Syllabus
For
B.Sc. (Hons.)BIOTECHNOLOGY

THREE YEAR FULL TIME PROGRAMME UNDER CBCS

RANI DURGAVATI UNIVERSITY

JABALPUR-482001

Note: Syllabus applicable for students seeking admission in the B.Sc. (HONS) Biotechnology Course from the academic year 2020-2021 onwards

Approved by
Board of Studies in Biotechnology on 15/09/2020, **Faculty of Life Science on** 14/10/2020
Standing committee on **Executive Council on**

Syllabus For
B.Sc. (Hons.) BIOTECHNOLOGY
(CBCS Pattern)

ACADEMIC YEAR 2020-2021 ONWARDS

The B.Sc. (Hons.) Biotechnology course would be of three years duration, divided into six semesters. Semester I to V would comprise of three core theory courses, two core practicals courses and one Elective course out of two choices, making a total of 30 courses in five semesters. Students will carry out Research work and submit a Dissertation in Semester VI. The course will commence from the academic session 2020-21. The syllabus has been prepared keeping in view the unique requirements of B.Sc. (Hons.) Biotechnology students under CBCS Programme. The contents have been drawn to accommodate the widening horizons of the Biotechnology discipline. It reflects the changing needs of the students, pertaining to the fields of Chemistry, Bioinformatics and Computational skills. The detailed syllabus for each paper is appended with a list of suggested readings. Teaching time allotted for each course shall be 3 hours for each theory course and 4 hours for each practical course per week, and 1 tutorial period for per week. Each practical batch should not have more than 20 students. Any number exceeding 20 will be divided into two equal batches. This is because biotechnology practical's require individual attention for imparting correct and adequate hands – on training to the students. One short educational trip will be planned to industry/national/research institutes in the $5^{th}/6^{th}$ semester to keep the students abreast with latest developments in the field of biotechnology.

BACHELOR OF SCIENCE IN BIOTECHNOLOGY
THREE YEAR FULL TIME PROGRAMME

PROGRAMME STRUCTURE

PART	SEMESTER/ COURSE CODE	COURSE TITLE
PART I	Semester-1	
	UBC 101	Botany
	UBC 102	Microbiology
	UBC 103	Chemistry-I
	UBC 104	Practical Based on UBC 101 & UBC 102
	UBC 105	Practical Based on UBC 103 & UBE 101/ UBE 102
	UBE 101/ UBE 102	Communicative English / Fundamentals of Statistics
	Semester-2	
	UBC 201	Zoology
	UBC 202	Basics of Computers
	UBC 203	Chemistry-II
	UBC 204	Practical Based on UBC 201 & UBC 202
	UBC 205	Practical Based on UBC 203 & UBE 201/ UBE 202
	UBE 201/ UBE 202	Fundamentals of Biochemistry / Bioanalytical Techniques
PART II	Semester-3	
	UBC 301	Cell Biology-I
	UBC 302	Molecular Biology-I
	UBC 303	Recombinant DNA Technology
	UBC 304	Practical Based on UBC 301 & UBC 302
	UBC 305	Practical Based on UBC 303 & UBE 301/ UBE 302
	UBE 301/ UBE 302	Fundamentals of Biophysics / Fermentation Technology
	Semester- 4	
	UBC 401	Immunology
	UBC 402	Cell Biology-II
	UBC 403	Molecular Biology-II
	UBC 404	Practical Based on UBC 401 & UBC 402
	UBC 405	Practical Based on UBC 403 & UBE 401/ UBE 402
	UBE 401/ UBE 402	Genetics and Genomics-I / Bioinformatics
PART III	Semester-5	
	UBC 501	Plant Biotechnology
	UBC 502	Environmental Biotechnology
	UBC 503	Animal Biotechnology
	UBC 504	Practical Based on UBC 501 & UBC 502
	UBC 505	Practical Based on UBC 503 & UBE 501/ UBE 502
	UBE 501/ UBE 502	Entrepreneurship and IPR / Genetics & Genomics-II
	Semester-6	DISSERTATION

SCHEME OF EXAMINATION

FIRST SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
Course Code	**Course Title**		**Continuous Evaluation**	**End Semester Exam**	**Total**
I-Core Courses					
UBC 101	Botany	3	40	60	100
UBC 102	Microbiology	3	40	60	100
UBC 103	Chemistry-I	3	40	60	100
II-Practical core courses					
UBC 104	Practical based on UBC 101 and UBC 102	4	40	60	100
UBC 105	Practical based On UBC103 and UBE 101/ UBE 102	4	40	60	100
III-Elective Courses (Any one to choose)					
UBE 101	Communicative English	3	40	60	100
UBE 102	Fundamentals of Statistics				
IV- Skill Development course					
SKILL	Skill Development module 1	2	Grade Point will be provided by Skill Development Centre		
Total valid credits		22			
(B) Comprehensive viva voce (Virtual credits)		04			50

SECOND SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
Course Code	**Course Title**		**Continuous Evaluation**	**End Semester Exam**	**Total**
I-Core Courses					
UBC 201	Zoology	3	40	60	100
UBC 202	Basics of Computers	3	40	60	100
UBC 203	Chemistry-II	3	40	60	100
II-Practical core courses					
UBC 204	Practical based on UBC 201 and UBC 202	4	40	60	100
UBC 205	Practical based on UBC 203 and UBE 201/ UBE 202	4	40	60	100
III-Elective Courses (Any one to choose)					
UBE 201	Fundamentals of Biochemistry	3	40	60	100
UBE 202	Bioanalytical Techniques				
IV- Skill Development course					
SKILL	Skill Development module 2	2	Grade Point will be provided by Skill Development Centre		
Total valid credits		22			
(B) Comprehensive viva voce (Virtual credits)		4			50

THIRD SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
Course Code	**Course Title**		**Continuous Evaluation**	**End Semester Exam**	**Total**
I-Core Courses					
UBC 301	Cell Biology-I	3	40	60	100
UBC 302	Molecular Biology-I	3	40	60	100
UBC 303	Recombinant DNA Technology	3	40	60	100
II-Practical core courses					
UBC 304	Practical basedon UBC 301 and UBC 302	4	40	60	100
UBC 305	Practical based on UBC 303 and UBE 301 / UBE 302	4	40	60	100
III-Elective Courses (Any one to choose)					
UBE 301	Fundamentals of Biophysics	3	40	60	100
UBE 302	Fermentation Technology				
IV- Skill Development course					
SKILL	Skill Development module 3	2	Grade Point will be provided by Skill Development Centre		
Total valid credits		22			
(B) Comprehensive viva voce (Virtual credits)		4			50

FOURTH SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
Course Code	**Course Title**		**Continuous Evaluation**	**End Semester Exam**	**Total**
I-Core Courses					
UBC 401	Immunology	3	40	60	100
UBC 402	Cell Biology-II	3	40	60	100
UBC 403	Molecular Biology-II	3	40	60	100
II-Practical core courses					
UBC 404	Practical based on UBC 401 and UBC 402	4	40	60	100
UBC 405	Practical based on UBC 403 and UBE 401 / UBE 402	4	40	60	100
III-Elective Courses (Any one to choose)					
UBE 401	Genetics and Genomics-I	3	40	60	100
UBE 402	Bioinformatics				
IV- Skill Development course					
SKILL	Skill Development module 4	2	Grade Point will be provided by Skill Development Centre		
Total valid credits		22			
(B) Comprehensive viva voce (Virtual credits)		04			50

FIFTH SEMESTER

CO1: Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
Course Code	**Course Title**		**Continuous Evaluation**	**End Semester Exam**	**Total**
I-Core Courses					
UBC 501	Plant Biotechnology	3	40	60	100
UBC 502	Environmental Biotechnology	3	40	60	100
UBC 503	Animal Biotechnology	3	40	60	100
II-Practical core courses					
UBC 504	Practical based on UBC 501 and UBC 502	4	40	60	100
UBC 505	Practical based on UBC 503 and UBE 501/ UBE 502	4	40	60	100
III- Elective Courses (Any one to choose)					
UBE 501	Entrepreneurship and IPR	3	40	60	100
UBE 502	Genetics and Genomics-II				
IV- Skill Development course					
SKILL	Skill Development module 5	2	Grade Point will be provided by Skill Development Centre		
Total valid credits		22			
CO2: Comprehensive viva voce (Virtual credits)		4			50

SIXTH SEMESTER

(A) DISSERTATION	Credits	Maximum Marks
A. Valuation (i) Language & Presentation (ii) Review of Literature (iii)Methodology (iv) Analysis & interpretation of Result	**18**	**300**
B. Viva-Voce EXTERNAL		**50**
C. Viva-Voce INTERNAL		**50**
Total		**400**

(B) Comprehensive viva voce (virtual credits)	**4**	**50**

PROGRAMME OUTCOMES

The aim of the undergraduate degree in Biotechnology is to make students knowledgeable about the various basic concepts in wide ranging contexts which involve the use of knowledge and skills of living entities and their manipulation. Their understanding, knowledge and skills in emerging biotechnological tools needs to be developed through a thorough teaching learning processes in the class, practical skills through the laboratory work, their presentation and articulation skills, exposure to industry and interaction with industry experts, write short research-based projects where they are guided and mentored by the academic and other experts of the subject.

PROGRAMME SPECIFIC OUTCOMES

A candidate who is conferred B.Sc. (Hons) degree in Biotechnology needs to have acquired/developed following competencies during the programme of the study:

1. Acquired knowledge and understanding of the biotechnological concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and related areas.

2. Demonstrate key practical skills/competencies in working with various biological entities for study and use in the laboratory as well as outside, including the use of modern molecular assessment and manipulation protocols.

3. Empower the students to undertake advance knowledge about biotechnological protocols and researches.

FIRST SEMESTER

CORE COURSE CODE UBC 101 BOTANY

(COURSE CREDIT= 03)

Course Objectives:

The course aims to empower the learners in the systematic position, occurrence, morphology, anatomy, development of reproductive structures, affinity and the classification of algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms.

Course Learning Outcomes:

CO1: The student will be able to identify major groups of plants and compare the characteristics of algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms.

CO2: Students will be able to use the evidence based comparative botanical approach to explain the evolution of organism and understand the genetic diversity on the earth.

CO3: Students will be able to understand adaptation, development, behavior, morphology, anatomy and reproduction of different forms of life.

CO4: Demonstrate proficiency in the experimental techniques and methods to study of algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms.

CO5: Students will be able to Understands concepts of Binomial Nomenclature and elementary knowledge of International Code of Botanical Nomenclature. Systematic position, distinguishing characters and economic importance of algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms

COURSE CONTENTS

UNIT I

Algae: Fritsch Classification, occurrence, structure, systematic position mode of reproduction and economic importance of the following generaChlamydomonas,,Chara, Sargassum, Polysiphonia, Nostoc.

UNIT II

Fungi: Outlines of classification of fungi, position, occurrence, structure and mode of reproduction in fungi, based on the following representatives:, Eurotium, Morchella, Agaricus and Alternaria, Economic importance of fungi, Lichens: Classification, occurrence, systematic position, mode of nutrition, reproduction and economic importance.

UNIT III

Bryophytes: Outlines of classification and importance of bryophytes, Systematic position occurrence, morphology, anatomy and reproduction in, Marchantia, Anthoceros (Development of Sporophyte only).

UNIT IV

Pteridophytes: Systematic Position, occurrence, morphology, anatomy and development of reproductive structures of Selaginella, Equisetum and Marsilea, Stelar system and its evolution in Pteridophytes, Heterospory and seed habit.

UNIT V

Gymnosperms & Taxonomy of Angiosperms

General characteristics, affinities and classification of Gymnospermsm(Chamberlains' and D.D Pant's classification) Systematic position, occurrence, morphology and development of reproductive structures and Economic importance of the following taxa- Cycas, Pinus, Ephedra, of Cycas, Pinus and Ephedra. Classification as proposed by Bentham and Hooker and Hutchinson, merits, demerits and comparison. Binomial Nomenclature and elementary knowledge of International Code of Botanical Nomenclature.Systematic position, distinguishing characters and economic importance of family: Rutaceae, Cucurbitaceae, Rosaceae, Apiaceae, Apocynaceae, Asclepiadaceae, Lamiaceae, Euphorbiaceae, and Poaceae.

Suggested Readings:

• College Botany Vol. I and II, Ganguli and Kar

• A Text Book of Botany, V. Singh, P.C. Pande & D.K. Jain

• Modern Plant Taxonomy, N.S. Subrahmanyam, Vikas Publishing House.

• A Text Book of Botany, V. Singh, P.C. Pande & D.K. Jain, Rastogi Publication.

• The Algae, V. J. Chapman and D. J. Chapman.

• Introductory Phycology, H. D. Kumar.

• A Text Book of Algae, H. D. Kumar and H.N. Singh.

• Introductory Mycology, Alexopaulos and Mims

• Cryptogamic Botany, G. M. Smith.

• A Text book of Algae, B. R. Vashishtha

• Bryophytes, N. S. Parihar

• Pteridophytes, N. S. Parihar

• An Introduction to Pteridophytes, A. Rashid. Plant Systematics Theory & Practice, Gurcharan Singh, Oxford & IBH Publishing Co.

• Taxonomy, V. Singh & D. K. Jain, Rastogi Publications.

• Botany for degree students – Gymnosperms, P.C. Vashishtha, S. Chand & Co.

• Gymnosperm, S. P. Bhatnagar & A. Moitra, New Age.

• College Botary Vol.2, B.P. Pandey, S. Chand & Co.

• Systematic Botany, S.C. Datta, New Age.

• Text Book of Botany Vol. II. S. N. Pandey, S. P Misra, P. S. Trivedi, Vikas Publishing House.

CORE COURSE CODE UBC 102: MICROBIOLOGY

(COURSE CREDITS = 03)

Course Objectives:

To provide a deep insight into the world of microorganisms, historical developments and major milestones leading to the development of microbiology as a separate discipline of science. The students will be able to understand the diversity, structure, evolution and impact of microbes in our day to day life and for the sustenance of life on Earth in general.

Course Learning Outcomes: Upon successful completion of the course, the students will:

CO1: Be acquainted with the historical account and development of microbiology as a scientific discipline.

CO2: Have gained knowledge on different systems of classification. They will also acquire an overview of acellular and cellular microorganisms.

CO3: Have acquired in-depth knowledge of the diversity, distribution, cell structure, life cycles and economic importance of algae.

CO4: Have gathered detailed information on the diversity, distribution, structure, life cycles and economic importance of fungi.

CO5: Be aware of general characteristics of protozoa and their economic importance and have a broad perspective of the scope of microbiology.

COURSE CONTENTS

UNIT I

History of Development of Microbiology

History- Discovery and Development of Microbial World, Spontaneous generation vs. biogenesis,

Fermentation, Germ Theory of Disease , Contribution of following scientists in the field oh=f Microbiology : Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming, Selman A. Waksman, Elie Metchnikoff, Norman Pace, Carl Woese and Ananda M. Chakraborty

UNIT II

Microbial Diversity and Classification

Occurrence, Binomial Nomenclature, Haekel's Classification, Whittaker’s five kingdom and Carl Woese’s three kingdom classification systems and their utility. Taxonomy- Principle and its types (Classical Approaches-Numerical, molecular Approach, Chemical, Serological and Genetics), Bacterial taxonomy- Bergey's manual of systematic bacteriology (Eubacteria and Archaebacteria), Difference between prokaryotic and eukaryotic microorganisms

General characteristics of different groups:

A cellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

UNIT III

Viruses

Definition- Virion, prions, viroids and virusoides. History, general characterstics and Structure, Virus-host (bacteria, animal and plants), Classification, Replication (TMV, poliovirus, T4 and λ phage), lytic and lysogenic cycles.

Bacteria

A General Characterstics- Morpholgical, Chemical , Cultural , Metabolic , Antigenic, very precise account of typical eubacteria, chlamydiae, rickettsiae, mycoplasma, and archaebacteria (extremophiles).

UNIT IV

Algae

History of phycology with emphasis on contributions of scientists; General characteristics of algae including occurrence, Classification, Morphology, Reproduction. Physiology and Cultivation.

UNIT V

Fungi

Historical developments in the field of Mycology, contributions of mycologists. General characteristics of fungi including habitat, distribution, Classification, Morphology, physiology, cultivation and Reproduction.

Practicals

1. Isolation of bacteria and fungi from soil, water and air. Morphological, cultural and biochemical identification.

2. Isolation and identification of pathogenic bacteria from sewage and waste water.

3. Determination of Plague Forming Unit (PFU/ml).

4. Determination of photosynthetic pigments in cyanobacteria.

5. Determination of growth curve and generation time of E. coli

Suggested readings

• Powar C. B. and H. F. Daginawala (2003).General Microbiology Vol.II; Himalaya Publishing House.

• Dubey R. C. and D. K. Maheshwari (2004). A Text book of microbiology, 1st Edition; S. Chand and Company Ltd.

• H.C. Dube (2005)A Textbook of Fungi, Vikas Publishing House.

• A Textbook of Fungi- Vashistha (2003) S. Chand and Company Ltd.

• Davis and Harper, General Microbiology

• Alexopoulos C. J. and C. W. Mims (1996). Introductory Mycology, 4th Edition; John Wiley and Sons, Inc. USA.

• Stanier, R.Y., J.L. Ingraham, M.L. Wheelis and P.R. Painter (1987) Vth edition. General Microbiology, Macmillan Press Ltd.

• Wiestrich G. A. and M. D. Lechtman (1988). Microbiology, 5th Edition; Macmillan Pulishing Company, New York.

• Trivedi, P.C. (2004) 1st Edition. Microbial Biotechnology, Aavishkar Publisher.

• Sharma, P.D. (2005) 2nd Edition. Microbiology, Rastogi Publications.

• Pelczar M. J., E. C. S. Chan and N. R. Krieg (2003) Microbiology, 5th Edition; Tata McGraw Hill Publishing Company , New Delhi

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CORE COURSE CODE UBC 103: CHEMISTRY-I

(COURSE CREDIT= 03)

Course Objectives:

To introduce the basic concepts and principles of general chemistry, and be familiarized with the principles, fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistry.

Course Learning Outcomes:

CO1: The students will learn about the principle, methodology, calculation and application involved in quantitative, chemical and spectrophotometric methods.

CO2: The student shall learn the essential concepts of chirality, configuration, isomerism in organic chemistry and nomenclature of isomers. Students will familiarize with the elementary concept of saturated aliphatic hydrocarbons reactions

CO3: The students shall learn about the fundamentals of organic chemistry with references to structure and reactivity, reagents and reactions & reaction and mechanism.

CO4: The students will learn about ionic, covalent bonding in molecules .compare/contrast the properties of molecular and ionic compounds.

CO5: The students will learn the elementary concepts of ionic chemical equilibrium with respect to acid – base, salt hydrolysis and solubility of ionic substances, including the IUPAC nomenclature, stereochemistry, structures, reactivity, and mechanism of the chemical reactions.

COURSE CONTENTS

UNIT I

Quantitative methods. Significant figures. Mole concept. Empirical and molecular formula. Molar and molal solutions, mole fraction, ppm and ppb solutions. Stoichiometry and calculations based on it involving acid-base, precipitation, redox, and complex formation reactions. *Chemical methods:* Principle, methodology and calculations involved in for dissolved oxygen (Winkler method), biological oxygen demand, chemical oxygen demand, and hardness of water. Determination of nitrogen in proteins (Kjeldahl method). *Spectrophotometric methods:* Determination of ammonia (by indophenol formation), nitrate (by nitrophenol formation), nitrite (by azo dye formation), and phosphorus (by molybdenum blue formation).

UNIT II

Chemical bonding and molecular structure.

Kossel-Lewis theory, octet rule, electrovalent and covalent bond. Formal charge. Polarity of bonds. The valence shell electron pair repulsion (VSEPR) theory, its postulates and geometry of molecules. Valence bond theory, orbital concept, hybridisation (sp, sp^2, sp^3, sp^3d and sp^3d^2). Molecular orbital theory. Linear combination of atomic orbitals (LCAO). Types and energy level diagram of molecular orbitals. Bond order. Bonding in homonuclear diatomic molecules. Magnetic properties.

UNIT III

Fundamental organic chemistry.

Structure and reactivity. Inductive and electromeric effects. Tautomerism, hyperconjugation and resonance. Intramolecular and intermolecular hydrogen bonding. Structure and stability of carbocations, carbanions and free radicals. Relative strength of organic carboxylic acids, phenols and amines. pKa and pKb values.

Reagents and reactions. Periodic acid, Grignard reagent, ethyl acetoacetate and diethyl malonate.

Reaction and mechanism. Claisen condensation, Benzoin condensation, Perkin reaction, Pinacol-pinacolone rearrangement,

UNIT IV

Stereochemistry of organic compounds.

Conformations. Fisher, sawhorse and Newman structures. IUPAC namenclature of conformational isomers. Conformations and their analysis of ethane, n-butane, cyclohexane and decalins.

Configurations. Chirality. Elements of symmetry. Optical activity, specific rotation. Enantiomers, diastereomers, and meso compounds. Racemic modification. Thereo and erythro compounds. R and S configuration, sequence rules. Geometrical isomerism, E and Z nomenclature.

Stereochemical aspects of chemical reactions. Addition of bromine to Z- and E-butene. E2 reactions.

UNIT V

Ionic equilibria.

Ostwald dilution law and its experimental verification. Application of Ostwald dilution law. Ionization of water. The pH value, relation between pH and pOH, the pH scale (numerical problems). The salt hydrolysis, and application to (i) salts of strong acids and strong bases, (ii) salts of weak acis and strong bases, (iii) salts of strong acids and weak bases, and (iv) salts of weak acids and weak bases. Hydrolysis constant and degree of hydrolysis.

Buffer solutions. Solubility and solubility product of sparingly soluble salts. Applications of solubility product principle.

PRACTICAL

1. Determination of hardness of water by titration with EDTA.

2. Determination of dissolved oxygen in environmental waters by the Winkler method.
3. Determination of chemical oxygen demand in environmental waters.
4. Determination of strength of a solution of sulphuric acid by titration with sodium hydroxide using pH meter.
5. Determination of ammonia by the indophenol formation, and spectrophotometry.
6. Determination of solubility product of mercuric iodate or lead iodate.

Suggested reference materials

1. Analytical Chemistry, G.D. Christian, John Wiley & Sons (Asia), Singapore
2. Fundamentals of Analytical Chemistry, D.S. Skoog, D.M. West, F.J. Holler and S.R. Cruch, Thomson, Singapore.
3. Organic Chemistry, R.T. Morrison and R.N. Boyd, Pearson Education, Delhi.
4. Organic Chemistry, P.Y. Bruice, Pearson Education, Delhi.
5. A Guidebook to Mechanism in Organic Chemistry, P.Sykes, Orient Longman, New Delhi.
6. Essentials of Physical Chemistry, A. Bahl, B.S. Bahl and G.D. Tuli, S. Chand & Company Ltd, New Delhi.

ELECTIVE COURSE CODE UBE 101: COMMUNICATIONIVE ENGLISH

(COURSE CREDIT= 03)

Course Objectives:

To develop the learner's communication skills in oral, written and interpersonal, by reinforcing the basics of English grammar.

Course learning outcomes: Students will

CO1: Improve LSRW, i.e. listening, speaking, reading and writing skills and the related sub-skills.

CO2: Recognize and use formal elements of organizational communications: Paper writing, reports, proposals, memorandums, letters etc.

CO3: Enhanced vocabulary with right pronunciation and improved accuracy in grammar.

CO4: Effective oral presentations.

COURSE CONTENTS

UNIT I

Communication: Language and communication, differences between speech and writing, distinct features of speech, distinct features of writing. Speech drills, pronunciation and ascent, stress and intonation.

UNIT II

Writing Skills; Selection of topic, thesis statement, developing the thesis, introductory, developmental, transitional and concluding paragraphs. Articles, parts of speech, tenses, sentence structure, subject- verb agreement, punctuation.

UNIT III

Use of dictionary. Use of words: Diminutives, Homonyms and Homophones. Linguistic unity, coherence and cohesion, descriptive, narrative, expository and argumentative writing.

UNIT IV

Effective writing skills, avoiding common errors. Technical Writing: Scientific and technical subjects; formal and informal writings; formal writings/reports, handbooks, writing assignments.

UNIT V

Purpose and scope of Report, Memo, Agenda and Minutes. Notice, Letters; types and minutes, Manuals.

Suggested reading:

• M. Frank. Writing as thinking: A guided process approach, Englewood Cliffs, Prentice Hall Reagents.

• L. Hamp-Lyons and B. Heasely: Study Writing; A course in written English. For academic and professional purposes, Cambridge Univ. Press.

• R. Quirk, S. Greenbaum, G. Leech and J. Svartik: A comprehensive grammar of the English language, Longman, London.

• Daniel G. Riordan & Steven A. Panley: “Technical Report Writing Today” -Biztaantra.

• Daniel G. Riordan, Steven E. Pauley, Biztantra (2004).: Technical Report Writing Today, 8th edition

• Contemporary Business Communication, Scot Ober, Biztantra, 5th Edition (2004).

ELECTIVE COURSE CODE UBE 102: FUNDAMENTALS OF STATISTICS

(COURSE CREDIT= 03)

Course Objectives:

It aims to students learn the use of basic statistical concepts, methods and principles in the field of biotechnology.

Course Learning outcomes:

CO1: Students understand the importance of Sets, Functions and their graphs: polynomial, sine, cosine, exponential and logarithmic functions, and Sample observations. Sequences finite sequences.

CO2: Students understand the intuitive idea of algebraic relationships and convergence, Infinite Geometric Series, Series formulas. Intuitive idea of discontinuity, continuity and limits.

CO3: Students study the differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions. Integration as reverse process of differentiation. Integrals of the functions introduced above.

CO4: Student understands the points in plane and space and coordinate form. Examples of matrices of biological sciences

CO5: Students studies about central tendency, Measures of dispersion; skewness, kurtosis. Elementary Probability. Types variable, distribution, and variance. Correlation and Regression.

COURSE CONTENTS

UNIT I

Sets, Functions and their graphs: polynomial, sine, cosine, exponential and logarithmic functions, Motivation and illustration for these functions through projectile motion, simple pendulum, biological rhythms, cell division, muscular fibres etc. Simple observations about these functions like increasing, decreasing and, periodicity. Sequences to be introduced through the examples arising in Science beginning with finite sequences, followed by concepts of recursion and difference equations. For instance, the Fibonacci sequence arising from branching habit of trees and breeding habit of rabbits.

UNIT II

Intuitive idea of algebraic relationships and convergence, Infinite Geometric Series, Series formulas for ex, log (1+x), sin x, cos x. Step function. Intuitive idea of discontinuity, continuity and limits.

UNIT III

Differentiation. Conception to be motivated through simple concrete examples as given above from Biological and Physical Sciences. Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions. Integration as reverse process of differentiation. Integrals of the functions introduced above.

UNIT IV

Points in plane and space and coordinate form. Examples of matrices inducing Dilation, Rotation, Reflection and System of linear equations. Examples of matrices arising in Physical, Biological Sciences and Biological networks. Sum and Produce of matrices upto order 3.

UNIT V

Measures of central tendency. Measures of dispersion; skewness, kurtosis. Elementary Probabilityand basic laws. Discrete and Continuous Random variable, Mathematical Expectation, Mean and Variance of Binomial, Poisson and Normal distribution. Sample mean and Sampling variance. Hypothesis testing using standard normal variate. Curve Fitting. Correlation and Regression. Emphasis on examples from Biological Sciences.

Suggested reading

• H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.

• E. Batschelet : Introduction to Mathematics for Life Scientists,S pringer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)

• A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.

• W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.

Note: It is desirable that softwares should be used for demonstrating visual, graphical and application oriented approaches.

SECOND SEMESTER

CORE COURSE CODE UBC 201: ZOOLOGY

(COURSE CREDIT= 03)

Course Objectives:

The course aims to empower the learners with the knowledge about systematics and characteristics of animal kingdom by imparting deep understanding about animal physiology through the study of different organ systems and their components.

Course Learning Outcomes:

CO1: Knowledge of classification of each phylum from protozoa to annelida and arthropoda to echinodermata up to class level with examples.

CO2: Understanding of characteristics and systematic position of classes of Chordata.

CO3: Discuss different organ systems- respiration, digestion, excretion, and osmoregulation; the structure and function of the organs related. Understanding of composition, function, formation, clotting mechanism, type of blood cells & blood groups with activity of the heart.

CO4: Conceptualise Nervous system and its components- neuron structure, nerve impulse transmission (Myelinated & Non Myelinated), Neurotransmitters, Muscle-Types, Neuromuscular junction, sliding filament theory. Understanding of metabolism of carbohydrates, fats and proteins; sense organs and endocrine glands.

CO5: Understanding human reproductive system- reproductive organs, female reproductive cycle, implantation, maternal change during pregnancy, labor and physiology of Lactation and methods of birth control.

COURSE CONTENTS

UNIT I

Invertebrata: Classification of the various phyla up to class level with examples Protozoa to Annelida, Arthropoda to Echinoderma.

1. Parasitic Protozoa. Entamoeba histolytica, Plasmodium Trypamosama, Leishmania
2. Canal system in sponges.

UNIT II

General characteristics, systemic position and examples of the following.

1. Agnatha: Hemichordata, Urochordata and Cephalochordata, Cyclostomes.
2. Gnathostomata:

i. Pisces. General characteristics of Pisces, distinguishing features and examples of Elasmoloranchii and Bony fishes (Chondrichthys and Osteichthys). A general idea of biodiversity and biological significance of fishes.

ii. Amphibia. Classification of living amphibia with examples, general characteristics of amphibia and the impact of terrestrialisation.

iii. Reptilia. Classification on the basis of temporal arcades of the skull. Poisonous and non-poisonous snakes, biting mechanism, snake venon and its medicinal importance.

iv. Birds. General characteristics of birds (palaeognathae and Neograthae). Archaeoptry, flightless birds, flight adaptations.

v. Mammals. General organisation of rabbit/rat. General characterists of mammals. Classification of living mannals up to orders. Primate characters and distinguishing characters of Homosapiens, aquatic mannals.

UNIT III

Physiology (with reference to mammals):

1. Respiratory system. Organs and transport of gases.
2. Digestive system. Organs and physiology of digestion, functions of various digestive enzymes.
3. Heart and circulatory system. Structure of the heart and cardiac cycle.
4. Blood. Composition of blood and its functions, clotting of blood, types of blood cells and blood groups.
5. Excretion. Structure of kidney and nephron, physiology and mechanism of urine formation.

UNIT IV

1. Composition of skeltal muscle, types of muscles, neuromuscular function, sliding filament theory of muscle contraction.
2. Structure of neurons, myslinated and non-myslinated nerve fibres, physiology of nerve impulse transmission.
3. Basic idea of intermediatry metabolism.
4. Sense organs. Eye and ear.
5. Endocrine glands. Source and function of various hormones.

UNIT V

Human reproduction:

1. Male and female reproductive organs.
2. Female reproductive cycle and its hormonal control.
3. Fertilisation and implantation of embryo.
4. Maternal changes during pregnancy.
5. Labor, physiology of lactation.

6. Methods of birth control.

Practical

1. Study of various systems in labeo/any fresh water fish, external features, respiratory system, digestive tract, cranial nerves, internal ear in situ.
2. Monsting of placoid and cycloid scale and their study.
3. Study of permanent slides of (mannals) muscles, blood, and T.S. intestine.
4. Study of paramecium and other phyto and zoo plankton form pond water.
5. Study of national parks of M.P.
6. Listing of animals found in and around your house/college/university.

Suggested reference materials

1. R.L. Kotpal. Modern textbook of zoology
2. R.L. Kotpal. Modern textbook of zoology: Vertebrate
3. Dhami & Dhami. Invertebrate zoology
4. Dhami & Dhami. Chordate zoology
5. Jordan & Verma. Invertebrate zoology
6. Jordan & Verma. Chordrate zoology
7. Reena Mathur. Animal behaviour

CORE COURSE CODE UBC 202: BASICS OF COMPUTERS

(COURSE CREDIT= 03)

Course Objectives:

This is a skill based paper that introduces the students to the basics of computer operations through knowledge on both hardware and software. The student has a better understanding on the use of computers for various applications

Course learning outcomes:

CO1: The students shall learn about the introduction, basics, organization, types and preliminary knowledge of operating systems and system tools.

CO2: Students will get the idea about data representation, networks terminologies, multimedia and its applications.

CO3: Students will get general awareness about the IT Act, system security and preliminary knowledge about the I-Tax, E banking and E reservations.

CO4: They learn basics of algorithms and programming.

COURSE CONTENTS

UNIT I

Computer Fundamentals: Introduction to Computers, Characteristics of Computers, Uses of computers, Types and generations of Computers, Basic Computer Organization - Units of a computer, CPU, ALU, memory hierarchy, registers, I/O devices, User Interface with the Operating System, System Tools

UNIT II

Data Representation: Binary representation of integers and real numbers, 1's Complement, 2's Complement, Addition and subtraction of bi. Networks terminology: Types of networks, router, switch, server-client architecture

UNIT III

Multimedia: Introduction, Characteristics, Elements, Applications

UNIT IV

Problem Solving: Notion of algorithms, stepwise methodology of developing an algorithm, developing macros in spreadsheet

UNIT V

General Awareness: IT Act, System Security (virus/firewall etc.) I-Tax, Reservations, Banking

Practical

1. Defined projects will be done by the students and evaluated by the instructor.

2. Document Preparation

3. Presentation Software

4. Familiarizing with the Operating System, Control Panel, Networking Configuration,

Firewall setting

5. Spreadsheet Handing, Working with worksheets, Creating a spreadsheet, entering and

formatting information, basic functions and formulas, creating charts, tables and graphs.

Suggested reading

• V Rajaraman, Fundamentals of Computers, Fourth Edition, PHI.

• Anita Goel, Fundamentals of Computers; Forthcoming title in Pearson-Education

Note: Use of Open Office/Star Office is recommended, as they are freely downloadable.

Reference manual for Open Office available at: http://www.openffice.org

Reference manual for Star Office available at: http://www.sun.com/software/staroffice/

CORE COURSE CODE UBC 203: CHEMISTRY-II

(COURSE CREDIT= 03)

Course Objectives:

It introduces the basic concepts and principles of general chemistry by familiarizing the students with principles, fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistry. Students will be able to explore new areas of research in both chemistry and allied fields of microbiology.

Course Learning Outcomes:

CO1: The students will learn about the energy and electromagnetic spectrum.

CO2: The student shall learn the principle, theory and applications of UV Visible spectroscopy and Infrared spectroscopy.

CO3: The students will get knowledge in the field of Electrochemistry special in references with Electrochemical cell, Nerst equation Gibbs energy.

CO4: The students will learn general structure, configuration and properties of Carbohydrates, Amino acids, Proteins and Peptides.

COURSE CONTENTS

UNIT I

Energy and the electromagnetic spectrum.

Units (wavelength, wavenumber, frequency) and energy of radiation.

UV-Visible spectroscopy.

Theory of electronic spectroscopy. Types of electronic transitions. Allowed and forbidden transitions. Solvent effects on electronic transitions. Beer and Lambert law. Molar absorptivity. Components of UV-Visible spectrophotometer. Application of electronic spectroscopy to conjugated dienes, and α,β-unsaturated carbonyl compounds. Woodward and Fieser rules.

Infrared spectroscopy.

Molecular vibrations, and calculation of vibrational frequencies. Factors affecting vibrational frequency, Vibrational coupling, hydrogen bonding, electronic effects and bond angles. Components of IR spectrophotometer. Interpretation of IR spectra of model organic compounds.

UNIT II

Electrochemistry.

The electrochemical cell. Galvanic and electrolytic cells. Electrode potential and its measurement. Nernst equation. Measurement of equilibrium constant by Nernst equation. Gibbs energy of the reaction. Conductance of electrolytic solutions. Measurement of conductivity of ionic solutions. Molar conductivity. Kohlrausch law of independent migration of ions. Faraday laws of electrolysis.

UNIT III

Carbohydrates.

Classification and general properties of carbohydrates. Osazone formation with phenylhydrazine. Open chain and cyclic structures. Mutarotation. Ascending and descending of monosaccharides.

Anomers and epimers. Determination of structure of glucose and fructose. Determination of ring size. Disaccharides and polysaccharides, and general ideas about the structure of sucrose, maltose, lactose, starch and cellulose.

UNIT IV

Amino acids.

Amino acids. General structures. Configuration of amino acids. The zwitter ion, isoelectric point and electrophoresis. Reactions of amino acids, acetylation, esterification and complexation. Ninhydrin test. Synthesis of amino acids by amination of α-haloacids, Gabriel synthesis and diethyl malonate synthesis.

UNIT V

Peptides and proteins.

The peptide bond. General idea about the structure of oxytocin. Primary, secondary, tertiary and quaternary structure of proteins. Determination of primary structure of proteins by N-terminal (Edmann degradation using 1-fluoro-2,4-dinitrobenzene, and phenylisothiocyanate) and C-terminal (hydrazinolysis) methods. Peptides (up to 3 amino acids) synthesis by N-protection and C-activation methods. Merrifield solid-phase synthesis.

PRACTICAL

1. Interpretation of bands in the pre-recorded standard IR spectra of model organic compounds.
2. Separation of mixture of amino acids (2 or 3 components) by paper chromatography.
3. Preparation of thin layer plates, and separation of organic compounds (coloured and colourless).
4. Preparation of chromatographic column and separation of carotenoids and chlorophyll from spinach.
5. Identification of glucose, fructose, sucrose, lactose and starch by standard chemical tests.
6. Determination of glucose by the Fehling reaction (titration and spectrophotometric methods). Demonstration on the application of glucometer.

Suggested reference materials

1. Organic Spectroscopy, W. Kemp, ELBS, Hampshire, UK.
2. Spectroscopic methods in Organic Chemistry, D.H. Williams and I. Fleming, Tata McGraw-Hill, New Delhi.
3. Organic Chemistry, R.T. Morrison and R.N. Boyd, Pearson Education, Delhi.
4. Organic Chemistry, P.Y. Bruice, Pearson Education, Delhi.
5. Essentials of Physical Chemistry, A. Bahl, B.S. Bahl and G.D. Tuli, S. Chand & Company Ltd, New Delhi.
6. Organic Chemistry, T.W.G. Solomons and C.B. Fryhle, Wiley India, New Delhi.

ELECTIVE COURSE CODE UBE 201: FUNDAMENTALS OF BIOCHEMISTRY

(COURSE CREDIT= 03)

Course objectives:

Student study about the biomolecules participating in different biochemical reactions and processes within the living system. These biochemical processes control and regulated by different enzymes for production of energy in form of ATP.

Course Learning outcomes:

CO1: Study water and their properties, buffers, pH, acid, base, covalent bond and weak bonds, structure of atom.

CO2: Enzyme, classification, structure, activity, inhibition, kinetics, allostoric enzymes etc.

CO3: Structure and chemistry of Carbohydrate, protein, lipid, vitamins, pigments, antibiotics; functions, analysis.

CO4: Biological membranes and Transport: membrane dynamics, solute transport across membranes.

CO5: Biosignaling, signaling in microorganisms and plants, Bioenergetics and Metabolism; bioenergetics and thermodynamics, phosphoryl group transfers and ATP.

COURSE CONTENTS

UNIT I

Basic building blocks: Biochemistry as molecular logic of living beings, Axioms of living matter, Major organic compounds of animate objects a general view. Chemical elements, structure of atoms, molecules and chemical bonds.Ionic, covalent, coordinate and hydrogen bonds. Structure, function and properties of water, Water as universal solvent, Acids, bases and salts, pH and buffers.

UNIT II

Carbohydrates: Classification of carbohydrates. Chemical structure and properties of monosaccharide, disaccharides, oligosaccharides and polysaccharides- Starch, cellulose and glycogen. Lipids: Saturated and unsaturated fatty acids.

UNIT III

Purines and Pyrimidines: structure and properties of Purines and Pyrimidines. Proteins: Structure and Classification of amino acids. Acid –base properties and solubilities. Amino acid sequencing of proteins. Primary, secondary and tertiary structure of proteins.

UNIT IV

Enzymes: General characteristics of enzymes Classification of enzymes, Co-enzymes and cofactors .Kinetics and Mechanism of enzyme action. Competitive and non competitive inhibition. Allosteric regulation of enzymes. Isoenzymes. Factors contributing to catalytic efficiency of enzymes.

UNIT V

Biological membranes and Transport: membrane dynamics, solute transport across membranes.

Biosignaling, signaling in microorganisms and plants, Bioenergetics and Metabolism; bioenergetics and thermodynamics, phosphoryl group transfers and ATP.

Practicals

1. Laboratory Instrument and Definition

2. Quantitative estimation of reducing and non reducing sugars.

3. Detection of water alkalinity and water acidity

4. Separation of amino acid by Paper chromatography and TLC.

5. Verification of Beer's law

6. Identification of biological compound: Carbohydrate (Glucose, fructose, Galatose, Sucrose, Lactose, Maltose), Protein (color reaction and precipitation reaction), Lipid.

Suggested reading

• Analytical Biochemistry 3rd Ed. by Holme, D. J. & Peck, H.

• Basic Concepts in Biochemistry A Student's Survival Guide by Gilbert, H. F.

• Biochemistry (3rd ed. 1994) by Rawn J. D.

• Biochemistry and Molecular Biology of Antimicrobial Drug Action by Franklin, T. J. & Snow, J. A.

• Biochemistry by Champe

• Biochemistry by Todd, W. B., Mason, M., Bruggen, R. V. & Macmillan.

• Biochemistry by Voet & Voet

• Biochemistry by Mathews 3rd Ed.

• Biochemistry The Chemical Reactions of Living Cells 2d Ed Vols 1&2 by Metzler, D. E.

• Biochemistry with Clinical Correlation by Devlin, T. M.

• Biochemistry: (3rd ed. Vol.1, 2, 3, 1993) by Zubay, J.

• Biochemistry2ed by Stryer

ELECTIVE COURSE CODE UBE 202: BIOANALYTICAL TECHNIQUES

(COURSE CREDIT= 03)

Course Objectives:

The major objective of this paper is to develop understanding of the key concepts of basic as well as some advanced experimental techniques used across biological sciences, with a focus on principle and design of the instruments. This will enable the students to connect between theoretical concepts of these techniques and their immense biological applications in diverse fields.

Course Learning Outcomes: Upon successful completion of the course, the student:

CO1: Will have identified the principle components of a light microscope, fluorescence microscope, phase contrast microscope, confocal and electron microscope, simultaneously learning about their principles and practical applications in visualizing, identifying and measuring cell, its components and biomolecules. The student will be familiar with staining and preparation of samples for microscopy.

CO2: Will have gained an in-depth knowledge of principles and applications of paper chromatography, thin layer chromatography, gel filtration chromatography, ion-exchange chromatography, affinity chromatography, GC, HPLC. This enables the students to apply the acquired knowledge in isolation and separation of biomolecules for analysis.

CO3: Will have learnt basic concepts of various techniques used to resolve and analyze nucleic acids and proteins - agarose gel electrophoresis, native polyacrylamide gel electrophoresis, SDSpolyacrylamide gel electrophoresis, isoelectric focusing, 2D gel electrophoresis, zymogram preparation.

CO4: Will be able to understand absorption spectra of biomolecules, and will be able to interpret UV-visible and fluorescence spectroscopy outputs.

CO5: Will have clear fundamentals of centrifugation, RCF, sedimentation coefficient, different types of rotors used, principle and working of differential and density gradient centrifugation, preparative and analytical scales of centrifuge, and the specific uses of ultracentrifuge. Students will also be acquainted with limitations of each method.

COURSE CONTENTS

Unit- I

Instruments, basic principles and usage: pH meter- working of pH meter, Types of electrodes, Centrifuge- Theory of centrifugation, Types of centrifugation, Density gradient centrifugation, Types of centrifuge.

Unit- II

Instruments, basic principles and usage: Spectrophotometers- Laws of absorption and emission, Visible and UV, IR, Atomic absorption, NMR, X-Ray crystallography.

Unit- III

Chromatography- Paper chromatography, thin layer chromatography, Basic principle of column chromatography, gel filtration, ion exchange chromatography, affinity chromatography, Gas chromatography and its application.

Unit- IV

Electrophoresis – SDS-Polyacrlamide Gel electrophoresis, Agarose Gel electrophoresis, Immuno electrophoresis, Iso electric focusing, MALDI-TOF, ESI.

Unit- V

Radioisotope tracer technique- Introduction, Radioisotopes and Radioactivity, Types of Radioactivity, Isotopic labeling, Autoradiography, Detection and measurement of radioactivity, scintillation counting.

Suggested reading

• Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker

• Bioinstrumentation, Webster

• Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic

• Crystal Structure Analysis, J.P. Glusker and K.N. Trueblood, Oxford University Press

• Modern Spectroscopy, J.M. Hollas, John Wiley and Son Ltd.

• NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry, H. Gunther, John Wiley and Sons Ltd.

• Principles of Physical Biochemistry, K.E. Van Holde, Prentice Hall.

• Principles and Practice of Bioanalysis, Richard F. Venn

• Microscopic Techniques in Biotechnology, Michael Hoppert

• Principles of Fermentation Technology, P.F. Stanbury, A. Whitaker, S.J. Hall

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THIRD SEMESTER

CORE COURSE CODE UBC 301: CELL BIOLOGY I

(COURSE CREDIT= 03)

Course Objectives:

The major objective of this course is to educate students about the fundamental concepts in eukaryotic cell biology. The students will be taught the latest developments in cell communication, regulation of cell cycle, and modern tools used to study cell biology. Advances in cancer biology including etiology, diagnosis and therapeutics, as well as the basics of stem cell technology and its applications will be covered.

Course Learning Outcomes: Upon successful completion of the course, the student:

CO1: Will have gained knowledge about features of the cell wall, plasma membrane, cell transport mechanisms and cytoskeleton.

CO2: Will be able to understand the structures and functions of the nucleus and different cell organelles. The structural organization and function roles of chromatin will be learnt.

CO3: Will have understood the mechanisms of protein sorting, intracellular trafficking, protein export.

CO4: Will have gathered understanding of how cells perceive and respond to various signals from within and outside.

CO5: Will have learnt the mechanisms of cell division and the significance of cell cycle and its regulation. Will become familiar with stem cell technology and its applications, and basics of cancer biology including diagnostic techniques and therapy.

COURSE CONTENTS

Unit- I

An Overview of cells: Overview of prokaryotic and eukaryotic cells, cell size and shape, Phages, Viroids, *Mycoplasma* and *Escherichia coli*:

Unit- II

Composition of cells: Molecules of cells, cell membranes, cell proteins; The Nucleus: Nuclear Envelope- structure of nuclear pore complex, nuclear lamina, transport across Nuclear Envelope. Chromatin: Molecular organization, Nucleolus and rRNA Processing.

Unit- III

Mitochondria, chloroplasts and peroxisomes: Structural organization, Function; Semiautonomous nature of mitochondria and chloroplast, chloroplast DNA, Peroxisome assembly.

Unit- IV

The Endoplasmic reticulum, the Golgi apparatus, Mechanism of vesicular transport, Lysosomes, Cytoskeleton and cell movement, Structure and organization of actin filaments; actin, myosin and cell movement.

Unit- V

Transport process: cell membrane models of membrane structure, membrane proteins and their properties, membrane carbohydrates and their role. Transport across membrane active and passive diffusion, their mechanism.

Practicals

1. Separation of nucleic acid bases by paper chromatography.

2. Microscopy- Theoretical knowledge of Light and Electron microscope.

3.Study of the following techniques through electron / photo micrographs: Fluorescence microscopy, autoradiography, positive staining, negative staining, freeze fracture, freeze etching, shadow casting.

4. Study of structure of cell organelles through electron micrographs.

Permanent slide preparation:

1. Cytochemical staining of DNA-Feulgen.

2. Cytochemical staining of DNA and RNA- Methyl Green Pyronin (MGP).

3. Cytochemical staining of Polysaccharides-Periodic Acid Schiff's (PAS).

4. Cytochemical staining of Total proteins- Bromophenol blue.

5. Cytochemical staining of Histones -Fast Green.

Suggested reading

• Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.

• De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.

• Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

• Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

CORE COURSE CODE UBC 302: MOLECULAR BIOLOGY I

(COURSE CREDIT= 03)

Course Objectives:

The major objective of this course is to develop a clear understanding of the basic concepts of molecular biology starting from the structure and function of DNA to its replication. The student will become familiar with the central dogma of molecular biology, and will learn about the conversion of information from DNA to RNA to proteins, by the study of transcriptional and translational processes.

Course Learning Outcomes: Upon successful completion of the course, the student:

CO1: Will be acquainted with the structure of various types of DNA and RNA as well as their organization as genetic material in various living organisms.

CO2: Will gain an in-depth knowledge of DNA replication mechanisms in prokaryotes and eukaryotes, enzymes and proteins involved in replication.

CO3: Will have learnt the fundamental principles of transcription in prokaryotes and eukaryotes, including the RNA polymerases and general transcription factors involved. Will be able to distinguish between the process in prokaryotes versus eukaryotes.

CO4: Will understand the concept of split genes, introns, exons, spliceosomes and alternative splicing besides learning about other processing events like polyadenylation and capping. Will become familiar with RNA interference and its significance, siRNA and miRNA.

CO5: Will get a clear understanding of translational mechanisms in both prokaryotes and eukaryotes along with the inhibitors of protein synthesis, and various mechanisms involved in regulation of gene expression in prokaryotes and eukaryotes at the level of transcription, post-transcriptional processes, and modifications in chromatin structure

COURSE CONTENTS

UNIT I

Nucleic Acids convey Genetic Information: DNA as the carrier of genetic information, Key

experiments establishing-The Central Dogma, DNA Double helix, Genetic code, Direction of Protein Synthesis, Genomics.

UNIT II

The Structures of DNA and RNA / Genetic Material: DNA Structure: Miescher to Watson and Crickhistoric perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology-linking number, topoisomerases; Organization of DNAProkaryotes, Viruses, Eukaryotes. RNA Structure Organelle DNA – mitochondria and chloroplast DNA.

UNIT III

Genome Structure, Chromatin and the Nucleosome: Genome Sequence and Chromosome Diversity, Chromosome Duplication and Segregation, The Nucleosome Chromatin structure-Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin. Regulation of Chromatin Structure and Nucleosome Assembly. Organization of Chromosomes

UNIT IV

The Replication of DNA (Prokaryotes and Eukaryotes): Chemistry of DNA synthesis, general principles - bidirectional replication, Semiconservative, Semi discontinuous,RNA priming, Various models of DNA replication including rolling circle, D-loop (mitochondrial), Θ (theta) mode of replication, replication of linear ds-DNA, replicating the 5'end of linear chromosome. Enzyme involved in DNA replication – DNA polymerases, DNA ligase, Primase, Telomerase and other accessory proteins

UNIT V

The Mutability and Repair of DNA: Definitions, Mutation, muton, replicon, principles of mutation, Replication Errors, DNA Damage, different types of mutations, deletions, duplications, UV induced mutations, repair mechanisms against mutations and their importance.

Practicals

1. Preparation of Polytene chromosome from Chironomous larva/Drosophila larva

2. Demonstration of mammalian sex chromatin.

3. Preparations of temporary mount and study the different stages of Mitosis (Onion root tip).

4. Perform Southern Blot Hybridization (Restrict DNA for Southern Blot electrophoresis, perform electrophoresis of restricted DNA, perform southern transfer, hybridization and detection of gene of interest)

5. Demonstration of Northern Blotting.

6. Demonstration of Western Blotting.

7. Perform DNA amplification by PCR.

8. Study of semi-conservative replication of DNA through micrographs/schematic representations.

Suggested reading

• Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition.John Wiley & Sons. Inc.

• De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology.VIII Edition. Lippincott Williams and Wilkins, Philadelphia.

• Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

• Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008)

• 5.Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

CORE COURSE CODE UBC 303: RECOMBINANT DNA TECHNOLOGY

(COURSE CREDIT= 03)

Course Objectives:

The main objective of this paper is to ensure that the student develops a clear comprehension of the concepts of recombinant DNA technology. The student will get acquainted with the tools and techniques used such as the enzymes, vectors, and cloning methods that can be used, and the applications of cloning such as creation of DNA libraries and recombinant products. A final exercise on a suitable strategy towards developing a genetically modified crop is incorporated to empower the student to apply the knowledge gained**.**

Course Learning Outcomes: Upon successful completion of the course, the student:

CO1: Will get an overview of developments and contributions of scientists in the field of genetic engineering.

CO2: Will get familiarized with basic cloning tools such as enzymes used to manipulate DNA, and cloning vectors.

CO3: Will have learnt various gene delivery methods and basic essential techniques of DNA, RNA and protein analysis.

CO4: Will gather in-depth knowledge of DNA amplification and sequencing methods, and become conversant with construction and screening of genomic and cDNA libraries

CO5: Will become aware of the applied aspects of all major techniques being used for the benefit of humankind in the areas of agriculture and pharmaceuticals. Students will design a strategy outlining all the steps of developing a novel recombinant.

COURSE CONTENTS

Unit I

Introduction to basic biotechnology: Milestones in genetic engineering and biotechnology, Tools of recombinant DNA technology, Hosts, E. coli strains; Yeast (Saccharomyces cerevisiae, Pichia pastoris); Fungi (Penicillium, Aspergillus), Mammalian cell lines - names and genotypes, Enzymes Restriction modification systems:Types I, II and III. Mode of action, nomenclature. Application of Type II restriction enzymes in genetic engineering. DNA modifying enzymes and their applications, Cloning Vectors- Definition and Properties. Plasmid vectors.

Unit II

Mammalian Expression Vectors: SV40, Vaccinia, Retroviral promoter based vectors, Basic DNA Cloning, Simple cloning of DNA fragments, Vectors: Definition and properties. E. coli

expression vectors-lac, tac and T7 promoter based vectors. Yeast expression vectors, Ti based vectors (Binary and Cointegrated vectors) and cloning using linkers and adaptors. Transformation of DNA by chemical method and electroporation

Unit III

Methods of gene delivery in plants and animals: Microinjection, biolistic method (gene gun), liposome and viral-mediated delivery, Agrobacterium-mediated delivery, Methods of DNA, RNA and Protein analysis and DNA typing: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot and colony hybridizations. Chromosome walking and jumping. DNA fingerprinting by RFLP and RAPD. Gel retardation assays. DNA footprinting by DNase I, DNA microarray analysis. SDS-PAGE and Western blotting. Phage display

Unit IV

Amplification of nucleic acids: Polymerase chain reaction - enzymes used, primer design. Cloning PCR products. RT-PCR and principles of real time PCR. Ligation chain reaction, Construction of Genomic and cDNA libraries, Genomic and cDNA libraries: Preparation and uses. Screening of libraries by colony hybridization and colony PCR

Unit V

DNA sequencing and synthesis: Maxam-Gilbert's and Sanger's method. Automated sequencing. Human genome sequencing project, Product of DNA technology: Human protein replacementsinsulin, hGH and Factor VIII. Human therapies - tPA, interferon, antisense molecules. Bt transgenics-rice, cotton, brinjal

Practicals

1. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.

2. Ligation of DNA fragments.

3. Demonstration of PCR.

4. Interpretation of sequencing gel electropherograms.

Suggested reading

• Alcamo IE. (2001). DNA Technology: The Awesome Skill. 2nd edition. Elsevier Academic Press, USA.

• Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.

• Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.

• Glick BR and Pasternak JJ. (2003). Molecular Biotechnology. 3rd edition. ASM Press Washington D.C.

• Nigam A and Ayyagari A. (2007). Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill, India.

• Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.

• Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

• Willey JM, Sherwood LM, and Woolverton CJ. (2008) Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

ELECTIVE COURSE CODE UBE 301: FUNDAMENTALS OF BIOPHYSICS

(COURSE CREDIT= 03)

Course Objectives:

The course aims to refresh knowledge of basic physics and chemistry to empower the learner in applying physical principles in chemical reactions and physiological systems.

Course Learning Outcomes:

CO1: Discuss molecular organization of different levels of protein and molecular structure of water- hydrogen bonds and physical property of water.

CO2: Knowledge of storage, flow of energy and their applications-electrical properties of biological compartments; electrochemical gradients, membrane potential, chemiosmotic hypothesis.

CO3: Application of law of optics in understanding strategies of light reception in microbes, plants and animals, correction of vision faults, generation and reception of sonic vibrations.

CO4: Understanding Neurotrasmitters, Intra and intermolecular interactions in biological system Spatial and charge compatibility as determinant of such interactions by applying laws of electricity.

CO5: Knowledge of principle, design, methods and application of UV spectroscopy; circular Dichroism and optical rotatory dispersion (ORD); Florescence spectroscopy; Infrared spectroscopy; NMR and ESR spectroscopy, Chromatography, Electrophoresis and Centrifugation.

COURSE CONTENTS

UNIT I

Introduction to Biophysics: Molecular organization, different level, organization of proteinprimary, secondary, tertiary and quaternary structure, Biophysics of Water: Molecular structure of water, hydrogen bonds and physical properties of water.

UNIT II

Bio-energetic: Laws of thermodynamics (1st & 2nd laws), electrical properties of biological compartments; electrochemical gradients, membrane potential, chemiosmotic hypothesis.

UNIT III

Energetic of a living body: Primary events in photosynthesis; strategies of light reception in microbes, plants and animals. Correction of vision faults, generation and reception of sonic vibrations.

UNIT IV

Electrical properties of biological compartments: Electricity as a potential signal, Neurotrasmitters, Intra and intermolecular interactions in biological system Spatial and charge compatibility as determinant of such interactions.

UNIT V

Principle, Instrument design, methods and application of UV spectroscopy; circular Dichroism and optical rotatory dispersion(ORD); Flurescence spectroscopy; Infrared spectroscopy; NMR and ESR spectroscopy, Chromatography, Electrophoresis and Centrifugation.

Practicals

1. Meaurement of pH using pH paper and pH meter-minor

2. Centrifugation – cell fractionation and separation of nuclei

3. Colorimetry – (a) Preparation of standard curve and estimate the concentration of solute in an unknown sample, (b) Determination of absorption maxima-minor

4. Chromatography – Determination of Rf value of amino acid and identification of amino acid.

5. Gel electrophoresis – demonstration.

6. Microscopy- Examination and study of parts of compound microscope, Camera lucida and its uses; micrometry- Calibration of microscope using stage and ocular micrometers, measurement of microscopic objects-minor

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ELECTIVE COURSE CODE UBE 302: FERMENTATION TECHNOLOGY

(COURSE CREDIT= 03)

Course Objectives:

The course is focused to enhance student's ability to develop skill in the field of commercial production units.

Course Learning Outcomes:

CO1: To understand the basis of fermentation.

CO2: To formulate and design the production media.

CO3: Screening and selection of production strains.

CO4: Operating and supervision of Fermenters.

CO5: Designing of fermentation processes for the products recovery. Knowledge of Biosafety and patent laws

COURSE CONTENTS

UNIT I

Definition, equipments and production process; Fermentation processes, Solid-state and liquid-state (stationary and submerged) fermentations; Batch, fedbatch and continuous fermentations

UNIT II

Bioreactors/fermenters , Components of a typical bioreactor, types of bioreactors-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

UNIT III

Control parameters, industrially important strains, media ingredients Measurement and control of fermentation parameters, Control and monitoring of different parameters in a bioreactor; pH, temperature, dissolved oxygen, foaming and aeration Isolation of industrially important microbial strain, Primary and secondary screening, strain development, preservation and maintenance of industrial strains Media and ingredients for industrial fermentations Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract.

UNIT IV

Down-stream Processing, Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying.

UNIT V

Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses), Citric acid, ethanol, penicillin, glutamic acid, riboflavin, enzymes (amylase, cellulase, protease, lipase, glucose isomerase, glucose oxidase), wine, beer, bioinsecticides (Bt) and Steroid transformations. Enzyme immobilization, Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

List of Practicals:

1. Comparative analysis of design of a batch and continuous fermenter.

2. Calculation of Mathematical derivation of growth kinetics.

3. Solvent extraction & analysis of a metabolite from a bacterial culture.

4. Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/glucosidase etc.).

Suggested Readings

1.Sullia S. B& Shantharam S: (1998) General Microbiology, Oxford & IBH Publishing Co. Pvt. Ltd.

2. Bisen P.S (1994) Frontiers in Microbial Technology, 1st Edition, CBS Publishers.

3. Glaser A.N & Nilaido.H (1995) Microbial Biotechnology,W.H Freeman & Co.

4. Prescott & Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers & Distributors.

5. Prescott & Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers.

6. Crueger W. & Crueger A. (2000) A text of Industrial Microbiology, 2nd Edition, Panima Publishing Corp.

7. Stanbury P.F, Ehitaker H, Hall S.J (1997) Priciples of Fermentation Technology., Aditya Books (P) Ltd. REFERENCE BOOKS:

8. Pauline.M.Doran ., "Bioprocess Engineering Principles";Academic press ..

9. Peter F.Stanbury, Allan Whitaker, "Principles of Fermentation Technology"

10. Michael L.Shuler and Fikret Kargi, "Bioprocess Engineering Basic concepts", Prentice Hall, 1992.

FOURTH SEMESTER

CORE COURSE CODE UBC 401: IMMUNOLOGY (COURSE CREDIT= 03)

Course Objectives:

The major objective of this course is to develop a clear understanding about the host immune system and advances in the field of Immunology. The student will become familiar with the cells, tissues, and organs constituting the immune system and the various mechanisms used to defend host against microorganisms.

Course Learning Outcomes: Upon successful completion of the course, the student

CO1: Will be acquainted with the emergence of immunology and how the immune system protects us from infection through various lines of defense. Will have gained an in-depth knowledge of characteristics and functions of the cells of the immune system and the organization of organs of the immune system.

CO2: Can understand the characteristics that make the molecules to act as antigens. The students will also be conversant with the types, properties and functions of antibodies made against the antigens. Will be able to outline the production and use of monoclonal antibodies

CO3: Will understand the cell surface proteins essential for generation of acquired immune response to differentiate self and non-self molecules and the pathways for antigen processing and presentation.

CO4: Will be acquainted with the mechanisms by which the complement system is recruited and enhances (complements) the ability of antibodies and phagocytic cells to clear microbes and damaged cells from an organism, promotes inflammation, and attacks the pathogen's cell membranes.

CO5: Will be acquainted with the generation and the killing mechanisms of humoral and cell mediated immunity. Will have gained in depth knowledge of various immunological techniques. Will be able to outline the immunodeficiency disorders like autoimmunity and hypersensitivity.

COURSE CONTENTS

UNIT I

Introduction: Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa, Immune Cells and Organs: Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs: Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT

UNIT II

Antigens: Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity), Haptens, Epitopes (T & B cell epitopes); T-dependent and T-independent antigens, Adjuvants, Antibodies: Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies

UNIT III

Major Histocompatibility Complex: Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways), Complement System: Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement activation

UNIT IV

Generation of Immune Response: Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells), Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals), Killing Mechanisms by CTL and NK cells, Introduction to tolerance

UNIT V

Immunological Disorders and Tumor Immunity: Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies- Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak-Higashi syndrome, Leukocyte adhesion deficiency, CGD; Characteristics of tumor antigens, Immunological Techniques: Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy, RIST, RAST, MLR.

List of Practicals

1. Identification of human blood groups.
2. To perform Total Leukocyte Count of the given blood sample.
3. To perform Differential Leukocyte Count of the given blood sample.
4. To separate serum from the blood sample (demonstration).
5. To perform immunodiffusion by Ouchterlony method.
6. To perform DOT ELISA.

7. To perform immunoelectrophoresis.

Suggested reading

• Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.

• Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.

• Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.

• Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.

• Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.

• Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

CORE COURSE CODE UBC 402: CELL BIOLOGY II

(COURSE CREDIT= 03)

Course Objectives:

The course aims to empower the learners by providing understanding of structure and function of cell, its component and transport across various organelles by empowering the learners with different tool and techniques of cell biology. It will provide deep understanding of cellular aspect of mechanism of signal transduction, cell cycle and cancer.

Course Learning Outcomes:

CO1: Understanding of cell structure of prokaryotic and eukaryotic cell, apply knowledge of microscopic techniques for cell study.

CO2: Knowledge of criteria of function integrity and structure of different cell organelles and transport of ions, nutrients and macromolecules across membranes.

CO3: Empowers student to acquire knowledge about signal transduction pathway with understanding of different type of receptors and signaling molecules.

CO4: Conceptualize cell cycle, cell division and cell death. Deep understanding of events of mitosis, apoptosis, embryonic stem cells and therapeutic cloning.

CO5: Empowers student to acquire knowledge about biology of cancer its causes. Understanding of oncogenes, tumor suppressor gene, tumor viruses and molecular approach of cancer treatment.

COURSE CONTENTS

UNIT I

The cell theory and precellular evolution. The Plasma Membrane: Structure; Transport of small molecules, Endocytosis.

UNIT II

Cell Wall, the Extracellular Matrix and Cell Interactions: Bacterial and Eukaryotic Cell Wall; the extracellular matrix and cell matrix interactions; cell-cell interactions.

UNIT III

Cell Signaling: Signaling molecules and their receptor; functions of cell surface receptors; Intracellular signal transduction pathway; signaling networks.

UNIT IV

The Cell Cycle & Cell Death and Cell Renewal: Eukaryotic Cell Cycle, Regulation of Cell cycle progression, Events of Mitotic Phase, Meiosis and Fertilization. Programmed Cell Death, Stem Cells and Maintenance of adult tissues, Embryonic Stem Cells and Therapeutic cloning.

UNIT V

Cancer: Development and Causes of Cancer, Tumor Viruses, Oncogenes, Tumor Suppressor genes, Cancer Treatment- molecular approach.

Practicals

1. To demonstrate the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B.

2. Study of polyploidy in Onion root tip by colchicine treatment.

3. Preparations of temporary mount of Grasshopper testis / onion flower bud anthers and study the different stages of Meiosis.

4. Study of mitosis and meiosis from permanent slides.

5. Identification and study of cancer cells- Slides/Photomicrographs.

Suggested reading

• Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.

• De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.

• Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

• Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

CORE COURSE CODE UBC 403: MOLECULAR BIOLOGY II

(COURSE CREDIT= 03)

Course Objectives:

Student will study about the molecular biology, different biochemical reaction and processes such as transcription and translation within the living system. These biochemical processes control and regulated by different enzymes, inhibitors, activators.

Course Learning outcomes –

CO1: RNA transcription in Prokaryotes and Eukaryotes, transcriptional regulation, RNA splicing and editing, Protein synthesis, ribosome structure and assembly,

CO2: Fidelity of translation. Inhibitors of protein synthesis. Regulation of translation Translation-dependent regulation of mRNA and Protein Stability.

CO3: Transcription Regulation in Eukaryotes mechanisms, Signal integration, combinatorial control, transcriptional repressors, signal transduction, Gene Silencing

CO4: Regulatory RNAs, Riboswitches, RNA interference, miRNA, siRNA, Regulatory RNA and Xinactivation.

COURSE CONTENTS

UNIT I

Mechanism of Transcription: RNA Polymerase and the transcription unit, Transcription in Prokaryotes and Transcription in Eukaryotes

UNIT II

RNA Modifications: Split genes, concept of introns and exons, removal of Introns, spliceosome machinery, splicing pathways, alternative splicing, exon shuffling, RNA editing, and mRNA transport.

UNIT III

Translation (Prokaryotes and Eukaryotes): Assembly line of polypeptide synthesis ribosome structure and assembly, various steps in protein synthesis. Charging of tRNA, aminoacyl tRNA synthetases. Proteins involved in initiation, elongation and termination of polypeptides. Fidelity of translation. Inhibitors of protein synthesis, Regulation of translation, Translation-dependent regulation of mRNA and Protein Stability.

UNIT IV

Transcription Regulation in Prokaryotes: Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons

UNIT V

Transcription Regulation in Eukaryotes & Regulatory RNAs: Conserved mechanism of regulation, Eukaryotic activators, Signal integration, combinatorial control, transcriptional repressors, signal transduction and control of transcriptional regulator, Gene Silencing Riboswitches, RNA interference, miRNA, siRNA, Regulatory RNA and X inactivation

List of Practicals

1. Preparation of culture medium (LB) for E.coli (both solid and liquid) and raise culture of E.coli.

2. Demonstration of antibiotic resistance. (Culture of E.coli containing plasmid (pUC 18/19) in LB medium with/without antibiotic pressure and interpretation of results).

3. Isolation and quantitative estimation of salmon sperm / calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement).

4. To perform Ames test in Salmonella / E.coli to study mutagenicity.

SUGGESTED READINGS

• Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.

• De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.

• Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

• Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008)

• Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

ELECTIVE COURSE CODE UBE 401: GENETICS & GENOMICS I

(COURSE CREDIT= 03)

Course Objectives:

The major objective of this course is to develop clear understanding of various aspects of microbial genetics and genomes in relation to microbial survival and propagation and to enable students to better understand courses taught later such as recombinant DNA technology and other allied papers.

Course Learning Outcomes: Upon successful completion of the course, the student will have

CO1: Understanding Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information. The student will be able to correlate Mendel's ratios through Mitosis and Meiosis.

CO2: Knowledge of Principles and theories of Inheritance, pedigree analysis, extensions of Mendelian Genetics; Incomplete and co dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked inheritance.

CO3: Deep understanding of crossing over and its Cytological and Molecular mechanism. They will be able to measure linkage intensity using Recombination frequency, two factor and three factor crosses, Interference and coincidence. Knowledge of somatic cell genetics an alternative approach to gene mapping.

CO4: Conceptualize types of Mutation, its molecular basis of mutation and detection using Attached X method, DNA repair mechanisms.

CO5: Empowers the student about mechanism of sex Determination: Environmental factors, Barr bodies, Dosage compensation, extra chromosomal Inheritance: Chloroplast mutation/Variegation in Four o' clock plant and Chlymodomonas, Mitochondrial mutations in Neurospora and yeast, maternal effects, Infective heredity- Kappa particles in Paramecium. Understanding of Quantitative Genetics: Quantitative and multifactor inheritance, Transgressive variations, Heterosis.

COURSE CONTENTS

Unit I

Introduction to Genetics: Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information. Mitosis and Meiosis: Interrelation between the cell structure and the genetics function, Mitosis, Meiosis (explaining Mendel's ratios).

Unit II

Mendelian Genetics and its Extension: Principles of Inheritance, Chromosome theory of inheritance, Laws of Probability, Pedigree analysis, Incomplete and codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked inheritance.

Unit III

Linkage, Crossing Over and Chromosomal Mapping: Linkage and crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics an alternative approach to gene mapping.

Unit IV

Mutations: Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy. Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations, Molecular basis of Mutations in relation to UV light and chemical mutagens, Detection of mutations: CLB method, Attached X method, DNA repair mechanisms.

Unit V

Sex Determination: Chromosomal mechanisms, Environmental factors determining sex determination, Barr bodies, Dosage compensation. Extrachromosomal Inheritance: Chloroplast mutation/Variegation in Four o' clock plant and Chlymodomonas, Mitochondrial mutations in Neurospora and yeast, Maternal effects, Infective heredity- Kappa particles in Paramecium. Quantitative Genetics: Quantitative and multifactor inheritance, Transgressive variations, Heterosis.

List of Practicals:

- Mendelian laws and gene interaction using Drosophila crosses.
- 2. Chi-square and probability.

ELECTIVE COURSE CODE UBE 402: BIOINFORMATICS

(COURSE CREDIT= 03)

Course Objectives:

Students are empowered to make independent usage of biological databases, understand various retrieval and alignment tools of biological sequences, and apply bioinformatics in different disciplines related to human welfare.

Course learning outcomes:

CO1: Students get familiarized with hardware and software of modern computers. They understand system and application softwares.

CO2: Students are exposed basics of bioinformatics and its tools.

CO3: Students study various biological databases, retrieval of genetic and biomolecular sequences.

CO4: Students learn various retrieval and alignment tools including construction of phylogenetic trees and annotations on sequences.

CO5: Students learn about different techniques and tools of genome analyses and reconstruction of metabolic pathways.

COURSE CONTENTS

Unit I

Computers: General introduction (characteristics, capabilities, generations), software, hardware: organization of hardware (input devices, memory, control unit arithmetic logic unit, output devices); software : (System software; application software, languages -low level, high level), interpreter, compiler, data processing; batch, on-line, real-time (examples from bioindustries; e.g. application of computers in co-ordination of solute concentration, pH, temperature, etc., of a fermenter in operation); internet application.

Unit II

Basic Bioinformatics: Introduction to Internet, Search Engines (Google, Yahoo, Entrez etc)

Unit III

Biological Databases: Sequence databases (EMBL, GenBank, DDBJ, -UNIPROT, PIR, TrEMBL), Protein family/domain databases (PROSITE, PRINTS, Pfam, BLOCK, etc), Cluster databases-An Introduction, Specialised databases (KEGG, etc), Database technologies (Flat-file), Structural databases (PDB)

Unit IV

Phylogenetic Analysis: Trees-splits and metrices on trees, tree interpretation, Distance – additive, ultrameric and nonadditive distances, tree building methods, phylogenetic analysis, parsimony, tree evaluation, maximum likelihood trees – continuous time markov chains, estimating the rate of change, likelihood and trees; analysis software. Annotation, comparison of different methods; ESTs – databases, clustering, gene discovery and identification, and functional classification.

Unit V

Genome analysis: Annotation, comparison of different methods; ESTs – databases, clustering, gene discovery and identification, and functional classification. Reconstruction of metabolic pathways; Genome analysis, genome anatomy, genome rearrangements with inversions, signed inversions, identification and functional classification.

Suggested reading

• Computer Science, J.G. Brookshear, Pearson, Addison Wesley

• Introduction to Bioinformation – T.Attawood

• A book on C by Kelley : Programming in C, Addison-Wesley Publishing

• Introduction to C++ for Engineers and Scientists, Prentice-Hall

• Schaum's Outline of Introduction of Computer Science, P. Cushman and R. Mata-Toledo, McGraw Hill Trade

• Bioinformatics – Managing Scientific Data, Zoe' Lacroix and Terence Critchlow

• Bioinformatics – Sequence, Structure and Databanks, Des Higgins & Willie Taylor

• Structural Bioinformatics, Philip E. Bourne, Helge Weissig 2003

• Statistical Methods in Bioinformatics: An Introduction, G.R. Grant, W.J. Ewens, Springer

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FIFTH SEMESTER

CORE COURSE CODE UBC 501: PLANT BIOTECHNOLOGY

(COURSE CREDIT= 03)

Course Objectives:

The course aims to impart understanding of the concepts, principles and techniques of plant tissue culture.

Course Learning Outcomes:

CO1: Recall terms, definitions and history of in vitro cultures in our country. Describe embryo and endosperm culture, embryo rescue after wide hybridization and its applications.

CO2: Knowledge of processes of plant regeneration under in vitro conditions and their practical application – organogenesis, somatic embryogenesis, meristem, Shoot tip culture and haploids.

CO3: Conceptualize protoplast isolation, culture and various steps in the regeneration of protoplasts.

CO4: Discuss various methods for fusing protoplasts- chemical and electrical. Define Cybrids and its application.

CO5: List use of plant cell, protoplasts and tissue culture for genetic manipulation of plants and practical application of genetic transformation. Understanding of Tumor formation on plants using A.tumefaciens (Monocots vs. Dicots).

COURSE CONTENTS

UNIT I

Terms and definitions. Beginning of in vitro cultures in our country (ovary and ovule culture, in vitro pollination and fertilization. Embryo culture, embryo rescue after wide hybridization, and its applications, Endosperm culture and production of triploids.

UNIT II

Introduction to the processes of embryogenesis and organogenesis and their practical applications: Micropropagation, axillary bud, shoot-tip and meristem culture. Haploids and their applications. Somaclonal variations and applications (Treasure your exceptions).

UNIT III

Introduction to protoplast isolation: Principles of protoplast isolation and applications, testing of viability of isolated protoplasts. Various steps in the regeneration of protoplasts.

UNIT IV

Introduction of somatic hybridization: Various methods for fusing protoplasts, chemical and electrical. Cybrids- definition and application.

UNIT V

Use of plant cell, protoplasts and tissue culture for genetic manipulation of plants: Introduction to A. tumefaciens. Tumor formation on plants using A.tumefaciens (Monocots vs. Dicots), Practicalapplication of genetic transformation.

Suggested reading

• An Introduction to Plant Tissue Culture, M.K. Razdan, Oxford and IBH Publishing

• Experiments in Plant Tissue Culture, J.H. Dodds and L.K. Roberts, Cambridge University Press

• Plant Biotechnology and Transgenic Plants, K.M.O. Caldenty, W.H. Barz and H.L. Wills, Marcel Dekker

• Plant Biotechnology, J. Hammond, P. McGarvy and V. Yusibov, Springer Verlag.

• Plant Cell & Tissue Culture for the production of Food Ingredients, T-J Fu, G. Singh and W.R. Curtis, Kluwer Academic/Plenum Press

• Plant Tissue Culture: Theory & Practice, S.S. Bhojwani and M.K. Razdan, Elsevier Health Sciences

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CORE COURSE CODE UBC 502: ENVIRONMENTAL BIOTECHNOLOGY

(COURSE CREDIT= 03)

Course Objectives:

The course aims to empower the learners with the basic concepts of the environmental components, pollution and its types, energy resources, global environmental issues, treatment of the municipal solid and liquid wastes, EIA and the basic concepts of the biofertilizers and biopesticides.

Course Learning Outcomes:

CO1: Deep understanding of existing and emerging technologies dealing with management of environmental quality and pollution.

CO2: Empowers the students with the knowledge of municipal solid and liquid waste treatments, Classification of Wastes.

CO3: Students will able to learn about the renewable and non-renewable energy resources and clean fuel technologies.

CO4: Students will be able to understand EIA and environmental audit.

CO5: Conceptual understanding of global environmental problems- ozone depletion, UV-B greenhouse effects and global warming, acid rain, and their impacts and biotechnology approaches for management.

COURSE CONTENTS

UNIT I

Environmental components, Environmental pollution and its types, Non-renewable and renewable energy resources. Biodiversity in India: Status, Threats, Utility & Conservation; Indian Biodiversity ACT 2002 and Biodiversity Rules 2004.

UNIT II

Conventional fuels and their major impacts: Global warming and greenhouse effect, Global Ozone Problem, Acid rain, Eutrophication, Biomagnification, Concept of clean fuel technology: Biomass energy and biofuels

UNIT III

Biodegradation and bioremediation of major pollutants, Biomineralisation: Use of microbial technology for mining

UNIT IV

Treatment of municipal solid and liquid wastes, Environmental impact assessment and

Environmental audit

UNIT V

Bioassessment of Environmental Quality, Biofertilizers and Biopesticides

Suggested reading

• Environmental Science, S.C. Santra

• Environmental Biotechnology, Pradipta Kumar Mohapatra

• Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and

Jesef Winter

• Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill

• Agricultural Biotechnology, S.S. Purohit

• Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John

F.T. Spencer

• Introduction to Environmental Biotechnology, Milton Wainwright

• Principles of Environmental Engineering, Gilbert Masters

• Principles of fermentation Technology, Salisbury, Whitaker and Hall

• Industrial Microbiology – Cassida

• Agricultural Biotechnology – S.S. Purohit

• Wastewater Engineering – Metcalf & Eddy.

CORE COURSE CODE UBC 503: ANIMAL BIOTECHNOLOGY

(COURSE CREDIT= 03)

Course Objectives:

The course aims to empower the learners with the concepts of culture, preservation, maintenance, production of animal cells and application of stem cells.

Course Learning Outcomes:

CO1: Deep understanding of animal cell culture substrate, culture media, preservation and maintenance of cell lines.

CO2: Empowers the students with the knowledge of production of monoclonal antibodies, and bioreactors for large scale culture of cells.

CO3: Students learn different growth factors promoting proliferation of animal cells (EGF, FGF, PDGF, IL-1, IL-2, NGF, and erythropoietin).

CO4: Knowledge of transgenic animals, in vitro fertilization and embryo transfer.

CO5: Conceptual understanding of Transplantation, Stem cells and its application.

COURSE CONTENTS

Unit I

Introduction of animal cell culture substrate, culture media, preservation and maintenance of cell lines.

Unit II

Production of monoclonal antibodies, Bioreactors for large scale culture of cells.

Unit III

Growth factors promoting proliferation of animal cells (EGF, FGF, PDGF, IL-1, IL-2, NGF, erythropoietin).

Unit IV

Transgenic animals, In-vitro fertilization and embryo transfer.

Unit V

Transplantation, Stem cells and its application,

Suggested reading

• Culture of Animal Cells, R.I Freshney, Wiley-Leiss.

• Animal Cell Culture – A Practical approach, J.R.W. Masters, Oxford.

• Animal Cell Culture Techniques, M. Clynes, Springer Verlag.

• Cell Culture Lab Fax, M. Butler and M. Dawson, Bios scientific Publications Ltd.

• Cell Growth and Division – A Practical approach, R. Basega, IRL Press.

• Comprehensive Biotechnology, Moo-Young, Alan T. Bullm Howard Dalton, Panima Publication.

ELECTIVE COURSE CODE UBE 501: ENTREPRENEURSHIP & IPR

(COURSE CREDIT= 03)

Course Objectives:

The course imparts necessary knowledge and skills required for organizing and carrying out entrepreneurial activities, developing the ability of analyzing and understanding business situations.

Course Learning Outcomes:

CO1: Understanding entrepreneurship, human behavior, business ethics, performance appraisal and (SWOT) analysis

CO2: Knowledge of Market survey techniques with principles of product selection and development.

CO3: Deciphering marketing and sales management; its characteristics and techniques.

CO4: Understanding financial – institutions, incentives and statements; books of accounts.

CO5: Application of technical feasibility of project, plant layout and process planning of product. QC, CPM, PERT for establishing SSI.

COURSE CONTENTS

Unit I

Need, scope and characteristics of entrepreneurship management of self and understanding human behaviour, business ethics, performance appraisal, and (SWOT) analysis.

Unit II

Market survey techniques, Criteria for the principles of product selection and development.

Unit III

Marketing & Sales Management- (a) Nature of product and market strategy (b) Packaging and advertising (c) After Sales Service (d) Pricing techniques.

Unit IV

Financial institutions, financial incentives, books of accounts and financial statements.

Unit V

Technical feasibility of the project, plant layout & process planning for the product, Quality Control, Critical Path Method (CPM) and Project Evaluation Review Techniques (PERT) as planning tools for establishing SSI.

Suggested reading

• Entrepreneurship: New Venture Creation, David H. Holt

• Patterns of Entrepreneurship : Jack M. Kaplan

• Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.

ELECTIVE COURSE CODE UBE 502: GENETICS & GENOMICS II

(COURSE CREDIT= 03)

Course Objectives:

This course aims to provide an insight and understanding of functional genomics, system biology, population genetics, and developmental biology. This course also introduces learners to bioinformatics.

Course Learning Outcomes:

CO1: Knowledge of genetic analysis and mapping in Bacteria and Bacteriophages.

CO2: Understanding of transposable element; prokaryotic, composite. Eukaryotic and uses of transposons.

CO3: Conceptualize the mechanism of developmental biology and embryonic development of different model; Drosophila melanogaster Sachharomyces cerevisiae, Caenorhabditis elegans, Arabidopsis thaliana, and Xenopus laevis.

CO4: Understand different biological database that provide information about protein and nucleic acid, sequence similarity and alignment; Gene feature identification. Understanding of Gene Annotation and analysis of transcription and translation; Post-translational analysis and Protein interaction.

CO5: Knowledge of genetic analysis, system biology, functional genomics, forward and reverse genetics. Understanding of population and evolutionary genetics.

COURSE CONTENTS

Unit I

Genetic Analysis and Mapping in Bacteria and Bacteriophages: Conjugation; Transformation; Transduction, Recombination.

Unit II

Genome Dynamics-Transposable genetic elements, Eukaryotic Viruses: Prokaryotic transposable elements- IS elements, Composite transposons, Tn-3 elements; Eukaryotic transposable elements- Ac-Ds system in maize and P elements in Drosophila; Uses of transposons; Eukaryotic Viruses.

Unit III

Developmental Genetics and Model System: Study of model systems in developmental genetics- Drosophila melanogaster Sachharomyces cerevisiae, Caenorhabditis elegans, Arabidopsis thaliana, and Xenopus laevis.

Unit IV

Genomics, Bioinformatics and Proteomics: Genomes of bacteria, Drosophila and Humans; Human genome project; Evolution and Comparative Genomics. Introduction to Bioinformatics, Gene and protein databases; Sequence similarity and alignment; Gene feature identification. Gene Annotation and analysis of transcription and translation; Post-translational analysis- Protein interaction.

Unit V

Genomic Analysis- Dissection of Gene Function: Genetic analysis using mutations, forward genetics, genomics, reverse genetics, RNAi, functional genomics and system biology. Population Genetics: Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift.Evolutionary Genetics: Genetic variation and Speciation.

Practicals

1. Genomic DNA isolation from E.coli (without plasmid).

2. Restriction enzyme digestion of genomic DNA from E.coli.

3. Isolation of plasmid DNA and genomic DNA together from E.coli. and restriction enzyme digestion.

4. Restriction enz yme digestion (EcoRI) of genomic and plasmid DNA (obtained from Expt.3).

5. Estimation of size of a DNA fragment after electrophoresis using DNA markers.

6. Construction of Restriction digestion maps from data provided.

7. Demonstration of DNA fingerprinting.

Suggested reading

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

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

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

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

• Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant

DNA. ASM Press, Washington

• Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

• Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis.

• Ghosh, Z. and Mallick,V. (2008). Bioinformatics-Principles and Applications. Oxford

SIXTH SEMESTER

(A) DISSERTATION	CREDITS	MAXIMUM MARKS
A. Valuation (i) Language & Presentation (ii) Review of Literature (iii) Methodology (iv) Analysis & interpretation of Result	**18**	**300**
B. Viva-Voce EXTERNAL		**50**
C. Viva-Voce INTERNAL		**50**
Total		**400**

(B) Comprehensive viva voce (virtual credits)	**4**	**50**

Course Objectives:

The key objective of this semester is to introduce the students to concepts in identification of a research problem and developing a hypothesis. The course will enable students to learn how to carry out survey of literature, perform experiments, and analysis of data. The student will learn how to write a scientific project report, and oral presentation of the results.

Course Learning Outcomes:

CO1: A student is able to formulate a hypothesis to be tested and learns how to collect and read literature related to the hypothesis.

CO2: Student is able to design experiments to test that hypothesis. Student is exposed to the use of a variety of instruments and is able to perform experiments such as making culture media for various biological organisms, its isolation from different sources, and examine its capacity to produce compounds of industrial importance.

CO3: Student learns about ethical issues in conducting research. Student learns how to examine the obtained data and interpret the results; and learns how to discuss their results integrating with earlier relevant researches.

CO4: Student learns the skill of writing a project report and its effective presentation before peers.

CO5: Student learns about ethical issues related to publishing, plagiarism and self-plagiarism.