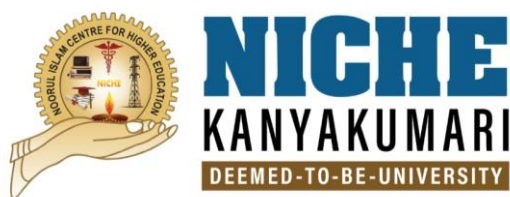


NOORUL ISLAM CENTRE FOR HIGHER EDUCATION
(Deemed to be University Under Section 3 of the UGC Act, 1956)
Kumaracoil, Thuckalay

DEPARTMENT OF ALLIED HEALTH SCIENCE



**B.Sc. HUMAN GENETICS AND MOLECULAR BIOLOGY
CURRICULUM AND SYLLABI**

REGULATION 2021



NICHE
KANYAKUMARI
DEEMED-TO-BE UNIVERSITY

NOORUL ISLAM CENTRE FOR HIGHER EDUCATION

📍 Kumaracoil - 629 180, Kanyakumari District, Tamil Nadu, India
🌐 www.niuniv.com ✉ info@niuniv.com
☎ +91-9486856101, 04651-250566

DEPARTMENT OF ALLIED HEALTH SCIENCES
B.Sc., HUMAN GENETICS AND MOLECULAR BIOLOGY

Regulation: 2021
Curriculum and Syllabi
B.Sc. Programme

Vision of the University

To be recognized by the Government and society at large as an institution able to deliver excellence with relevance in the field of higher education and research focusing on the needs of the nation in tune with the technological revolution to cope with the knowledge explosion and global competence.

Mission of the University

To develop the institution as a Centre of Excellence, keeping pace with the advances in the field, so as to provide quality higher education to the students and instill in them high standards of discipline and ethics so that they become enlightened individuals in the service of humanity and to carry out focused research in the frontier areas of science and technology.

Faculty of Allied Health Sciences

Department of Allied Health Sciences

Vision of the Department

Empower and elevate students to understand the conditions conducive to harmonious healthy society by building up youth towards achieving it when it is practiced effectively.

Mission of the Department

The mission of the department of Allied Health Sciences at NICHE is to build up new chorum of youth towards application and practice of knowledge. Recent techniques provide accessible, innovative care service, antisocial activities and ways to improve outcomes through science and advanced research.

Description of the programme

A Human Genetics and Molecular Genetics program is an academic or research-focused program that explores the principles, mechanisms, and applications of genetics, particularly in relation to human biology and health.

The curriculum typically includes a combination of foundational courses, specialized electives, and laboratory experiences. Core courses may cover topics such as genetics principles, molecular biology, bioinformatics, genomics, and ethical issues in genetics research.

Advanced courses may delve into specialized areas such as cancer genetics, developmental genetics, epigenetics, and personalized medicine. Students may also have the opportunity to participate in seminars, journal clubs, and research projects.

Programme Educational Objectives – PEO	
PEO-01	The students can be employed as geneticists in hospitals and Health care sector.
PEO-02	The students can go for higher education in reputed National and International Institutions.
PEO-03	The candidates would be able to establish a Genetic testing laboratory
PEO-04	The Students as Clinical Geneticist can transform the knowledge into design the health care tools/methods for disease diagnosis and treatment of genetic diseases.
PEO-05	Delineate and evaluate the clinical data for the diagnosis of diseases of public health concern.

Graduate Attributes-GA	
GA-1	Foundational Scientific Knowledge Acquire a deep understanding of fundamental principles across core scientific disciplines, including physics, chemistry, biology, and mathematics, providing a strong foundation for further learning and research.
GA-2	Practical Skills and Laboratory Competence Develop hands-on laboratory skills and the ability to conduct experiments, analyze data, and apply scientific methods to real-world problems in various scientific domains
GA-3	Research and Analytical Thinking Foster research capabilities and critical thinking skills, enabling the design and execution of scientific investigations, interpretation of experimental results, and formulation of evidence-based conclusions.
GA-4	Data Analysis and Statistical Techniques Utilize modern data analysis techniques and statistical tools to interpret experimental data, draw meaningful conclusions, and solve complex scientific and mathematical problems.
GA-5	Interdisciplinary Knowledge and Applications Integrate knowledge from multiple scientific disciplines to approach problems holistically, understanding how different scientific fields contribute to innovation and real-world applications.
GA-6	Environmental Awareness and Sustainability Demonstrate an understanding of environmental issues and the impact of scientific practices on the environment, promoting sustainability and responsible use of natural resources in all scientific endeavors.
GA-7	Ethical Conduct and Scientific Integrity Uphold ethical standards and integrity in scientific research and practice, ensuring honesty, accuracy, and responsibility in data handling, experimentation, and reporting.
GA-8	Communication and Presentation Skills Develop effective communication skills to articulate scientific concepts, research findings, and technical information clearly and concisely to both scientific and non-scientific audiences.
GA-9	Technology Integration and Innovation Apply cutting-edge technologies and tools in scientific experimentation and research, leveraging innovation to drive progress and stay at the forefront of scientific discovery.
GA-10	Lifelong Learning and Adaptability Cultivate a mindset of continuous learning, staying informed about scientific advancements and adapting to new tools, methods, and technologies to remain competitive in a rapidly evolving scientific landscape.

Programme Outcome – POs

Programme Outcome (PO)	
PO-A	Students are familiar with basic subjects of Human genetics and Molecular Biology.
PO-B	Knowledge on the interdisciplinary subjects make them excel in the programme.
PO-C	Provides solutions for their experiments through their theoretical knowledge.
PO-D	Based on the theoretical knowledge obtained, new solutions can be formulated for the genetic disorders.
PO-E	Knowledge on genetics and their applications will help them to Diagnose prenatal disorders.
PO-F	Provide genetic counselling to the society.
PO-G	Giving awareness to the society about existing technologies in human genetics.
PO-H	Group assignments and projects will make them to understand and cooperate with co workers.
PO-I	They can communicate with well-versed with the team members about the problems and solutions in an effective manner.
PO-J	In-plant training enables them to understand their roles and responsibilities as an professional geneticians in the society.
PO-K	Designing new experimental methods for society in concern with genetics and social ethics.
PO-L	Innovating reliable cost effective technology which can be affordable for all sector of the society.
PO-M	Motivating the student to acquire update knowledge and innovations will make them continuous learner.

Mapping of Graduate Attributes and Programme Educational Objectives (PEO)

GAs PEOs	GA-01	GA-02	GA-03	GA-04	GA-05	GA-06	GA-07	GA-08	GA-09	GA-10
PEO-A	H	A	A	A	H	H	A	A	A	A
PEO-B	H	A	A	A	H	H	A	A	A	A
PEO-C	H	A	A	A	H	H	A	A	A	A
PEO-D	H	A	A	A	H	H	A	A	A	A
PEO-E	H	A	N	H	A	A	A	A	A	H

H- Highly Associated

A- Associated

Not – Not Associated

Mapping of Programme Educational Objective (PEOs) and Programme Outcomes (POs)

PEO PO	PEO-01	PEO-02	PEO-03	PEO-04	PEO-05
PO-A	H	H	H	H	H
PO-B	H	H	H	H	A
PO-C	A	A	H	H	A
PO-D	H	H	H	H	H
PO-E	H	H	H	H	H
PO-F	A	A	A	A	A
PO-G	H	H	H	H	H
PO-H	H	H	H	H	A
PO-I	H	H	H	H	A
PO-J	H	H	H	H	A
PO-K	H	H	H	H	A
PO-L	H	H	H	H	H
PO-M	A	A	A	H	A

H- Highly Associated

A- Associated

Not – Not Associated

Duration of the programme: 3 Years/ 6 Semesters

Total credits: 132

CURRICULUM & SYLLABI
SEMESTER I

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	EG3601	English - I	3	1	0	4
2.	MS36F1	French - I	3	0	0	3
3.	BS3614	Environmental Science	2	0	0	2
4.	HG3601	Cell and Molecular Biology	4	0	0	4
5.	HG3602	Biochemistry	3	0	0	3
6.	HG3603	Biophysics and Bioinstrumentation	3	0	0	3
PRACTICAL						
7.	HG3671	Cell and Molecular Biology Laboratory	0	0	2	2
8.	HG3672	Biochemistry Laboratory	0	0	2	2
9.	HG3673	Biophysics and Bioinstrumentation Laboratory	0	0	2	2
TOTAL			18	1	6	25

SEMESTER II

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	EG3602	English – II	3	1	0	4
2.	MS36F2	French - II	3	0	0	3
3.	GE3605	Human Values & Professional Ethics	2	0	0	2

4.	HG3604	Basics of Human Genetics	4	0	0	4
5.	HG3605	Basics of Microbiology and Microbial Genetics	3	0	0	3
6.	BS3615	Introduction to Computer & Office Automation	3	0	0	3
PRACTICAL						
7.	HG3674	Basics of Human Genetics Laboratory	0	0	2	2
8.	HG3675	Basics of Microbiology and Microbial Genetics Laboratory	0	0	2	2
9.	BS3684	Computer and Office Automation Laboratory	0	0	2	2
TOTAL			18	1	6	25

SEMESTER III

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	HG3606	Human Embryology and Developmental Genetics	4	0	0	4
2.	HG3607	Molecular Genetics	3	0	0	3
3.	HG3608	Principles of Immunology and Immunotechniques	3	0	0	3
4.	HG3609	Environmental Genetics	2	0	0	2
5.	HG3610	Transmission Genetics	3	0	0	3
PRACTICAL						
7.	HG3676	Human Embryology and Developmental Genetics Lab	0	0	2	2
8.	HG3677	Molecular Genetics Lab	0	0	2	2
9.	HG3678	Principles of Immunology and Immunotechniques Lab	0	0	2	2
TOTAL			15	0	6	21

SEMESTER IV

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	HG3611	Genetic Engineering	4	0	0	4
2.	HG3612	Bioinformatics	3	0	0	3
3.	HG3613	Molecular Genetic Techniques	3	0	0	3
4.	HG3614	Genetic screening and Genetic Counseling	2	0	0	2
5.	HG3615	Fundamentals of Biostatistics and Research Methodology	2	1	0	3
PRACTICAL						
7.	HG3679	Genetic Engineering Lab	0	0	2	2
8.	HG3680	Bioinformatics Lab	0	0	2	2
9.	HG3681	Molecular Genetic Techniques Lab	0	0	2	2
TOTAL			14	1	6	21

SEMESTER V

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	HG3616	Medical Biotechnology and Clinical Diagnostics	4	0	0	4
2.	HG3617	Mammalian cell culture and techniques	3	0	0	3
3.	HG3618	Human Cytogenetics	3	0	0	3
4.	HG36XX	Elective	2	0	0	2
5.	HG3619	Genomics and Proteomics	3	0	0	3

PRACTICAL						
7.	HG3683	Recombinant DNA Technology Laboratory	0	0	2	2
8.	HG3684	Medical Biotechnology & Clinical Diagnostics Laboratory	0	0	2	2
9.	HG3685	Human Cytogenetics Laboratory	0	0	2	2
TOTAL			15	0	6	21

SEMESTER VI

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	HG3620	Pharmacogenomics	4	0	0	4
2.	HG3621	Population and evolutionary genetics	3	1	0	4
3.	HG3622	Stem cell and gene therapy	3	0	0	3
4.	HG36XX	Elective	2	0	0	2
PRACTICAL						
7.	HG36P1	Project	0	1	5	6
TOTAL			12	2	5	19

List of Electives

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1	HG36A1	Cancer Genetics	2	0	0	2
2	HG36A2	Behavioral Genetics	2	0	0	2
3	HG36A3	Techniques of Nanotechnology	2	0	0	2
4	HG36A4	Metabolomics and Metabolic Engineering	2	0	0	2
5	HG36A5	Nutrigenomics	2	0	0	2
6	HG36A6	Epigenetics	2	0	0	2
7	HG36A7	Invitro Fertilization	2	0	0	2
8	HG36A8	Bioethics, Biosafety and Intellectual Property Rights	2	0	0	2

SEMESTER I

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	EG3601	English - I	3	1	0	4
2.	MS36F1	French - I	3	0	0	3
3.	BS3614	Environmental Science	2	0	0	2
4.	HG3601	Cell and Molecular Biology	4	0	0	4
5.	HG3602	Biochemistry	3	0	0	3
6.	HG3603	Biophysics and Bioinstrumentation	3	0	0	3
PRACTICAL						
7.	HG3671	Cell and Molecular Biology Laboratory	0	0	2	2
8.	HG3672	Biochemistry Laboratory	0	0	2	2
9.	HG3673	Biophysics and Bioinstrumentation Laboratory	0	0	2	2
TOTAL			18	1	6	25

EG3601	English I	L	T	P	C
		3	1	0	4

OBJECTIVES

To make the students acquire basic knowledge in English with communicative competence. To enable them to develop their communication skills effectively. To make them get exposure to English prose, poetry, short story and grammar for language enrichment.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Learn the prose of various English authors like George Bernard Shaw, L. A. G. Strong, James Thurber, Oscar Wilde and Robert Lynd.	R, U

CO-02	Learn the poetry of an Indian author Nissim Ezekiel, the romantic poet William Wordsworth and Robert Frost.	R,U
CO-03	Learn the short story of an Indian author Kushwant Singh, and English writers O. Henry and W. Somerset Maugham.	R, U,
CO-04	Improve their technical vocabulary, and they will learn basic grammatical competencies such as Tense, Active Voice, Passive Voice, Transformation of Sentence, Agreement of subject with verb, Vocabulary – Antonyms, Synonyms, Suffix, Prefix, One word Substitution, odd one out.	U, A
CO-05	Learn about the format of writing formal letters as well as business letters, thereby improving their writing skill and developing their reading skill by reading comprehension.	U, A

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	L	M	L	M	L	M	M	M	L	M
CO-02	L	M	L	M	L	M	M	M	L	M
CO-03	L	M	L	M	L	M	M	M	L	M
CO-04	L	M	L	M	L	M	M	M	L	M
CO-05	L	M	L	M	L	M	M	M	L	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Prose: A Galaxy of Precious Prose: (Detailed)

15

1. Spoken English and Broken English – George Bernard Shaw
2. Reading for Pleasure – L. A. G. Strong
3. University Days – James Thurber
4. The Model Millionaire – Oscar Wilde
5. On Forgetting – Robert Lynd

Unit II: Poetry: Harmony (Detailed)

15

1. The Solitary Reaper – William Wordsworth
2. Stopping by Woods on a Snowy Evening – Robert Frost
3. Enterprise – Nissim Ezekiel

4. Lead, Kindly Light – Cardinal Newman
 5. Where the mind is without fear – Rabindranath Tagore

Unit III: Short Story: Popular Short Stories (Non –Detailed) 12

1. The Gift of the Magi – O. Henry
 2. The Ant and the Grasshopper – W. Somerset Maugham
 3. The Mark of Vishnu – Kushwant Singh

Unit IV: Grammar 9

1. FUNCTIONAL ENGLISH – Parts of Speech, Articles, Prepositions, Auxiliaries and Modals, Agreement of subject with verb
 2. VOCABULARY – Antonyms, Synonyms, Suffixes, Prefixes, One Word Substitutes, Odd words Out

Unit V: Letter Writing 9

Basics of Letter Writing – Reading Comprehension

TOTAL: 60 HOURS

TEXT BOOKS

1. Galaxy of English Prose, Ed. Dr. B. Symala Rao, Blackie Books, Madras
 2. An Anthology of Poems Harmony, Ed. Biyot K. Tripathy.

REFERENCE BOOKS

1. Popular Short Stories, ed. Board of Editors, Oxford Press, 1997.

MS36F1	French Theory Part I	L	T	P	C
		3	0	0	3

OBJECTIVE

To develop proficiency in the French language enabling effective communication in scientific contexts, enhancing cross cultural understanding and facilitating collaboration in international research and academic settings within the Human Genetics field.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Learn basics words in French language such as article, subject verbs, proposition and some adjectives.	R, A
CO-02	Learn French sentences structure, salutation in French and new words.	R, U
CO-03	Study about the verbs and technical user to indentify a group of verb.	S, A

CO-04	Acquire knowledge about the French pronunciation and speaking through dialogues.	U, A
CO-05	Received French language history and France as country in particularly.	U, R

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO- B	PO- C	PO- D	PO- E	PO- F	PO- G	PO- H	PO- - I	PO- J	PO- k	PO - L	PO- M
CO-01	M	S	M	M	L	S	S	M	L	M	L	L	S
CO-02	L	M	M	M	N	S	S	L	L	M	L	L	M
CO-03	N	L	L	L	M	M	S	M	M	M	M	L	M
CO-04	N	L	N	M	N	L	S	L	L	N	N	L	M
CO-05	N	L	N	N	N	M	S	L	N	N	N	N	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Parcours d'initiation

9

Comment vous vous appelez - vous parlez français - vous êtes allemande - tu habites où - qu'est-ce que c'est - qui est-ce - vos papiers s'il vous plaît - cartes postales et messages.

Unit II: Vous comprenez?

9

les pays qui parlez le français - conjuguer les verbes – distinguer le masculin et le féminin, le singulier et le pluriel – ouverture de chanson – les sons et les lettres – le monde en français.

Unit III: Au travail!

9

Est-ce que vous connaissez.... La France et les pays francophones – les articles – groupe des verbes – répétitions de chanson – écrits.

Unit IV: On se détend ?

9

Nouveaux résidents – le cyber café – parler de ses activités – faire un projet – fausses notes de la chanson.

Unit V: Racontez-moi –Bilan

9

Musées et le monument – juillet en France – qui sont entrés dans la musée de Grévin – présentez des événements passés – préciser la date et l'heure – paroles de la chanson – récits de vie – rythmes de vie.

TOTAL: 45 HOURS

TEXT BOOKS

1. Jacky GIRARDET, Jacques PECHEUR, J. Echo A1, méthode de français, CLE International, Paris, 2010

BS3614	Environmental Science	L	T	P	C
		2	0	0	2

OBJECTIVE

Students will learn the need of environment and its protection in current scenario and will be able to understand the problems related to environment and solutions for it.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Deep knowledge about the importance of natural resources and the equitable use of resources for sustainable lifestyles and the role of an individual in conservation of natural resources.	U, R
CO-02	Acquire knowledge about the concept of an ecosystem, energy flow in the ecosystem, ecological succession, food chains, food webs and ecological pyramids.	U
CO-03	Understanding about biodiversity, its value, levels, hot-spots, threats to Biodiversity and Conservation of Biodiversity	R
CO-04	Learns about the definition, causes, effects and control measures of pollution and waste management	A, R
CO-05	Obtains information about the conservation of energy and natural resources and the impacts of population	U, R

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	L	N	N	N	N	M	N	N	N	N	L
CO-02	S	S	M	L	N	N	N	M	M	N	L	L	L
CO-03	S	S	S	L	M	N	M	S	S	L	L	M	M
CO-04	S	S	L	M	M	N	L	M	S	N	L	L	L
CO-05	S	S	L	N	N	N	N	S	M	N	M	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Natural Resources

6

Environmental Science- Definition, scope and importance. Natural resources and associated problems: Forest, Water, Minerals, Food, Energy, Land. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles lectures.

Unit II: Concept of Ecosystem**6**

Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids.

Unit III: Biodiversity**6**

Definition: Genetic, species and ecosystem diversity. Biogeographical classification of India. Value of Biodiversity: Consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. Hot-spots of Bio-diversity Threats to Biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of Biodiversity: In-situ and Ex-situ conservation of Biodiversity.

Unit IV: Pollution and disaster management**6**

Definition, Causes, effects and control measures of: (a) Air pollution, (b) Water pollution, (c) Soil pollution, (d) Marine pollution, (e) Noise Pollution, (f) Thermal pollution, (g) Nuclear hazards. Solid waste management: Causes, effects and control measures of urban and industrial wastes. Role of individual in prevention of pollution. Disaster management: floods, earthquake, cyclone and landslides.

Unit V: Conservation of water and Environmental ethics**6**

Urban problems related to energy Water conservation, rainwater harvesting, watershed management. Environmental ethics: issues and possible solutions. Population growth, variation among nations. Population Explosion-Family Welfare programme. Environment and human health Human Rights.

TOTAL : 30 HOURS**TEXT BOOKS**

1. Text book of Environmental studies for Undergraduate Courses, Erach Bharucha, 2021,
2. Basics of Environmental Science, G.S. Vijayalakshmi, A.G. Murugesan and N. Sukumaran, 2006, Manonmaniam Sundaranar University, Publications, Tirunelveli.

REFERENCE BOOKS

1. Environmental Science, Daniel D. Chiras, Jones and Bartlett Publishers, 2014, 10th edition.
2. Environment Science, William P. Cunningham, Mary Ann Cunningham, 2017, McGraw-Hill Education, 14th edition.
3. Environmental Biology, Agarwal. K.C. Nidi Publications Limited, Bikaner, 2001, 3rd Edition.

HG3601	Cell and Molecular Biology	L	T	P	C
		4	0	0	4

OBJECTIVE

It deals with basic concepts of Cell, Transport process, Cell cycle and Molecular biology gene mechanisms.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Understand the structures and purposes of basic components of membranes, and organelles and their related functions.	U
CO-02	Analyze about the transport mechanisms and cellular signal transport.	An
CO-03	Evaluate the Cell cycle mechanisms.	E
CO-04	Understanding the molecular processes of DNA replication, and how they are managed in cells.	U
CO-05	Understand the basic mechanisms of transcription, and translation and regulation of gene expression	U, R

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	M	S	S	M	S	S	S	M	L	M	L	M	M
CO-02	S	S	S	M	M	S	S	M	S	M	L	M	L
CO-03	M	S	S	M	S	S	S	M	L	M	L	M	M
CO-04	S	S	M	L	M	S	S	M	L	M	M	S	S
CO-05	S	M	S	S	S	M	M	S	M	L	M	L	N

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Cell and Its organelles

12

Introduction to the Cell: Structural organization of prokaryotic and eukaryotic cells. Ultra-structure and function of nucleus, mitochondria, endoplasmic reticulum, Golgi apparatus, Lysosome and peroxisomes. Plasma Membrane – fluid mosaic model.

Unit II: Membrane transport system**12**

Membrane transport – Simple diffusion, Active transport – Uniport, symport, antiport, Na⁺ K⁺ ATPase, Ca⁺ ATPase carriers, Ionophores. Endocytosis and exocytosis. Cell junction; desmosome, tight junction and gap junction, Cell signalling – types and pathways.

Unit III: Cell Cycle**12**

The cell cycle – Interphase, G1, S and G2 phases, Regulation of cell cycle. Cell division – mitosis – various stages of mitosis- prophase, metaphase, anaphase and telophase. Meiosis – various stages of meiosis, Cell death Necrosis and Apoptosis.

Unit IV: DNA and RNA**12**

Chemical structure and types of DNA and RNA, Watson-Crick model of DNA, Functions of DNA, RNA types and functions, Exons and introns, DNA replication in prokaryotes and eukaryotes.

Unit V: Central Dogma of Molecular Biology**12**

Transcription -initiation, elongation and termination of RNA synthesis. Genetic code, Translation- activation of amino acid, initiation, elongation and termination. Inhibitors of transcription and translation, Operon concept- lac, trp, arabinose operons

TOTAL: 60 HOURS**TEXT BOOKS**

1. Molecular Biology of the cell. by Alberts, D., Lewis, J., Roberts, K. and Watson, J.D. 2010. Published by Garland publishers, Oxford, New York.
2. Cell biology by Celis J.E. (A laboratory handbook, Vol 1, 2, 3), 2006. Published by Academic Press, UK.
3. Cytology, Genetics and Evolution by Gupta, P.K. (2008). Published by Rastogi publications, Meerut, India.
4. Cell and Molecular Biology: Concepts and Experiments, by Karp, G. 2010. Published by John Wiley & Sons. Inc. New Delhi, India.
5. Cell and Molecular Biology by Robertis, 2011. Published by Lippincott Williams & Wilkins, New York..

REFERENCE BOOKS

1. Practical Handbook of Biochemistry and Molecular Biology by Fasman, G.D. 1989. Published by CRC Press, Taylor and Francis Group, UK.
2. Molecular Biology of the Gene by James, D.W., Baker, T.A., Bell, S.P., Gann, A. 2009. Published by Benjamin Cummings, USA.
3. Lewin's Genes, by Jocelyn, E.K., Elliott, S.G., Stephen, T.K. 2009. Published by X. Jones & Bartlett Publishers, USA.

HG3602	Biochemistry	L	T	P	C
		3	0	0	3

OBJECTIVE

To provide comprehensive information of fundamentals of biochemistry and understanding on the origin and history of biochemistry. To familiarize the students with the various branches of biochemistry. To provide knowledge about the biomolecules and metabolism.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Gain knowledge in scope of biochemistry.	U
CO-02	Deals with the general introduction to physical techniques.	A
CO-03	Understand about the structure and function of vitamins.	E
CO-04	Deals with enzyme classification and mechanism of action studies.	U
CO-05	Gain knowledge about metabolism.	R

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	M	L	M	S	S	M	L	M	M	S	S
CO-02	S	S	S	M	M	S	S	M	S	M	L	S	L
CO-03	M	S	S	M	S	S	S	S	L	M	L	M	M
CO-04	M	S	S	S	S	S	M	M	S	S	M	S	M
CO-05	S	S	S	M	M	S	S	M	S	M	L	M	L

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Buffers and Bondings

9

Scope and importance of biochemistry, atoms, molecules, chemical bonds, electrolytes and non-electrolytes, acid base concept and buffers; pH; hydrogen bonding; hydrophobic, electrostatic and Van der Waals forces, oxidation, reduction, redox reactions.

Unit II: Biomolecules**9**

Carbohydrates - Classification, types, structure and function, lipids - Classification, structure and function and bio membranes, Amino acids – classification and function, Proteins - Classification, types, structure and function, and nucleic acids – types, structure and nucleic acids.

Unit III: Enzymes and Vitamins**9**

Enzymes - classification and mechanism of action, regulation, factors affecting enzyme action, Co-enzymes, co factors, vitamins - Structure and biological functions.

Unit IV: Thermodynamics and Electron transport system**9**

Fundamentals of thermodynamic principles: Laws of thermodynamics and concepts of free energy, enthalpy and entropy. High energy phosphate compounds and significance of ATP, Electron transport chain and its significance, oxidative phosphorylation.

Unit V: Metabolism of biomolecules**9**

Metabolism of carbohydrates – Glycolysis, TCA, Pentose phosphate pathway and gluconeogenesis-Regulation. Metabolism of proteins and Lipids, Photosynthesis and respiration.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Biochemistry by Keshav Trehan, 1990. Wiley Eastern Publications.
2. Fundamentals of Biochemistry by J.L. Jain et al. (4th edition) 1994. S. Chand and Company.
3. The Biochemistry of Nucleic acid, Tenth Edition, Roger L.P. Adams, John T. Knowler and David P. Leader, 1992. Chapman and Hall Publications.
4. Biochemistry by S. C. Rastogi, 2nd edition. 2003. Tata McGraw Hill Publishing Company, Ltd., N. Delhi.

REFERENCE BOOKS

1. Biochemistry, by D. Voet and J.G. Voet, 2004. John Wiley and Sons, USA Biochemistry, by R.H. Garrett and C.M. Grisham, (3rd Edition) 2007 Saunders College Publishers.
2. Principles of Biochemistry by Albert L. Lehninger (4th edition) 2004. CBS Publishers and Distributors, New Delhi.
3. Biochemistry by Lubert Stryer (4th edition) 2000. Freeman International Edition.

HG3603	Biophysics and Bioinstrumentation	L	T	P	C
		3	0	0	3

OBJECTIVE

The course is designed to train the students in biophysics and bioinstrumentation techniques essential for the understanding of life sciences for which basic knowledge in physics or Biophysics at graduate level is expected and is necessary for the proper understanding of this topic at postgraduate level. To introduce the physical aspects and bioenergetics of the living system and to familiarize the principle and working of various instruments used in experiments.

Course Outcome At the end of the course students should be able to		Cognitive skill
CO-01	Understand about bioenergetics in living system and basic techniques like microscopy.	U
CO-02	Acquire knowledge about different types of centrifuges, Instrumentation, working and their applications.	A
CO-03	Understand about chromatographic and electrophoretic methods	An
CO-04	Learn about different types of spectroscopic methods and their applications	E
CO-05	Acquire knowledge about radioactive substances in environment and the measurement of radioactivity.	R

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO -A	P O -B	PO- C	PO- D	PO- E	PO- F	PO- G	PO- H	PO- I	PO- J	PO- k	PO- L	PO- M
CO-01	M	S	S	M	S	S	S	M	L	M	L	M	M
CO-02	S	S	S	M	M	S	S	M	S	M	L	M	L
CO-03	M	S	S	M	S	S	S	M	L	M	L	M	M
CO-04	S	S	M	L	M	S	S	M	L	M	M	S	S
CO-05	S	M	S	S	S	M	M	S	M	L	M	L	N

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Bioenergetics and Microscopy**9**

Bioenergetics, Tools and Technique in Biology: Bioenergetics: Concepts of Entropy, free energy, enthalpy, redox potential. Tools and Technique in Biology: – Measurement of pH. Microscopy - Light microscopy, Bright & Dark Field microscopy, Fluorescence microscopy, Phase Contrast microscopy, TEM, SEM.

Unit II: Centrifugation**9**

Centrifugation – Basic Principle of Centrifugation, Standard Sedimentation Coefficient, Factors affecting Sedimentation velocity, Instrumentation of Ultracentrifuge (Preparative, Analytical), Rate-Zonal centrifugation, sedimentation equilibrium Centrifugation.

Unit III: Chromatography and Electrophoresis**9**

Separation & Identification of Materials; Chromatography -concept of Chromatography, Paper Chromatography, TLC, column chromatography, size exclusion chromatography, Ion exchange chromatography, Affinity chromatography, HPLC, GLC. Electrophoresis (Gel Electrophoresis, Paper Electrophoresis).

Unit IV: Spectroscopy**9**

Spectroscopy – Principle and application of Beer and Lambert's law – Instrumentation of colorimeter, spectrophotometer - Applications – Principle and instrumentation of IR and NMR, Atomic Absorption spectrophotometer (AAS), ultraviolet visible (UV-VIS), Raman Spectroscopy– Applications.

Unit V: Radioactivity**9**

Radioactive substances: radioisotopes – α particles, β particles, γ particles, radioactivity – units of radioactivity, radioactive decay, half-life, effect of radiations on biological systems. measurement of radioactivity – Geiger-Muller Counter, Liquid Scintillation Counter, γ ray detector, Autoradiography.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Biophysics and Biophysical Chemistry by Das, D.J. 1987. Academic Publishers. Calcutta.
2. Modern Experimental Biochemistry by Boyer, R. F. 1986. The Benjamin/Cummings Publishing Co. Inc. New York.
3. Elementary Biophysics, by Srivastava, P.K. 2005. Narosa Publishing House, New Delhi.
4. Biophysics by Piramal, V. 2005. Dominant Publishers and Distributors, New Delhi.

REFERENCE BOOKS

1. Biophysical Science by Ackerman 1962. Prentice Hall, Inc.
2. Basic Biophysics, by Daniel, M. 1989. Agro Botanical Publishers Bikner.

HG3671	Cell and Molecular Biology Lab	L	T	P	C
		0	0	2	2

OBJECTIVE

The objective is to gain knowledge in the analysis of different blood cells, to observe and understand the process of mitosis, to get familiarize in isolation, extraction and quantification of nucleic acids.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Understand about cell structure and isolation procedures.	A
CO-02	Evaluate to study about staining techniques.	U
CO-03	Acquire and understand knowledge about cellular techniques.	R
CO-04	Acquire knowledge and analyse about DNA studies	A
CO-05	Deals and analyse about DNA analyzing techniques.	U

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of

Course Outcome with Programme Outcome

PO CO	P O - A	PO -B	PO- C	PO- D	PO -E	PO- F	PO -G	PO -H	PO- I	PO- J	PO -k	PO -L	PO- M
CO-01	S	S	M	N	N	N	S	M	M	S	S	S	M
CO-02	S	S	L	N	N	N	M	L	M	M	N	N	M
CO-03	M	M	L	L	N	L	N	L	L	M	M	M	M
CO-04	L	L	N	N	N	N	M	M	N	N	N	L	L
CO-05	S	S	S	S	M	L	S	M	M	S	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals

1. Observation of distinguishing features of prokaryotic and eukaryotic cells
2. Preparation of blood smear and differential staining of blood cells.
3. Squash preparation of onion root tip for mitotic stages
4. Cell Counting and viability
5. Observation of Polytene chromosome
6. Preparation of different stock solutions used in molecular biology (Solutions used in PCR, electrophoresis, DNA isolation, RNA isolation and Protein isolation)
7. Quantification of DNA through spectrophotometer
8. Quantification of RNA through spectrophotometer

9. Isolation of plant cellular DNA
10. Metagenomic DNA purification from soil
11. Separation of DNA using agarose gel electrophoresis

TOTAL: 30 HOURS

HG3672	Biochemistry Lab	L	T	P	C
		0	0	2	2

OBJECTIVE

The objective of this course is to acquire knowledge in estimation, determination of different values and separation of chromatography and to get knowledge in different functional test.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Understand and identify the estimation process.	A
CO-02	Deals with the general introduction of physical techniques.	R
CO-03	Understand about the principles of spectrophotometer.	U
CO-04	Evaluate of biomolecule levels.	E
CO-05	Gain knowledge about functional tests.	An

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO -A	PO -B	PO -C	PO -D	PO- E	PO -F	PO -G	PO- H	PO - I	PO- J	PO- k	PO -L	PO- M
CO-01	S	S	M	M	M	S	S	L	L	L	N	S	M
CO-02	S	S	M	L	S	S	M	L	M	L	L	S	N
CO-03	S	S	S	M	M	S	M	L	M	L	L	S	N
CO-04	M	M	L	S	S	L	M	S	M	S	L	L	S
CO-05	S	S	S	L	M	S	S	L	M	N	S	S	L

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals

1. Estimation of protein by Folin Lowry method.
2. TLC separation of Aminoacids/sugars.
3. Verification of Beer's Law Spectrophotometrically

4. Testing of Blood Sugar.
5. Testing of Liver Function Test
 - a. Bilirubin
 - b. AST
 - c. ALT
6. Albumin, Globulin, Albumin/Globulin ratio
7. Total Protein.
8. Renal Function Test (Urea, Uric acid, Creatinine)

TOTAL: 30HOURS

HG3673	Biophysics and Bioinstrumentation Lab	L	T	P	C
		0	0	2	2

OBJECTIVE

The course gives an idea for the maintenance of laboratory and the practices that should be accomplished in a laboratory. To make aware of the students on basic knowledge of various instruments used in bioscience laboratory including the basic principle - application and working.

Course outcome At the end of the course students should be able to		Cognitive skill
CO-01	Understand about basic techniques like microscopy, and pH meter.	U
CO-02	Learn about media preparation and sterilization techniques.	A
CO-03	Acquire knowledge about different types of centrifuges, Instrumentation, working and their applications	A
CO-04	Learn about colorimeter and Spectrophotometer	E
CO-05	Understand about chromatographic and electrophoretic methods.	An

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO -A	PO -B	PO -C	PO -D	PO -E	PO- F	PO- G	PO -H	PO - I	PO- J	PO- k	PO- L	PO- M
CO-01	S	S	M	L	M	M	S	S	S	M	L	M	L
CO-02	S	S	S	M	M	S	S	M	S	M	L	M	L
CO-03	M	S	S	M	S	S	S	M	L	M	L	M	M
CO-04	S	S	M	L	M	S	S	M	L	M	M	S	S
CO-05	S	M	S	S	S	M	M	S	M	L	M	L	N

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals

1. Microscopy – Light microscopy: principles, parts & function, Operation.
2. Sterilization: principles & operations – Autoclave, Hot Air Oven
3. Sterilization: principles & operations –Filtration, Laminar Air Flow
4. Principles & operations of Incubators & Shakers
5. Principle & operation of Centrifuge
6. Determination of pH – using pH paper and pH electrode.
7. Separation of Chlorophyll pigments by Paper chromatography
8. Principle & operation of Colorimeter
9. Principle & operation of Spectrophotometer

TOTAL: 30 HOURS**SEMESTER II**

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	EG3602	English – II	3	1	0	4
2.	MS36F2	French - II	3	0	0	3
3.	GE3605	Human Values & Professional Ethics	2	0	0	2
4.	HG3604	Basics of Human Genetics	4	0	0	4
5.	HG3605	Basics of Microbiology and Microbial Genetics	3	0	0	3
6.	BS3615	Introduction to Computer & Office Automation	3	0	0	3
PRACTICAL						
7.	HG3674	Basics of Human Genetics Laboratory	0	0	2	2
8.	HG3675	Basics of Microbiology and Microbial Genetics Laboratory	0	0	2	2
9.	BS3684	Computer and Office Automation Laboratory	0	0	2	2
TOTAL			18	1	6	25

HG3602	English II	L	T	P	C
		3	1	0	4

OBJECTIVE

To make the learners acquire basic knowledge in English with communicative competence, to communicate effectively in English, to understand and assimilate the genres of poetry, prose, and short story and grammar for language enrichment

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Understand English prose. That will help them to improve their vocabulary and writing skill.	U, A
CO-02	Learn how to analyze a poem and they will be able to find out the poetic devices using in a poem.	An
CO-03	Understand the structure of a short story, and it will also help to enrich their vocabulary and reading skill.	A, U
CO-04	Get an idea about grammar and they learn to use parts of speech, it will help to improve their reading and writing skill. It will enable the learner to communicate effectively in English.	U, A
CO-05	Understand non-verbal communication. They can apply this in their day today life, it will improve their communication skill.	A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	M	L	S	M	L	S	S	S	M	N	M
CO-02	M	S	L	S	N	M	S	L	N	M	M	N	S
CO-03	S	S	L	L	N	M	S	L	M	N	L	S	S
CO-04	S	S	M	S	S	M	N	S	L	N	S	L	S
CO-05	S	M	L	L	M	M	S	N	S	L	S	S	N

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Prose: A Galaxy Of Precious Prose: (Detailed)

15

1. On Saying Please – A. G. Gardiner
2. My visions for India – A. P. J. Abdul Kalam
3. Water the Elixir of Life – C. V. Raman
4. An Astrologer's Day – R. K. Narayan
5. Hazards of Sensual Drugs – Hardin B. Jones

Unit II: Poetry: Harmony (Detailed) 15

1. La Belle Dame Sans Merci – John Keats
2. All the World's a Stage – William Shakespeare
3. Palanquin Bearers – Sarojini Naidu
4. Tithonus – Alfred Lord Tennyson
5. If – Rudyard Kipling

Unit III: Short Story: Popular Short Stories (Non-Detailed) 12

1. The Necklace – Guy De Maupassant
2. The World Renowned Nose – Vaikkam Muhammad Basheer
3. The Selfish Giant – Oscar Wilde

Unit IV: Grammar 9

1. FUNCTIONAL ENGLISH – Tense, Active Voice, Passive Voice, Conditional Clauses, Direct Speech, Indirect Speech
2. VOCABULARY – Homonyms, Homophones, Word Formation - Derivatives

Unit V: Non-Verbal Communication 9

Facial Expressions – Eye Contact – Posture– Gestures– Paralanguage– Proxemics – Use of Body – Body Movements or Kinesics– Physiological Changes

TOTAL: 60 HOURS**TEXT BOOKS**

1. Harmony: An Anthology of Poems, ed. Tripathy, Biyot K. , OUP India, 1997.
2. Popular Short Stories, ed. Board of Editors, Oxford Press, 1997.

REFERENCE BOOKS

1. A Galaxy of Precious Prose, ed. Dr. Rao, Syamala B. , Madras. Blackie Books, 2001.

MS36F2	French Theory Part II	L	T	P	C
		3	0	0	3

OBJECTIVE

To develop proficiency in the French language enabling effective communication in scientific contexts, enhancing cross cultural understanding and facilitating collaboration in international research and academic settings within the Human Genetics field.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Learn how to be resilient in the countries that were used French language.	R, U

CO-02	Study about the question structure and answers and they will learn different various market items.	U, A
CO-03	Acquire knowledge about planning to travel all French country.	S, A
CO-04	Learn how to formulate a composition in French language, letter and invitation.	U, A
CO-05	Getting knowledge to the new words in Science / HGMB Science Terms.	U, R

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO- B	PO- C	PO- D	PO- E	PO- F	PO- G	PO- H	PO- - I	PO- J	PO- k	PO- -L	PO- M
CO-01	M	S	M	M	L	S	S	M	L	M	L	L	S
CO-02	L	M	M	M	N	S	S	L	L	M	L	L	M
CO-03	N	L	L	L	M	M	S	M	M	M	M	L	M
CO-04	N	L	N	M	N	L	S	L	L	N	N	L	M
CO-05	N	L	N	N	N	M	S	L	N	N	N	N	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Bon voyage

9

Survivre en français – alpha voyages – comparer les choses – adjectives – décision de traversée de l’Hexagone – le weekend rouge – voyager en France.

Unit II: Bon appetite!

9

Le plaisir du marche: traiteur – nommer les choses – interroger et répandre - en route de traversée de l’Hexagone - des restaurants pas comme les autre – questionnaire sur les habitudes des France.

Unit III: Quelle journee!

9

Le forum question est réponses – les berbes du type “se lever” – les mots de quantité – surprises de traversée de l’hexagone – tout est gradué ou Presque – acheter.

Unit IV: Orion est bien ict!**9**

Logement en France – situer ous’orienter – grosse fatigue de taversee de l’Hexagone – cadres de ville.

Unit V: Science / HGMB Science Terms**9**

Science vocabulary

TOTAL: 45 HOURS**TEXT BOOKS**

1. Jacky GIRARDET, Jacques PECHEUR, J. Echo A1, méthode de français, CLE International, Paris, 2010.

GE3605	Human Values and Professional Ethics	L	T	P	C
		2	0	0	2

OBJECTIVE

To understand the basic guidelines, content and process for value education and understanding harmony in human being, nature, existence and professional ethics and implications of the humanistic constitution

Course outcome At the end of the course students should be able to		Cognitive skill
CO-01	Gain basic Knowledge of moral issues.	U
CO-02	Gain basic Knowledge of concept of ethics.	U
CO-03	Gain basic knowledge of principles of ethics and morality.	R
CO-04	Gain basic knowledge of harmony in nature and its existence.	A
CO-05	Gain basic knowledge of professional & professional ethics.	A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO -A	PO -B	PO - C	PO- D	PO - E	PO- F	PO -G	PO -H	PO - I	PO- J	PO- k	PO -L	PO- M
CO-01	S	M	M	L	S	M	L	S	S	S	M	N	M
CO-02	M	S	L	S	N	M	S	L	N	M	M	N	S
CO-03	S	S	L	L	N	M	S	L	M	N	L	S	S
CO-04	S	S	M	S	S	M	N	S	L	N	S	L	S
CO-05	S	M	L	L	M	M	S	N	S	L	S	S	N

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit 1: Introduction to Human Education**6**

Definition, concept and need for Value Education, Self-exploration as the Process for Value Education: Natural acceptance, Experiential Validation, Basic Human Aspirations: Happiness and Prosperity, Method to Fulfil the Basic Human Aspirations

Unit II: Harmony in the Human Being, Nature and Existence**6**

Understanding Myself as Co-existence of the Self and the Body (Human being is more than just the Body). Discriminating between characteristics and needs of Self ('I') and 'Body'. Harmony of the Self ('I') with the Body: correct appraisal of Physical needs, meaning of Prosperity. Human Being as Co-existence, Harmony with Self, Body, Family, Society, Nature. Universal Human Values & Ethical Human Conduct. Understanding Existence as Co-existence of mutually interacting.

Unit III: Harmony in the Family and Society**6**

Family – the Basic Unit of Human Interaction, Values in Human to Human Relationships: 'Trust' as the Foundational value and 'Respect' and basis of respect: Affection, Care, Guidance, Reverence, Glory, Gratitude and Love, Harmony in the Society (an extension of family): Comprehensive Human Goal: The Five dimensions of Human Endeavour, Visualizing a universal harmonious order in society-Undivided Society- Universal Order- from family to world family

Unit IV: Concept of Ethics**6**

Ethics – Meaning, Integrity, Honesty, Personality, Character. Respect for Others – Work culture, Social responsibility, Responsibilities as a citizen, Cooperation and commitment. Customs and practices – Self-interest, Fear, Deception, Ignorance, Ego, Uncritical acceptance of authority. Ethical Principles like Utilitarianism, Rights & Duties, Justice & Fairness, Integration among Principles. Ethics and Organizations, Employee Duties and Rights.

Unit V: Profession & Professional Ethics**6**

Profession – Meaning, Occupation & Profession, Characteristics of Professional. Competence and professional ethics - Competence in professional ethics, Augmenting universal human order, The implications of value-based living at all four levels of living, Contradictions and dilemmas in professional life, Evaluation of holistic technology, Strategy for transition to universal human order.

TOTAL: 30 HOURS**TEXT BOOKS**

1. Gaur, R. R., Sangal, R., and G P Bagaria. (2008) A foundation course in Human Values and professional Ethics, Excel books, New Delhi
2. Naagarazan, R. S. (2006) A Textbook of Professional Ethics & Human Values, New Age Publisher, New Delhi.

- Kiran, D, R. (2014) Professional Ethics & Human Values, 2nd Edition, McGraw Hill, New Delhi.

REFERENCE BOOKS

- A N Tripathy, 2003, Human Values, New Age International Publishers.
- Bajpai.B.L., Indian Ethos and Modern Management, New Royal Book Co., Lucknow, Reprinted, 2004
- S. B. Gogate. Human Values & Professional Ethics, Vikas Publication House Pvt. Ltd. 2019.

HG3604	Basics of Human Genetics	L	T	P	C
		4	0	0	4

OBJECTIVE

It deals with basic concepts of genetics, inheritance patterns and chromosomal aberrations and inborn errors of metabolism.

Course outcome At the end of the course students should be able to		Cognitive skill
CO-01	Understand the basic knowledge of genetics.	U
CO-02	Develop basic knowledge in chromosomal aberrations.	E
CO-03	Know and understand the inheritance patterns.	U
CO-04	Analyse and understand the details of complications of pedigree patterns.	An, U
CO-05	Analyse the concept of inborn errors of metabolism.	An

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO -A	PO -B	PO -C	PO -D	PO- E	PO- F	PO- G	PO- H	PO - I	PO - J	PO - k	PO -L	PO- M
CO-01	S	S	M	L	M	S	S	M	L	M	M	S	S
CO-02	S	S	S	M	M	S	S	M	S	M	L	M	L
CO-03	M	S	S	M	S	S	S	M	L	M	L	M	M
CO-04	M	S	S	S	S	S	M	M	S	S	M	S	M
CO-05	S	S	S	M	M	S	S	M	S	M	L	M	L

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Concepts of Genetics**12**

Science of Genetics – Genes, History and Development of Human Genetics. Mendelism – Mendel's principles, Mendel's laws, Pedigree-gathering family history, pedigree symbols, construction of pedigrees

Unit II: Chromosome structure and aberrations**12**

Chromosome-Structure of chromosome, Classification of Chromosome, Mutation and Types, Numerical aberrations and their chromosomal syndromes, Structural aberrations and their chromosomal syndromes. Chromosomal basis of Sex determination

Unit III: Inheritance**12**

Inheritance-Sex-linked inheritance, Sex-limited and sex-influenced traits, Autosomal inheritance-dominant, recessive, Mitochondrial Inheritance, Multiple gene inheritance, Simple Mendelian traits in Man, MIM number, monozygotic and dizygotic twins.

Unit IV: Pedigree patterns**12**

Complications to the basic pedigree patterns: non penetrance, variable expressivity, pleiotropy, late onset, dominance problems, anticipation, genetic heterogeneity, genomic imprinting and uniparental disomy, X-inactivation. mosaicism and chimerism. Consanguinity and its effects.

Unit V: Inborn errors and Genetics**12**

Inborn errors of metabolism-Phenylketonuria-Neurogenetic disorders: Alzheimer's disease, Muscle genetic disorders: Duchenne Muscular Dystrophy-Genetic disorders of Haematopoietic system: Sickle cell anemia-Multifactorial disorders: Diabetes mellitus.

TOTAL: 60 HOURS**TEXT BOOKS**

1. Molecular Biology of the Cell, by Alberts et al., (4th Edition) 2007. Published by Garland Science, Garland New York.
2. Basic human Genetics, by Mange and Mange (2nd second, Revised Edition) 1999, Published by Sinauer Associates, U.S ..
3. Molecular and genetic analysis of human traits, by Maroni Gustavo 2001. Published by Wiley, Malden, MA, Blackwell Science.
4. An introduction to molecular genetics, by Jack J. Pasternack (Second Edition) 2000. Published by Wiley-Liss Blackwell Science.
5. Human Molecular genetics, by Tom Strachan (Third Edition) 2003. Published by Garland Science/Taylor & Francis Group United States Publisher: New York.

REFERENCE BOOKS

1. An introduction to genetic analysis, by Griffiths and Miller, (Seventh Edition) 2000. Published by W. H. Freeman and Company, New York
2. Genes IX, by Benjamin Lewin (9th Edition) 2007. Published by Jones and Bartlett Publishers.
3. Principles of Genetics, by Snustad and Simmons (4th Edition), 2005. Published by Wiley, New York.

HG3605	Basics of Microbiology and Microbial Genetics	L	T	P	C
		3	0	0	3

OBJECTIVE

Students will learn the importance of Microbiology and the concept of Genetics.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Deep knowledge about History, scope and the contributions of eminent scientists in Microbiology.	R
CO-02	Acquire knowledge in the taxonomy of Microorganisms and the identifying characters to classify the organisms.	U
CO-03	Learn to perform sterilization, pure culture techniques and also learn to identify microorganisms by various staining procedures.	An
CO-04	Get an idea in the concept of gene, plasmids, transposons and mutations.	U
CO-05	Obtain information about the gene transfer techniques.	E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO -A	PO -B	PO -C	PO -D	PO- E	PO -F	PO- G	PO -H	PO - I	PO- J	PO- k	PO -L	PO -M
CO-01	S	S	M	S	S	S	S	L	S	S	S	N	S
CO-02	S	S	S	S	M	L	M	L	N	S	S	S	S
CO-03	M	N	S	S	S	S	M	S	S	S	L	N	S
CO-04	S	S	N	M	L	S	L	S	S	S	S	L	S
CO-05	L	S	S	M	S	L	S	L	S	S	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: History of Microbiology and contribution of scientists**9**

History and scope of Microbiology - Biogenesis and abiogenesis - Contributions of Redi, Spallanzani, Needham, Pasteur, Tyndal, Joseph Lister, Koch [Germ Theory], Edward Jenner and Flemming [Penicillin].

Unit II: Classification of Microbes**9**

Classification of Microbes - General properties and principles of classification of microorganisms (Bacteria, virus, fungi, algae and protozoa), Systems of classification, Numerical taxonomy, Identifying characters for classification, Classification of Microorganisms on the basis of Nutrition, temperature and oxygen requirement.

Unit III: Sterilization and Staining Techniques**9**

Concept of Sterilization - Physical and Chemical methods of sterilization; Determination of phenol coefficient of disinfectant. Culture media and pure culture techniques. Anaerobic culture techniques. Stains and staining methods - gram staining, acid fast staining, negative staining, capsule staining, flagella staining, endospore staining, Lactophenol cotton blue staining.

Unit IV: Plasmids, Transposons and Mutations**9**

Molecular concept of gene. Bacterial plasmids – structures & properties; Bacteriophage – Lytic & Lysogenic cycle. Structures of bacterial Transposons – Types of bacterial Transposons. Mutations - Spontaneous, induced, base pair changes, frame shift, deletion, insertion, tandem, duplications, transversions - Genotypic and phenotypic mutants - Reversion and suppression - Ames test, Mechanism of Antibiotic resistance.

Unit V: Gene Transfer Mechanisms**9**

Gene transfer mechanisms - Conjugation (cell transmissible plasmids, F factor and Hfr strains) - Transformation (Natural transformation, competence, DNA uptake, role of natural transformation artificially induced competence and electroporation) - Genetic recombination (Requirements molecular basis and genetic analysis of recombination in bacteria) - Generalized and specialized transduction.

TOTAL: 45 HOURS**TEXT BOOKS**

1. General Microbiology by Robert F Boyd, 1984. Times mirror/Mosby college publishers.
2. Text Book of Microbiology by Ananthanarayan R and Jayaram Paniker CK, 2005. Seventh edition, Orient Longman Limited, Hyderabad.
3. A text of Microbiology by Dubey RC and Maheswari DK, 2012. (Revised edition). S.Chand and Company Ltd., New Delhi.
4. Microbiology by Prescott L M, J P Harley and D A Klein, 2005. Sixth edition, International edition, Mc Graw Hill.

REFERENCE BOOKS

1. Principles of Genetics by Gardner, E. J, Simmons, M J& D P Snustard, 1991, 8th edition. John Wiley & Sons. NY.
2. Microbial Genetics by Freifelder. S, 1987 Jones & Bartlett, Boston.
3. Principles of Genetics by Robert H. Tamarin, 1996. 5th edition, Cm Brown Publishers.
4. Genes by Lewin. B, 1990. 6th edition, Oxford University Press.
5. Essentials of Genetics by Klug. W.S. & Cummings, MR, 1996, Mentics Hail. New Jersey.

BS3615	Introduction to Computer and Office Automation	L	T	P	C
		3	0	0	3

OBJECTIVE

The course objective is to develop the required skill of the students in the area of Computer Science. They are familiar with Office Automation, Operating System and Networks

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Successful completion of this course the students will be able to understand about different types of computers and Softwares.	U
CO-02	Understand about different types of OS and Networks	R
CO-03	Become familiar with documentation with MS-Word	A
CO-04	Understand about Electronic Spread Sheet using MS-Excel	U, A
CO-05	Understand about Presentation using MS-PowerPoint	U, A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO -A	PO -B	PO- C	PO- D	PO- E	PO- F	PO- G	PO- H	PO - I	PO- J	PO- k	PO -L	PO- M
CO-01	N	N	M	N	L	N	M	M	M	M	L	L	M
CO-02	N	N	M	L	L	N	M	M	M	M	L	N	M
CO-03	S	N	S	M	M	N	M	M	N	M	N	L	N
CO-04	M	N	N	N	S	N	M	M	M	L	N	N	M
CO-05	N	N	M	M	M	N	M	N	S	L	L	L	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Hardware and software**9**

Introduction to Computers-Generations of Computer– Types of Computers- Hardware: CPU, Input, Output Devices, Memory Devices–System – Software - Operating Systems, Programming Languages, Application Software.

Unit II: Operating system**9**

Operating System - Objectives, Types, Characteristics and functions of Operating System. Computer Networks, Client – Server Network, Internet and Intranet, Computer Viruses - Types of computer virus, Use of Antivirus software.

Unit III: MS Word**9**

Documentation Using MS-Word - Introduction to Office Automation, Creating & Editing Document, Formatting Document, Auto-text, Autocorrect, Spelling and Grammar Tool, Document Dictionary, Page Formatting, Bookmark, Advance Features of MS-Word-Mail Merge, Macros, Tables, File Management, Printing, Styles, linking and embedding object, Template.

Unit IV: MS Excel**9**

Electronic Spread Sheet using MS-Excel - Introduction to MS-Excel, Creating & Editing Worksheet, Formatting and Essential Operations, Formulas and Functions, Charts, Advance features of MS-Excel-Pivottable & Pivot Chart, Linking and Consolidation.

Unit V: MS Powerpoint**9**

Presentation using MS-PowerPoint: Presentations, Creating, Manipulating & Enhancing Slides, Organizational Charts, Excel Charts, Word Art, Layering art Objects, Animations and Sounds, Inserting Animated Pictures or Accessing through Object, Inserting Recorded Sound Effect or In-Built Sound Effect.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Introduction to computer by Gilbert Brands, 2010. PHI Learning Pvt Ltd, New Delhi, First edition.
2. Advances in Computer science and Information Technology by Hojatt Adeli, 2003, New Age International (P), Ltd.
3. Computer organisation and Architecture, Rajaraman V, Radhakrishnan.T., 2001. First edition. PHI Learning Private Limited, New Delhi.

REFERENCE BOOKS

1. Computer Science, Robert Sedgewick, Kevin Wayne, 2012. PHI Learning Pvt Ltd, New Delhi, First edition.
2. Computer Fundamentals, P K Sinha & Priti Sinha, 2015, New Age International (P), Ltd, Fourth Edition.

HG3674	Basics of Human Genetics Lab	L	T	P	C
		0	0	2	2

OBJECTIVE

The objective of this course is to gain knowledge mendalian inheritance, mono and dihybrid crosses, also to gain knowledge in the pedigree assessment and chromosomal abberations.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Gain knowledge in creating Pedigree charts	A
CO-02	Deals with complications in basic pedigree pattern	U
CO-03	Understand about all inheritance patterns	R
CO-04	Gain knowledge in Polygenic Inheritance	R
CO-05	Familiar with the study about Inborn errors in Metabolism	A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO -A	PO -B	PO - C	PO- D	PO- E	PO- F	PO- G	PO- H	PO - I	PO- J	PO- k	PO -L	PO- M
CO-01	S	S	M	L	M	S	S	M	L	M	M	S	S
CO-02	S	S	S	M	M	S	S	M	S	M	L	M	L
CO-03	M	S	S	M	S	S	S	M	L	M	L	M	M
CO-04	M	S	S	S	S	S	M	M	S	S	M	S	M
CO-05	S	S	S	M	M	S	S	M	S	M	L	M	L

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals

1. Mendalian Patterns of Inheritance
2. Solving Problems in Mendalian Patterns of Inheritance.
3. Simple genetic problems in monohybrid crosses, incomplete dominance and lethal genes
4. Simple problems on dihybrid ratio and interaction of factors
5. Constructing Pedigrees
6. Risk assessment in Pedigrees
7. Chromosomal Abberations
8. Inheritance of Multiple genes
9. Online Mendalian Inheritance in Man

10. Locating Chromosome of a Gene
11. Polygenic Inheritance – Observation of Height and Weight of Students.
12. Study about Inborn errors in Metabolism - Alzheimer's disease, Duchene Muscular Dystrophy, Sickle cell anemia, Diabetes Mellitus

TOTAL: 30 HOURS

HG3675	Basics of Microbiology and Microbial Genetics Lab	L	T	P	C
		0	0	2	2

OBJECTIVE

Students will learn the basic techniques in Microbiology and the concept of Genetics.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Get a deep knowledge staining techniques.	R
CO-02	Acquire knowledge in preparation of different culture media.	U
CO-03	Learn to serial dilution and pure culture techniques	An
CO-04	Get an idea in the concept of gene transfer techniques	U
CO-05	Learn about the antibiotic sensitivity test and ame's test	E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	P O -L	PO-M
CO-01	S	S	M	L	M	S	S	M	L	M	M	S	S
CO-02	S	S	S	M	M	S	S	M	S	M	L	M	L
CO-03	M	S	S	M	S	S	S	M	L	M	L	M	M
CO-04	M	S	S	S	S	S	M	M	S	S	M	S	M
CO-05	S	S	S	M	M	S	S	M	S	M	L	M	L

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals

1. Staining techniques (Simple staining, Gram Staining, capsule staining, acid fast staining, endospore staining, negative staining, Lactophenol cotton blue staining)
2. Preparation of Culture media (nutrient broth, nutrient agar, selective media, differential media)

3. Serial dilution technique
4. Pure culture techniques – pour plate, spread plate and streak plate technique
5. Enumeration of microorganisms from soil, water and air.
6. Antibiotic sensitivity test
7. Conjugation – interrupted and uninterrupted
8. Transformation
9. Isolation of bacteriophage from sewage
10. Phage titre
11. Ame's test
12. Molecular diagnosis of Pathogens

TOTAL: 30 HOURS

BS3684	Computers and Office Automation Lab	L	T	P	C
		0	0	2	2

OBJECTIVE

The course objective is to develop the required skill of the students in the area of Computer Science. They are familiar with Office Automation.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Understand and access different types of office automation applications.	R
CO-02	Familiar with formatting the document.	U, A
CO-03	Become expert on MS-Word	A
CO-04	Understand about the MS-Excel	U
CO-05	Familiar to work with MS-Powerpoint	A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	N	N	M	N	L	N	M	M	M	M	L	L	M
CO-02	N	N	M	L	L	N	M	M	M	M	L	N	M
CO-03	S	N	S	M	M	N	M	M	N	M	N	L	N
CO-04	M	N	N	N	S	N	M	M	M	L	N	N	M
CO-05	N	N	M	M	M	N	M	N	S	L	L	L	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals

MS-WORD

1. Create a document with tables, and do the following
Formatting, tab setting, page setting for printing, and Header & Footer setting
2. Drawing flow chart using drawing toolbar, inserting picture and setting frames
3. Mail Merge in word (Creating main document, data source, inserting merge fields and viewing merge data, viewing and printing merged letter, using main merge to print envelope creating mailing labels)
- 4.. Create a document, Format the document and edit the document as follows:
 - (i). Find and Replace options
 - (ii). Cut, Copy and Paste options
 - (iii). Undo and Redo options
 - (iv). Using Bold, Underline and Italic.
 - (v). Change Character size using the font dialog box.
 - (vi). Formatting paragraph: Center, Left aligns & Right aligns
 - (vii). Changing paragraph and line spacing Using Bullets and Numbering in paragraphs

MS – EXCEL

1. Create a work sheet, moving / copying / inserting / deleting rows and Columns. (Usage of cut, paste commands, copying a single cell, copying a range of data, filling up a cell. Undo command, Inserting a row, column Deleting rows and columns.)
Create a worksheet and perform to date, time, Math functions, and Logical and financial functions
2. Creating charts (pie, Bar, Line)
 - a. Using chart wizard (five steps)
 - b. Changing the chart type (pie, Bar, Line)
 - c. Inserting titles for the Axes x, y
 - d. Changing colors
 - e. Printing charts

MS – POWER POINT

1. Creating a presentation
2. Different views in power point presentation
3. Setting animation effects / grouping / ungrouping / cropping power/ point objects
4. Design to presentation to market the product using animation effects/ buttons/links

MS-PAINT

1. Draw a Picture using shape tools. Magnify the image.
2. Create a simple Brochure using MS-Paint
3. Image Editing using MS- Paint

TOTAL: 30 HOURS

SEMESTER III

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	HG3606	Human Embryology and Developmental Genetics	4	0	0	4
2.	HG3607	Molecular Genetics	3	0	0	3
3.	HG3608	Principles of Immunology and Immunotechniques	3	0	0	3
4.	HG3609	Environmental Genetics	2	0	0	2
5.	HG3610	Transmission Genetics	3	0	0	3
PRACTICAL						
7.	HG3676	Human Embryology and Developmental Genetics Lab	0	0	2	2
8.	HG3677	Molecular Genetics Lab	0	0	2	2
9.	HG3678	Principles of Immunology and Immunotechniques Lab	0	0	2	2
TOTAL			15	0	6	21

HG3606	Human Embryology and Developmental Genetics	L	T	P	C
		4	0	0	4

OBJECTIVE

Students will learn the basic concepts of embryology and its developmental process.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Get a deep knowledge about the basic concepts of developmental biology.	U, R
CO-02	Acquire knowledge about the concept of fertilization process	E
CO-03	Gains knowledge about embryogenesis process	R
CO-04	Learn about the developmental events.	An, R

CO-05	Obtain information about the invitro embryo developmental process.	U, R
-------	--	------

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	P O -L	P O -M
CO-01	S	S	M	L	N	N	M	N	N	M	S	S	S
CO-02	S	M	M	L	M	N	M	N	L	S	S	M	S
CO-03	S	S	M	M	M	N	M	N	N	M	S	M	S
CO-04	S	S	M	S	M	M	S	N	L	S	N	M	L
CO-05	S	S	L	M	L	N	M	N	N	S	S	M	L

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Basic concepts of developmental biology

12

Introduction to human embryology. Structure and functions of adult human reproductive organs. Oogenesis: Development of Oocytes, types of eggs, Biochemical changes during Oogenesis. Ovarian cycle. Structure of mammalian egg - Egg membranes, Patterns of egg. Spermatogenesis: Origin of Primordial germ cells, Structure of human Spermatozoa, Differentiation of spermatozoa, motility of sperm.

Unit II: Fertilization Process

12

Steps of fertilization – Capacitation, agglutination, sperm penetration, activation of egg, amphimixis, Activation of sperm and egg, interaction of sperm and egg. Post-fertilization changes: Physiological and biochemical changes during and after fertilization. Dosage compensation in human. Role of hormones during and after fertilization. Implantation. Development of Placenta- Physiology and functions.

Unit III: Embryogenesis

12

Human embryogenesis- Stages of Human embryonic development, Early embryogenesis- Cleavage- chemical changes during cleavage, pattern of cleavage, blastulation, gastrulation - Principles and patterns of gastrulation and neurulation. Distribution of cytoplasmic substances in the egg – role of egg cortex, morphogenetic gradient in the egg cytoplasm. Fate map. Role of genes in embryogenesis, Genetics of sex differentiation.

Unit IV: Post Embryonic Developmental Events**12**

Developmental patterns: Development of the body -- Integumentary, skeletal and muscular systems, respiratory system, face, Limb, head, and neck, Nervous system, Sense organs, Male reproductive system, Female reproductive system, Gastrointestinal tract, Urinary system, Cardiovascular system. Gestation -Fetal period and birth. Developmental disorders: causes, mechanisms and patterns - Chromosomal abnormalities in spontaneous abortions.

Unit V: Invitro Embryo Developmental Process**12**

Sperm banking, Cryo-preservation of gametes and embryos, Artificial insemination. Assisted reproductive technologies - Intra cytoplasmic sperm injection, In-vitro fertilization and embryo transfer, ZIFT, GIFT. Fertility control and regulation. Prenatal diagnosis -amniocentesis, alpha-foeto protein (AFP) estimation, chorionic villus sampling, ultrasound scanning. Artificial Intelligence - the future of embryo selection.

TOTAL: 60 HOURS**TEXT BOOKS**

1. Human Embryology and Developmental Biology by Bruce Carlson ,(6th Edition) November 26, 2018 .Published by Elsevier.
2. Text Book of Human Reproductive genetics by Karen Sermon and Stephene Viville, 2014 .Published by Cambridge UniversityPress.
3. Developmental Biology by Michael J.F. Barresi and Scott F. Gilbert ,(12thediion) 2019).Published by Oxford University Press.
4. Developmental Biology-The cellular Basis of metamorphosis by Leon W. Browder, 2012.Published by University of Calgary.

REFERENCE BOOKS

1. Human Embryology and Developmental Biology E-Book: with Student Consult Online Access (5th Edition), by Bruse N Carlson , Dec 24,2012 . Published by Saunders.
2. Principles of Development by Lewis Wolpert, (6th edition) 2019.Published by Oxford University Press, Oxford.

HG3607	Molecular Genetics	L	T	P	C
		3	0	0	3

OBJECTIVE

The course objective is to develop the required skill of the students in the area of Molecular human genetics. Especially in understanding the concept of Gene Mapping, disease gene identification and Human Karyotypes.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Help the students to understand about Genetic mapping	U
CO-02	Analyze the methods of genome mapping	A
CO-03	Acquire knowledge and Understand about molecular pathology of gene	U
CO-04	Understand and acquire knowledge about Identifying Human disease genes	U
CO-05	Deal with the analyses of genetic testing and human karyotype	A

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	L	L	N	N	M	S	N	S	S	S	L
CO-02	S	S	M	L	M	N	M	N	L	M	S	M	M
CO-03	S	S	M	L	N	N	M	N	N	M	S	M	L
CO-04	M	S	N	S	S	M	S	N	L	S	M	M	M
CO-05	M	S	L	S	N	N	M	N	N	S	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Genetics Markers

9

Identifying recombinants and non- recombinants in pedigrees, Genetic and Physical map distances, Mapping with molecular markers, Genetic markers-PCR based genetic markers, Hybridization based genetic markers and their applications.

Unit II: Identifying Human Disease Genes

9

Principles of techniques and various ways of identifying disease genes, Identifying the susceptibility alleles, Genetic susceptibility in complex traits- Cancer, Alzheimer and Parkinson diseases, cardiovascular disease, diabetes mellitus, obesity & epilepsy. Genome-wide association studies.

Unit III: Mutation and Molecular Pathology**9**

Rules for nomenclature of mutations & databases of mutations – Factors and types of Mutation in Human Genomes - Loss of function mutations, Gain of function mutations, Mutation and instability of human genome. Molecular pathology from gene to disease, Molecular pathology of chromosomal disorders, Pathogenicity associated with repeated sequences.

Unit IV: Human Genome Mapping Methods**9**

Physical mapping: Restriction Mapping-Fingerprint mapping and Optical mapping, Fluorescent in situ hybridization (FISH) mapping, Sequence tagged mapping. Hybridization mapping- NGS.

Unit V: DNA testing and Human Karyotypes**9**

Methods of Genetic testing, Direct DNA studies and in direct DNA studies. Cytogenetic location of a gene, Chromosome analysis, Chromosome banding, Nomenclature of karyotypes.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Molecular Genetics an introductory narrative, Gunther S Stend and Richard calendar, 2nd edition, 2004.
2. An introduction to Human Molecular Genetics: mechanism of inherited Diseases, Jack J Pasternak, 2nd edition, 2000.
3. Lewis, "Human Genetics", 7th Edition, WCB & McGraw, 2007.
4. Pasternak, "An Introduction to Molecular Human Genetics", 2nd Edition, Fritzgarald, 2005.

REFERENCE BOOKS

1. The End of Genetics: Designing Humanity's DNA, David B Goldstein, 2022.
2. Human molecular Genetics, Tom Strachan and Andrew Read, 5th Edition, 2010.
3. Human genetics: Concepts and Applications, Ricki Lewis, 12th edition, 2020.

HG3608	Principles of Immunology and Immunotechniques	L	T	P	C
		3	0	0	3

OBJECTIVE

The candidate will gain knowledge about the immune system, types of immunoglobulin, complement proteins, MHC genes and antigenic structure; ABO and other grouping systems; transplantation and tumor immunology.

Course Outcome At the end of the course students should be able to		Cognitive Skills
CO-01	Understand the basics of immune system such as immunity, immune cells and organs	U
CO-02	Create ability to distinguish different types of immunoglobulin and know the characteristics of antigens	An
CO-03	Learn MHC genes and products and know the genetics of human blood groups	U,E
CO-04	Comprehend the overreaction by our immune system leading to hypersensitive conditions and know how autoimmunity develops in a host	U
CO-05	Analyse the antigen and antibody interactions and know the background information of vaccines and vaccination .	U, E

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO- B	PO- C	PO- D	PO- E	PO- F	PO- G	PO- H	PO- I	PO- J	PO- k	P O - L	P O - M
CO-01	S	S	M	L	M	N	N	M	N	M	M	L	L
CO-02	S	M	M	M	M	N	M	N	L	S	S	M	S
CO-03	S	S	M	M	M	N	M	L	N	M	S	L	M
CO-04	S	M	L	M	L	M	S	L	L	S	S	L	L
CO-05	S	M	N	M	N	L	M	L	N	S	S	N	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Immune System

9

Introduction to immune system, Types of Immunity: Innate immunity- anatomic, physiological, phagocytic, endocytic barriers, inflammation and anti-microbial substances. Acquired immunity - active and passive immunity. Cells of the immune system- lymphoid cells, mononuclear phagocytes, granulocytes. Organs of the immune system- primary lymphoid organs and secondary lymphoid organs. Immune responses- primary and secondary responses.

Unit II: Antigens, Antibodies and Immunization

9

Antigens and immunogenicity: Terminologies - antigen, immunogen, haptens, superantigen, epitope, paratope. Characteristics of antigens, Basis of antigen specificity, Antigen processing and

presentation to T- lymphocytes. Antibody - Immunoglobulin- structure, types, distribution, biological and chemical properties, Monoclonal and polyclonal antibodies and their applications. Vaccines & Vaccination – Principles of vaccination - DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, tumor vaccines, Passive and active immunization, immunization Schedule.

Unit III: Complement, MHC and Immunohematology

9

Complement system: mode of activation- classical, alternate and lectin pathways, biological functions. Major Histocompatibility antigens: MHC genes and products, Structure of MHC molecules, Genetics of HLA Systems and HLA typing. Immunohematology: Genetic basis and significance of ABO blood groups, other blood groups, Secretors and Non-secretors, Rh system and genetic basis of D- antigens – Genetic basis of diseases.

Unit IV: Hypersensitivity and Autoimmune disorders

9

Hypersensitivity reactions and types – Type I, Type II, Type III and Type IV hypersensitivity. Autoimmunity and mechanisms of auto-immune disorders- Insulin dependent diabetes mellitus (IDDM), Rheumatoid Arthritis (RA) and Systemic Lupus Erythematosus (SLE) Immunodeficiency disorders: Congenital Immunodeficiency disorders, Severe combined Immunodeficiency (SCID), Acquired Immunodeficiency Disorders (AIDS). Transplantation immunology: Bone marrow and organ transplantation – Pre and post-transplant chimerism - Tumor immunology.

Unit V: Immunization and Immunotechniques

9

Immunotechniques – Agglutination reactions – Active, Passive and Hemagglutination - Immunoprecipitation, Agglutination vs Precipitation, Immunodiffusion techniques – single immunodiffusion, double immunodiffusion – Complement fixation test, Flocculation test - Immunoelectrophoresis – Rocket Immunoelectrophoresis, Counter Immunoelectrophoresis, Radioimmuno Assay, ELISA, Immunofluoresence technique.

TOTAL: 45 HOURS

TEXT BOOKS

1. Immunology, by Ivan M. Roitt, J. Brostoff and D. K. Male, 1993 Gower Medical Publishing, London.
2. Immunology, by Janis Kuby, 2008 W. H. Freeman and Company, New York.
3. Immunobiology- the immune system in health and disease, by Janeway Travers, 1997 Current Biology Ltd. London, New York. 3rd ed.
4. Encyclopedia of Immunology, by Peter J. Delves, Ivan M. Roitt, 1998 Academic Press. 2nd ed.
5. Immunogenetics and Immunodeficiency, by Benacerraf B, 1975 William Clowes and Sons ltd. London.
6. Immunogenetics, by Zaleski MB, Dubiski S, Niles EG and Cunningham RK, 1983 Pitman, Toronto.

7. Basic Immunogenetics, by Hugh Fudenberg H, Pink JRL, Wang A and Ferrera GB, 1984 Oxford University Press, NY.
8. Essential Immunogenetics, by Williamson AR and Turner MN, 1987 Blackwell Scientific Publications, London.

REFERENCE BOOKS

- 1.. Immunology, by Roit, I.N., Brostaff, J.J. and Male, D.K., 2007 C. Mosby, St. Louis.
- 2.. Immunobiology, by Murphy, K., Travers, P., and M. Walport. 2008 7th- Jane way's Garland Science (Taylor and Francis).

HG3609	Environmental Genetics	L	T	P	C
		2	0	0	2

OBJECTIVE

At the end of the course the student will have basic knowledge of, Environmental factors affecting genes and the mechanisms of gene expression. Students will have skills in the use of tools for genetic manipulation and the use of genetic tools for the monitoring and conservation of genetic diversity, both in domestic and wild species.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Get knowledge about Environmental factors affecting genes.	U
CO-02	Understand mutagens and chromosomal mutations.	An
CO-03	Understand about Molecular basis of mutations	U, E
CO-04	Get knowledge about Human mutations	U
CO-05	Understand the genomic approaches for studying molecular events perturbed by environmental agents.	U, A

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	M	M	M	L	L	N	M	N	L	M	S	M	S
CO-02	M	M	M	L	M	L	M	N	L	S	S	S	S
CO-03	M	M	M	M	M	N	M	N	L	M	S	M	S
CO-04	S	M	M	M	M	M	S	L	L	S	S	L	M
CO-05	S	S	L	S	L	N	M	N	N	S	S	L	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Environmental Genomics

6

Environmental genomics- overview, goals, and objectives. Genomic approaches for studying molecular events perturbed by environmental agents in the microbial, invertebrate, aquatic, plant, and mammalian model systems. Exploration of genome databases- Nucleic acid isolation from environmental samples- Real-time PCR, multiplexing, gene signature arrays- Cloning analysis- Denaturing gradient gel electrophoresis (DGGE), NNGS – Metagenomics.

Unit II: Mutation and Environmental mutagens

6

Heritable changes: Spontaneous and induced mutations Luria Delbruck fluctuation Test, Somatic mutation and germinal mutation, genetic mosaics. Environmental Mutagens: Physical- Corpuscular Radiations-Alpha particles, Beta particles, and Neutrons - Electromagnetic radiations - Gamma rays, X rays, and ultraviolet radiations, Interaction of radiations with matter ionization and excitation, Photoelectric effect, Compton effect, Pair production, Properties of radio nucleotides, Radiation units. Chemical- Alkylating agents, Base analogues, Acridines, deaminating agents, and miscellaneous - Food related chemicals (food additives and adulterants) – Symbols of toxic chemicals. Environmental impact on the genetic organization of human genome.

Unit III: Molecular basis of mutations

6

Molecular Mutations: Tautomeric shifts, transitions, and transversions, back mutations, suppression mutations, Silent mutations, Neutral mutation, Missense mutations, Nonsense mutations, and Frameshift mutations (ii) Mutation detection systems: Specific locus test, Ames test, CIB method, Muller-5 method, Attached X-Chromosomes, mutation detection in humans, mutation frequency, Super Mutagens (iii) DNA repair mechanisms: Photoreactivation, Excision repair, Post replication recombination, Mismatch repair, SOS repair – Methods to avoid mutation.

Unit IV:Genetic Toxicology**6**

Toxicology and safety, Transfer across Membrane Barriers, Absorption, Distribution and Elimination of Toxic Agents, Sites of Biotransformation, Biotransformation Reactions, Hematotoxicity: Basic Concepts and Background, Direct Toxicological Effects of CO₂, Inorganic Nitrates/Nitrites and Chlorate Salts. Chemical Carcinogenesis: Terminology of Cancer, Carcinogenesis by Chemicals, Molecular Aspects of Carcinogenesis, Testing Chemicals for Carcinogenic Activity, Occupational Carcinogens, Cancer and Environment Chromosomal Analysis – Endocrine mimicking chemical – Zebra fish as model organism to study genetic toxicology.

Unit V: Environmental Protection**6**

Environmental Protection Act – Environmental Laws, national movements, sustainable development, environmental policies, environmental economics, environmental ethics – holistic approach of environmental protection and conservation, IUCN – role in environmental protection. Concept with reference to UN – declaration, aim and objectives of human right policies with reference to India, recent north-south debate on the priorities of implementation, Environmental Protection Agency (EPA) – Contribution of individuals in environmental protection.

TOTAL: 30 HOURS**TEXT BOOKS**

1. Brooker, J.B 1999 Genetics Analysis and Principles Addison-Wesley California.
2. Gardner, E.J., Simmons, M.J. & Snustad, D.P. 1991 Principles of Genetics, (8th edition) John Wiley & Sons New York.
3. Stansfield F. 1991 Genetics. (3rd edition), Schaum's outline series, McGraw Hill, New York.
4. Suzuki, J.H., Lewontin, D.T. & Gelbart, R.C. 1999 An Introduction to Genetic analysis (7th edition) W.H Freeman & Co., New York

REFERENCE BOOKS

1. Hartl, D. L.& Jones E.W. 2002. Genetics an analysis of Genes and Genomes (5th edition), Jones & Bartlett Publishers, Boston
2. Klung W & Cummings M. R2003 Concepts of Genetics (seventh edition) Peason Education, Singapore.
3. Russell, P. J. Essential of Genetics. 2003 Genetics: A Conceptual Approach. Benjamin A. Pierce. W.H. Freeman & Company, New York
4. Russell, P.J. 2005. Genetics A Molecular Approach (2nd edition). Pearson/Benjamin Cumin g, San Francisco.
5. Weaver, R.F & Hedrick P.W. Genetics, WmC Brown Publishers, Toronto.

HG3610	Transmission Genetics	L	T	P	C
		3	0	0	3

OBJECTIVE

Students will learn the allelic variation, extra chromosomal inheritance and non-disjunction process

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Get a deep knowledge about the transmission genetics	U, R
CO-02	Acquire knowledge about the allelic variation and gene function	U
CO-03	Gain knowledge about extra chromosomal inheritance	R
CO-04	Learn about the chromosomes and ploidy.	A, R
CO-05	Obtain information about the non -disjunction process and syndromes.	U, R

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	P O - L	P O- M
CO-01	S	S	M	L	L	N	M	N	N	S	S	S	S
CO-02	S	M	M	N	M	L	S	N	L	S	M	L	S
CO-03	M	S	M	M	M	N	M	N	L	M	S	M	S
CO-04	M	S	M	S	M	M	M	N	N	S	L	M	S
CO-05	S	S	S	S	L	N	M	L	N	M	S	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Basic concepts of transmission genetics

9

Science of Genetics –an overview of modern history of Genetics. Theories of Genetics-Vapor theory, Fluid theory, Preformation theory, Theory of Epigenesis, Particulate theory, pangenetic theory, Germplasm theory, Chromosome Theory of Heredity (Sutton-Boveri), Endosymbiont

theory. Inheritance of acquired characters and Mutation theory. Heredity and Environment: variation, Types of Variations-Continuous and discontinuous; heritable and non – heritable. Concepts of Phenotype, Genotype, Heredity, Pure lines and Inbred lines. Back cross, Test Cross.

Unit II: Genetic Interaction

9

9Pseudoalleles, Nature of wings in *Drosophila*, Coat colour in rabbits. Genetic interaction- Complementary genes, supplementary genes, Duplicate genes, Epistasis, Lethal genes, Codominance, Incomplete Dominance, Complete dominance, Pleiotrophism, Penetrance, Expressivity, Cumulative genes. Modifier/Modifying genes – gene dosage.

Unit III: Extra Chromosomal Inheritance

9

Characteristic features of Cytoplasmic Inheritance. Evidences for Cytoplasmic factors, Extra-chromosomal inheritance: Maternal Inheritance-Shell coiling in snail, Mutations in *Chlamydomonas*, Inheritance involving infectious particles- Kappa in *Paramecium*, Infective particles in *Drosophila*, Zebra fish - Inheritance of pigments in *Ephesia* – CCID - Molecular organization and gene products of mitochondrial DNA.

Unit IV: Chromosomes and Ploidy

9

Structure and Significance of Special type of Chromosomes: Polytene Chromosome - Salivary gland chromosome in *Drosophila*, Lampbrush chromosome in amphibian Oocyte, Supernumerary B Chromosome. Evolutionary history of life on earth and evolution of chromosomal aberrations. Significance of chromosomal aberrations. Ploidy- Aneuploid segregation in animals, Aneuploidy in Human, Polyploidy in Animals, Induced Polyploidy, applications of Polyploidy,

Unit V: Non Disjunction

9

Nondisjunction-Mitotic and Meiotic behavior of chromosome, Meiotic non-disjunction, Mitotic non-disjunction, Bridges theory of non-disjunction, Syndromes related to non-disjunction, Primary and secondary non disjunction in *drosophila*. Genomic position effects on Gene expression. Centromeric & Non-centromeric breaks in chromosomes,

TOTAL: 45 HOURS

TEXT BOOKS

1. Genes IX by Benjamin Lewin, (9th Edition), 2007. Published by Jones and Barlett publishers.
2. Principles of Genetics by Gardner, Simmons, Snustad (8th Edition) 2006. Published by Wiley India Pvt.
3. Limited Lewis, "Human Genetics", 7th Edition, WCB & McGraw, 2007.

REFERENCE BOOKS

1. Human Genetics: The Basics by Ricky Lewis, 2nd Edition (Special Indian Edition) 2020.

2. Basics of human genetics 2ND edition published on 2017, by Katira. V (Author).
 3. Family communication about genetics: theory and practice, Clara L. GaffandCarma L. Bylund (2010)

HG3676	Human Embryology and Development Genetics Lab	L	T	P	C
		0	0	2	2

OBJECTIVE

Students will learn the basic concepts of embryology and its developmental process.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Get a deep knowledge about the basic concepts of developmental biology.	U, R
CO-02	Acquire knowledge about the concept of fertilization process	E
CO-03	Gain Knowledge about embryogenesis process	R
CO-04	Learn about the developmental events.	An, R
CO-05	Obtain information about the invitro embryo developmental process.	U, R

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	M	L	N	N	M	N	N	M	S	S	S
CO-02	S	M	M	L	M	N	M	N	L	S	S	M	S
CO-03	S	S	M	M	M	N	M	N	N	M	S	M	S
CO-04	S	S	M	S	M	M	S	N	L	S	N	M	L
CO-05	S	S	L	M	L	N	M	N	N	S	S	M	L

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals

1. Observation of chick embryos – 16, 24, 33, 48 hrs

2. Cytokine induced angiogenesis in chick embryos
3. Isolation of Zebrafish embryos
4. Effect of pH Levels on the Developmental Growth of Brachydanio rerio
5. Observation of developmental stages of embryo.
6. Observation of the difference between normal and abnormal embryo development
7. Analysis of cleavage patterns in human embryo (observation of model/chart)
8. Embryo biopsy (Chart/Demo)
9. Amniotic fluid / Chorionic Villi Sampling (Chart/Demo)
10. Study of various stages of human fetal internal and external structure development.

TOTAL: 30 HOURS

HG3677	Molecular Genetics Lab	L	T	P	C
		0	0	2	2

OBJECTIVE

To promote knowledge in the isolation and analysis techniques in Molecular Genetics.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Understand the chromosomal abnormalities using Karyotyping	U
CO-02	Analyze about the isolation of RNA, Plasmid DNA and Genomic DNA	A
CO-03	Understand about the estimation of RNA and DNA.	U
CO-04	Evaluate and acquire knowledge about Restriction Digestion and Ligation.	U
CO-05	Understand and analyze the molecular techniques such as Southern blotting and Polymerase Chain Reaction	A, U

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	L	L	N	N	M	S	N	S	S	S	L
CO-02	S	S	M	L	M	N	M	N	L	M	S	M	M
CO-03	S	S	M	L	N	N	M	N	N	M	S	M	L

CO-04	M	S	N	S	S	M	S	N	L	S	M	M	M
CO-05	M	S	L	S	N	N	M	N	N	S	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals

1. Isolation of Plasmid DNA
2. Isolation of Blood genomic DNA
3. Isolation of RNA
4. Estimation of DNA
5. Estimation of RNA
6. Restriction Digestion and Ligation
7. Southern Blotting
8. Polymerase Chain Reaction
9. Cell division stages
10. Types of PCR

TOTAL: 30 HOURS

HG3678	Principles of Immunology and Immunotechniques Lab	L	T	P	C
		0	0	2	2

OBJECTIVE

The candidate will gain hands-on knowledge and acquire adequate skill required to perform agglutination reactions.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Identify blood groups and types	An
CO-02	Develop their ability to perform qualitative assay of Widal test	A
CO-03	Competently perform serological diagnostic tests such as RF, ASO, and CRP	U, E
CO-04	Improve their ability to perform latex agglutination RPR test	A, E
CO-05	Analyse the antigen-antibody interactions demonstrated in gels and to visualize the bands	U, E

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO -B	PO- C	PO -D	PO- E	PO- F	PO -G	PO -H	PO -I	PO -J	PO- k	PO -L	PO- M
CO-01	S	S	M	L	M	N	N	M	N	M	M	L	L
CO-02	S	M	M	M	M	N	M	N	L	S	S	M	S
CO-03	S	S	M	M	M	N	M	L	N	M	S	L	M
CO-04	S	M	L	M	L	M	S	L	L	S	S	L	L
CO-05	S	M	N	M	N	L	M	L	N	S	S	N	M

Practicals

1. Blood grouping and Rh typing.
2. Widal slide test.
3. C – reactive protein (CRP) test.
4. Rheumatoid arthritis (RA) test.
5. Anti-Streptolysin O (ASO) test.
6. Rapid Anti-HIV test.
7. Rapid plasma reagin (RPR) test.
8. Ouchterlony double immuno diffusion.
9. Rocket immuno-electrophoresis.
10. HLA typing by PCR

TOTAL: 30 HOURS

SEMESTER IV

Sl. No.	Course Code	Course Title	L	T	P	C
Theory						
1	HG3611	Genetic Engineering	4	0	0	4
2	HG3612	Bioinformatics	3	0	0	3
3	HG3613	Molecular Genetic Techniques	3	0	0	3
4	HG3614	Genetic screening and Genetic Counselling	2	0	0	2
5	HG3615	Fundamentals of Biostatistics and Research Methodology	2	1	0	3

Practicals						
6	HG3679	Genetic Engineering Lab	0	0	2	2
7	HG3680	Bioinformatics Lab	0	0	2	2
8	HG3681	Molecular Genetic Techniques Lab	0	0	2	2
Total			14	1	6	21

HG3611	Genetic Engineering	L	T	P	C
		4	0	0	4

OBJECTIVE

The objective of the course is to familiarize the students with the basic concepts of genetic engineering.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Get knowledge about the enzymes used in the genetic engineering.	U
CO-02	Acquire an understanding about the types of cloning vectors and their applications.	U, A
CO-03	Study and understand about the Cloning strategy and the methods of gene transfer.	A
CO-04	Apply the knowledge of Techniques in genetic engineering	A
CO-05	Understand the applications of rDNA technology and genetic engineering for the therapeutic, industrial purposes	A

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	M	L	N	N	M	N	M	M	L	S	S
CO-02	S	S	M	L	N	N	M	N	L	M	S	M	S
CO-03	S	S	M	M	L	N	M	N	N	M	S	M	S

CO-04	M	S	L	M	M	M	S	N	M	S	S	M	S
CO-05	S	S	L	S	L	N	M	N	N	S	S	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Enzymes in Genetic Engineering

12

Principles and methods in genetic engineering: Isolation of genetic material - Host cell Restriction and modification system; Enzymes involved in genetic engineering - Restriction enzymes: Types, nomenclature and applications, Modification of restriction fragment ends – Analysis of Restriction fragments - DNA ligases and ligation, Thermostable DNA polymerases. Alkaline phosphatase, topoisomerases

Unit II: Techniques in Genetic Engineering

12

Method in genetic engineering- western, northern and southern blotting - DNA foot printing– PCR - DNA Finger printing – RFLP, AFLP, RAPD, ISSR – DNA Barcoding - DNA sequencing and sequence assembly, shot gun sequencing, NGS (Next Generation Sequencing) – Gene Editing.

Unit III: Cloning vectors

12

Plasmid based vectors - pBR322 and pUC construction: Phage based vectors - Lamda phage vectors – M13 based vectors and its derivatives: Hybrid vectors - phagemid, phasmid and cosmid – Eukaryotic vectors – Yeast vectors - Viral vectors - Vaccinia, Retroviral, SV40 and Baculoviral system – plant vectors – Gemini virus, Ti plasmid - BAC and YAC.

Unit IV: Cloning and gene transfer methods

12

Cloning strategies – Principles – types – Basic steps of cloning techniques - Cloning in prokaryotes and eukaryotes - Organ cloning – Construction of chimeric DNA –Genomic DNA and cDNA library Construction - Methods of Gene transfer – transformation, transfection, Electroporation, microinjection and biolistics - Screening methods - Gene targeting.

Unit V: Application of Genetic Engineering

12

Transgenic Animals – disease resistance – Increasing the productivity – Treating the genetic disorders –Biopharming – antihemophilic factors – Artificial insemination - Gene Therapy – Gene Knock Out – Vaccine and hormone development – GMO – GM foods – Super bugs – Positive and negative aspects of genetic engineering.

TOTAL: 60 HOURS

TEXT BOOKS

1. Lewin's Genes XII by Joycelyn. E. Krebs, Elliott. S. Goldstein and Stephen. T. Kilpatrick (12th edition) 2018, Jones and Barlett publishers.
2. Human Molecular Genetics 4 E (pb) by Strachan, Routledge Taylor and Francis (4th edition) 2012. Routledge Taylor and Francis group publishers.
3. Genomes by Terence. A. Brown (4th edition). 2017. Garland science publishers

REFERENCE BOOKS

1. Karp's cell and molecular biology by Gerald Karp, Janet Iwasa, Wallace Marshall. (9th edition) 2020, Wiley publications.
2. Concept of Genetics, Global edition by William Klug, Micheal cummings, Charolette Spencer, Micheal Palladino and Darrell Killian. (12th edition). 2019. Pearson publishers.

HG3612	Bioinformatics	L	T	P	C
		3	0	0	3

OBJECTIVE

It deals with basics of Biological Databases, Structure Prediction and Various Sequence analysis tools

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Gain knowledge in Biological Databases	U, A, An
CO-02	Understand about Sequence Alignment and Visualization Tools	R, U ,A
CO-03	Know about Sequence Analysis Tools	R, An
CO-04	Familiar with Protein Structure Prediction	U, A, An
CO-05	Understand about applications of Bioinformatics	R, U

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	P O - E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	M	S	M	L	L	N	M	N	N	L	M	S	L

CO-02	M	M	M	L	M	N	M	L	L	S	S	M	L
CO-03	M	M	M	M	M	N	M	L	N	M	S	N	N
CO-04	M	S	L	S	M	M	S	N	L	S	S	M	M
CO-05	M	S	L	S	L	N	M	L	N	S	M	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Bioinformatics

9

Bioinformatics - Introduction, History, Scope, Applications and its relation with Molecular Biology. Biological Databases: Nucleic acid sequence – GenBank, EMBL, DDBJ, Protein Sequence Database – Uniprot, tremble, Structural databases – PDB, CATH, SCOP, Carbohydrate Databases, Enzyme Databases, Pathway Databases, OMIM, Literature Database – PubMed, Database access and Retrieval Tools - ENTREZ, SRS, Commercial biological databases.

Unit II: Sequence Alignments and Visualization

9

Introduction to Sequences, Alignments and Dynamic Programming, Programming in Bioinformatics - Dotplots, Scoring matrices –Blossom Matrices, PAM Matrix, Gap Penalty Alignment Algorithms, Local alignment and Global alignment- Algorithm and Example, Multiple sequence alignment, 3D Structure Visualization Tools.

Unit III: Sequence Analysis Tools

9

Pairwise Sequence alignment Tools: BLAST - Steps involved in using BLAST, Interpreting BLAST results, FASTA –Alignment Scores, Multiple Alignment Tool- ClustalW, Phylogenetic Tree, EMBOSS.

Unit IV: Protein Structure Prediction

9

Secondary structure Prediction - Chou-Fasman – GOR, Transmembrane protein prediction, Tertiary structure prediction –Comparative Modelling, Protein Threading, Ab initio prediction, Structure Prediction Tools.

Unit V: Applications of Bioinformatics

9

Application aspects – Genome Annotation, Drug designing, Cheminformatics, Human Genome Project, Systems biology, Biodiversity informatics

TOTAL: 45 HOURS

TEXT BOOKS

1. Introduction to Bioinformatics, T.K. Altwood, D. J. Parry-Smith (2004).
2. Pearson A Bioinformatics Guide for Molecular Biologists, Aerni S & Sirota M, CSHL Press, 2014.
3. Bioinformatics for beginners, R. Amjesh, S.S. Vinodchandra, (2019), LAP LAMBERT Academic Publishing.

REFERENCE BOOKS

1. Advances in Bioinformatics, Vijai Singh, Ajay Kumar, (2021) 1st Edition, Springer edition
2. Introduction to Bioinformatics, Bagchi (2018), Narosa Publishing House.
3. Pharmacogenomics An Introduction and Clinical Perspective. BY Joseph S. Bertino, Angela Kashuba, Joseph D. Ma, UweFuhr, C. Lindsay DeVane. Published by Mc-Grow Hill Publications.
4. Genetics, Genomics, Proteomics & Bioinformatics, by Rajeev Tyagi and Yougesh Kumar. Published by Mangalam Publishers and Distributors.

HG3613	Molecular Genetic Techniques	L	T	P	C
		3	0	0	3

OBJECTIVE

Students become acquainted with a variety of techniques including, karyotyping, PCR, Reverse Transcription, Microarray, Sanger Sequencing and Next-Generation Sequencing (NGS). These genetics techniques are applied to problems in human genetics, such as diagnosis, determining prognosis, family studies and mutation analysis; and used to determination test results, interpretation and reporting findings.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Understand the molecular genetic techniques.	U
CO-02	Know about the protein analysis techniques such as PAGE, SDS etc.	An
CO-03	Know the genetic techniques in clinical field including types of ELISA	R, U
CO-04	Understand and inculcate knowledge in the techniques of chromosome analysis.	U
CO-05	Apply the learned patenting procedure in the Prenatal analysis techniques.	A, R

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	P O-M
CO-01	S	M	M	L	L	N	M	N	N	S	M	M	S
CO-02	S	M	M	L	M	N	M	N	L	S	S	M	S
CO-03	S	M	M	M	M	N	M	N	N	M	S	M	S
CO-04	S	S	M	S	M	M	S	N	L	S	M	M	S
CO-05	S	S	M	S	L	N	M	N	L	S	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Molecular Genetic techniques

9

Electrophoretic Techniques – Agarose gel electrophoresis, Pulse field Gel electrophoresis - Polymerase chain reaction(PCR), quantitative Polymerase chain reaction (qPCR), Reverse transcription Polymerase chain reaction (RT-PCR), Gene mapping, DNA and RNAi Microarray, Exome sequencing, Whole genome sequencing - Genetic analysis using RNAi - Antisense technology.

Unit II: Protein analysis techniques

9

Polyacrylamide Gel Electrophoresis, Native gel electrophoresis, Isoelectric focusing, Two dimensional Gel Electrophoresis - Western blotting, Protein tagging, Protein microarray - Chromatographic method for protein identification,

Unit III: Prenatal analysis techniques

9

Ultrasonography, Amniocentesis, Chorionic villus sampling, Maternal blood sampling NIPT techniques, Fetoscopy, Pre implantation genetic screening technique, Next Generation sequencing, SNP Array Method, Whole genome amplification(WGA), Array- Comparative genomic Hybridization.

Unit IV: Genetic Variation and Mutation analysis Techniques

9

Genetic variation and complex trait inheritance: Basics of genetic variations; genetic markers – SNP, CNV, Ins/dels, VNTR, STR, microsatellite; concepts of tag markers and haplotypes, linkage disequilibrium; quantitative genetic analysis; QTL and eQTL.

Unit V: Artificial Intelligence in Genetics

9

Artificial intelligence / Machine learning in Genetics – Computer vision – Time series analysis – Variant calling – Gene annotation and variant classification – Classification of coding and non-

coding variant – phenotype to genotype mapping – image to genetic diagnosis – genotype to phenotype prediction. AI in Disease diagnosis – AI in disease therapy.

TOTAL: 45 HOURS

TEXT BOOKS

1. Concepts of Genetics by Klug W.S., et al. 12th Edition published on 2005.
2. Genetics: A Conceptual approach by Pierce, B.A, 6th Edition.
3. Analysis of Genes and Genomes, by Hartwell, L.H, Michal L Gordberg and *et al*, 5th Edition.

REFERENCE BOOKS

1. Human Genetics: The Basics by Ricky Lewis, 2nd Edition (Special Indian Edition-2020).
2. Principles of Genetics by Peter J, Snustad, M.J. Simmons, 6th Edition.
3. Basics of human genetics 2ND edition published on 2017, by Katira. V(Author)
4. Wilson and Walkers Principles and Techniques Of Biochemistry And Molecular Biology 8th Edition, (Pb 2018) by HOFMANN A (Author).
5. Human Genetics, 6th edition Paperback – 1 January 2021 by Gangane (Author)

HG3614	Genetic Screening and Genetic Counselling	L	T	P	C
		2	0	0	2

OBJECTIVE

At the end of the course the student will have basic knowledge of various genetic screening and prenatal screening methods. Students will be mastered pedigree construction, analysis, and risk calculation and developed intensive practical knowledge of Genetic counseling.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Get knowledge about various genetic screening and Prenatal screening methods	U
CO-02	Understand the methods of Genetic Testing	An
CO-03	Develop deep knowledge about predictive Genetic Testing	U,E
CO-04	Understand Genetic Counseling and its importance	U
CO-05	Get knowledge about counseling for common congenital anomalies	U, E

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO- C	PO-D	PO- E	PO- F	PO-G	PO-H	PO - I	PO- J	PO- k	PO -L	PO-M
CO-01	S	S	M	L	L	N	M	N	N	S	S	S	S
CO-02	S	S	M	L	M	N	M	N	L	S	S	M	S
CO-03	S	S	M	M	M	N	M	N	N	M	S	M	S
CO-04	S	S	L	S	M	M	S	N	L	S	S	M	S
CO-05	S	S	L	S	L	N	M	N	N	S	S	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Genetic screening

6

Scope of genetic screening- Screening for Genetic Disease -Screening Those at High Risk, Carrier Testing for Autosomal Recessive and X-Linked Disorders. Presymptomatic Diagnosis of Autosomal Dominant Disorders. Prenatal and Postnatal screening- New born screening, family screening and Population screening for genetic diseases.

Unit II: Diagnostics Genetic

6

Uses of Genetic Testing and Screening. Genetic Testing to Diagnose Disorders. Genetic Testing for Research-Identification Testing. Laboratory Methods of Genetic Testing, DNA-Based Testing Cytogenetic Testing. Gene Product and Metabolite Analysis-Limitations and Complexity of Genetic Testing. Future Directions in Genetic Testing Technologies- Chip Technology and Microarrays.

Unit III: Predictive Genetic Testing

6

Reproductive Testing- Carrier Testing-Prenatal Testing, Pre-implantation Genetic Testing of Embryos Sperm Selection, Benefits and Risks of Reproductive Testing. Predictive Testing for Late-Onset Disorders-Presymptomatic Testing. Susceptibility (Predispositional) Testing-Benefits and Risks of Late-Onset Testing-Beyond Clinical Disease Prediction: Biomarkers- Tissue specific and organ specific - Biomarkers for Treatment: Pharmacogenetics-Biomarkers of Susceptibility to Environmental Agents- Issues Surrounding Pleiotropic Genetic Information.

Unit IV: Genetic Counseling

6

Historical overview of genetic counseling Models of Eugenic, Medical/Preventive, Decision making, Psychotherapeutic counseling; current definition and goals Philosophy and ethos of genetic services and counseling. Components of genetic counseling -Indications and purpose -

Information gathering and construction of pedigrees. Medical Genetic evaluation -Basic components of Medical History, Past medical history, social & family history. Physical examination. -General and dysmorphology examination, Documentation.

Unit V: Antenatal, Prenatal, Peri-conceptual Counseling and Management of Genetic Disease

6

Counseling for common congenital anomalies, fetal ultrasonography Prenatal Counseling- Biochemical screening – timing, methods, result interpretation. Counseling to parents - Counseling regarding various prenatal diagnosis techniques, risks associated with invasive procedures, interpretation of laboratory results, and their limitations. Peri-conceptual Counseling - Counseling recurrent pregnancy loss, pre-marital counseling. Treatment of Genetic Disease - Conventional Approaches to Treatment of Genetic Disease, Therapeutic Applications of Recombinant DNA Technology, Challenges in Genetic counselling.

TOTAL: 30 HOURS

TEXT BOOKS

1. Genetic testing and screening in the age of genomic medicine November 2000. The New York State Task Force On Life and the Law.
2. Human Molecular Genetics by T. Strachan and AP Read
3. Human Genetics by F. Vogel and A.G. Motulsky
4. Medical Genetics by Jorde et al
5. Young (1999). Introduction to Risk Calculation in Genetic Counseling. Oxford

REFERENCE BOOKS

1. Genetic Counseling by W. Fuhrmann and F. Vogel
2. Baker et al (1998). A Guide to Genetic Counseling. Wiley
3. Harper (2001). Practical Genetic Counseling. Arnold
4. Rose & Lucassen (1999). Practical genetics of primary care. Oxford

HG3615	Subject Name: Fundamentals of Biostatistics and Research Methodology	L	T	P	C
		2	1	0	3

OBJECTIVE

To provide knowledge about tools and techniques related with scientific communication and research methodology. To give students a brief knowledge about the various methods of organization of statistical data and its presentation.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Understand the methodologies of scientific research and acquiring the skills of scientific reading, writing and presentations.	U
CO-02	Analyze the tools and techniques related with scientific communication and research methodology.	An
CO-03	Understand the basics of biostatistics such as tabulation, graphical and diagrammatic representation.	U
CO-04	Calculate and interpret measures of central tendency, correlation and regression analysis in statistical data.	A
CO-05	Identify appropriate tests to perform hypothesis and compare different population sample using ANOVA and interpret the output adequately.	A

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO- B	PO- C	PO- D	PO- E	PO- F	PO- G	PO- H	PO- I	PO- J	P O - k	PO -L	P O - M
CO-01	S	S	M	L	L	N	M	N	N	S	S	S	S
CO-02	M	S	M	L	M	N	M	N	L	S	M	M	S
CO-03	S	S	M	M	M	N	M	L	N	M	M	M	S
CO-04	M	S	L	S	M	M	S	L	L	S	S	M	S
CO-05	M	S	L	M	L	N	M	L	N	S	S	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Biostatistics

9

Definition - scope of biostatistics - Population and Sample - collection, classification, and tabulation of data - graphical and diagrammatic representation - scale diagram - histograms - pie diagrams - frequency polygon - frequency curves.

Unit II: Data collection**9**

Methods of data collection – primary data – interview method, questionnaire, secondary data, and case study method. Online data base library. Computer and its role in research.

Unit III: Measures of central tendency**9**

Measures of central tendency - arithmetic mean, median, and mode - calculation of mean, median and mode in series of individual observation, discrete series continuous open - end classes. Measure of dispersion - standard deviation – Methods of regression – T test - ANOVA

Unit IV: Research methodology**9**

Research methodology: An introduction – meaning, objective and types of research. Hypothesis – Types of hypothesis - Defining research problem – selection of problems. Sampling design – random sample. Measurement and scaling techniques, error in measurement.

Unit V: Scientific documents**9**

Preparation of scientific documents: Search Engines - Data management, Research papers, review articles, format of journals – proof reading. Journals: Standard of research journals, impact factor, citation index, methods of citation. Oral presentation, poster presentation, bibliography, References – softwares - Dissertation writing – Plagiarism.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Research Methodology for Biological Science, by Gurumani N, 2006 MJP Publishers, Chennai.
2. Communicate Science Papers, Presentations, and Posters Effectively, by Patience GS, Boffito DC, Patience P, 2015 Academic Press, ISBN: 978-0128015001.
3. On Being a Scientist: a Guide to Responsible Conduct in Research, by Washington DC, 2009 National Academies Press, 3rd Edition.

REFERENCE BOOKS

1. Research Methodology: Methods and Techniques, by Kothari CR and Garg G, 2019 New Age International Publishers, ISBN: 978-9386649225, 4th Edition.
2. Successful Scientific Writing: A Step-by-Step Guide for the Biological and Medical Sciences, by Matthews JR and Matthews RW, 2014 Cambridge University Press ISBN: 978-1107691933, 4th Edition.

HG3679	Genetic Engineering Lab	L	T	P	C
		0	0	2	2

OBJECTIVE

The course objective is to develop the required skill of the students in the area of Genetic Engineering.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Acquire knowledge about Restriction Digestion	An
CO-02	Enables to study about the DNA Finger printing.	E
CO-03	Understand about the Mapping of genes.	U, E
CO-04	Acquire knowledge about DNA Barcode.	A
CO-05	Understand the Sequencing techniques.	A

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO- B	PO- C	PO- D	PO- E	PO - F	PO -G	PO- H	PO - I	PO - J	PO - k	P O -L	PO -M
CO-01	S	M	M	L	N	N	M	N	M	M	L	S	S
CO-02	S	S	M	L	N	N	M	N	L	M	S	M	S
CO-03	S	S	M	M	L	N	M	N	N	M	S	M	S
CO-04	M	S	L	M	M	M	S	N	M	S	S	M	S
CO-05	S	S	L	S	L	N	M	N	N	S	S	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals

1. Isolation of Plasmid from E. Coli cells
2. Qualtitative analysis of Plasmid DNA
3. Quantitative analysis of Plasmid DNA
4. Restrction digestion Of DNA
5. Ligation of DNA

6. Isolation of RNA from Yeast
7. cDNA Synthesis
8. Protein Separation by SDS-PAGE
9. RAPD
10. DNA Sequencing

TOTAL: 30 HOURS

HG3680	Bioinformatics Lab	L	T	P	C
		0	0	2	2

OBJECTIVE

It deals with basics of Biological Databases, Structure Prediction and Various Sequence analysis tools.

Course Outcome At the end of the course students should be able to		Cognitive Skill
CO-01	Gain knowledge in Biological Databases	U, A, An
CO-02	Understand about Visualization Tools	R, U ,A
CO-03	Know about Sequence Analysis Tools	R, An
CO-04	Familiar with Protein Structure Prediction tools.	U, A, An
CO-05	Understand about Gene Prediction tools.	A, R

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	P O - k	PO-L	PO-M
CO-01	M	S	M	L	L	N	M	N	N	L	M	S	L
CO-02	M	M	M	L	M	N	M	L	L	S	S	M	L
CO-03	M	M	M	M	M	N	M	L	N	M	S	N	N
CO-04	M	S	L	S	M	M	S	N	L	S	S	M	M
CO-05	M	S	L	S	L	N	M	L	N	S	M	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals

- 1.Exploration of the resources available in NCBI and PUBMED
- 2.Retrieval & Analysis of a Genbank Entry using an accession number
- 3.Retrieval and analysis of a protein sequence from protein database
- 4.Secondary structure prediction, validation & visualisation of a protein
- 5.Pair-wise and multiple sequence alignment
- 6.Alignment of two Sequences and determination of Scoring Matrix
- 7.Similarity Search using BLAST and Interpretation of Results - Nucleotide
- 8.Conversion of Gene Sequence into its Corresponding Amino Acid Sequence
- 9.Primer Designing
10. Genome annotation

TOTAL: 30 HOURS

HG3681	Molecular Genetic Techniques Lab	L	T	P	C
		0	0	2	2

OBJECTIVE

Students become acquainted with a variety of techniques and these genetics techniques are applied to problems in human genetics such as diagnosis, determining prognosis, family studies and mutation analysis; and used to determination test results, interpretation and reporting findings.

Course Outcomes		Cognitive Skills
At the end of the course students should be able to		
CO-01	Understand the molecular genetic techniques.	U
CO-02	Know about the protein analysis techniques such as PAGE, SDS etc.	An
CO-03	Know the genetic techniques in clinical field including types of ELISA.	R, U
CO-04	Understand and inculcate knowledge in the techniques of chromosome analysis.	U
CO-05	Apply the learned patenting procedure in the Prenatal analysis techniques.	A, R

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
------------------------	------	------	------	------	------	------	------	------	------	------	------	------	------

CO-01	S	M	M	L	L	N	M	N	N	S	M	M	S
CO-02	S	M	M	L	M	N	M	N	L	S	S	M	S
CO-03	S	M	M	M	M	N	M	N	N	M	S	M	S
CO-04	S	S	M	S	M	M	S	N	L	S	M	M	S
CO-05	S	S	M	S	L	N	M	N	L	S	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals

1. DNA extraction – FTA method (from Dried Blood Spots)
2. Preparation and maintenance of cell culture media
3. Tissue culture: Lymphocyte culture
4. Cell counting and Cell viability assay
5. Cell proliferation assay (MTT)
6. Haemoglobin typing by agarose gel electrophoresis
7. Pathogenic Mutation detection by PCR
8. Real Time (quantitative) PCR
9. MLPA
10. PCR Variations & Applications in Diagnostics

TOTAL: 30 HOURS

SEMESTER V

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	HG3616	Medical Biotechnology and Clinical Diagnostics	4	0	0	4
2.	HG3617	Mammalian cell culture and techniques	3	0	0	3
3.	HG3618	Human Cytogenetics	3	0	0	3
4.	HG3619	Genomics and Proteomics	3	0	0	3
5.	HG36XX	Elective	2	0	0	2
PRACTICAL						
7.	HG3683	Recombinant DNA Technology Laboratory	0	0	2	2

8.	HG3684	Medical Biotechnology & Clinical Diagnostics Laboratory	0	0	2	2
9.	HG3685	Human Cytogenetics Laboratory	0	0	2	2
TOTAL			15	0	6	21

HG3616	Medical Biotechnology and Clinical Diagnostics	L	T	P	C
		4	0	0	4

OBJECTIVE

This course introduces and explores the techniques, theory and concepts that underpin medical biotechnology and clinical diagnostics. This rapidly advancing area in bioscience is recognized as having the potential to revolutionize new diagnostic techniques for inherited disorders and many other diseases.

Course Outcome At the end of the course, students should able to		Cognitive Skill
CO-01	Learn about various Molecular Techniques for Diagnosis.	A
CO-02	Knowledge and critical understanding of the Genetic Diseases and its Diagnosis.	An,
CO-03	Knowledge and critical understanding of the Biochemical and Immunodiagnostics	U, A
CO-04	Learn different types of Health care products-available to treat various diseases	U, An
CO-05	Understand the trends and Future of Medical Biotechnology	U

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	M	M	L	L	S	S	S	S	M	M	S
CO-02	S	S	M	S	M	S	M	S	S	S	S	M	S
CO-03	S	S	S	M	S	M	M	S	M	M	S	S	S

CO-04	S	S	M	M	S	L	S	M	M	S	S	M	S
CO-05	S	S	M	S	L	S	S	M	M	M	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Genetic Diseases and its Diagnosis

12

Identifying disease genes - position independent strategies, positional cloning, Methods for the diagnosis of genetic diseases - Sickle cell anemia, Hemophilia, Duchenne muscular Dystrophy, Rheumatoid arthritis, Alzheimers disease, Huntingtons disease, Parkinson's disease, Schizophrenia. Retinoblastoma, Cystic Fibrosis, Diabetes, hypertension, and Sex - linked inherited disorders.

Unit II: Biochemical and Immunodiagnostics

12

Biochemical diagnostics: Major Metabolic disorders and its causes. Methods available for the diagnosis of metabolic disorders., Immunodiagnostics: diagnosis of respiratory diseases (influenza) Infectious diseases- (HIV and Corona), bacterial diseases, enteric diseases, parasitic diseases and Mycobacterium diseases.

Unit III: Techniques for Diagnosis

12

Genome: resolution, detection & analysis: PCR: Real-time; ARMS, Multiplex, ISH, FISH, ISA, RFLP, DHPLC, DGGE, CSCE, SSCP. Nucleic acid sequencing, Microarray chips, EST, SAGE, molecular markers: 16S rRNA typing; Diagnostic proteomics: SELDI-TOF-MS- Bioinformatics data acquisition & analysis.

Unit IV: Drugs and Vaccines

12

Drugs and their Mechanism: Antiviral drugs, drugs for metabolic diseases, Anticancer drugs, Anti-hypertensive drugs, Bronchodilator drugs and their mode of actions. rDNA drugs and vaccines, Hormones - insulin, growth hormone, Monoclonal antibodies. Current strategies for development of vaccines.

Unit V: Future of Medical Biotechnology

12

Future of Medical Biotechnology: Individualized medicine; Gene therapy, Medical microrobotics, Nanodiagnostics, Nanomedicine and Nanosurgery- for cancers, Prenatal diagnosis- invasive and non-invasive techniques; Protein and enzyme markers, DNA probes, Enzyme probes,

TOTAL: 60 HOURS

TEXT BOOKS

1. Albert Sasson (2006), Medical Biotechnology published by United Nations Publications.
2. S.N. Jogland (2000) Medical Biotechnology; published by Himalaya Publication.
3. Joseph Bronzino and Bronzino and Bronzino. Medical Devices and Systems in Biomedical Engineering Handbook, Vol 2.

- Rodney J.Y. Hoan milo Gilbaldi, (2003) Biotechnology and Biopharmaceuticals published by Wiley John and Sons.
- Sharon Walker (2006) Biotechnology Demystified published by McGraw Hill Publication.

REFERENCE BOOKS

- Terence A. Brown, 2002, Genomes (2nd edition), Garland Science publishing,
- Old R.W, Primrose S.B, Twyman R. M, (2002) -Blackwell, Principles of Gene manipulation (6thed.). Published by Wiley
- Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA, published by Washington, DC: ASM Press.
- Coleman, W. B., & Tsongalis, G. J. (2010). Molecular Diagnostics: for the Clinical Laboratorian published by Totowa, NJ: Humana Press.

HG3617	Mammalian Cell Culture and Techniques	L	T	P	C
		3	0	0	3

OBJECTIVE

The goal of this course is to provide necessary theoretical knowledge on mammalian cells for in vitro studies, maintenance of mammalian cells in vitro and application of molecular techniques in vitro situations.

Course Outcome At the end of the course, students should able to		Cognitive Skill
CO-01	Discuss and analyse the laboratory design and equipment of Cell Culture	An
CO-02	Understand Cell Culture Media and Reagents	U
CO-03	Know about Cell Culture Types and Characterization	U, E
CO-04	Understand the techniques of mammalian cell culture	U, E
CO-05	Know the mechanisms of advanced scale up techniques of cell culture	U, E

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO- B	PO- C	PO- D	PO- E	PO- F	PO -G	PO -H	PO - I	PO - J	PO- k	P O -L	P O - M
CO-01	S	S	M	M	L	N	M	N	N	S	M	M	S

CO-02	M	S	M	L	M	N	M	L	L	S	S	M	S
CO-03	M	S	S	M	S	L	M	N	L	M	S	L	S
CO-04	S	M	M	S	S	S	S	L	L	S	S	M	S
CO-05	S	S	M	S	L	L	M	N	L	M	S	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Cell Culture Laboratory Design and Equipment

9

History of Mammalian cell culture, Good Laboratory Practices (GLP), Planning, construction and services, Basic equipment, aseptic work area, cell culture hood, cell culture hood layout, CO₂ Incubator, Maintenance of sterility- sterilization methods and techniques in animal cell culture, Cell culture vessels. Cryogenic storage - Liquid nitrogen freezers, Slow cooling system for cell freezing, cell counter,

Unit II: Cell Culture Media and Reagents

9

Cell culture medium - Types and ingredients of media, Physiochemical properties, CO₂ and bicarbonates, Buffering, Oxygen, Osmolality, Temperature, Surface tension and foaming, Balance salt solutions, Antibiotics, growth factors and purified proteins, Foetal bovine serum, Serum free media, Trypsin solution. Selection of and Importance of medium. Conditioned media, other cell culture reagents. Preparation and sterilization of cell culture media, Cell lines, Media for mammalian cell culture, transfection and selection, transfection reagents.

Unit III: Cell Culture Types and Characterization

9

Primary Cell culture – Isolation and separation of cells, culturing and sub-culturing of cells, Contamination testing of culture, Determination of cell count, viability and cytotoxicity, measurement of growth parameters, maintenance of cell culture, cell line immortalization, cell line preservation and Revival.

Unit IV: Cell lines and Cell assay techniques

9

Types of cell cultures – immobilized cultures, Stem cell culture. Cell lines-commercial cell lines and insect cell lines – HeLa cells, African Green monkey cell line, mouse fibroblast cell lines, Chinese hamster ovary (CHO) cells, Human embryonic kidney (HEK) 293, MCF-7, High Five (BTI-Tn-5B1-\$) cell line. Invitro transfection of cells, cell-based assays – cell proliferation assay, cell viability assay, cytotoxicity assay, cell senescence assay, cell death assay. cell differentiation and movement.

Unit V: Techniques of mammalian cell culture**9**

Tissue culture techniques, Trypsinization, Cell separation, Continuous cell lines, Suspension culture, Organ culture. Behavior of cells in culture conditions- division, growth pattern, metabolism and estimation of cell number, Development of cell lines, Characterization and maintenance of cell lines, Common cell culture contaminants.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Freshney R. I. (2005). Culture of Animal Cells. John Willy and Sons Ltd. USA.
2. Butler, M. (2004). Animal Cell Culture and Technology. Taylor and Francis. New York, USA.
3. Ranga M.M. (2002). Animal Biotechnology. Agrobios India Limited.
4. FreshneyWiley-Liss. (2000), Animal Cell Culture - Practical Approach 3rd Edition, Masters Oxford University Press.
5. Jayakody T. (2022), A Beginner's guide to Mammalian Cell Culture. Blue Rose publisher.

REFERENCE BOOKS

1. Freshney, R. I. (2016). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley-Blackwell, 7th Edition.
2. Martin Clynes. (1998). Animal Cell Culture Techniques. Springer,
3. Ashok Mukhopadhyay (2016). Mammalian Cell Technology and its application. I K International Publishing House Pvt Ltd.

HG3618	Human Cytogenetics	L	T	P	C
		3	0	0	3

OBJECTIVE

At the end of the course the students will learn the changes in certain chromosomes which may be a sign of a genetic disease. Students also will analyse the chromosomal abnormalities using techniques in Human cytogenetics and diagnose the genetic disorder.

Course Outcome		Cognitive Skill
At the end of the course, students should able to		
CO-01	Discuss and analyse the History and Development of Human Cytogenetics	An
CO-02	Understand Human chromosomes and cell cycles	U
CO-03	Know about human chromosomal anomalies and diseases	U, E

CO-04	Understand and apply the cytogenetic techniques for chromosome analysis	U, E, A
CO-05	Know the mechanisms of advanced molecular cytogenetic techniques to diagnose the genetic disorders	U, E

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO -B	PO- C	PO -D	PO- E	PO - F	PO -G	PO- H	PO - I	PO - J	P O- k	PO - L	P O - M
CO-01	S	M	M	M	L	N	M	N	N	S	M	M	S
CO-02	M	S	M	L	M	N	M	N	L	S	S	M	S
CO-03	M	S	M	M	S	N	M	N	L	M	S	M	S
CO-04	S	M	M	S	S	S	S	L	L	S	S	M	S
CO-05	S	S	M	S	L	L	M	N	N	M	S	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: History and Development of Human Cytogenetics

9

History of human cytogenetics, confirmation of human chromosome number, Morphological variability of the human chromosomes, classification of human chromosomes into different groups (A-G), International System for Human Cytogenetic Nomenclature (ISCN).

Unit II: Human chromosomes and Cell cycles

9

General features of human chromosomes, Functions of chromosomes. Chromatin structure, Constitutive and facultative heterochromatin, Nucleosome, Solenoid model, Centromeres, Kinetochores, Telomeres, Nuclear organization region (NOR), Cell-cycle progression and check points, Chromosome dynamics in M-phase and its regulation, Role of condensins and Cohesins.

Unit III: Human Chromosomal Anomalies and Diseases

9

Chromosomal aberrations in Human: Numerical abnormalities- aneuploidy, euploidy, polyploidy and its chromosomal disorders. Structural abnormalities- Deletion, Duplication, Inversion, Translocation and its Chromosomal disorders - Down's syndrome (trisomy 21), Edward syndrome (trisomy 18), Cri du chat syndrome, Patau syndrome (trisomy 13) and Turner syndrome.

Unit IV: Cytogenetic Techniques**9**

Chromosome analysis: Karyotyping procedure, idiograms of human chromosomes and advantages of karyotyping. Banding techniques: High resolution banding (HRB), Giemsa (G-) banding, reverse (R-) banding, Quinacrine (Q-) banding, Nucleolar Organizer Region (NOR-) banding and Telomeric R (T-) banding, Sister chromatid exchange (SCE). Chromosome microarray, Fluorescent in-situ Hybridization (FISH).

UnitV: Advanced Molecular Cytogenetic Techniques**9**

Principles and procedures involved and their applications in clinical diagnosis of genetic abnormalities (including complex chromosomal translocations – CCR) - Primed in situ labeling (PRINS), comparative genomic hybridization (CGH), Spectral karyotyping (SKY), Multicolor FISH (mFISH) and multicolor banding (mBAND), Fiber FISH with examples.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Snustad D. P and Simmons M.J. (2012). Principles of Genetics. John Willey & Sons Publication, 6th Edition.
2. Gangane, (2017). Human Genetics. 5th Edition.
3. Gardner. (1968). Principles of Genetics 8th Edition.
4. Snustad D. P and Simmons M.J. (2005). Principles of Genetics. John Willey & Sons Publication, 4th Edition.

REFERENCE BOOKS

1. Hamerton J. L. (1971) Human Cytogenetics (vol. I & II). Academic Press.
2. Ford E.H. (1973) Human Chromosomes. Academic Press Inc.
3. Vogel F. and Motulsky A.G. (2010). Human Genetics – Problems and approaches.
4. Gangane S.D. (2017). Human Genetics. 5th Edition. Elsevier.

HG3619	Genomics and Proteomics	L	T	P	C
		3	0	0	3

OBJECTIVE

It deals with basics of DNA Polymorphism, DNA Typing, Genomic and Proteomic Analysis and its applications.

Course Outcome At the end of the course, Students can able to		Cognitive Skill
CO-01	Gain knowledge in DNA Typing.	U, A, An
CO-02	Understand about Transcriptome Analysis, Gene expression and DNA microarray	R, U ,A
CO-03	Know about functional Genomics	R, An

CO-04	Familiar with Proteomics	U, A, An
CO-05	Understand about research areas in Genomics and Proteomics	U, R

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	M	M	S	L	N	N	N	S	M	L	L	M	M
CO-02	M	M	M	N	N	N	N	M	M	L	N	N	L
CO-03	S	S	S	S	S	M	M	M	M	S	S	M	M
CO-04	S	S	S	S	S	S	S	M	M	M	S	M	M
CO-05	M	M	M	S	S	S	S	M	M	M	M	M	L

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: DNA Typing

9

DNA Polymorphism – SNP, Basis of DNA typing, Minisatellite analysis, Polymerase chain reaction based analysis, RT-PCR, Short tandem repeat analysis. Mitochondrial DNA analysis and Y chromosome analysis.

Unit II: Gene expression and DNA microarray

9

Gene expression - Introduction, Basic steps for gene expression, Microarray- Concept of microarrays; spotted arrays, oligonucleotide arrays, designing the experiment, applications and Tools for microarray analysis - Soft-finder, xCluster, MADAM.

Unit III: Proteomics

9

Proteomics and beyond - Analysis of the transcriptome, Proteomics - Expression analysis and Characterization of proteins, Metabolomics and global biochemical networks.

Unit IV: Proteomics Analysis

9

Tools and techniques in proteomics- 2-D gel electrophoresis, Gel filtration, PAGE, isoelectric focusing, fixing and spot visualization, Mass spectroscopy - MALDI-TOF, Tandem mass spectroscopy (MS/MS) analysis, Peptide fingerprinting (PMF), Protein Microarray.

Unit V: Applications of Genomics and Proteomics Analysis

9

Analysis of Genomes – Human, Mouse, Plasmodium falsiparum, Saccharomyces cerevisiae, Mycobacterium tuberculosis. Pharmaceutical Applications - Role of proteomics in drug discovery, development and toxicology, Proteomics in drug Discovery and Glycobiology.

TOTAL: 45 HOURS

TEXT BOOKS

1. Concept and techniques in genomics and proteomics, N Saraswathy, P Ramalingam (2011), Elsevier Science publications.
2. Bioinformatics: Genomics and Proteomics, Ruchi Singh (2015), Vikas Publishing House.
3. Introduction to Bioinformatics, Lesk, A.M. (2007), Oxford University Press, Oxford.

REFERENCE BOOKS

1. Bioinformatics, Methods And Applications - Genomics, Proteomics And Drug Discovery, Rastogi, S.C., Rastogi, Parag, Mendiratta, Namita, (2022), fifth edition, PHI Learning Pvt. Ltd.
2. Advances in Bioinformatics, Ajay Kumar, Vijai Singh (2021), Springer Singapore.

HG3683	Recombinant DNA Technology Lab	L	T	P	C
		0	0	2	2

OBJECTIVE

It deals with basic concepts of process of genetic engineering and recombinant DNA technology, Probe construction, DNA amplification.

Course Outcome At the end of the course, students should able to		Cognitive Skill
CO-01	It helps to understand about Different Kinds of Vectors.	U
CO-02	Enables to remember and apply about Host - vector system.	R, A
CO-03	Students will understand and analyse about Analysis of expression.	U, An
CO-04	Students will acquire knowledge about the evaluation and Application of rDNA Technology in plants.	E
CO-05	It deals about synthesis Application of rDNA Technology in animals.	S

R- Remember, U-Understand, A-Appl, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO \ CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	S	M	S	M	L	S	S	L	M	S	S
CO-02	S	S	M	N	L	S	S	S	S	S	M	S	S
CO-03	M	S	S	S	S	S	S	S	s	L	L	N	S

CO-04	S	M	S	S	S	M	L	S	S	S	S	S	S
CO-05	M	S	M	S	S	S	S	S	S	S	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals

- 1.Preparation of plasmid DNA and genomic DNA from E.coli
- 2.Preparation of genomic DNA from animals/human/plant
- 3.Agarose gel electrophoresis of plasmid and genomic DNA
- 4.Restriction digestion of DNA. - Single and double digestion
- 5.PCR amplification
- 6.RFLP
- 7.Southern blotting
- 8.Transformation of E.coli with plasmid DNA using CaCl₂

TOTAL: 30 HOURS

HG3684	Medical Biotechnology and Clinical Diagnostics Lab	L	T	P	C
		0	0	2	2

OBJECTIVE

It deals with basic concepts of Identifying disease genes, Hematology, common laboratory methods.

Course Outcome At the end of the course, students should able to		Cognitive Skill
CO-01	Understand about susceptibility test for PCR	U
CO-02	Study about Methods for the diagnosis of genetic diseases	R, A
CO-03	Understand and acquire knowledge about traditional methods for the diagnosis of metabolic errors	U, An
CO-04	Evaluate about Identifying disease genes -position	E
CO-05	Deals about synthesis of hematology methods	S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO- B	PO- C	PO- D	PO- E	PO- F	PO- G	PO- H	PO- I	PO- - J	PO- -k	P O- L	P O- M
CO-01	S	S	M	L	N	N	L	L	M	S	S	S	S
CO-02	S	S	S	L	N	N	M	L	M	S	S	S	S
CO-03	S	S	S	M	N	S	L	L	M	M	S	S	S
CO-04	S	S	M	L	N	N	L	L	S	S	S	M	S
CO-05	S	S	S	M	N	N	M	L	M	M	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals

1. RT - PCR
2. DNA sequencing
3. Single nucleotide polymorphism
4. ELISA
5. DNA finger printing
6. Immunohistochemistry
7. H and E staining
8. PCR mediated diagnosis

TOTAL: 30 HOURS

HG3685	Human Cytogenetics Lab	L	T	P	C
		0	0	2	2

OBJECTIVE

At the end of the course, the student will learn techniques in cytogenetics and solve problems on mendelian genetics and its deviation. Students will prepare and analyze the karyotype of normal and syndromic individual.

Course Outcome At the end of the course, students should able to		Cognitive Skill
CO-01	Conduct the experimental methods of cell culture.	An, E
CO-02	Develop deep knowledge in Chromosomal structure and the number of chromosomes using microscopic analysis.	A
CO-03	Discuss clinical cases with pathological karyotypes.	An

CO-04	Know about linkage analysis.	U, E
CO-05	Understand the crossing over mechanisms.	U, E

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO -B	PO- C	PO -D	PO- E	PO- F	PO -G	PO -H	PO -I	PO -J	PO- k	PO -L	PO- M
CO-01	S	M	M	M	L	N	M	N	N	S	M	M	S
CO-02	M	S	M	L	M	N	M	N	L	S	S	M	S
CO-03	M	S	M	M	S	N	M	N	L	M	S	M	S
CO-04	S	M	M	S	S	S	S	L	L	S	S	M	S
CO-05	S	S	M	S	L	L	M	N	N	M	S	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals

1. Cell Culture – Media preparation
2. Cell Counting using hemocytometer
3. Cell viability by Dye exclusion method
4. Peripheral blood lymphocyte culture – G Banding
5. Culturing of Drosophila melanogaster & Observation of Polytene Chromosome
6. Study of stages of meiotic and mitosis chromosomes
7. Mitotic index
8. Dermatoglyphics as a Model for Polygenic Inheritance
9. Karyotype study of aneuploidies
10. Sister Chromatid exchange analysis from peripheral blood

TOTAL: 30 HOURS

SEMESTER VI

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	HG3620	Pharmacogenomics	4	0	0	4
2.	HG3621	Population and evolutionary genetics	3	1	0	4

3.	HG3622	Stem cell and gene therapy	3	0	0	3
4.	HG36XX	Elective	2	0	0	2
PRACTICAL						
7.	HG36P1	Project	0	1	5	6
TOTAL			12	2	5	19

HG3620	Pharmacogenomics	L	T	P	C
		4	0	0	4

OBJECTIVE

It deals with basic concepts of effect of drugs, individualized drug therapy and chemotherapeutic agents for cancer treatments.

Course Outcome At the end of the course, students can able to		Cognitive Skill
CO-01	Students will get knowledge in Genetic Drug Response, Drug Discovery and Personalized Medicine.	U, An, R
CO-02	Students acquire knowledge about the association studies in Pharmacogenomics.	An
CO-03	Students gains understanding about Genomics application for Drug action and toxicity.	E
CO-04	Students learns about the genomics applications related to Drug Design.	U
CO-05	Students obtains information about the Case studies related to Pharmacogenomics.	U, R

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	P O- L	P O- M
CO-01	S	M	S	M	N	N	N	S	M	L	L	M	M

CO-02	M	S	M	M	N	N	N	M	M	L	N	N	L
CO-03	S	S	S	S	S	M	M	L	M	S	S	M	M
CO-04	S	S	S	S	S	S	S	M	M	L	S	M	M
CO-05	M	M	M	S	S	S	S	M	M	M	M	M	L

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Pharmacokinetics and dynamics

12

Pharmacogenomics- Roots of pharmacogenomics, pharmacogenomics in drug discovery and drug development. Concept of individualized drug therapy, Drivers and the promise of personalized medicine, Strategies for application of pharmacogenomics. Genetic drug response profiles, the effect of drugs on Gene expression.

Unit II: Association Studies in Pharmacogenomics

12

Toxicity, Viability and Adverse drug reaction in drug response, Multiple inherited genetic factors influence the outcome of drug treatments, Association studies in pharmacogenomics, Strategies for pharmacogenomics Association studies, Benefits of Pharmacogenomics in Drug R & D.

Unit III: Pharmacogenomics in Drug Action and Toxicity

12

Platform technologies and Pharmaceutical process, its applications to the pharmaceutical industry, Understanding biology and diseases, High throughput screening (HTS), Target identification and validation, Drug candidate identification and optimization, ADME, safety and toxicology studies.

Unit IV: Applications for Drug Design

12

The need of protein structure information, protein structure and variation in drug targets-the scale of problem, Mutation of drug targets leading to change in the ligand binding pocket.

Unit V: Pharmacogenomics – Case Studies

12

Study of pharmacogenomics of human P-Glycoprotein, drug transporters, lipid lowering drugs, chemotherapeutic agents for cardio, respire and renal disorders.

TOTAL: 60 HOURS

TEXT BOOKS

1. Martin M. Zdanowicz, M.M. “Concepts in Pharmacogenomics” Second Edition, American Society of Health-System Pharmacists, 2017.
2. Yan Q, “Pharmacogenomics in Drug Discovery and Development” Humana Press, 2nd Edition, 2014.
3. Werner, K., Meyer, U.A., Tyndale, R.F. “Pharmacogenomics”, Second Edition, Taylor and Francis, 2005.ug transporters, lipid lowering drugs, chemotherapeutic agents for cancer treatment.

REFERENCE BOOKS

1. Licinio, J and Wong, Ma-Li. "Pharmacogenomics: The Search for the Individualized Therapies", Wiley-Blackwell, 2009.
2. Brazeau, D.A. and Brazeau, G.A. "Principles of the Human Genome and Pharmacogenomics" American Pharmacist Association, 2011.

HG3621	Population and Evolutionary Genetics	L	T	P	C
		3	1	0	4

OBJECTIVE

To adhere the knowledge in population and evolutionary genetics with their historical review, human ancestry and phylogeny.

Course Outcome At the end of the course, students will able to		Cognitive Skill
CO-01	Understand the genetic polymorphism and allele frequency	U
CO-02	Find out the application and methods of Hardy-Weinberg.	U
CO-03	Study about historical review of evolutionary concept	An
CO-04	Study about life beginnings	E
CO-05	Deal about human ancestry and phylogeny	S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	P O- L	PO-M
CO-01	S	M	S	S	M	M	M	S	M	M	M	S	M
CO-02	S	M	M	S	M	M	M	M	S	M	S	M	S
CO-03	S	S	S	S	S	M	M	S	M	S	S	M	M
CO-04	S	S	S	S	S	S	S	S	M	M	S	S	M
CO-05	S	M	M	S	S	S	S	S	S	M	M	M	L

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Allele frequencies

12

Allele frequencies - deriving genotypic and allelic frequencies, Introduction to quantitative genetics, deriving allelic frequencies from molecular data, changes in allele frequencies. Classical,

Ecological Genetics and Polymorphism - phenotypic and genotypic polymorphisms, transient polymorphism, balanced polymorphisms. Random and Non-random mating – positive and negative assortative mating, role in population size and change in gene frequency.

Unit II: Hardy-Weinberg method and Genetic drift

12

Hardy-Weinberg method and its applications – calculating allelic frequencies, assumptions of Hardy-Weinberg equilibrium, proof of Hardy-Weinberg equilibrium, Generation time, testing for fit to Hardy-Weinberg equilibrium. Random Genetic drift – effects in small and large populations, bottlenecking and founder effect, genetic drift simulation, genetic drift vs selection. Genetic equilibrium –conditions for its stability and deviation (evolution).

Unit III: Evolutionary Concepts

12

Historical Review of Evolutionary Concept: Pre - Darwinian ideas - List of contributors influencing Darwin indicated as a timeline. Lamarckism - Merits and demerits. Darwinism Merits and demerits, Post - Darwinian era - Modern synthetic theory; biomathematics and the theory of population genetics leading to Neo - Darwinism.

Unit IV: Concepts of Life

12

Life beginnings: Chemogeny - An overview of pre - biotic conditions and events; experimental proofs to abiotic origin of micro - and macro - molecules. Current concept of chemogeny RNA first hypothesis. Biogeny - Cellular evolution based on proto - cell models (coacervates and proteinoid micro - spheres). Origin of photosynthesis - Evolution of oxygen and ozone build - up. Endosymbiotic theory - Evolution of Eukaryotes from Prokaryotes.

Unit V: Human Ancestry and Phylogenetic Analysis

12

Human Ancestry and Phylogeny: Primate characteristics and unique Hominin characteristics. Primate phylogeny leading to Hominin line. Human migration - Theories. Brief reference to molecular analysis of human origin - Mitochondrial DNA and Y - chromosome studies. Pedigree analysis.

TOTAL: 60 HOURS

TEXT BOOKS

1. Hartl and Jones. (1998). Genetics: Principles and Analysis. Jones and Bartlett.
2. Hoelzel. (1998). Molecular Genetic Analysis of Populations. Oxford Univ.
3. Jobling et al. (2004). Human Evolutionary Genetics. Garland.
4. Strickberger. (2000). Evolution. Jones and Bartlett.
5. Smith. (1998). Evolutionary Genetics. Oxford.

REFERENCE BOOKS

1. Dobzhansky T, (1937). Genetics and the Origin of Species. New York: Columbia Univ.
2. Fisher R. A. (1930). The Genetical Theory of Natural Selection. Oxford: Oxford Univ.

- 3.Simpson G. G. (1991). Tempo and Mode of Evolution. New York: Columbia Univ. Press.
- 4.Crow J. F. (1991). Basic Concepts in Population, Quantitative, and Evolutionary Genetics, New York: W. H. Freeman.
- 5.Saetre G P. (2019). Evolutionary Genetics: Concepts, Analysis and practice. Illustrated edition.
- 6.Weinreich D.M. (2023). The foundations of population Genetics. The MIT Press.

HG3622	Stem Cell and Gene Therapy	L	T	P	C
		3	0	0	3

OBJECTIVE

This course introduces and explores the principles, theory and concepts that underpin stem cell and gene therapy. This rapidly advancing area in bioscience is recognised as having the potential to revolutionize therapy for inherited disorders and many other diseases.

Course Outcome At the end of the course, students should able to		Cognitive Skill
CO-01	Students will be able to understand the basics of Stem cell.	U
CO-02	Know about the Stem cell Techniques such as FACS.	An, E
CO-03	Know about Gene Therapy and its methods.	U
CO-04	Students will be able to learn different types of Gene therapy available for inherited or acquired diseases	U, E
CO-05	Demonstrate knowledge and critical understanding of the challenges and potential of stem cell and gene therapies to address inherited conditions and disease.	U

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	M	M	L	M	M	S	M	S	M	M	S
CO-02	S	S	M	S	M	M	M	S	M	S	M	M	S
CO-03	S	S	M	M	S	S	M	M	M	M	S	M	S

CO-04	S	S	M	S	S	S	S	L	S	S	M	M	S
CO-05	S	S	M	S	L	S	M	M	M	M	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Stem cells - An Introduction

9

Stem cells - Definition, Classification, Sources and Properties –Types of stem cells: methods of isolation, study of stem cells and their viability IPSC. Embryonic stem cell: Isolation, Culturing, Differentiation, Properties – Adult stem cell: Isolation, Culturing, Differentiation, Trans-differentiation, Plasticity, and Properties. Preservations of Stem cell.

Unit II: Stem cell and therapy

9

Stem Cell biology and therapy- Stem cell Therapy for neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns, skin ulcers, muscular dystrophy and orthopaedic applications.

Unit III: Gene delivery techniques

9

Gene Therapy - Introduction, History and evolution of Gene therapy, optimal disease targets, Failures and successes with gene therapy and future prospects, Genetic Perspectives for Gene Therapy, Gene Delivery methods: Viral vectors and Non-viral vectors – lipid based vectors, polymer based vectors. DNA viral vectors – adenoviral vectors (AdV) adeno-associated viral vectors (AAV), RNA viral vectors – retroviral vectors (RV), lentiviral vectors (LV).

Unit IV: Gene therapy of inherited or acquired diseases

9

Gene therapy of inherited or acquired diseases - Monogenic inherited diseases: General aspects; Specific diseases (Primary immune deficiencies; Cystic fibrosis; Inherited coagulopathies), Gene therapy of infectious diseases: HIV, Gene therapy of ischemic diseases, Gene therapy of ocular diseases, Gene therapy clinical trials.

Unit V: Ethical issues

9

Regulatory and Ethical Considerations of stem cell and Gene Therapy, Assessing Human Stem Cell Safety, Use of Genetically Modified Stem Cells in Experimental Gene Therapies, Stem cell policy and ethics, stem cell research: Hype, hope and controversy. Ethical Issues associated with stem cell-based regenerative medicine field.

TOTAL: 45 HOURS

TEXT BOOKS

1. Booth C. (1998). Stem cell biology and gene therapy, published by Cell Biology International, Academic Press
2. Alexander Battler, Jonathan Leo, (2006). Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, published by Springer,

3. Quesenberry PJ, Stein GS (1998). Stem Cell Biology and Gene Therapy, published by Wiley,
4. Roger Bertolotti, Keiya Ozawa and H. Kirk Hammond, (2004). Progress in gene therapy, Volume 2, Pioneering stem cell/gene therapy trials, published by VSP international science publishers

REFERENCE BOOKS

1. Stewart Sell (2003). Stem Cells Handbook published by Humana Press; Totowa NJ, USA.
2. Daniel Marshak, Richard L. Gardener and David Gottlieb (2001). Stem Cell Biology, published by Cold Spring Harbour Laboratory Press.
3. Slack J.M.W. (2017). The science of stem cell. John Wiley & Sons, Inc.
4. Scherman D. (2019). Advanced Textbook on Gene transfer, Gene therapy and genetic pharmacology: Principles, delivery and pharmacological and biomedical applications of nucleotide based therapies. 2nd Edition.

HG36P1	Project	L	T	P	C
		0	1	5	6

OBJECTIVE

To adhere the appropriate project work to the discipline at all times and to adopt safe working practices relevant to the field of research.

Course Outcome At the end of the course, students will able to		Cognitive Skill
CO-01	Formulate a scientific question	U,A
CO-02	Present scientific approach to solve the problem	An, A
CO-03	Interpret, discuss and communicate scientific results in written form.	U,A
CO-04	Gain experience in writing a scientific proposal	An
CO-05	Learn how to present and explain their research findings to the audience effectively.	An.A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	S	S	M	L	M	M	M	S	M	L	S	S
CO-02	S	S	M	M	M	S	S	S	M	S	M	M	S

CO-03	S	S	M	S	M	M	L	M	M	M	M	M	S
CO-04	S	S	S	S	M	S	S	S	S	M	S	M	S
CO-05	S	S	S	M	S	S	M	S	M	S	M	L	M

S-Strong, M-Medium,L-Low,N-Not relevant

GUIDELINES FOR REVIEW AND EVALUATION

To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports, to face reviews and viva voce examination. The students in a group of 3 to 4 work on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. Project work should be presented at a national or international conference. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL -90 HOURS

List of electives

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1	HG36A1	Cancer Genetics	2	0	0	2
2	HG36A2	Behavioral Genetics	2	0	0	2
3	HG36A3	Techniques of Nanotechnology	2	0	0	2
4	HG36 A4	Metabolomics and Metabolic Engineering	2	0	0	2
5	HG36 A5	Nutrigenomics	2	0	0	2
6	HG36 A6	Epigenetics	2	0	0	2
7	HG36 A7	Invitro Fertilization	2	0	0	2
8	HG36 A8	Bioethics, Biosafety and Intellectual Property Rights	2	0	0	2

HG36A1	Cancer Genetics	L	T	P	C
		2	0	0	2

OBJECTIVE

It deals with the cancer development steps. To know about the role of various genes in cancer and to know about the diagnostic and therapeutic processes

Course Outcome At the end of the course, students should able to		Cognitive Skill
CO-01	Deep knowledge about the classification of cancer	U, R
CO-02	Acquire knowledge about the concept of apoptosis and its pathways	U
CO-03	Gains understanding about molecular basis of carcinogenesis	R
CO-04	Learns about the cancer syndromes.	A, R
CO-05	Obtains information about the cancer screening and therapy.	U, R

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	N	S	S	S	N	L	N	S	M	S	L	S	M
CO-02	S	S	M	S	M	S	S	M	M	L	N	S	L
CO-03	S	S	M	S	S	M	M	N	S	S	S	M	M
CO-04	S	S	S	L	S	S	S	M	M	M	S	M	M
CO-05	M	M	M	S	S	S	S	M	M	M	L	M	L

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Introduction to Cancer Genetics

6

Cancer: Definition and Properties of cancer cells. Neoplasia - nomenclature and Biology of Neoplasm. Classification and types of cancer, Features of Benign and Malignant tumor. Causes of cancer, Dysplasia, Carcinoma insitu, Precancerous lesion. Development of cancer and its symptoms. Tumour progression: angiogenesis and metastasis. Multi- step evolution of cancer.

Unit II: Cancer Cytogenetics**6**

Cell cycle - Check points and Control of the cell cycle. Regulations and inhibitors. Relation between apoptosis and cancer, Genes regulating apoptosis, P53 mediated apoptotic pathway, JAK -STAT pathway, EGFR pathway, RAS -RAF kinase pathway, Role of growth factors.

Unit III: Molecular basis of carcinogenesis**6**

Proto-oncogene - Activation of proto – oncogenes, Role of proto– oncogenes in regulating cell growth and survival, Tumour suppressor gene -Types, Tumor Suppressor pathways (The p16 - cyclin D - pRb - E2F pathway, p19ARF - Mdm2). Care taker genes - Role and Examples. Gate keeper genes - Role and Examples. Oncogenes: Types, Mechanisms of activation of oncogenes.

Unit IV: Cancer screening**6**

Cancer screening - Early detection and prevention, Cancer Biomarkers - Principles of cancer biomarker and their applications. Genetic Screening tests for cancer syndromes.

Unit V: Cancer therapy**6**

Cancer therapy - cellular, gene and protein level. Chemotherapeutics for cancer, Phytotherapy for cancer. Advance therapies in cancer. Genetic counselling for cancer patients and care taker. Radiotherapy, Alternative therapy.

TOTAL: 30 HOURS**TEXT BOOKS**

1. Molecular Biology of Cancer by Lauren Pecorino 2008. Published by Oxford Uni. Press, Oxford.
2. Developmental Biology by Michael J.F. Barresi and Scott F. Gilbert, (12th edition) 2019). Published by Oxford University Press.
3. Developmental Biology-The cellular Basis of metamorphosis by Leon W. Browder, 2012. Published by University of Calgary.

REFERENCE BOOKS

1. Clinical Cancer Genetics, Risk counseling and by Offit, Kenneth, 1998. Published by Liss Wiley-Liss, New York.
2. Principles of cancer Genetics by Fred Bung (2nd edition) 2016. Published by Springer.

HG36A2	Subject Name: Behavioral Genetics	L	T	P	C
		2	0	0	2

OBJECTIVE

Students will know the importance of Cognitive abilities and disabilities, Personality and Personality disorders.

Course Outcome At the end of the course, students will able to		Cognitive Skill
CO-01	Will acquire a deep knowledge about the introduction of behavioural genetics	An,R
CO-02	They will understand the fundamentals of gene an environment	U
CO-03	Also they will get knowledge in Cognitive abilities and its disabilities	R
CO-04	Learn the concept of Personality and Personality disorder	An
CO-05	Obtain information about the Psychiatric disorders	E

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO- B	PO- C	PO- D	PO- E	PO- F	PO- G	PO- H	PO- I	PO- J	P O- k	PO- L	PO- M
CO-01	M	S	S	L	S	S	S	S	S	M	L	S	S
CO-02	S	S	S	S	M	S	S	M	S	L	L	N	L
CO-03	S	M	S	M	S	S	S	S	L	M	S	M	S
CO-04	S	S	M	S	S	S	M	M	S	S	M	S	M
CO-05	S	S	S	M	M	S	S	M	S	M	L	M	L

S-Strong,M-Medium,L-Low,N-NotRelevant

Unit I: Introduction to Behavioral Genetics

6

Introduction - What is Behavioral Genetics? Review Mendelian genetics. Genetic Variations. Inheritance, Heritability. Evidence from Animal Models and Human Studies - Dogs and the domestication syndrome. Twin and adoption studies.

Unit II: Genes and Environment

6

The interplay between genes and environment. Linking Genes to Behaviou. Pathways between genes and behavior. Identifying genes for behavior (Induced mutations, QTL, syteny homology). Environmental influences – shared and non – shared environment.

Unit III: Cognitive abilities and disabilities

6

Cognitive ability and cognitive disorders, Mental retardation and its types, Learning disorders (dyslexia, ADHD, dyscalculia, dysgraphia, and dyspraxia), Communication disorders (Language

Disorder, Speech Sound Disorder (previously Phonological Disorder), Childhood-Onset Fluency Disorder (Stuttering), Social (Pragmatic) Communication Disorder, and Unspecified Communication Disorder).

Unit IV: Personality and Personality disorders

6

Personality and its types. Personality disorders – causes and its types. Circadian disorders. Antisocial personality, criminal behavior, social behavior.

Unit V:Psychiatric disorders

6

Psychiatric disorders - Psychopathology- Signs and symptoms – Schizophrenia, mood disorders, anxiety disorders, disorders of childhood, Personality and personality disorders

TOTAL: 30 HOURS

TEXT BOOKS

1. Plomin et al. (2012) Behavioral Genetics, 7th Ed (or prior editions), ISBN-10: 1-4641-7605-1, ISBN-13: 978-1-4641-7605-0.
2. SawaandMcInnes.(2007) Neurogenetics of Psychiatric disorders. Informa Health care
3. Robert RH Anholt TrudyF. C. Mackay (2009) Principles of behavioural genetics, Published by Elsevier science publishing . 334, ISBN :978-0-1237-2575-2.

REFERENCE BOOKS

1. ValerieS.Knopik,(2016), BehavioralGenetics ,7th Edition,Published by Freeman Macmillan ISBN : 978-1-4641-7605-0.
2. Straub RichardO (2023) Health Psychology A Biopsychosocial Approach, Published ByWorth Publishers : ISBN 978-1-3194-9851-1.

HG36A3	Techniques of Nanobiology	L	T	P	C
		2	0	0	2

OBJECTIVE

Students will acquire knowledge about the different techniques used in nanotechnology, and their applications in diagnosis and treatment.

Course Outcome At the end of the course ,students will able to		Cognitive Skill
CO-01	Will get a deep knowledge about the introduction to Nanobiology	E
CO-02	They will know and understand the Nano techniques for diagnosis	R
CO-03	Understand and learn the concept of nanotechnology by in the treatment process	R,U
CO-04	Also they will get knowledge n the usage of nanotechnology for drug delivery	An
CO-05	Will acquire information about the tissue engineering	An, R

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

CO \ PO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	N	S	S	S	S	M	S	S	S	M	L	S	S
CO-02	S	M	M	S	M	S	S	S	S	L	L	N	L
CO-03	S	M	S	M	S	S	S	S	M	M	S	S	S
CO-04	S	S	M	S	M	S	M	M	S	S	M	S	M
CO-05	S	S	S	M	M	S	S	M	S	M	L	M	S

S-Strong,M-Medium,L-Low,N-NotRelevant

Unit I: Introduction to Nanobiology

6

Nanobiotechnology – Introduction - learning from nature - DNA nanotechnology - self- assembled DNA nanotubes and their applications - nanoparticles for biological assays - nanoparticles for drug delivery vehicles. Genetic and chemical alteration of Engineered NPs

Unit II: Nanotechnology for diagnosis**6**

Nanotechnology and patient diagnostics – optical diagnostic techniques – electrical diagnostic techniques – imaging diagnostics – nanotechnology enhanced tools - Raman spectroscopy– mass spectrometry – immunoassays - nanoscale cantilevers, for sensitive detection of cancer-related molecules – nano diagnostic systems for HIV – nanotechnology and future of patient diagnostics.

Unit III: Nanotechnology for treatment of diseases**6**

Fundamentals of targeting strategies – use of nano tubes and quantum dots – polymeric conjugates used for tumor targeted imaging and delivery - dendritic nanostructures used for cancer imaging and therapy - nanoshell based cancer therapy, use of multifunctional nanoparticles in chemotherapy. Nano encapsulation technologies for diabetes treatment – nano features and nanoparticles in restorative dentistry - nano biology in cardiology and cardiac surgery - nanotechnology in organ transplantation.

Unit IV: Nanotechnology for drug delivery**6**

Nanoparticles for targeted drug delivery - drug eluting stents - activation and targeting – development of nanostructures for drug delivery applications - polymeric nanoparticles - nanofibres- dendrimers – Liposome and lipid nanoparticles – nanotubes and fullerenes – nanogels- nanocrystals – protein nanoparticles.

Unit V: Nanotechnology for tissue engineering**6**

Introduction - scaffolds for tissue engineering- nanofibrous scaffolds - relevance and role of nano structured scaffolds in vascular, neural and cardiac tissue engineering - 3D patterning of hydrogels at nanoscale for tissue engineering applications - nanotechnologies for development of artificial skin substitutes – nanolithography– nanolithographic techniques in tissue engineering.

TOTAL: 30 HOURS**TEST BOOKS**

1. Challa S.S.R. Kumar (Ed) - Nanomaterials for Biosensors, Wiley-VCH, Verlag, Weinheim, 2007.
2. Challa S.S.R. Kumar (Ed) - Nanosystem Characterization Tools in the Life Science, Wiley-VCH, Verlag, Weinheim, 2006.
3. Arben Merkoci- Biosensing using Nanomaterials. Wiley Publication, New Jersey, 2009.
4. Challa Kumar (Ed) - Semiconductor Nanomaterials, Wiley-VCH, 2010.

REFERENCE BOOKS

1. Sulbha Kulkarni, (2017) Nanotechnology: Principles and Practices 3rd edition, Published by Capital Publishing Company; ISBN-10 :9381891265
2. M.A. Shah (Ed) Principles of Nanoscience and Nanotechnology (2020) ISBN-13- 9788184870725.

HG36A4	Metabolomics and Metabolic Engineering	L	T	P	C
		2	0	0	2

OBJECTIVE

Students will know the importance of metabolomics and metabolic engineering.

Course Outcome		Cognitive Skill
At the end of the course, students will able to		
CO-01	Get a deep knowledge about the introduction to metabolomics	R
CO-02	Also they will get knowledge in separation techniques	An
CO-03	Study about the role of metabolomics data analysis	U
CO-04	Learn the concept to metabolic engineering and its usage	E,An
CO-05	Obtain information about the analysis of metabolomics	U

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

CO \ PO	PO- A	PO- B	PO- C	PO- D	PO- E	PO- F	PO- G	PO- H	PO- I	PO- J	PO- k	PO – L	PO- M
CO-01	S	M	S	L	S	M	S	S	L	M	M	S	S
CO-02	S	S	S	S	M	S	S	S	S	L	S	M	S
CO-03	M	M	S	M	S	S	M	S	L	M	S	M	M
CO-04	N	S	S	S	S	S	M	S	S	S	M	S	M
CO-05	S	S	S	M	M	S	S	M	S	M	L	M	S

S-Strong, M-Medium, L-Low, N-Not Relevant

Unit I: Introduction to metabolomics

6

Metabolites and metabolism - Types of metabolism-primary and secondary, Structural diversity of metabolites-physical and chemical properties, metabolites in the biological system, metabolons, Metabolites isolation from the biological system.

Unit II: Separation techniques**6**

Separation methods for metabolomics - Gas chromatography (GC), HPLC, Capillary electrophoresis (CE); Detection methods-GC-MS, Secondary ion mass spectrometry (SIMS), NMR-1D and 2D.

Unit III: Metabolomic data analysis**6**

Metabolomic Data Analysis and Integration, Peak detection, retention time alignment; identification of molecular features and metabolites; structural confirmation of metabolites. Software- Multiquant, MZmine, XCMS, Marker View, Lipid Search. Metabolic pathways and inborn errors of metabolism; Metabolomics in drug discovery, Metabolic profiling, Metabolic fingerprinting, Metabolic foot-printing.

Unit IV: Metabolic Engineering**6**

Introduction to Metabolic Engineering, Basic concepts; Scopes and Applications; Metabolism (Cellular Transport processes, Fuelling Reactions) Cellular Metabolism (Biosynthetic reactions, Polymerization, Growth Energetics); Regulation of Metabolic Pathways, Reconstruction of Genome-scale metabolic network. Examples of pathway manipulations by metabolic engineering: Ethanol, Amino acids, antibiotics, vitamins, biopolymers, etc., Improvements of cellular properties, Biodegradation.

Unit V: Analysis of metabolics**6**

Metabolic Flux Analysis: Flux Balance Analysis (FBA), Flux Variability Analysis, Flux Map, Determination of Metabolic Fluxes: Isotope labelled substrate, Isotope mapping, Mapping Matrix, Isotope Distribution Vector, Application of metabolic Flux Analysis.

TOTAL: 30 HOURS**TEXTBOOKS**

1. Devlin, Thomas M. Textbook of Biochemistry: With Clinical Correlations. Hoboken, N.J.: Wiley-Liss, 2006.
2. Jeevan, K.P. Metabolomics - Fundamentals and Applications. , 2016.
3. Nelson, David L, Michael M. Cox, and Albert L. Lehninger. Lehninger Principles of Biochemistry. , 2017.
4. Nielsen, Jens H. Biotechnology for the Future. Berlin: Springer, 2011.

REFERENCE BOOKS

1. Stephanopoulos, G, Aristos A. Aristidou, and Jens H. Nielsen. Metabolic Engineering: Principles and Methodologies. San Diego: Academic Press, 1998.
2. Sussulini, Alessandra. Metabolomics: from Fundamentals to Clinical Applications. , 2017.
3. Voet, Donald, and Judith G. Voet. Biochemistry. Hoboken, NJ: John Wiley and Sons,

HG36A5	Nutrigenomics	L	T	P	C
		2	0	0	2

OBJECTIVES

Students will know the importance of nutrition and its relation to gene

Course Outcome At the end of the course, students will able to		Cognitive Skill
CO-01	Get adeep knowledge about the gene dietinteractions	R
CO-02	Understand and will get knowledge in risk of nutrigenomics	An
CO-03	Study about ther ole of genomics and proteomics in nutrigenomics	U
CO-04	Learn the concept of metabolic and computational technologiesin nutrigenomics	E,An
CO-05	Obtain information about the Nutrigenomics in industry, health professionals and in public	U

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of course outcomewith programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	S	L	S	M	S	S	L	M	M	S	S
CO-02	S	S	S	S	M	S	S	S	S	L	S	M	S
CO-03	M	M	S	M	S	S	M	S	L	M	S	M	S
CO-04	M	S	S	S	S	S	M	S	S	S	M	S	S
CO-05	S	S	S	M	M	S	S	M	S	M	L	M	M

S-Strong, M-Medium, L-Low ,N-Not Relevant

Unit I: Introduction to gene-diet interactions**6**

Nutrigenomics - Scope and Importance to Human Health and Industry. Micronutrients in humans. Polymorphisms in genes affecting the uptake and transport of omega-6 and omega-3 polyunsaturated fatty acids - interactions with dietary lipids and chronic disease risk. The intestinal microbiota - role in nutrigenomics.

Unit II: Modifying disease risk through nutrigenomics**6**

Modulating the risk of diseases like cardiovascular disease, diabetes, inflammatory bowel diseases, obesity, cancer and malnutrition through nutrigenomics.

Unit III: Genomic and proteomic technologies in nutrigenomics**6**

Genomics Techniques - Different sequencing approaches, Microarray, Mass array, SNP genotyping, PCR and RT-PCR techniques. Proteomics Techniques - 1-D, 2-Dgel electrophoresis, DIGE, novel peptide identification, peptide sequencing methods.

Unit IV: Metabolomic and computational technologies in nutrigenomics**6**

Metabolomics Techniques - Chromatography and mass spectrometry techniques, Discovery and validation of biomarkers for important diseases and disorders. Computational Approaches - Introduction to different types of public domain databases, data mining strategies, primer designing.

Unit V: Nutrigenomics in industry, health professionals and in public**6**

Nutrigenomics in food industry: Industry-Academia partnerships as an important challenge. Nutrigenomics in public - Public health significance of nutrigenomics and nutrigenomics.

TOTAL: 30 HOURS**TEXT BOOKS**

1. Raffaele DE Caterina *et al.*, Principles of Nutrigenetics and Nutrigenomics Fundamentals of Individualized Nutrition (2020) ISBN: 978-0-12-804572-5, Published by Academic Press.
2. Carsten Carlberg *et al.*, Nutrigenomics (2016) 1st edition ISBN 978-3-319-30413-7 Published by Springer International Publishing Switzerland.
3. S. Karger AG, Nutrigenetics and Nutrigenomics (2004). ISBN: 978-3-8055-7782-3, Published by Karger International, Switzerland.

REFERENCE BOOKS

1. Martin Kussmann, Nutrigenomics and Proteomics in Health and Disease: Towards a Systems-level Understanding of Gene-diet Interactions, (2017) 2nd
2. Gerald Rimbach and Jürgen Fuchs Nutrigenomics (2005) 1st Edition ISBN 9780824726638.

HG36A6	Epigenetics	L	T	P	C
		2	0	0	2

OBJECTIVES

Students will know the importance of epigenetics and the role of epigenetics in human gene expression and regulation.

Course Outcome At th end of the course, students will able to		Cognitive Skill
CO-01	Get a deep knowledge about the history of epigenetics. They will understand the fundamentals of gene expression and regulation.	R
CO-02	Acquire knowledge about the DNA methylation and the analysis of DNA methylation. Also they will get knowledge in gene variegation, X chromosome inactivation.	U
CO-03	Study about the role of regulatory elements and the mechanism which regulates the development, differentiation etc. Also theywill studyabout the factors influencing the epigenetic modifications.	E
CO-04	Learn the concept of epigenetic sand various human disorders and how-to treat the human disorders by epigenetic therapy.	An
CO-05	Obtain information about the neuronal development, evolutionary significance of epigenetics and epigenetics in drug discovery.	R

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	P O - M
CO-01	S	S	M	L	M	S	S	M	L	M	M	S	S
CO-02	S	S	S	M	M	S	S	M	S	M	L	M	L
CO-03	M	S	S	M	S	S	S	M	L	M	L	M	M
CO-04	M	S	S	S	S	S	M	M	S	S	M	S	M
CO-05	S	S	S	M	M	S	S	M	S	M	L	M	L

S-Strong,M-Medium,L-Low,N-NotRelevant

Unit I: Organization of Chromatin and Histone**6**

Introduction and brief history of epigenetics, Fundamentals of regulation of gene expression, histone code and chromatin organization – nucleosome solenoid model, Histone modifications and Histone variants and their role in gene regulation, Role of Polycomb group proteins and Trithorax group proteins.

Unit II: DNA Methylation and Epigenetic control of Gene**6**

DNA methylation and its effect on gene regulation, Mechanisms of DNA methylation, analysis of gene-specific DNA methylation, methods of assessing genome-wide DNA methylation, chromosomal position effect and gene variegation, epigenetic control of gene activity, X-chromosome inactivation.

Unit III: Regulatory elements and mechanism of regulation**6**

Role of regulatory elements - boundary elements and insulators, mechanism to regulate development, differentiation and complex diseases. Impact factors of epigenetic modifications: Diet, Metabolism, stress, Aging, memory.

Unit IV: Human disorders and Epigenetic therapy**6**

Epigenetics and human diseases: Cancer epigenetics, Cancer metabolic regulation of epigenetics metabolic diseases, brain disorders, imprinting disorders. Role of epigenetic in immune diseases and disorders. Epigenetic therapy. Non-coding RNA (ncRNA)-associated gene silencing role of epigenetics in a variety of human disorders and fatal diseases.

Unit V: Neuronal, evolutionary epigenetics and Epigenetics in drug discovery**6**

Neuronal development and function. Evolutionary significance of epigenetic modifications, transgenerational inheritance. Epigenetic programming in cell renewal and pluripotency, Epigenetics in drug discovery, Model animal systems for studying epigenetic regulation.

TOTAL:30 HOURS**TEXT BOOKS**

- 1.Introduction to Epigenetics by Renato Paro, Ueli Grossniklaus, Raffaella Santoro and Anton Wutz, 2021. Springer International Publishing, Nature Switzerland AG ISBN: 9783030686697.
- 2.Handbook of Epigenetics: The New Molecular and Medical Genetics by Trygve O. Tollesfsbol, 2017, Edison 2. Academic Press, USA.

REFERENCE BOOKS

- 1.Epigenetics by C.David Allis, Marie-Laure Caparros, Thomas Jenuwein, Danny Reinberg, Associate editor, Monica Lachner, 2015. Edition 2 Cold Spring Harbor Laboratory Press, New York
- 2.The Epigenetics Revolution by Nessa Carey, 2012. Publisher: Garland Science: 1st Edition.
- 3.Epigenetics by Lyle Armstrong, 2014. Garland Science, 1st Edition

HG36A7	Invitro Fertilization	L	T	P	C
		2	0	0	2

OBJECTIVES

Students will know the importance of different processes in invitro fertilization and its treatment protocols.

Course Outcome		Cognitive Skill
At the end of the course, students will able to		
CO-01	Acquire a deep knowledge about the basic human embryology	R
CO-02	Students will get knowledge in Oocyte.	U
CO-03	Study about the role of sperm in IVF.	E
CO-04	Learn the concept of IVF techniques.	An
CO-05	Obtain information about the embryo transfer protocols.	R

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO \ CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	M	S	M	S	M	S	S	M	L	M	M	S	M
CO-02	M	S	S	S	M	S	S	M	S	M	L	M	M
CO-03	S	S	S	S	S	S	S	M	L	M	L	M	M
CO-04	S	S	S	S	S	S	M	M	S	S	M	S	S
CO-05	M	S	S	S	M	S	S	M	S	M	L	M	M

S-Strong, M-Medium, L-Low, N-Not Relevant

Unit I: Basic Human Embryology

6

Gametogenesis, Meiosis, Implantation and placentation - Preimplantation embryo development, Development of various organs - Anatomy of Male Reproductive System, Anatomy of Female Reproductive System - Anatomy of Sperms - Physiology of Ovulation, Folliculogenesis,

Physiology of Menses - Hormonal control of human, Natural Cycle, Various stimulation protocols, Ovarian Hyper stimulation syndrome (OHSS), Complication of stimulation – Monitoring of patients, Reproductive function and causes of subfertility – Investigating male and female patients, Infertility and its management, Ultrasound, Elderly Patients Reproduction - Andrology, Physiology of Sperm, Spermatogenesis, Male Factor.

Unit II: Oocyte

6

Miscarriage, Ectopic Pregnancies, Multiple Gestation, Heterotrophic, Pregnancies - Oocyte In vitro maturation (IVM I). Generalities of IVM in domestic animals and women. In vitro maturation (IVM II). Markers of cytoplasmic and nuclear maturation. Current results in domestic animals and women. Donation Programme, Surrogacy.

Unit III: Sperm

6

Sperm Separation, Sperm Survival Test, Sperm preparation for IUI & IVF, Grading of Sperms, Semen cryopreservation-both neat and processed sample, Sperm freezing, Donor Sperm Programme. In vitro fertilization (IVF I). Generalities and current status. In vitro fertilization (IVF II). Methods of in vitro sperm capacitation. Coculture of gametes. Sperm concentration, ratio sperm/oocyte, volume of medium, coculture time.

Unit IV: In vitro fertilization

6

Intracytoplasmic Sperm Injection (ICSI). Advantages and disadvantages of ICSI and IVF techniques. Preparation of gametes. Microinjection technique: calibration of the micromanipulator, culture media for oocyte and sperm handling, sham injection, role of the polyvinylpyrrolidone in the microinjection. Evaluation of IVF and ICSI results. Methods for fixing and staining of pronuclear stage zygotes. Chronology of the development of the zygote during the first 24h.

Unit V: Embryo Culture

6

Embryo culture (EC I): generalities, methods, environmental conditions, supplements. Needs of the embryo in the early stages. Evaluation of embryonic development. Current results. Embryo culture (EC II): problems derived from in vitro culture.

TOTAL: 30 HOURS

TEXTBOOKS

1. Bruce Carlson. (2013). Human Embryology and Developmental Biology.
2. Johnson M. (2007). Essential Reproduction. 6th edition, Blackwell Scientific.
3. Elder and Dale. (2011). In vitro fertilization. 3rd edition. Cambridge University Press.

REFERENCE BOOKS

1. Gardner D.K., Weissman A., Howles C. and Shohan Z. (2018) Textbook of assisted reproductive techniques. 5th edition.
2. World Health Organization. (2010). WHO laboratory manual for the examination and processing of human semen, 5th edition.

HG36A8	Bioethics, Biosafety and Intellectual Property Rights	L	T	P	C
		2	0	0	2

OBJECTIVE

To adhere the ethical practices appropriate to the discipline at all times and to adopt safe working practices relevant to the bio industries and field of research.

Course Outcome At the end of the course, Students can able to		Cognitive Skill
CO-01	Understand the Bioethics, Biosafety and Intellectual Property Rights.	U
CO-02	Interpret the Intellectual Property Rights to take measure for the protecting their ideas.	U
CO-03	Analyze the devise business strategies by taking account of Intellectual Property Rights.	An
CO-04	Evaluate to assists in technology upgradation and enhancing competitiveness.	E
CO-05	Create the more advanced insights into regulatory affairs.	S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Program Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	P O - L	PO -M
CO-01	S	M	S	S	M	M	M	S	M	M	M	S	M
CO-02	S	M	M	S	M	M	M	M	S	M	S	M	S
CO-03	S	S	S	S	S	M	M	S	M	S	S	M	M
CO-04	S	S	S	S	S	S	S	S	M	M	S	S	M
CO-05	S	M	M	S	S	S	S	S	S	M	M	M	L

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Introduction to Bioethics**6**

Introduction to bioethics. Definition of biosafety. Biosafety for human health and environment. Social and ethical issue. Special procedure for rDNA based products, transgenic plants and animals.

Unit II: Human and Animal Ethics**6**

Human ethics – underlying ethical principles, General regulatory oversight, ethical and regulatory debate, ethics in human research, the Nuremberg code, common rules. Animal ethics - CPCSEA guidelines for laboratory animal facility - Goal, Animal procurement, Quarantine, Sterilization, Surveillance, Animal care and technical personnel, Multiple surgical procedures on single animal, Duration of experiments, Dose fixation, facilities, Environment, Animal husbandry, Activity, Food, Bedding, Water, Sanitation and cleanliness, Assessing the effectiveness of sanitation, Waste disposal, Pest control, Emergency measures.

Unit III: Regulatory affairs**6**

Regulatory affairs: regulation, national and international guidelines of biosafety, rDNA guidelines, regulatory requirements for drugs and biological Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP). Types of biosafety containment.

Unit IV: Biosafety**6**

Introduction to biosafety. Concepts, symbols and significance in experimental biological sciences. Levels of Biosafety (BSL-1to3) for Specific microorganisms. Biological Safety Cabinets. Introduction to the concept of Good Laboratory Practices (GLP).

Unit V: Intellectual Property Rights**6**

Intellectual Property Rights: Intellectual property rights and protection, patents and methods of application of patents, Trade secrets, copyrights, Trademarks, legal implication, farmer's rights, International and National conventions on biotechnology and microbiology areas, WTO guidelines.

TOTAL: 30 HOURS**TEXT BOOKS**

1. Mike, Martin and Roland Schinzinger. (1996). Ethics in Engineering, McGraw-Hill, New York.
2. Govindarajan M, Natarajan S, Senthil Kumar. V.S (2004) Engineering Ethics, Prentice Hall of India, New Delhi.
3. Byers K.B. and Wooley D.P. (2017). Biological safety: Principles and practices. 5th Edition, ASM books.
4. Sateesh M.K. (2013). Bioethics and Biosafety. I K International Publishing.
5. Goel and Parashar. (2013). IPR Biosafety and Bioethics. 1st edition. Pearson Education India.

REFERENCE BOOKS

1. Sasson A, (1993). Biotechnologies and Developing countries present and future, UNESCO Publishers.
2. Sasson A, (1998). Biotechnologies and Development countries, UNESCO Publication.
3. Edmund G Seebauer and Robert L Barry. (2001). Fundamentals of Ethics for Scientists and Engineers, Oxford University Press, Oxford, Singh K, Intellectual Property Rights on Biotechnology, BCIL, New Delhi.
4. Sibi G. (2020). Intellectual property rights, bioethics, biosafety and entrepreneurship in biotechnology. 1st Edition. I K International Publishing House Pvt. Ltd.