)
CHEM-6304	Bioorganic Chemistry	4(3-1)
CHEM-6117	Metabolism and Bioenergetics	4(3-1)
Total Credits		17(13-4)

Semester-VI:

Course Code	Course Title	Credits
CHEM-6305	Basic Statistics for Chemists	2(2-0)
CHEM-6306	Human Physiology	3(3-0)
CHEM-6307	Clinical Biochemistry	4(3-1)
CHEM-6308	Enzyme Kinetics and Mechanisms	4(3-1)
CHEM-6309	Bioinorganic Chemistry	3(3-0)
Total Credits		16(14-2)

Semester-VII:

Course Code	Title of Course	Credits
CHEM-6310	Fundamentals of Forensic Sciences	3(3-0)
CHEM-6311	Introduction to Genomics and Proteomics	3(3-0)
CHEM-6312	Introduction to Nutritional Biochemistry	4(3-1)
CHEM-6313	Molecular Biology II	4(3-1)
CHEM-6314	Research*	4(4-0)
Total Credits		18(16-2)

Courses in lieu of research*

Four credits from the following courses can be offered to some students in lieu of research

Course Code	Title of Course	Credits
CHEM-6315	Biosafety & Ethics	2(2-0)
CHEM-6316	Animal and Plant Tissue Culture	2(2-0)
CHEM-6317	Biotechnology	2(2-0)
CHEM-6318	Spectroscopic Methods in Biochemistry	4(3-1)

Semester- VIII

Course Code	Title of Course	Credits
CHEM-6319	Environmental Biochemistry and Toxicology	4(3-1)
CHEM-6320	Endocrine System	3(3-0)
CHEM-6321	Chemotherapy and Immunology	3(3-0)
CHEM-6322	Introduction to Recombinant DNA Technology	4(3-1)
CHEM-6313	Research*	4(4-0)
Total Credits		18 (16-2)

***Courses in lieu of research**

Four credits from the following courses can be offered to some students in lieu of research

Course Code	Title of Course	Credits
CHEM-6323	Bioinformatics and Comparative Genomics	2(2-0)
CHEM-6324	Biomembranes & Cell Signalling	2(2-0)
CHEM-6325	Current Topics in Biochemistry	2(2-0)
CHEM-6326	Blood Chemistry and Physiology	2(2-0)

Faint handwritten signature or mark.

**Details of Courses for BS Biochemistry
(Session 2023-Onwards)**

SEMESTER-I

BOTN-5101

Diversity of Plants

4(3+1)

This course offers an evolutionary survey of the origin and diversification of land plants through geological time. The course will start with the green algae and on how plants may have transitioned from aquatic to the land environment. Land plants that will be discussed include bryophytes, lycophytes, pteridophytes, gymnosperms and angiosperms with emphasis on representative fossil and living taxa. Lectures will emphasize on life histories, anatomical and morphological adaptations, ecology and climate change, extinction, phylogenetics, economic importance, and conservation strategies of representative taxa. Plants are one of the most successful and abundant groups of organisms on earth, comprising the majority of terrestrial biomass, being integral to ecosystem structure, and providing humans with food, shelter, and materials. The laboratory will provide ample hands-on opportunities for analysis of plant anatomy and morphology, reproductive mechanisms, evolutionary adaptations, and identification of a variety of living and preserved specimens. Plants are multi-cellular and mostly photosynthetic organisms which found essentially everywhere, both in water and on land. Plants are really important for the planet and for all living things. Plants absorb carbon dioxide and release oxygen from their leaves, which humans and animals need to breathe.

Contents

Comparative study of life form, structure, reproduction and economic significance of:

1. Viruses (RNA and DNA types) with special reference to TMV
2. Bacteria and Cyanobacteria (*Nostoc*, *Anabaena*, *Oscillatoria*) with specific reference to bio fertilizers, pathogenicity and industrial importance.
3. Algae (*Chlamydomonas*, *Spirogyra*, *Chara*, *Vaucheria*, *Pinnularia*, *Ectocarpus*, *Polysiphonia*)
4. Fungi (*Mucor*, *Penicillium*, *Phyllactinia*, *Ustilago*, *Puccinia*, *Agaricus*) their implication on crop production and industrial applications.
5. Lichens (*Physcia*)
6. Bryophytes (*Riccia*, *Anthoceros*, *Funaria*)
7. Pteridophytes: Psilopsida (*Psilotum*), Pteropsida (*Marsilea*), Sphenopsida (*Equisetum*) Lycopsida (*Selaginella*)
8. Gymnosperms (*Cycas*, *Pinus*, *Ephedra*)
9. Angiosperms: Monocot (Poaceae), Dicot (Solanaceae)

Diversity of Plants Lab

1. Culturing, maintenance, preservation and staining of microorganisms.
2. Study of morphology and reproductive structures of the types mentioned in theory.
3. Identification of various types mentioned from prepared slides and fresh collections.

Recommended Texts

1. Bellinger, E. G. & Sigee, D. C. (2015). *Freshwater Algae, USA*: Wiley Publishers.
2. Prestre, P. G. (2017). *Governing Global Biodiversity: The Evolution and Implementation of the Convention on Biological Diversity*. UK: Routledge Publishers.

Suggested Readings

1. Şen, B., & Grillo, O. (2018) *Selected Studies in Biodiversity*. USA: Intech Open Publishers.
2. Zotz, G. (2016) *Plants on Plants: The Biology of Vascular Epiphytes*. Germany: Springer-Verlag

Fint

This course is the first part of this program, introduction to Physical Chemistry. This foundation course of physical chemistry covers basic knowledge and its application for learning chemical principles of physics to chemistry. This offers complementary approaches to the fundamental understanding of chemical systems. Students will acquire knowledge to enable themselves to understand the kinetic theory of gases, collision theory of reactions, fundamental principles and laws of thermodynamics and chemical equilibria and to investigate the physical properties of ideal/non-ideal binary solutions. Students will also be able to study the rates of reactions and perform related calculations. The general goal of learning physical chemistry is to obtain a vision of matter-energy relationship in physical and chemical systems. Learning objectives emphasized in CHEM 5101 involve developing an understanding of basic principles of physical chemistry. Students learned in class to modern physical chemistry techniques which give them opportunities to see how Physical Chemists are solving current, real-world problems.

Contents

1. Physical States of Matter: Gases (van der Waal's equation, critical Phenomena, Critical values of T , P and V); Liquification of gases; molecular collisions; collision diameter; mean free path); Liquids (viscosity, Parachor value, Refractive index, molar refraction and its applications; Dipole moment; Solids (Unit cells; Bragg crystal analysis; crystal structure of NaCl; powder method of crystal structure analysis).
2. Atomic Structure: De Broglie equation; Schrodinger wave equation; solution for particle in 1D box; quantization concept; Heisenberg Uncertainty Principle; Pauli Exclusion Principle; Hund's Rule.
3. Chemical Thermodynamics: First law of thermodynamics; state functions; isothermal and adiabatic processes in ideal gases; heat capacity; reversible and irreversible processes; Spontaneous and non-spontaneous processes; second law of thermodynamics; change of entropy with change in T , P and V .
4. Chemical Equilibrium: Law of Mass Action; equilibrium constant; relationship between K_c , K_p , K_x and K_a and LeChaterlier's Principle.
5. Solutions: composition; ideal and non-ideal solutions; Raoult's law; Colligative properties; ebullioscopy; cryoscopy; osmotic pressure; distillation and concept of azeotropes.
6. Chemical Kinetics: Zero, first and second order reaction; Arrhenius equation; activation energy; Lindemann's mechanism; collision theory and transition state theory.
7. Electrochemistry: Conductance; dependence of conductance on the nature of solvent and temperature; Kohlrausch's law and its applications; measurement of conductance strong and weak electrolytes; degree of dissociation.

Physical Chemistry Lab

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

13. Determination of equilibrium constant of KI – I₂ / KI₃.
14. Conductometric titration of strong acid and strong base.

Recommended Texts

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

Suggested Readings

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

CHEM5201

Amino Acids, Proteins and Nucleic Acids

4(3+1)

This course will cover the fundamental concepts in biochemistry, specifically about amino acids, proteins and nucleic acids. A general introduction to the science of biochemistry, importance, and the scope of biochemistry. This course will help to understand the common characteristics of amino acids, highlight the variations among individual amino acids, describe the role of chirality in amino acid chemistry and the structure and types of nucleic acid and their importance in living systems.

Contents

Amino acid and Proteins:

1. Introduction to amino acids and classification
2. Introduction to proteins and its types
3. Acid- base properties of amino acids
4. pH dependent ionization of amino acids
5. Identification of amino acids by different methods
6. Chemical and enzymatic reactions of amino acids
7. Introduction to proteins, classification; structure and function of proteins; physical and chemical properties; conjugated proteins; primary, secondary, tertiary, and quaternary structure determination
8. Protein denaturation and renaturation
9. Isolation, purification, and characterization of proteins; advanced techniques for protein analysis

Nucleic acids:

10. Brief introduction of nucleic acids
11. Composition and structure of DNA & RNA
12. Types of DNA and RNA
13. Function of the DNA & RNA
14. Extra nuclear DNA

Lab (Cr 01):

1. Qualitative tests of proteins & amino acids: Biuret Test; Ninhydrin Test; Xanthoproteic Test; Pauly's Test; Hoplem's Test; Ehrlich's Test; Sakaguchi Test; Sodium nitroprusside Test; Sullivan Test; sulphate Test Phosphate Test; Aldehyde Test
2. Extraction of proteins from plant sources and their confirmative tests.
3. Separation of Amino Acids using Paper and Thin Layer Chromatography
4. Determination of total proteins by using different methods (Bradford, lowery and biuret methods); Protein estimation by using UV/Visible spectrophotometer
5. Determination of Secondary structure of Proteins using online available software; Protein purification by using different chromatographic techniques
6. Isolation of DNA and RNA from plants and blood sample
7. Quantification of DNA and RNA

Recommended Texts

1. *Lehninger Principles of Biochemistry* (6th ed.). (2012) Edited by David L. Nelson, Michael M. Cox W.H. Freeman.
2. Moran, L. A., Horton, R. A., Scrimgeour, G., & Perry, M. (2011) *Principles of Biochemistry* (5th ed.).
3. Voet, D. J., Voet G.J. Pratt C. W. (2010) *Fundamentals of Biochemistry* (4th ed.)

Suggested Readings

1. Joshi A. Rashmi. B. (2002) *Textbook of Practical Biochemistry*.
2. Sawhney S. K., Singh R. (2005) *Introductory Practical Biochemistry*.
3. *Harper's Illustrated Biochemistry* (29th ed.), (2012) Edited by Robert Murray, David Bender, Kathleen M. Botham, Peter J. Kennelly, Victor Rodwell, P. Anthony Weil. McGraw-Hill Medical.

URCE-5101

English I (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. Fastwood, 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 Lexical Grammar of English*. Amsterdam: John Benjamins.

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 Muhammad ﷺ. 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 (Text 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 and Hadith
11. Seeratul-Nabi (PBUH), necessity and importance of Seerat, role of Seerah in the development of personality, Pact of Madinah, Khutbah Hajjat al-Wada' & ethical teachings of Prophet (PBUH).
12. Legal Position of Sunnah
13. Islamic Culture and Civilization
14. Characteristics of Islamic Culture and Civilization
15. Historical Development of Islamic Culture and Civilization
16. Comparative Religions and Contemporary Issues
17. Impact of Islamic civilization

Recommend 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.

SEMESTER-II

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 advanced 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 develops 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, Group trends and periodic properties, Atomic and ionic radii, ionization potentials, electron affinities and electronegativities; Redox potential, electrochemical series and its applications, Corrosion and electroplating.
2. Acid Base Equilibria: Acids and bases, relative strengths of acids, pH, pKa, pKb. Hard and soft acid and Bases. SHAB Principle and its application. Buffers, types buffer, Preparation, Buffer capacity and applications of buffers. Indicators: (Acid-base, Redox, Adsorption), Solubility product, Common ion effect and its applications.
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. Special types of bonds such as Metallic bonds, Hydrogen Bonding, Bent bond, Ion-dipole-dipole bond, ion induced-dipole bond.
4. Chemistry of p-Block Elements: Introduction to p-block elements (Group trends in p-block elements with reference to, atomic sizes and chemical reactivities). Boranes and Boride; aluminium halides, hydrides and Alums; Silicates (Structural aspects, classifications and applications); silicones (Structural aspects, classifications and applications). Germanes; phosphazenes, Phosphides, Oxoacids of Phosphorous; Oxoacids and salts of sulphur; Noble gases (compounds of Xe, Kr, Ra; bonding and applications). Production of pure silicon chips for solar energy cells.
5. Chemistry of d-Block Elements: Electronic configuration. Characteristics. Nomenclature. Nature of bonding in coordination compounds: Werner's theory, VBT, MOT and CFT for coordination compounds. Isomerism in coordination compounds. Chelates: Classification and applications. Applications of coordination compounds (Medicinal, Industrial, Agricultural).
6. Separation Techniques: General introduction and Applications (Solvent extraction and Chromatographic techniques such as paper, Ion exchange and Column).
7. Introduction to Analytical Techniques in Inorganic Chemistry: Introduction to spectroscopic Techniques: Principle, brief instrumentation, sample handling and applications (Flame emission, Atomic Absorption, IR and UV/Vis).
8. 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
3. Determination of total hardness of water using EDTA.
4. Estimation of manganese (II) using EDTA.
5. Estimation of copper (Iodometrically).

6. Determination of thiosulphate ion (Iodometrically).
7. Determination of ferricyanide using KI solution.
8. Determination of chloride by Volhard's and Mohr's methods.
9. Estimation of chloride ions using adsorption (Fluorescein) indicator.
10. Estimation of bromide ions using adsorption (Eosin) indicator.
11. Estimation of percentage of ferrous ions in the Mohr's salt using KMnO_4 .
12. Percentage determination of ferric ions in ferric alum using KMnO_4 solution.
13. Determination of purity of commercial potassium oxalate using KMnO_4 solution.
14. Estimation of ferrous ions using $\text{K}_2\text{Cr}_2\text{O}_7$ solution.

Recommended Texts

1. Iqbal, M. Z. (2015). *Textbook of Inorganic Chemistry*. Lahore: IlmiKitabKhana
2. Lee, J. D. (1996). *Concise Inorganic Chemistry*. (5thed.). UK: Chapman and Hall
3. Vogel, A. I. (1995). *A Textbook of Macro and Semi Micro Qualitative Inorganic Analysis*. New York: Longman Green and Co.
4. Skoog, D. A., West, D.M., & Holler, F. J. (1994). *Analytical Chemistry* (6thed.). UK: Saunders College Publications.

Suggested Readings

1. Graham, H., & Man, H. (2000). *Chemistry in Context* (5thed.). UK: Thomas Nelson Ltd.
2. Philp, M. (1996). *Advance Chemistry*. UK: Cambridge Publishing.
3. David, H. (2000). *Modern Analytical Chemistry*. New York: McGraw Hil.

CHEM-5202

Carbohydrates and Lipids

4(3+1)

To understand the principles and concepts concerning the chemical, physical, and biological properties of carbohydrates and lipid in biological processes including signal transduction. This course will help to understand the general structure and properties of lipids and phospholipids and their function in the cell. The general structure and properties of carbohydrates and their function in the cell along with properties of various lipid molecules will be discussed at length.

Contents

1. Introduction, historical background, occurrence and biological significance of carbohydrates
Nomenclature and classification of carbohydrates
2. Structures, chemical and physical properties of monosaccharides, oligosaccharides and polysaccharides
3. Introduction, classification, and biological functions of lipids
4. Classification, nomenclature, structures and properties of fatty acids
5. Structure and properties of simple and mixed triglycerides and waxes
6. Structure, properties and functions of phospholipids, sphingolipids and glycolipids
7. Steroids: Structure, classification, nomenclature and their biological role. Lipids as signals, cofactors and pigments

Lab

1. Qualitative Analysis of known carbohydrates (e.g., Glucose, galactose, fructose, maltose, lactose, sucrose, starch glycogen and cellulose).
2. Qualitative Analysis of carbohydrates of given unknown samples
3. Extraction of starch from plant sources and its confirmative tests (e.g., Potato, Wheat, Rice, Pulses, Barely, Maize etc).
4. Extraction of Glycogen from animal sources (e.g., liver, muscle, etc) & its confirmative tests.
5. Qualitative tests for lipids and fatty acids
6. Extraction of lipids from animal and plant sources.

Recommended Texts

1. *Harpers Illustrated Biochemistry* (29th ed.), (2012) Edited by Robert Murray, David Bender, Kathleen M. Botham, Peter J. Kennelly, Victor Rodwell, P. Anthony Weil. McGraw-Hill Medical.
2. Berg, J. M., Tymoczko, J. L., and Stryer, L. (2011) *Biochemistry* (7th ed.), Palgrave MacMillan.

Suggested Readings

1. Voet, D. J., Voet G.J. Pratt C. W. (2010) *Fundamentals of Biochemistry* (4th ed.)
2. *Lehninger Principles of Biochemistry* (6th ed.). (2012) Edited by David L. Nelson, Michael M. Cox W.H. Freeman.

URCE-5102

Language Comprehension and Presentation Skills

3(3+0)

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

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, inferring, 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 Text 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 and Row.
2. Horowitz, R., & Samuels, S. J. (1987). *Comprehending Oral and Written Language*. San Diego: Academic Press.
3. Opitz, M. F., & Zbaracki, M. D. (2004). *Listen Hear: 25 Effective Listening Comprehension Strategies*. Heinemann Educational Books.
4. Liang, L. A., & Galda, L. (2009). Responding and comprehending: Reading with delight and understanding. *The Reading Teacher*, 63(4), 330-333.

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

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, J. A. (2004). *Pakistan's Political Economic and Diplomatic Dynamics*. Lahore: Kitabistan Paper Products.

Suggested Readings

1. Hayat, S. (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, I. (1998). *Pakistan: A Modern History*. London: Hurst and Company.

ZOOL-5101

Animal Diversity-I (Invertebrates)

4(3+1)

(Foundation-I)

This course will provide the knowledge of evolutionary/phylogenetic relationship. It imparts the basic taxonomic characteristics and classification of all the invertebrate phyla. This includes more than 95% of all of the described species of animals and far more than 99% of all of the individual animals on the planet. The central theme running throughout this course will be phylogeny. It provides understanding of body organization, mode of feeding, digestion, reproduction and development of invertebrates. It delivers information to students about economic and ecological importance of invertebrates. Students will understand invertebrate organismal concepts in laboratory and field. The primary objectives for the laboratory section of this course includes introduction of structure, function and behaviour of selected invertebrate types through the observation of both living and preserved specimens, to reinforce basic laboratory skills of students like microscopy, dissection and careful observation, to provide students with the ability to recognize the major groups of invertebrate and to increase understanding of the methods of investigating animal evolution.

Contents

1. Introduction: Classification of organisms, Evolutionary relationships and Tree diagrams: Patterns of organization.
2. Animal-like protists: the protozoa: Evolutionary perspective; Life within a single plasma Membrane. Symbiotic Lifestyles, Protozoan Taxonomy, Pseudopodia and Amoeboid Locomotion; Cilia and other pellicular structure, Nutrition; Genetic Control and Reproduction; Symbiotic ciliates, Further Phylogenetic consideration.
3. Multicellular and tissue levels of organization: Evolutionary Perspective, Origins of Multicellularity; Animal Origins, Phylum Porifera, Cnidaria, Ctenophora, Characters and Classification, Maintenance functions.
4. The triploblastic and with acoelomate body plan: Phylum Platyhelminthes, Phylum Nematode, Gastrotricha, Evolutionary Perspective; Classification up to class, Body plan and functions.
5. Pseudocoelomate body plan: Phylum Aschelminths, Evolutionary perspective; General Characteristics; Classification up to order with External Features, Feeding and Digestive system; Other Organ System; Reproduction and Development including Phylum Rotifera, Phylum Nematoda and Phylum Kinorhyncha. Some important Nematode parasites of Humans.
6. Phylum Mollusca: Evolutionary perspective: Relationship to other animals; Origin of the Coelom; Characteristics, Classification up to class. The characteristics of shell and associated structures, Feeding, Digestion, Gas Exchange, Locomotion, Reproduction and Development, Other maintenance Functions and Diversity in Gastropods, Bivalves and Cephalopods.
7. Phylum Annelida: The Metameric Body Form; Evolutionary perspective; Relationship to other animals, Metamerism and Tagmatization, Classification up to Class. External Structure and Locomotion, Feeding and the Digestive system, Gas Exchange and Circulation, Nervous and Sensory Functions, Excretion, Regeneration, Reproduction and Development, Polychaeta, Oligochaeta and Hirudinea, Further Phylogenetic Consideration.
8. Phylum Arthropoda: Evolutionary Perspective: Classification and relationship to other Animals; Metamerism and Tagmatization; The Exoskeleton; Metamorphosis: Classification up to Class.
9. The Hexapods and Myriapods: Evolutionary Perspective: Classification upto class. External Structure and Locomotion, Nutrition and the Digestive system, Gas Exchange, Circulation and Temperature Regulation, Nervous and Sensory Functions, Excretion, Chemical Regulation, Reproduction and Development in Hexapoda, Insects Behavior, Insect and Human.
10. Phylum Echinoderms: Evolutionary Perspective: Relationship to other Animals; Echinoderm Characteristics; Classification up to class. Maintenance functions, regeneration, reproduction, and development in Asterozoa, Ophiurozoa, Echinozoa, Holothurozoa and Crinozoa.
11. Some lesser-known Invertebrates: Lophozoa, Entoprocta, Cycliophora, and Ctenophora.

Animal Diversity-I (Invertebrates) lab

Note: Classification of each member of each phylum upto order with adaptations in relation to habitat of the specimen. Preserved Specimen and or colored projection slide and or CD ROM projection of computer must be used.

1. Study of Euglena, Amoeba, Endameba, Plasmodium, Trypanosome, Paramecium as representative of animal like Protists.
2. Study of representatives of Phylum Porifera and prepared slides of spicules of sponges
3. Study of principal representatives of classes of Phylum Coelenterate.
4. Study of principal representatives of classes of Phylum Platyhelminthes.
5. Study of representatives of phylum Rotifer, Phylum Nematode.
6. Study of principal representatives of classes of Phylum Mollusca.
7. Study of principal representatives of classes of Phylum Annelida.
8. Study of principal representatives of classes of groups of Phylum Arthropoda
9. Study of representatives of classes of Phylum Echinodermata.
10. Preparation of permanent mount of Leucosolenia, Obelia, Hydra, Proglottid of Tapeworm. Parapodia of Nereis and Daphnia. Drawing and labeling.
11. Preparation of permanent slide of mouthpart of insects (after dissection).
12. How to make grade-wise series for preparation of temporary and permanent slides.

Recommended Texts

1. Miller, A. S., & Harley, J. B. (2016). *Zoology* (10thed.) Singapore: McGraw Hill.
2. Hickman, C. P., Roberts, L. C. & Larson, A. (2007). *Integrated Principles of Zoology* (12th ed.). Singapore: McGraw-Hill.

Suggested Readings

1. Hickman, C. P., Roberts, L. C., & Larson, A. (2018). *Integrated Principles of Zoology* (15thed.). Singapore: McGraw-Hill.
2. Pechenik, J. A. (2015). *Biology of Invertebrates* (7thed.). Singapore: McGraw-Hill
3. Kent, G. C., & Miller, S. (2001). *Comparative Anatomy of Vertebrates*. New York: McGraw-Hill.

SEMESTER-III

Cell biology, genetics and evolution are fundamental to an understanding of the processes of life. In this unit, students will be able to examine the structure and function of prokaryotic and eukaryotic cells, including a discussion of the energy flow in photosynthesis, respiration and metabolism. A brief introduction to DNA structure and function from molecular to organism levels and current applications of DNA technology will be studied. This will also enlighten and introduce with classical genetic and evolutionary theory as unifying explanations of life. This course is intended for the student interested in understanding and appreciating common biological topics in the study of the smallest units within biology: molecules and cells. There are thousands of opportunities within the medical, pharmaceutical, agricultural, and industrial fields for a person with a concentrated knowledge of molecular and cellular processes. This course will give you a general introduction of cell organelles, cell division and enzymes which are involved in the process of metabolism. Evolution is the process of change in all forms of life over generations, and evolutionary biology is the study of how evolution occurs. Laboratory practical will investigate enzyme function, cytogenetics and the genetic analysis of populations.

Contents

Cell Biology

1. Structure and Function of Biomolecules (Carbohydrates, Lipids, Proteins, Nucleic Acids)
2. Cell: Cell theory, cell types (prokaryotes, eukaryotes), basic properties of cell.
3. Brief description of structure and function of the following cell organelles (Cell wall, Cell membrane, Nucleus, Endoplasmic reticulum, Plastids, Mitochondria, Ribosomes, Dictyosomes, Vacuoles)
4. Reproduction in somatic and embryogenic cell, mitosis, meiosis and cell cycle

Genetics

5. Introduction, scope and brief history of genetics. Mendelian inheritance; Law of segregation and independent assortment, back cross, test cross, dominance and incomplete dominance
6. Molecular genetics; DNA replication, nature of gene, genetic code, transcription, translation, protein synthesis, regulation of gene expression (e.g. lac operon).
7. Chromosomal aberrations; Changes in the number of chromosomes, Aneuploidy and Euploidy, Changes in the structure of chromosomes, deficiency, duplication, inversion and translocation.
8. Evolution: Introduction and theories.

Cell Biology, Genetics and Evolution Lab

1. Study of cell structure using compound microscope and elucidation of ultra structure from electron microphotographs
2. Measurement of cell size.
3. Study of mitosis and meiosis by smear/squash method and from prepared slides.
4. Study of chromosome morphology and variation in chromosome number.
5. Extraction & estimation of carbohydrate, protein, RNA & DNA from plant sources.
6. Genetical problems related to transmission and distribution of genetic material.
7. Identification of chromosomes in plant material, Carmine/orcein staining.
8. Determination of blood groups

Recommended Texts

1. Templeton, N.C. (2015). *Gene and Cell Therapy* (4thed.), Germany: Taylor and Francis Publications
2. Sybille, M., & Shoshan, M. (2015). *Tumor Cell Metabolism*, Germany: Springer Publications.

Suggested Readings

1. Verma P. S., & Agarwal, V. K. (2016). *Cell Biology (Cytology, Biomolecules and Molecular Biology)*. India: S. Chand Publishing.
2. Milo, R., & Phillips, R. (2015). *Cell Biology by the Numbers (1sted.)*. Germany: Taylor and Francis publications.
3. Bradshaw, R., & Stahl, P. (2015). *Encyclopaedia of Cell Biology*. Amsterdam: Elsevier Publications.

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, properties of bonds, inductive effect, dipole moment. The concept of resonance, rules of resonance, resonance energy, steric inhibition of resonance, hyperconjugation, resonance effect, hydrogen bonding, tautomerism.
2. Introduction to spectroscopy with special reference to the infrared, ultraviolet/visible spectroscopy.
3. Hydrocarbons: classification of hydrocarbons. Nomenclature. Methods of preparation, physical characteristics and chemical reactions of alkanes, alkenes and alkynes. Source of aromatic hydrocarbons. Structure of benzene and the concept of aromatic hydrocarbon. Aromatic electrophilic substitution.
4. Stereoisomerism: conformational analysis of ethane and butane. Optical isomerism, optical activity, chiral carbon atom and optical isomerism, relative and absolute configuration, creation of chiral carbon and racemization. Optical isomerism in compounds containing two chiral carbons atom, diastereoisomer, elements of symmetry, resolution of racemic mixture, geometric isomerism, cis/trans isomerism, designation of isomerism, determination of configuration.
5. Alkyl halide: nomenclature, method of preparation and chemical reaction with special reference to the nucleophilic substitution and elimination reaction of alkyl halide. Preparation, structure and synthetic application of grignard reagent.
6. The hydroxyl group and ether: nature of hydroxyl group in phenol and alcohol.
7. Alcohol: classification and nomenclature, preparation method and chemical reaction, distinction between primary, secondary and tertiary alcohol, polyhydric alcohols. Phenol: preparation method, acidity of phenol, chemical reaction.
8. Ether: preparation and reactions.
9. The carbonyl group: nature and its reactivity, nomenclature of aldehyde and ketone, aldehyde and ketone preparation and reactions along with distinction between them. Carboxylic acid and their derivatives: nomenclature, preparation and chemical reactions, strength of acid and factors affecting it, formation and hydrolysis of acid anhydrides, acid halides, acid amides, esters including glycerides. Introduction to amino acid.

10. Nitrogen compounds: amines: classification, nomenclature, preparation and chemical reactions, distinction between primary, secondary and tertiary amines. Preparation and reaction of aniline. Basicity of aromatic and aliphatic amines and factors affecting it. Diazonium salts and their synthetic applications.

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, tribromophenol, aspirin, nitrobenzene.

Recommended Texts

1. Younas, M. (2006). *Organic Spectroscopy*. Lahore: A. H. Publisher
2. Solomons, T. W. G. (2016). *Fundamentals of Organic Chemistry*. (12thed.). New York: Wiley.
3. Vogel, A. I. (1996). *A Text Book of Practical Organic Chemistry*. New York: Prentice Hall.

Suggested Readings

1. Kemp, W. (1990). *Organic Spectroscopy*. London: Macmillan
2. Chughtai, F. A. (1995). *Organic Reactions*. Lahore: Majid Book Depot.
3. Streitwieser, A. Heathcock, C. & Kosower, E. M. (2017). *Introduction to Organic Chemistry*. (4thed.). New York: Macmillan.

CHEM 5203

Enzymes and Vitamins

4(3+1)

The objective of this course is to provide in depth knowledge of how enzymes work as biological catalysts and how the rates of reactions are impacted by a variety of different factors and environmental conditions.

Contents

1. Introduction to enzymes, nomenclature and classification
2. Isoenzymes, coenzymes and role of cofactors
3. Structure of enzyme; active site and regulatory sites
4. Enzyme specificity and different types
5. Kinetics of chemical reactions
6. Michaelis-Menten equation and other models used to understand kinetics • Multienzyme system and two substrate reactions
7. Enzyme Inhibition and types of inhibition
8. Ribozyme
9. Enzyme catalysis: catalytic strategies and mechanisms of different enzymes
10. Regulation of enzyme activity
11. Effect of various factors on rate of reactions
12. Enzyme assays
13. Immobilized enzyme
14. Applications of enzyme
15. Type and function of fat soluble and water-soluble vitamin.

Lab

1. Extraction and estimation of enzymes from plant source.
2. Acid and enzymatic hydrolysis of glycogen and starch Biosynthesis of enzymes by fungi and bacteria.
3. Effect of Temperature on enzymes activity.
4. Effect of Substrate concentration on enzyme activity.
5. Effect of Enzyme concentration on enzyme activity.
6. Effect of heat on stability of enzyme.

Handwritten signature

- 7 Estimation of ascorbic acid.

Recommended Texts

1. Berg, J. M., Tymoczko, J. L., and Stryer, L. (2011), *Biochemistry* (7th ed.) W.H. Freeman & Co.
2. Voet, D. J., Voet G.J. Pratt C. W. (2010) *Fundamentals of Biochemistry* (4th ed.).
3. *Lehninger Principles of Biochemistry* (6thed.). (2012) Edited by David L. Nelson. Michael M. Cox W.H. Freeman.

Suggested Readings

1. Mathews C. K., Van Holde K. E, & Ahern K.G (1999). *Biochemistry*. (3rd ed.). Prentice Hall.
2. R.K. Murray, D.K. Grannar, V.W. *Harper's Illustrated Biochemistry* (27thed).

URCE-5103

Academic Writing

3(3+0)

Academic writing is a formal, structured and sophisticated writing to fulfil 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 Developing argument
- 5 Rhetoric: persuasion and identification
- 6 Elements of rhetoric: Text, author, audience, purposes, setting
- 7 Sentence structure: Accuracy, variation, appropriateness, and conciseness
- 8 Appropriate use of active and passive voice
- 9 Paragraph and essay writing
- 10 Organization and structure of paragraph and essay
- 11 Logical reasoning
- 12 Transitional devices (word, phrase and expressions)
- 13 Development of ideas in writing
- 14 Styles of documentation (MLA and APA)
- 15 In-text citations
- 16 Plagiarism and strategies for avoiding it

Recommended Texts

- 1 Swales, J. M., & Feak, C. B. (2012). *Academic writing for graduate students: Essential tasks and skills* (3rd ed.). Ann Arbor: The University of Michigan Press.
- 2 Bailey, S. (2011). *Academic writing: A handbook for international students* (3rd ed.). New York: Routledge.

Suggested Readings

1. Craswell, G. (2004). *Writing for academic success*. London: SAGE.
2. Johnson-Sheehan, R. (2019). *Writing today*. Don Mills: Pearson.
3. Silvia, P. J. (2019). *How to write a lot: A practical guide to productive academic writing*. Washington: American Psychological Association.

LRC1-5109 Introduction to Information and Communication Technologies 3(3+0)

The course introduces students to information and communication technologies and their current applications in their respective areas. Objectives include basic understanding of computer software, hardware, and associated technologies. They can make use of technology to get maximum benefit related to their study domain. Students can learn how the Information and Communications systems can improve their work ability and productivity. How Internet technologies, E-Commerce applications and Mobile Computing can influence the businesses and workplace. At the end of semester students will get basic understanding of Computer Systems, Storage Devices, Operating systems, E-commerce, Data Networks, Databases, and associated technologies. They will also learn Microsoft Office tools that includes Word, Power Point, 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. Introduction, Overview and its types.
2. Hardware: Computer Systems and Components, Storage Devices and Cloud Computing.
3. Software: Operating Systems, Programming and Application Software,
4. Introduction to Programming Language
5. Databases and Information Systems Networks
6. The Hierarchy of Data and Maintaining Data,
7. File Processing Versus Database Management Systems
8. Data Communication and Networks.
9. Physical Transmission Media and Wireless Transmission Media
10. Applications of smart phone and usage
11. The Internet, Browsers and Search Engines.
12. Websites Concepts, Mobile Computing and their applications.
13. Collaborative Computing and Social Networking
14. E-Commerce and Applications.
15. IT Security and other issues
16. Cyber Laws and Ethics of using Social media
17. Use of Microsoft Office tools (Word, Power Point, Excel), mobile apps or other similar tools depending on the operating system.
18. Other IT tools/software specific to field of study of the students if any

Recommended Texts

1. Vermaat, M. E. (2018). *Discovering Computers: Digital Technology, Data and Devices*. Boston: Course Technology Press.

Suggested Readings

1. Timothy, J., O'Leary & Linda, I. (2017). *Computing Essentials*. (26thed.). San Francisco: McGraw Hill Higher Education.
2. Schneider, G. M., & Gersting, J. (2018). *Invitation to Computer Science*. Boston: Cengage Learning.

SEMESTER-IV

This is an introductory course about the management of organizations. It provides instructions on principles of management that have general applicability to all types of enterprises; basic management philosophy and decision making; principles involved in planning, organizing, leading, and controlling; and recent concepts in management. Have you ever wondered what qualities billionaire Warren Buffet, visionary Steve Jobs, or Jeff Bezos all have in common? After you finish studying business practices in this course, you may discover that you have some of the same qualities as other successful entrepreneurs. This course is designed as a survey course that will expose you to business terminology, concepts, and current business issues. The intent is to develop a viable business vocabulary, foster critical and analytical thinking, and refine your business decision-making skills. These skills will be acquired by the reading materials, exercises, and research assignments in this course that simulate the workplace today. Course objectives include to analyze management principles and concepts as they apply to business situations; to identify the steps of problem solving and decision making in organizations and to explore and inquire the applicability of western management principles and theories in local settings.

Contents

1. Introduction to management the management process
2. Importance of management for a business
3. Organizational theories
4. Nature and types of organizations
5. The organizational culture and the management
6. The external environment and the manager
7. The internal environment and the manager
8. The manager's role as decision maker
9. Decision making process
10. Type of decision-making processes
11. Basics of strategic management
12. Organizational structure, types of organizational structure
13. Human Resource Management
14. Important of human resource for a business
15. Motivation its theories, teamwork and group behaviour.
16. Leadership and its characteristics, leadership style and behaviour
17. The process of control, case of controlling

Recommended Texts

1. Robbins, S. P., Coulter, M., & Langton, N. (2007). *Fundamentals of Management*. (9thed). Upper Saddle River: Pearson Education.

Suggested Readings

1. Hannaway, J. (1989). *Managers Managing: The Workings of an Administrative System*. (3rded.). New York: Oxford University Press
2. Stephen, P. R., & Mary, A. C. (2017). *Management* (14thed.). New York: Pearson Publication.
3. Eccles, R. G., and Nohria, N. (1992). *Beyond the Hype: Rediscovering the Essence of Management*. Boston: The Harvard Business School Press.

This course also covers the theory and techniques of biochemical analysis including handling of experimental data from characterization of biomolecules, in-depth study of biophysical tools including Spectroscopy, Column chromatography (ion exchange and gel filtration), Gas chromatography (GC), GC-MS/LC-MS, affinity chromatography, HPLC as well as classical methods of analysis and electrochemistry.

Contents

1. Characterization of biomolecules and Simple Heterocycles: (carbohydrates, proteins, lipids, nucleic acids, their importance, nomenclature, properties, synthesis and reactions of simple heterocycles).
2. Introduction to Spectroscopy: (IR & UV/Vis).
3. Homogenization, centrifugation, ultra-centrifugation,
4. Chromatography: principles, methods and applications of paper and thin layer chromatography, Column chromatography (ion exchange and gel filtration), Gas chromatography (GC), GC-MS/LC-MS, affinity chromatography, HPLC,
5. Lyophilization,
6. Electrophoresis.
7. Flame photometry, atomic absorption spectrophotometry, Spectro-fluorimetry

Lab

1. Preparation of sample for mineral analysis by ashing method
2. Wet digestion procedure of sample preparation for mineral analysis
3. Mineral analysis of plant tissues using atomic absorption spectrophotometer.
4. Centrifugation of fresh milk and Acetic Acid, Fractionation of cells by density gradient centrifugation
5. Separation of biomolecules by using TLC, Separation of crud plants extracts by using TLC
6. Separation of Biomolecules by affinity chromatography identification of sugars, proteins etc. by uv/vis spectrophotometer.
7. Determination of sodium and potassium content in blood serum by flamephotometer.
8. Separation of amino acids by amino acid analyzer.
9. Gel chromatography and ion exchange chromatography Determination of molecular weight of a given protein by gel filtration.
10. Separation of Hb and serum proteins by electrophoresis.
11. Disk-gel electrophoresis of proteins.
12. Separation of proteins by isoelectric focusing.

Recommended Texts

1. Voet, D. R and Voet, J. G. (2001) *Biochemistry*, John Wiley & Sons, NY
2. Younas, M. (2005) *Organic Spectroscopy*, A. H. Publisher, Lahore.
3. Boyer R. F., *Modern Experimental Biochemistry* (3rded.).

Suggested Readings

1. Wilson, K. & Walker, J. *Principles and Techniques of Biochemistry and Molecular Biology* (6thed.)
2. Snyder, L.L. & Kirkland, J.J.(1979) *Introduction to Modern Liquid Chromatography*, John Wiley & Sons

CHEM 5205

Molecular Biology I

4(3+1)

To acquaint students with the chemistry and biology of macromolecules. This course aims at students with basic competences in biochemistry and serves as a memorandum as well as extension course for those intending to major in all disciplines in biochemistry. The class starts with an overview over the features of DNA as the carrier of genetic information in cells and the mechanisms by which it is maintained over cell generations. Further, it addresses the fundamental mechanisms by which the information encoded in DNA is transcribed into RNA and then translated into proteins as functional

units. Basic concepts of eukaryote genetics such as chromosome function will be covered, as well as aspects of bacterial genetics relevant for experimental molecular biology.

Contents

1. Introduction to molecular biology and history
2. Structure and function of DNA; chromatin and structure of chromosomes
3. Organelle's genome (Mitochondrial and chloroplast)
4. DNA replication in prokaryotes and eukaryotes
5. Transcription in prokaryotes and eukaryotes; post transcriptional processing (e.g., RNA splicing, alternative splicing, editing); genetic code
6. Translation, posttranslational processing in prokaryotes and eukaryotes
7. Protein folding, targeting and turnover
8. DNA damage and repair
9. Recombination and transposable elements.
10. Signalling and control of gene regulation in prokaryotes and eukaryotes

Lab

1. Safety rules and regulations in Laboratory of molecular biology
2. Reagent Preparation: Preparation of Stock and Working Solutions.
3. Methods of DNA Extraction
4. Quantification of Nucleic Acid
5. Extraction of RNA from blood
6. Preparations of Solutions for electrophoresis, Agarose gel electrophoresis and SDS PAGE
7. Polymerase chain reaction for amplification of DNA

Recommended Texts

1. *Lehninger Principles of Biochemistry* (6thed.). (2012) Edited by David L. Nelson, Michael M. Cox W.H. Freeman.
2. Lodish et al., 2012. *Molecular Cell Biology* (7th ed.), WH Freeman, New York
3. Berg, J. M., Tymoczko, J. L., and Stryer, L. (2011) *Biochemistry* (7th ed.), Palgrave MacMillan.

Suggested Readings

1. Alberts B, Johnson A, Lewis J, et al. *Molecular Biology of the Cell* (4thed.). (2002). New York: Garland Science.
2. Weaver R. 2011. *Molecular Biology*. (5th ed); McGraw-Hill

ZOOL 5103 Animal Form and Function- I (A Comparative Perspective) 4(3+1)

This course teaches about animal's diversity adapted in different strategies for performance of their similar functions through modifications in body parts in past and present times. It imparts understanding of diverse strategic structural adaptations in each of the functions of integumentary, skeletal, muscular, nervous and sensory, endocrine, circulatory and respiratory systems for effective survival in their specific conditions. The course mainly aims to teach the students about animal's diversity adapted in different ways for their functions through modifications in body parts, about the diversity in integumentary, skeletal, muscular, nervous and sensory, endocrine, circulatory, respiratory, nutritive, excretory, osmoregulatory and reproductive systems according to strategies to survive in their specific conditions. It will also introduce about organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body along with the basic structure of each system that determines its particular function of animal body.

Contents

1. Protection, Support, and Movement: Protection: the integumentary system of invertebrates and vertebrates; Movement and support: the skeletal system of invertebrates and vertebrates:

- Movement: non-muscular movement; an introduction to animal muscles; the muscular system of invertebrates and vertebrates
2. Communication I: Nerves: Neurons: structure and function.
 3. Communication II: Senses: Sensory reception: baroreceptors, chemoreceptors, georeceptors, hygroreceptors, phonoreceptors, photoreceptors, proprioceptors, tactile receptors, and thermoreceptors of invertebrates Lateral line system and electrical sensing, lateral-line system and mechanoreception, hearing and equilibrium in air and water, skin sensors of mechanical stimuli, sonar, smell, taste and vision in vertebrates.
 4. Communication III: The Endocrine System and Chemical Messengers: Chemical messengers: hormones chemistry; and their feedback systems; mechanisms of hormone action, Hormones with principal function each of porifera, cnidarians, platyhelminthes, nemertean, nematodes, molluscs, annelids, arthropods, and echinoderms invertebrates; an overview of the vertebrate endocrine system; endocrine systems of vertebrates, endocrine systems of birds and mammals
 5. Circulation and Immunity: Internal transport and circulatory systems in invertebrates Characteristics of invertebrate coelomic fluid, hemolymph, and blood cells, transport systems in vertebrates; characteristics of vertebrate blood, blood cells and vessels; the hearts and circulatory systems of bony fishes, amphibians, reptiles, birds and mammals; the human heart: blood pressure and the lymphatic system; immunity: nonspecific defenses, the immune response

Animal Form and Function- I (A Comparative Perspective) Lab

1. Study of insect chitin, fish scale, amphibian skin, reptilian scales, feathers and mammalian skin.
2. Study and notes of skeleton of Labeo (Labeorohita), Frog (Hoplobatrachustigerinus), Varanus (Varanus bengalensis), fowl (Gallus gallus domesticus) and rabbit (Oryctolagus cuniculus).
Note: Exercises of notes on the adaptations of skeletons to their function must be done.
3. Earthworm or leech; cockroach, freshwater mussel, Channa or Catlacatla or Labeo or any other local fish, frog, pigeon and rat or mouse and rabbits dissections as per availability.
4. Study of heart, principal arteries and veins in a representative vertebrate (dissection of representative fish/mammals).

Recommended Texts

1. Pechenik, J. A. (2013). *Biology of Invertebrates* (4thed.). Singapore: McGraw-Hill.
2. Hickman, C. P., Roberts, L. S., & Larson, A. (2004). *Integrated Principles of Zoology*, (11thed.). Singapore: McGraw-Hill.

Suggested Readings

1. Campbell, N. A (2002), *Biology* (6thed.). California: Benjamin Cummings.
2. Kent, G. C., & Miller, S. (2001). *Comparative Anatomy of Vertebrates*. New York: McGraw-Hill.

URCE-5104

Introduction to English Literature

3(3+0)

The course is designed to provide the familiarity and comprehension of English literary pieces. The students may not be familiar or well-versed in the various genres of literature prior to taking this course. The course provides training and skills necessary to engage, understand, critically analyze, and enjoy the literary genres of literature: short story, poetry, novel and drama. The students will explore the basic concepts of literary technique, narrative, poetic, and dramatic structures and innovations to engage with the more advanced cognitive aspects of literature. In addition to these theoretical skills, students will also read below the surface of the texts for their historical, ethical, psychological, social, and philosophical value by developing insights in how literature gives us a window into both the experiences of others and wider appreciation for the human condition. The course explores literary production in English against local context in particular, by emphasizing shifts in thought as well as genre innovation, i.e. medieval to modern. It provides an introduction to

key texts, authors and literary periods, exploring the relationship of texts to their contexts and considering multiple perspectives in the different literary genres.

Contents

1. Poems, Milton: *Book IX*, lines 897–959.
2. Shakespeare: All the World is a Stage.
3. Browning: My Last Duchess
4. Wordsworth: The Leech Gatherer
5. Keats: Ode to Autumn
6. Walter De La Mare: Tartary
7. Short Stories, *The Necklace*
8. The Woman Who had Imagination
9. Shadow in the Rose Garden
10. Essays, *My Tailor*
11. Whistling of the Birds
12. One Act Play, *Riders to the Sea*
13. Novel, Animal Farm

Recommended Readings

1. Kennedy, X. J., & Gioia, D. (2014). *Literature: An Introduction to Fiction, Poetry, Drama, and Writing*. Boston: Pearson.
2. Mays, K. J. (2014). *The Norton Introduction to Literature*. New York: Norton.

Suggested Readings

1. Bausch, R., & Cassill, R.V. (2006). *The Norton Anthology of Short Fiction*. New York: Norton and Company.
2. Gardner, J. E., Lawn, B., Ridl, J., & Schakel, p. (2016). *Literature: A Portable Anthology*. Boston: Bedford St. Martins.

SEMESTER-V

CHEM-6301

Basic Mathematics for Biochemists

2(2+0)

This course aims at an audience with basic competences in mathematics. It will serve as a sharpen tools as well as extension course for those with major in biology. The course includes an overview over the features of basic algebra and its significance in biochemistry. Further, it addresses the fundamental mechanisms by which Logarithmic and exponential functions are explained. Basic concepts of matrices, eigen value problems and curve fitting will also be discussed.

Contents

1. Introduction to algebra
2. Review of basic algebra,
3. Graphs and their significance in biochemistry.
4. Trigonometric.
5. Logarithmic and exponential functions.
6. Differentiation, partial differentiation, differential equations and their use in chemical problems.
7. Concept of maxima and minima.
8. Integration, Determinants and Matrices, their properties and use in chemical problems.
9. Solutions of linear equations (simple, determinant and matrices methods), operator theory,
10. The eigen value problem
11. curve fitting.
12. Biochemistry examples

Recommended Readings

1. Paul M. (2006). *Maths for Chemistry* (1sted.), Oxford University Press, UK.
2. Ghram D. (1996). *Mathematics in Chemistry* (1sted.). Prentice Hall, NY.

Suggested Readings

1. Tebutt P (1998). *Basic Mathematics for Chemists* (2nded) John Wiley & Sons, NY
2. Stanely P (2006). *Maths for Science* (3rd ed.), Oxford University Press, UK.

CHEM-6302

Microbiology & Industrial Fermentations

3(3+0)

This course is offered to the students who have adapted Biochemistry as a major subject and provides a comprehensive understanding of industrial applications of microorganisms in production and fermentation processes. This course also provides technical information on fermenter design, operation and growth kinetics of microbes involved in the fermentation processes. Types of fermentations and the commercial products derived from microbes are also discussed in this course. Students will get hands on experience in the microbial production of biopolymer, enzymes, bioactive compounds and biomass. Based on the skills acquired in this course, graduate students would have a mini project / review writing/ assignment as an additional component. Upon the completion of course, students will be able to have a better understanding of microorganisms, their classification, identification and characterization techniques. Students will also learn about industrial fermentation processes involved in production of Cheese, Alcohol, Citric acid, Acetic acid and Antibiotic synthesis. The students will also be able to discuss the role of microorganisms in industry, as well as to carry out experiments to produce microbial metabolites.

Contents

1. Definitions and Scope of Microbiology and fermentation.
2. Classification, methods of isolation, microscopic examination, general morphology and cytology of microorganisms.
3. General effects of environments on microorganisms.
4. Nutrition of microorganisms.
5. Growth (Normal growth Cycle and Continuous Culture) and Reproduction, Pure culture Study.
6. Introduction to industrial microbiology and chemical biology.
7. Industrial Uses of Bacteria, Molds, Yeast and viruses.
8. Microbial production of Cheese, Alcohol, Citric acid, Acetic acid, Antibiotic, enzyme production, Fermented Foods, Vinegar production, Amino Acid.
9. Petroleum Microbiology & Deterioration of Materials (Paper, Textile & Cordage, Painted Surface).
10. Microbial assays

Recommended Texts

1. Willey, J. Sherwood, L. & Woolverton, C. J. (2017). *Prescott's Microbiology*. (10th ed.). New York, USA: Prescott Publishers.
2. Dawis, B. D., Dulbecco, R., Eisen, H. N., & Ginsberg, H. S. (2002). *Microbiology*. New York, USA: Harper & Row.

Suggested Readings

1. *Lehninger Principles of Biochemistry* (6th ed.). (2012). Edited by David L. Nelson. Michael M. Cox W.H. Freeman.
2. Voet, D. R., & Voet, J. G. (2016). *Biochemistry*. (5th ed.). New York, USA: John Wiley & Sons.

CHEM-6303

Introduction to Computers in Biochemistry

3(2+1)

This course provides a broad and balanced knowledge and understanding of key use of computer in chemistry. This course will introduce the basic use of computer essential for chemistry students. Student will learn the use of basic software including MS Office, ChemDraw/ChemSketch. A knowledge of databases and referencing will be provided. Student will be able to learn a range of practical skills to understand the software required for research in chemistry. Upon successful completion of the course, students will be able to work effectively with a range of current, standard, Office Productivity software applications and Evaluate, select and use office productivity software appropriate to a given situation. This course will enhance student knowledge to solve a range of problems using office productivity applications, and adapt quickly to new software releases. Maintain quality assurance through critically evaluating procedures and results. Students will be able to demonstrate their skills in chemistry related software and will be able to learn more by self-reading and practicing the software learned during the course.

Contents

1. Introduction and history of computers
2. Use of basic internet for chemistry
3. Chemical databases and their applications
4. Data handling for chemistry data
5. Databases for literature survey for chemistry
6. Standard curve fitting and errors calculations
7. Graphical display of data
8. Molecular modeling for small molecules
9. Protein and DNA modelling and applications
10. Introduction to Programming languages i.e., Python
11. Basics concepts in python and its use in biochemistry

12. Use of ChemSketch and ChemDraw
13. Use of chemical compound databases on internet i.e PubChem, PDB.
14. Uses of Microsoft Office (MS Word, MS Excel, MS PowerPoint).
15. Basic statistics using MS excel.
16. Use of MS publisher and Poster preparation
17. Basic use of CorelDraw
18. Endnote referencing for biochemistry
19. MD Simulations and animation

Recommended Texts

1. Arora, K. (2004). *Computer Applications in Chemistry*. Delhi, India: Anmol Publications PVT. LTD.
2. Sherry, W. K. & Sherry, K. (2007). *Microsoft Office 2007 Simplified*. (1sted.). New York, USA: John Wiley & Sons.
3. *Chem Sketch 5.0 User's Guide*, (2001). *Advanced Chemistry Development*. USA: Chem Sketch Development.

Suggested Readings

1. David, C., & Young, B. (2001). *Computational Chemistry*. New York: John Wiley & Sons
2. Ramesh, K. (2005). *Computers and their Applications to Chemistry*. Delhi, India: Alpha Science International

CHEM-6304

Bioorganic Chemistry

4(3+1)

It is a course designed to deliver fundamental concepts in organic chemistry for core understanding of basics of organic chemistry in nomenclature of organic molecules (both carbocycles and heterocycles), involvement of electronic ($-I$, $+I$)/resonance ($-R$, $+R$)/steric factors in reactions and stereochemical aspects are major focus of this course. Stereochemistry spans the entire spectrum of organic, inorganic, biological, physical and especially supramolecular chemistry. It includes methods for determining and describing these relationships; the effect on the physical or biological properties these relationships impart upon the molecules in question, and the manner in which these relationships influence the reactivity of the molecules in question (dynamic stereochemistry)

Contents

1. IUPAC nomenclature of polyfunctional aliphatic, alicyclic, aromatic, heterocyclic, multicyclic organic compounds, spiro and allenes.
2. Inductive effect, resonance, hyperconjugation, aromaticity & tautomerism. The effect of structure, medium and steric factor on the strength of acids, bases and on acid-base equilibria. Introductory linear free energy relationship.
3. Geometrical Isomerism: *cis/trans*, *E/Z* & *syn/anti* conventions, optical isomerism
4. Chirality and symmetry, elements of chirality and elements of symmetry.
5. Optical isomerism of compounds up to three asymmetric centers, configuration vs conformation.
6. Primary and secondary metabolites, introduction to natural products and classification on different basis
7. Isolation, classification, biosynthesis, laboratory synthesis and structure elucidation of flavonoids, alkaloids and terpenoids by chemical, spectroscopic and spectrometric methods of analyses.

Organic Chemistry Lab. – I

Separation & identification of two and three component mixture of organic compounds by physical and chemical methods.

Recommended Texts

1. Clayden, J., Greeves, N., and Warren, S. (2012). *Organic Chemistry*. (2nded.). Oxford. London.
2. Solomons, T. W. G. (2016). *Fundamentals of Organic Chemistry*. (12thed.). New York: Wiley.

- Hendrickson, J. B., Cram, D. J., & Hammond, G. S. (1980), *Organic Chemistry*. New York: McGraw-Hill Book Co.

Suggested Readings

- Streitwieser, A., Heathcock, C. and Kosower, E. M. (2017). *Introduction to Organic Chemistry*. (4thed.). New York: Macmillan.
- Vogel, A. I. (1989). *Practical Organic Chemistry*. (4thed.). London: Longman Publisher.

CHEM-6117

Metabolism and Bioenergetics

4(3+1)

This course aims at providing a better understanding of metabolic pathways, their control mechanisms and disorders. This course includes both theory and practical modules that are offered to the students who have adapted Biochemistry as a major or minor subject. This course focuses on the metabolic pathways in living cells from prokaryotes to Eukaryotes, and how these pathways are regulated and disturbed in disease state, and how metabolic energy is obtained and transduced to meet a cell's requirements. This focus will allow calculations of bioenergy produced and assimilate in the metabolic pathways and will enhance the knowledge of students about how these pathways are integrated. Students will learn about enzymes involved in metabolic reactions and their reaction mechanisms, regulation of metabolic routes for energy production in form of ATP and diseases related to metabolic dysfunctions. Student will also be able to enhance their knowledge about metabolic diseases and their treatments.

Contents

- Principles of Bioenergetics and Biochemical, Types of reaction involved in metabolism,
- Carbohydrate Metabolism: Glycolysis; mechanism of reactions of enzymes.
- Regulation of glycolysis. Reaction energy calculations.
- Net ATP consumption.
- Gluconeogenesis: dedicated reaction, regulations and net energy calculations.
- Fermentation
- Pentose Phosphate Pathway; relationship to glycolysis, gluconeogenesis
- Metabolism of carbohydrates other than glucose; fructose, galactose, mannose starch and Glycogen.
- The Citric Acid Cycle; regulations, reaction mechanism.
- Fatty Acid Metabolism; Beta oxidation of even and odd chain fatty acids, Lipid Biosynthesis
- Oxidative Phosphorylation, Electron transport chain and Photophosphorylation.
- Protein Metabolism; amino Acid Oxidation and production of Urea,
- Biosynthesis of Amino Acids
- Nucleotide metabolism, Synthesis and degradation.
- Integration and Hormonal Regulation of Mammalian Metabolism

Biochemistry Lab. II

- Isolation of serum and plasma from human blood
- Estimation of fasting/random glucose levels in human serum by colorimetric methods (DNS method, glucose peroxidase method).
- Estimation of Hemoglobin in human blood.
- Estimation of total protein serum/urine proteins by Colorimetric method.
- Estimation of nitrogen content by microkjeldahl method.

6. Estimation of urea, creatinine triglycerides Glutathione, ammonia and cholesterol in human serum/urine.
7. Liver function tests using human serum/urine and chicken liver sample.
8. Determination of antioxidant and lipid profiles of human serum
9. Determination of vitamin contents i.e. Ascorbic acid in food samples
10. Estimation of Sodium (Na⁺), Potassium (K⁺) and Chloride (Cl⁻) from serum using flame photometer.
11. Estimation of heavy metals in human serum using atomic absorption.
12. Isolation and enzymatic hydrolysis of Glycogen from Liver
13. Sterilization and Preparation of culture media i.e use of autoclave
14. Streak, pour and spread plate methods using a wire loop and spreader
15. Testing sensitivity to antimicrobial substances, Preparing serial dilutions of cultures
16. Use of microscope and differential staining: Gram's staining method
17. Online resources for metabolic pathways i.e. KEGG, MetaCyc

Recommended Texts

1. *Lehninger Principles of Biochemistry* (6thed.). (2012) Edited by David L. Nelson, Michael M. Cox W.H. Freeman
2. Voet, D.R., & Voet, J. G. (2016). *Biochemistry*. (5thed.). New York, USA: John Wiley & Sons.
3. Boyer R. F. (2000). *Modern Experimental Biochemistry*. (3rded.). London, England: Pearson Press.

Suggested Readings

1. Swaminathan, R. (2011). *Handbook of Clinical Biochemistry*. (2nded.). Singapore: World Scientific Publishing Company
2. Walker, J. M. (1994). *The Basic Protein and Peptide Protocols*. New Jersey, USA: Humana Press.

SEMESTER-VI

CHEM-6305

Basic Statistics for Biochemists

2(2+0)

This course aims at providing students basic knowledge of statistics. Student will be able to use simple linear regression, multiple regression (for two independent variables), and Correlation in terms of chemistry. Students will be provided with the theoretical concepts, tools and methods of statistics as well as the opportunity to work through example problems. This course also provides basic statistical concepts for measuring the central tendency and dispersion, probability distributions, the central limit theorem, sampling, estimation, hypothesis testing, analysis of variance, correlation and regression analysis, multiple regression and statistical forecasting. Upon the completing this course the students will be able to compute and interpret the results of Bivariate and Multivariate Regression and Correlation Analysis, for forecasting and also perform ANOVA and F-test. This will further enhance student knowledge to understand both the meaning and applicability of a dummy variable and the assumptions which underline a regression model. Be able to perform a multiple regression using computer software.

Contents

1. Statistics- Introduction.
2. Definition, Descriptive and inferential statistics, Population, Sample, Data collecting. Use of Microsoft Excel for data analysis
3. Applications of statistics in chemistry.
4. Graphical Representation.
5. Simple Bar chart, Multiple Bar chart
6. Rectangle Sub-divided Chart. Histogram
7. Frequency Polygon, Histogram, Pi- Chart
8. Central Tendencies (A.M., G.M. Median, Mode, H.M. for Ungrouped Data.
9. Quantiles with Interpretation (for ungrouped data)
10. Quartiles, Percentiles, Deciles
11. Measures of dispersion (Mean Deviation, Variance, Standard Deviation, Coefficient of Variation).
12. Basic Probability Theory.
13. Regression. Definitions of Simple linear regression
14. Multiple regression (for two independent variables), and Correlation.
15. Estimation: Point estimate, interval estimates
16. Confidence Interval for Single Mean, Difference of Mean.
17. Testing of Hypothesis: t- test for single mean for paired samples and for independent samples.
18. ANOVA. Multiple Comparison Test, (LSD and DUCANSAN).
19. Chi Square for Association.

Recommended Texts

1. Navidi, J. (2010). *Statistics for Engineers and Scientists*. (1sted.). New York, USA: John Wiley.
2. Schuenemeyer, J. (2011). *Larry Drew Statistics for Earth and Environmental Scientists*. New York, USA: John Wiley.

Suggested Readings

1. Miller, C. J. & Miller, N. J. (1993). *Statistics for Analytical Chemistry*. New York: Ellis Horwood Ltd.
2. Miller, N. J. & Miller, C. J. (2001) *Statistics and Chemometrics for Analytical Chemistry*. (4thed.) New York: Prentice Hall.

CHEM-6306

Human Physiology

3(3+0)

This course is designed to provide a holistic overview of the various aspects of human. This course introduces students to the physiology of the human body. Students examine the mechanisms of body function, organized around the central theme of homeostasis – how the body meets changing demands while maintaining the internal constancy necessary for all cells and organs to function.

Course content focuses on cell physiology, nervous system, musculoskeletal system, digestive system, lymphatic, respiratory system, endocrine, and circulatory systems.

Contents

1. Digestion and absorption of macromolecules: Digestion, absorption and transport of carbohydrate, lipid and Protein.
2. Hormones: Introduction, classification, chemical nature, general mechanism of action, regulation, secretion, mode of action and biological functions of thyroid, parathyroid, pituitary, adrenal, gonadal and pancreatic hormones.
3. Blood: General composition, characteristics and functions; hemoglobin: chemistry, properties, synthesis, degradation, functions and derivatives. Blood coagulation and blood clotting factors: blood pressure, groups and buffers.
4. Respiration: Structure and functions of lungs; transport of oxygen and carbon dioxide in blood; acid base balance.
5. Specialized Tissues and cells: Structure and functions of muscle. Kidney; structure and functions, acid base balance, water and electrolyte balance. Structure and functions of liver; with special reference to detoxification functions.

Recommended Texts

1. *Lehninger Principles of Biochemistry* (6thed.). (2012). Edited by David L. Nelson, Michael M. Cox W.H. Freeman.
2. Voet, D. R. & Voet, J.G. (2016). *Biochemistry*, (5thed.) John Wiley & Sons, New York.
3. *Harper's Biochemistry* (31st ed.), (2018), Edited by Murray, R.K., Mayes, P.A., Granner, D.K. & Rodwell, V.W: Appleton and Lange, UK.

Suggested Readings

1. Stryer, L (2010). *Biochemistry*, (7th ed.) Freeman & Co. NY.
2. Guyton, A. C., & Hall, J. E. (2010). *Textbook of Medical Physiology*. (12thed.). Philadelphia, Pennsylvania, USA: W. B. Saunders Company.

CHEM-6307

Clinical Biochemistry

3(3+1)

This course is designed to understand the pathophysiological bases of the most relevant and prevalent diseases in our population, and to elaborate main biological properties of diseases that are examined in a clinical biochemistry laboratory.

Contents

1. Blood sampling Techniques
2. Microscopy
3. Complete blood count. Preparation of blood smear, staining, differential leukocytes count
4. Liver function tests: SGOT, SGPT, ALP, LDH, CPK, Bleeding and clotting time
5. Clinical tests including Renal test Profile Urea, Uric Acid, Creatinine, Lipid Profiles; LDL, VDL, Cholesterol, Cardiac Enzymes test. CKMB, kidney Function tests, A/G ratio, serum Na, K, Ca and HClO₄, Urine Analysis, bile pigments, bilirubin, urobilinogen, urobilin, albumin, urea
6. Pregnancy and fertility tests
7. Blood groups, sera-diagnosis of infectious diseases, tests for malaria and typhoid.
8. Assay of the various hormones including thyroid, growth, adrenal by radioimmunoassay (RIA).
9. Enzyme-linked immunosorbent assay (ELISA) methods for the assay of biological compounds.
10. Use of PCR in diagnosis and paternity tests, DNA Sequencing
11. Disease biomarkers especially different types of cancer and heart diseases.
12. Cultivation of microorganisms in laboratory using solid and liquid culture media

13. Isolation of pure culture; study of physical characteristics of microorganisms; bacterial growth curve; preservation of microbial strains.

Recommended Texts

1. Boyer R. F. (2000). *Modern Experimental Biochemistry*. (3rded.). London, England: Pearson Press.
2. Stryer, L. (2010). *Biochemistry* (7thed.); Freeman & Co. NY.

Suggested Readings

1. Swaminathan, R. (2011). *Handbook of Clinical Biochemistry*. (2nded.). Singapore: World Scientific Publishing Company.
2. *Harper's Biochemistry* (31st ed.), (2018), Edited by Murray, R.K., Mayes, P.A., Granner, D.K. & Rodwell, V.W; Appleton and Lange, UK.

CHEM-6308

Enzyme Kinetics and Mechanisms

4(3+1)

This course provides insight about the function, classification and characterization of enzymes in terms of kinetics and reaction mechanism. Studying the enzyme kinetics provide a better understanding of enzyme catalytic efficiency and inhibition. This course also provides structural and functional characteristics of macronutrients (carbohydrates, lipids, proteins) and micronutrients (vitamins) in food consumed by humans. Students will learn about the biochemical mechanisms associated with the digestion and assimilation of macronutrients and are introduced to analytical techniques in food biochemistry. Enzymes involved in food metabolism will also be explained to the students. Upon the completion of this course, students will be able to have a better understanding of classification of food, metabolic rates, micro- and macro- nutrients and their deficiencies. Students will obtain the basic knowledges about the relationship between properties and structure of the enzymes, their mechanism of action and kinetics of enzymatic reactions. Students will obtain basic knowledges about the relationship between properties and structure of the enzymes, their mechanism of action and kinetics of enzymatic reactions.

Contents

1. Enzyme Structure and Functions: Chemical nature, nomenclature and classification of enzymes
2. Cofactors, effect of different factors on enzyme activity
3. Kinetics Studies of substrate reactions. (Michaelis- Menten Equation and Lineweaver-Burke Plot)
4. Quantitative assay of enzyme activity, substrate specificity
5. Enzyme substrate interactions and nature of the active site
6. Models of enzyme substrate complex
7. Mechanism of enzyme action with specific reference to Chymotrypsin and nuclease
8. Inhibition, Competitive, uncompetitive, non-competitive and irreversible inhibition
9. Regulatory enzymes: Allosteric enzymes, multi-enzyme systems, Zymogens
10. Isoenzymes Non-Protein Bio-catalysis Ribosome's, (RNA as Enzyme)
11. Enzymatic control of metabolic pathways
12. Therapeutic uses of Enzyme and Immobilized enzymes.
13. Nutrition: Classification of Food, Source of Nutrients, Respiration
14. Caloric value of food, Calorimetry, Respiratory Quotient, Basal metabolic rate (BMR)
15. General Factor, chemical composition, functions
16. Deficiency symptoms and requirements of Nutrients and their biological values
17. Balanced diet, Role of nutrition in growth, development and Chronic disease.

Recommended Texts

1. *Lehninger Principles of Biochemistry* (6thed.) (2012). Edited by David L. Nelson, Michael M. Cox W.H. Freeman.
2. Voet, D. R. & Voet, J.G. (2016) *Biochemistry*, (5thed.) John Wiley & Sons, New York.

Suggested Readings

1. *Harper's Biochemistry* (31st ed.), (2018), Edited by Murray, R.K., Mayes, P.A., Granner, D.K. & Rodwell, V.W; Appleton and Lange, UK.
2. Stryer, L. (2010). *Biochemistry*. (7thed.). New York, USA: Freeman & Co.

CHEM-6309

Bioinorganic Chemistry

3(3+0)

Bioinorganic chemistry is a field that examines the role of metals in biology. Bioinorganic chemistry includes the study of both natural phenomena such as the behavior of metalloproteins as well as artificially introduced metals, including those that are non-essential, in medicine and toxicology. Interaction of various inorganic compounds with the biological species enables the scientist to design and formulate medicines for different diseases. Preparation of organometallic compounds by using different reaction conditions will also be discussed to lead a new era of research for preparation of stable metal complexes having metal-carbon bonding. Moreover, the role and interaction of different metal ions will also be discussed in living organisms. Further, the metal-carbon bonding unlike carbon-carbon bonding provides basis for catalysis. Starting from polymerization of ethylene by Zeigler and Natta leading to industrial revolution, the recent M-C bond chemistry has been studied in detail to materialize those reactions which otherwise are not possible. The fundamental rules like Eighteen-electron-rule explain the stability of organometallic compounds.

Contents

1. Applications of organometallic compounds in biochemistry
2. Applications of organometallic compounds.
3. Bio-inorganic chemistry: introduction
4. Bio-inorganic chemistry : Environmental intrusion
5. Role of inorganic species in vivo and in vitro
6. Main group ions (Na⁺, K⁺, Ca²⁺, Mg²⁺)
7. Trace elements: general roles, lanthanides & actinides, Zn, Cu, Cr, Mo, W, Co, Si, Se, Sn, I.
8. Storage and transport of iron
9. Metalloenzymes
10. Heavy metal toxicity

Recommended Texts

1. Huheey, J.E., Keiter, E.A., Keiter, R.L., & Medhi, O.K. (2006). *Inorganic Chemistry: Principles of Structure and Reactivity*. Mumbai, India: Pearson Education.
2. Roat-Malone, R. M. (2007). *Bioinorganic Chemistry: a Short Course*. New York: John Wiley & Sons.

Suggested Readings

1. Hill, A.F., & Hill, A. (2002). *Organotransition Metal Chemistry*. Cambridge, U.K.: Royal Society of Chemistry.
2. Astruc, D. (2007). *Organometallic Chemistry and Catalysis*. Berlin, Germany: Springer.

SEMESTER-VII

CHEM-6310

Fundamentals of Forensic Sciences

3(3+0)

This subject will integrate the concept and techniques developed in chemistry, physiology and biochemistry and apply them to the pharmacology and detection of drugs and toxins. Most important topics in forensic science are fingerprinting, forensic serology, hair and fiber analysis, explosive residues, glass comparisons, drug analysis, bullet and cartridge analysis, DNA analysis, Forensic botany and forensic toxicology.

Contents

1. History of Forensic science forensic chemistry, Applications of forensic chemistry in relation to other sciences e.g., Botany, Zoology, Geology, Odontology, Pathology etc
2. Types and classification of evidence, Physical, chemical biological evidence, Classifications of forensic evidence
3. Fingerprint analysis. history, types, latent vs visible fingerprints, chemical tests for latent and visible fingerprints. AFIS, fingerprint database. Hair as a forensic physical evidence, composition and structure of hair, differences between human and animal hair and identification. Fiber as a forensic evidence, composition, chemical composition of fiber, microscopic analysis, chemical tests for fiber analysis. Glass as a forensic evidence, Physical and chemical properties of glass, chemical analysis
4. Trace evidences, Physical and chemical properties, qualitative and quantitative metal analysis, Microscopic analysis, Trace evidence types, characterization, chemical tests, collection, analysis, exhibiting in court. Analysis of paints, vehicles, fire, bullet and cartridge analysis, tests for explosive residues, glass comparisons. Anthropometry, body measurement.
5. Toxicology, History, relation with other sciences, introduction to drugs, narcotics, toxins, laws related to poisons. Classification of poisons, organic, inorganic and mechanical poisons, Corrosives, irritants, neurotics, and miscellaneous poisons. Mechanisms of poisons, methods of administration, routes of excretion. Diagnosis of poisons. Analytical chemistry techniques for drug and poison analysis, narcotics analysis.
6. Serology, forensic analysis of blood patterns, and chemical tests for identifications.
7. Forensic biology and DNA analysis; DNA CODIS databases, PCR, blotting, RE digestion, RFLP, STRs, VNTRs analysis, DNA Fingerprinting, paternity tests.

Recommended Texts

1. Bell, S.(2012) *Forensic Chemistry*(2nd ed.), Prentice Hall, NY.
2. Jackson, A.R.W. & Jackson, J.M. (2016) *Forensic Science* (4th ed.), Prentice Hall, NY.

Suggested Readings

1. Khan, J., Kennedy, T.J.&Christian, D.R.(2012) *Basic Principles of Forensic Chemistry*, (kindle ed) Humana Press, NJ.

CHEM-6311

Introduction to Genomics and Proteomics

3(3+0)

This course provides basics of Genomics and Proteomics with emphasis on current techniques and applications. This course is designed to provide the basic knowledge of techniques and methods of Proteomics, interactomics, metabolomics and Proteogenomic. The students are expected to learn about proteome proteomics-based biomarkers and pathogen identification. Understanding of genomics techniques will help students to learn about gene annotations, genome organization and cDNA libraries.

Contents

1. Introduction to Proteomics; basic concepts
2. Methods in proteomics
3. Gel electrophoresis

Final

4. HPLC, Chromatographic separations, isoelectric focusing
5. Mass Spectrometry
6. DNA and gene Databases
7. Genomes and their annotations
8. Analysis of genomic data, applications of genomics
9. Bioinformatical methods
10. Metabolomics

Recommended Texts

1. Lesk, M. J. (2002). *Introduction to Bioinformatics*. Oxford, UK: Oxford University Press.
2. Brown, T. A. (2016). *Gene Cloning and DNA Manipulation: An Introduction*. (7thed.). New Jersey, USA: Blackwell Publishing Inc.

Suggested Readings

1. Westermeier R., Naven T. and Hans-Rudolf (2008). *Proteomics in Practice: A Guide to Successful Experimental Design* (2nded). J.Wiley & Sons
2. Twyman RM (2004). *Principles of Proteomics*. BIOS Scientific Publishers

CHEM-6312

Introduction to Nutritional Biochemistry

4(3+1)

This course provides introduction to biochemistry of macro- and micronutrients with a limited focus on medical aspects of nutrient deficiencies and metabolism. This course covers key concepts of nutrition and human health and the essential components of a balanced diet. Food selection and meal planning for healthy individuals. Balanced diet: recommended dietary allowances for different categories of the human beings. This course covers key concepts of nutrition and human health and the essential components of a balanced diet. Food selection and meal planning for healthy individuals.

Contents

1. Introduction to Nutritional Biochemistry
2. Classification of nutrients; Nutrient's structure & functional characteristics
3. Measurement of energy of foods and expenditure. Direct and indirect caloric measurement.
4. Basal metabolism.
5. Obesity and Factors affecting BMR. Respiratory quotient
6. Food borne diseases
7. Nutritional aspects and dietetic treatment of a few important primary nutritional and general diseases. Fasting, Starvation and anorexia nervosa, Endemic goitre, Idiosyncrasies
8. Food intolerance and food allergies
9. FAO global information and early warning system for food and agriculture.
10. Micronutrients: Sources, Daily allowance, Deficiency diseases,
11. Biological role of the water- and fat-soluble Vitamins
12. Biological importance of minerals
13. Nutrigenomics

Lab

1. Assessment and surveillance
2. Clinical surveys
3. physical examination
4. anthropometry, laboratory examinations
5. dietary surveys; calculations of energy values of food
6. calculation of recommended daily allowance (RDA)
7. calculation of basal energy expenditure (BEE)
8. basal metabolic rate (BMR)
9. BMI
10. estimation of vitamin

Recommended Texts

1. Mahan L.K., Raymond J.L., (2016). *Krause's Food & the Nutrition Care Process*. Elsevier Health Sciences.
2. Whitney E. N. & Rolfes S. R. (2002) *Understanding Nutrition* (9thed.) Wadsworth / Thomson Learning: New York.
3. Brody, T. (1999) *Nutritional Biochemistry* (2nd ed.) Academic Press: New York.
4. Joshi S.A. (2002) *Nutrition & Dietetics* (2nd ed.), Tata McGraw Hill Publishers .

Suggested Readings

1. Weigley, E. S., Mueller, D. H. & Robinson C. H. (1997) *Basic Nutrition & Diet Therapy*. Prentice Hall.
2. Jain, J. I. (2008) *Fundamentals of Biochemistry*. S. Chand & Co. India
3. Satyanarayana, U. & Chakarapani, U. (2006) *Biochemistry* (3rded), Books and Allied: Kolkata.

CHEM-6313

Molecular Biology II

4(3+1)

This course aims at introducing the DNA technology and familiarizing students with basic techniques in molecular Biology. It also acquaints students with the modern concept of molecular biology. Upon successful completion of the course, the student will not only acquire the basic knowledge and concepts of molecular biology but also understand the concepts of basic principles and techniques used molecular biology.

Contents

1. Molecular dogma; DNA as a genetic material. DNA replication in prokaryotes and Eukaryotes.
2. Type of DNA polymerases and functions.
3. DNA damage: types of mutations. DNA repair; NER, MMR, homologous DNA repair.
4. Virus DNA/RNA replication and its protein regulation.
5. Protein synthesis and regulation.
6. Transcription in prokaryotes and Eukaryotes: operons. Splicing; introns, exons and ribozymes. Gene regulation.
7. Translation; Metabolism of RNA and DNA nucleosides.
8. Structure of Chromatin and its functions.
9. Protein expression purification and characterization using different biophysical methods i.e. UV/Vis Spectrophotometry, FT-IR, Circular Dichroism (CD), Surface Plasmon Resonance (SPR), Gel electrophoresis (SDS-PAGE, agarose gel electrophoresis and capillary electrophoresis), Ultra-, analytical and gradient centrifugation, Cryo-electron microscopy, protein NMR, X-ray crystallography/Diffraction.
10. DNA amplification by PCR and real time PCR.
11. Applications of DNA sequencing,
12. Mass spectrometry and isotopes in molecular biology.

Lab

1. Methods for the isolation of proteins from plant and animal samples i.e., liver plasma protein, Salivary and Barley amylase using various cell disruption methods.
2. Protein precipitation by NH_4SO_4 method, using acid and organic solvent methods.
3. Protein dialysis and ultrafiltration methods.
4. Estimation of proteins using UV, Bradford and Lowry's methods.
5. Characterization of proteins i.e., amylase activity by enzyme assays, plasma proteins by characterization by SDS PAGE and Western blotting, analysis of a Protein from Egg White
6. Chromatographic separation/purification of proteins
7. Characterization of protein secondary structure using UV, FT-IR and circular dichroism spectroscopy.

8. Estimation and Isolation of total DNA/RNA from plant/animal tissues/cells, preparation of genomic plasmid DNA from bacteria. Phenol/chloroform extraction of DNA. Mini- and Maxi-preparation of DNA
9. Isolation of RNA from mammalian cells
10. Characterization of DNA by Agarose Gel Electrophoresis and Southern blotting
11. Primer design and amplification of target DNA by PCR
12. Restriction enzyme digestion
13. Preparation of competent cells and gene cloning
14. Preparation of sequencing gels and DNA sequencing
15. PCR primer designing by online resources
16. Characterization of proteins using online tools.

Recommended Texts

1. *Lehninger Principles of Biochemistry* (6thed.). (2012). Edited by David L. Nelson, Michael M. Cox W.H. Freeman.
2. Voet, D. R., & Voet, J. G. (2016). *Biochemistry*. (5thed.). New York, USA: John Wiley & Sons.

Suggested Readings

1. Stryer, L (2010). *Biochemistry*,(7th ed) Freeman & Co. NY .
2. Kathleen, L. Stump, M. S. E. (2009). *Krause's Food, Nutrition and Diet Therapy* (11thed.) Saunders
3. Jain, J. I. (2008). *Fundamentals of Biochemistry*. S. Chand & Co. India

SEMESTER-VIII

CHEM-6319

Environmental Biochemistry and Toxicology

3(3+0)

This course is an introduction to the field of environmental toxicology. It aims to provide fundamental knowledge on major classes of chemicals of environmental concern; the properties of these chemicals; how they are released and transported in the environment; how they interact with living systems to cause a toxic response.

This course is about the toxic effects of substances present in our environment. The nature of toxic substances depends upon their chemical characteristics- how they are bonded together, and how they react. Mechanisms of toxicity are basically chemical in nature. Chemical processes carried out by organisms play a strong role in determining the fates of toxic substances. In some cases, chemical modification of toxicants by organisms reduces the toxicity of chemical substances or makes them entirely nontoxic. In other cases, chemical activation of foreign compounds makes them more toxic. Since most substances in living organisms, as well as most toxic substances, are organic materials containing carbon, it is also essential to have an understanding of organic chemistry in order to consider toxicological biochemistry. It is important to consider the effects of toxic substances within the context of the environment through which exposure of various organisms occurs. Furthermore, toxic substances are created, altered, or detoxified by environmental chemical processes in water, in soil, and when substances are exposed to the atmosphere. Therefore, this course integrates environmental chemistry, biochemistry and toxicology.

Contents

1. Air pollution and acid rains, atmospheric chemistry
2. Solid and hazardous waste, soil chemistry
3. Water pollution, aquatic chemistry
4. Effects of pollutants on plants, animals and humans
5. How pollutants mimic nature
6. Biochemical pathways for the removal of xenobiotics
7. Microbial bioremediation
8. Phytoremediation
9. Wastewater treatment
10. Radiation hazards
11. Biomarkers used to assess environmental exposures

Recommended Texts

1. Kumar, A. (2005) *Environmental Chemistry*, Wiley Eastern, New Delhi.
2. Moore, J.W. & Moore, E.M.(2004) *Environmental Chemistry*, Academic Press, New York.
3. Banerji, S. K. (2006) *Environmental Chemistry*, Tata Publisher, Delhi.
4. Manahan, S. E. (2005) *Environmental Chemistry*, Brooks, California.

Suggested Readings

1. Neil, P.O (2004). *Environmental Chemistry*, Chapman, London.
2. Baird, C (2003). *Environmental Chemistry*, Freeman, New York.

CHEM-6320

Endocrine Systems

3(3+0)

The course aims to provide information on significance of different control systems for normal physiological functions. Comprehensive knowledge about structures, classification, and properties of hormones as well as understanding of the mechanism of action and diseases associated with hormones. This course also focuses on the biochemical properties of biological fluids. The primary metabolism is regulated by the generation and integration of numerous signaling cascades, as well as on the crosstalk among these signals. The most important signaling system in the human body that regulates almost every aspect of metabolism is the endocrine system that is comprised of endocrine glands and their secretions, called hormones. Current course describes the basic components of

endocrine system plus chemistry, physiology and functions of various hormones. Major focus will be on the biochemical aspects of various diseases that arise due to disturbed values of different hormones.

Contents

Endocrine System:

1. Introduction
2. Chemical nature of Hormones
3. Common characteristics
4. mode of action, chemistry
5. metabolism and biological functions of Pituitary
6. Adrenal gland
7. Thyroid, Parathyroid
8. Pancreatic and gonadal hormones.

Biochemistry and body fluids:

9. Composition and function of Blood
10. blood plasma
11. Blood proteins, Red blood cells
12. Hemoglobin, White blood cells, Platelets
13. Blood coagulation and blood pressure
14. Antibodies, Antigens and blood groups.
15. Composition of Urine. Extra- cellular fluid like cerebrospinal fluid, Lymph sweats tears
16. Synovial fluid and interstitial fluid.

Recommended Texts

1. Clark D.C., Pazdernik N., McGehee M. (2018). *Molecular Biology* (3rd ed.), Elsevier.
2. Lodish, H. (2016). *Molecular Cell Biology*. Global ed.

Suggested Readings

1. *Lehninger Principles of Biochemistry* (6thed.). (2012). Edited by David L. Nelson, Michael M. Cox W.H. Freeman.
2. Voet, D. R., & Voet, J. G. (2016). *Biochemistry*. (5thed.). New York, USA: John Wiley & Sons.

CHEM-6321

Chemotherapy and Immunology

3(3+0)

The course will also introduce current general principles of chemotherapy and immunology. This course provides an understanding of immune system fundamentals and the changes that develop in cancer patients. Upon completion of this course the students will be able to understand the use of chemotherapy in cancer management. They also come to know major chemotherapy drug classifications and their general mechanisms of action. The students learn about the chemical structure and the therapeutic role these important compounds available in the market. An introduction to disease mechanism and drug design is also included in the course.

Contents

1. Cancer: Reasons, Types and definition of various terms (Metastasis, Benign and malignant tumors, Oncogenes, Proto-oncogenes, hyperplasia, carcinoma in situ etc.).
2. Chemotherapy: Definition, different treatment strategies. Problems associated with chemotherapy, mechanism of drug resistance and Historical Highlights.
3. Chemotherapeutic Agents: Chemical structures, mechanism of action and mechanism of drug resistance of various classes (antitumor-antibiotics, Antimetabolites, Alkylating agents, Microtubule Inhibitors, Steroids and their Antagonists, Aromatase inhibitors, Monoclonal antibodies, Platinum based drugs, Irinotecan and topotecan, Etoposide, L-Asparaginase, Interferons and Imatinib).
4. Chemical structures, mechanism of action and mechanism of drug resistance of various classes of antibacterial, antifungal, antiviral, antipyretic, analgesic and antimalarial drugs.

5. Immunology: Fluid systems of the body, Blood groups (A, B, O and Rh system), components of Immune system, Definitions and Principles of Innate, adaptive, cell-mediated and humoral immunity, and the complement system.
6. Antibodies: Classes, biochemical structures, characteristics and functions.
7. Mechanism of allergy, hypersensitivity, acquired immunity, Immunodeficiencies and antigen-antibody reaction.

Recommended Texts

1. Sharma, A. K. (2019) *Immunology: An Introductory Textbook*, Jenny Stanford Publishing
2. Gadebusch H. (2019) *Chemotherapy of Infectious Disease* (1sted). CRC Press.
3. Runte, F., Renner IV, P., & Hoppe, M. (2019). *Kuby Immunology*, Macmillan Publishing Co.

Suggested Readings

1. Dawis, B.D., Dulbecco, R., Eisen, H.N. & Ginsbery, H.S. (2002). *Microbiology*, Harper & Row, NY.
2. Richard, H. A., Michelle, C.A., Richard, F., Rey, B.C.P.P., Jose, A. (2011). *Lippincott Illustrated Reviews Series LWW*: North American ed.

CHEM-6322

Introduction to Recombinant DNA Technology

4(3+1)

The course also introduces introduction to various methods and applications involved in recombinant DNA technology including polymerase chain reaction (PCR), DNA cloning, DNA sequencing, restriction enzymes, gene libraries, blotting techniques, expression of recombinant proteins, gene mapping, transgenic animals, and gene therapy. Student will learn about the genomic libraries, cDNA libraries and their applications with emphasis to their role in agriculture, production of therapeutic proteins.

Contents

1. DNA Cloning and application
2. DNA cloning restriction enzymes, DNA ligase
3. Gene vectors including plasmids, bacteriophages, cosmids
4. DNA vectors, shuttle and expression vectors
5. Gene splicing, genomic libraries, screening methods for gene libraries
6. DNA and RNA blotting
7. Chromosome walking; PCR: site specific mutagenesis
8. Overexpression of proteins
9. Restriction fragment length polymorphisms and disease detection (e.g. cystic fibrosis)
10. Stem cell technology
11. Social and commercial considerations

Recommended Texts

1. Brown, T. A. (2016). *Gene Cloning and DNA Manipulation: An Introduction*. (7thed.). New Jersey, USA: Blackwell Publishing Inc.
2. Primrose, S. B., Twyman, R. M., & Old, R.W. (2006). *Principles of Gene Manipulation* (7th ed.). New Jersey, USA: Wiley-Blackwell.

Suggested Readings

1. Dawis, B.D., Dulbecco, R., Eisen, H.N. & Ginsbery, H.S (2002). *Microbiology*, Harper & Row, NY.
2. Richard, H. A., Michelle, C.A., Richard, F., Rey, B.C.P.P., Jose, A. (2011). *Lippincott Illustrated Reviews Series, LWW*: North American ed.

Zink