

Amrita School of Nanosciences and Molecular Medicine

**Program in the
Master of Technology (M.Tech)
Nanobiotechnology**

2024

Amrita Vishwa Vidyapeetham

M. TECH – NANOBIO TECHNOLOGY

EDUCATIONAL OBJECTIVES:

The M.Tech in Nanobiotechnology is a course designed for students to explore in depth the application of nanotechnology to the biomedical area. Such applications include new implant technologies, regenerative engineering, new nanomedicines to combat cancer and drug resistance, targeted medicines for treatment with reduced side effects, diagnostic technologies using nanomaterials etc. To gain strength in this new area the course covers in-depth nanomaterials and their properties, nanosystems design, the physics and chemistry of nanomaterials and applications of nanotechnology to the biomedical area, including engineering of scaffolds and the engineering of devices at the nanoscale for diagnostics and treatment.

The program also offers clinical exposure via interaction with the clinicians, which help students develop an understanding of the medical applications of nanotechnology. In short, this is a pioneering program that aims to develop an all-round scientist and technologist with interdisciplinary specialization in three areas-- nanotechnology, biotechnology and medical sciences. This course gives the students hands-on training in state-of-the-art facilities for development and characterization of nanomaterials. Additionally, the students undertake a full one year intensive research study, whereby the student completes a thesis in a topic of choice in nanomedicines, diagnosis, drug delivery, tissue engineering and regenerative medicine.

PROGRAMME EDUCATIONAL OBJECTIVES:

- To apply the principles of nanotechnology in developing more effectual and safe therapeutics and diagnostics to combat diseases, as well as guide the principles of tissue regeneration.
- To advance the learning gathered during the course and undertake research in the broad areas of bioengineering or medical practice, or for advanced study in engineering, medicine, or other related fields.
- To establish careers in their branch of study, ie., Nanotechnology or Nanomedicine, or the interdisciplinary and multidisciplinary fields such as pharmaceuticals, biotechnology polymers/advanced materials, food processing, energy, and environmental engineering.
- To develop altitude of professionalism to function effectively in the complex modern work environment, both as individuals as well as in team, with the ability to assume leadership roles and achieve understanding and appreciation of ethical behavior, social responsibility and diversity.

PROGRAM OUTCOMES

Each graduate will be able to:-

- ☐ apply knowledge of the fundamental aspects of physics, chemistry, biology and engineering principles to analyze and interpret data and design and conduct experiments safely, and also have the ability to design a process that meets desired specifications with consideration of environmental, safety, economic and ethical criteria
- ☐ utilize the education imparted during the program for an effectual understanding of the impact of nanotechnology in the fields of biotechnology and medical sciences and extend the fundamental scientific understanding to related disciplines
- ☐ demonstrate a working knowledge, including safety and environmental aspects of nanomaterials, applicability of nanomaterials in the fields of medicine for disease diagnosis and therapy, drug delivery, tissue engineering and regenerative medicine, biosensors and bioengineering design.
- ☐ have the ability to communicate effectively in written, oral, and graphical forms as well as work as a member of multidisciplinary teams, and have an understanding of team leadership.
- ☐ compete with peers in the field of Nanoscience and technology for competitive positions within or outside the country
- ☐ pursue higher learning in field of nanobiotechnology or medicine, involve in startups, be an entrepreneur or follow an academic or research career

M. TECH – NANOBIO TECHNOLOGY

First Semester

Course Code	Course Title	L T P	Credit
24NB601	Program Core I - Nanomaterials: Synthesis and Characterization	300	3
24NB602	Program Core II - Nanomaterials: Science & Properties	300	3
	Amrita Value Program		1
23HU601	Career Competency-I*	0 0 3	P/F
24NB681	Nanomaterials Lab I	004	2
22AVP103	Mastery Over Mind	102	2
	Elective I (Any One from below)	300	3
	24NB631 Advanced Cell Biology		
	24NB632 Molecular Biology		
	Elective II (Any One from below)	300	3
	24NB641 Nanobiomaterials & Tissue Interaction		
	24NB642 Bioinformatics and Structure based drug design	201	
	Total Credits		17

* Non Credit Course

Second Semester

Course Number	Course	Scheme of studies per week (LTP)	Credits
24NB611	Program Core III - Nanomedicine: Diagnosis & Therapy	300	3
24NB612	Program Core IV – Regenerative Medicine & Tissue Engineering	300	3
24NB682	Immunology & Microbiology Lab	004	2
24NB683	Nanomaterials Lab II	004	2
	Elective III (Any Two from below)	300	6
	24NB651 Drug Delivery, Pharmacokinetics & Pharmacodynamics		
	24NB652 Immunology		
	24NB653 Regulatory Aspects in Translational Medicine		
	Elective IV (Any One from below)	300	3
	24NB661 Cancer Nanotechnology		
	24NB662 Molecular Basis of Diseases		
	Total Credits		19

Third Semester

Course Number	Course	Scheme of studies per week LTP	Credits
	ELECTIVE – VI (Any One from below)	200	2
	24NB731 Molecular Diagnostics		
	24NB732 Organoids and Organs-on-Chips		
24NB798	Dissertation-I	0 0 28	14
24NB701	Statistical Data Analysis	2 0 0	2
24NB781	Cell Culture and Animal Lab	0 0 4	2
24NB702	Ethics in Research and Research Methodology	2 0 0	2
	Total Credits		22

Fourth Semester

Course Number	Course	Scheme of studies per week	Credits
24NB799	Dissertation-II	0 0 3 4	17
23HU611	Career Competency-II	0 0 3	1
	Total Credits		18
	Overall Total Credits		76

Table 2 New names for Amrita Value Programmes for PG programmes

Course Code	Title	L-T-P	Credits
22ADM502	Vedanta in day-to-day life	1-0-0	1
22AVP506	Message of Swami Vivekananda	1-0-0	1
22AVP508	Indian Arts and Literature	1-0-0	1
22AVP510	Appreciation of Kerala Mural ArtsForms	1-0-0	1
22AVP501	Message of Śrī Mātā Amritanandamayi Devi	1-0-0	1
22AVP502	Insights from the Ramayana	1-0-0	1
22AVP503	Insights from the Mahabharata	1-0-0	1
22AVP504	Insights from the Upanishads	1-0-0	1
22AVP505	Insights from Bhagavad Gita	1-0-0	1
22AVP512	Ancient Indian Science and Technology	1-0-0	1
22AVP507	Great Spiritual Teachers of India	1-0-0	1
22AVP509	Yoga and Meditation	1-0-0	1

SYLLABUS

24NB601

NANOMATERIALS SYNTHESIS & CHARACTERISATION

3 0 0 3

Pre-requisites: Basic level Physics & Chemistry

Total number of classes: 45

Course Outcomes:

- *To understand various chemical synthesis (Bottom-up) of diverse types of nanomaterials (0D, 1D and 2D)*
- *To understand various physical methods (Top-down) of fabricating nanomaterials and nanostructures*
- *Decipher information on the various class of nanomaterials based on composition, shape and size (1D, 2D, 3/0D nanostructures)*
- *To understand the application potential of nanomaterials based on their unique properties and importance of selecting appropriate synthesis methods that will suit the specific application.*
- *To learn the fundamental principles of characterizing nanomaterials for their morphology, structure, chemistry and functionality through diverse methods of microscopy, spectroscopy, scattering and diffraction.*

Course content

Nanomaterial Synthesis:

Unit 1

(No. of classes = 5)

Synthesis of nanomaterials: Basic chemistry concepts, Inorganic, organic synthesis and analytical chemistry methods, concepts of precipitation reaction, mechanisms of nanocrystal growth, LaMer theory, Oswald ripening, coalescence

Unit 2

(No. of classes = 5)

Bottom-up synthesis approaches – Nanoprecipitation reaction, synthesis of zero-dimensional metal, metal oxides, semiconductor nanoparticles by nanoprecipitation routes, high-pressure homogenization

Unit 3

(No. of classes = 5)

Bottom-up synthesis approaches- Micro-emulsion route of synthesis, basic concepts of surfactant, emulsion, micelles, reverse micelles, critical micellar concentration, micro-emulsions: water-in-oil and oil-in-water emulsions, double emulsion and applications

Unit 4

(No. of classes = 4)

Bottom-up synthesis approaches: Sol-gel method, hydrolysis and condensation, Self-assembly, Kinetically Confined Synthesis of Nanoparticles

Unit 5

(No. of classes = 4)

Template-based synthesis; Synthesis of one dimensional nanosystems by different routes – VLS and SLS methods, Synthesis of two dimensional nanosystems

Unit 6

(No. of classes = 5)

Top-down approaches: Fundamentals of nano–thin film Growth; Vapor phase deposition methods - Physical and chemical vapor phase methods; Langmuir-Blodgett Films; Electrochemical Deposition; laws of electrolysis and deposition

Characterization:

Unit 7: Structure, Morphology and Surface

(No. of classes = 10)

Crystal structure, Lattice parameters, nanoparticle size by Debye-Scherrer's formula. Working principles of the Scanning electron microscope and Transmission electron Microscope, particle size Dynamic Light scattering, Elemental analysis using energy dispersive X-ray analysis, Atomic absorption and Inductively coupled Plasma. Fundamental working principles of scanning probe microscopy (STM) Atomic Force Microscopy, confocal fluorescence microscopy

Unit 8: Spectroscopy

(No. of classes = 7)

Fundamentals of spectroscopy, vibrational and rotational spectroscopy, Nanomaterials analysis using UV-VIS, Infrared & Raman spectroscopy, Surface enhanced Raman spectroscopy using nanotechnology. FTIR and NMR spectroscopy, Basic principles and applications of Mass spectrometry, chromatography and High-pressure Liquid chromatography in nanomaterial or nanomedicine characterization.

References

1. *Nanomaterials – An introduction to synthesis, properties and applications*, D. Vollath, Wiley-VCH, Second Edition 2013.
2. *G. Cao, Nanostructures and Nanomaterials – Synthesis, Properties and Applications*, Imperial College Press 2006.
3. *Elements of X-ray Diffraction*, B. D. Cullity and S. R. Stock (Pearson)
4. *Physical Principles of Electron Microscopy*, R.F. Egerton (Springer)
5. *Scanning Probe Microscopy and Spectroscopy*, D. A. Bonnell (Wiley)
6. *Fundamentals of Molecular Spectroscopy*, C. N. Banwell (McGraw Hill)
7. *Nanostructured materials: Processing, Properties and Potential Applications*, Edited by Carl. C. Koch, Noyes Publications, 2002.
8. *Materials Science and Engineering – An Introduction*, William D Callister, 12th Edition, John Wiley (Available in Amazon India, Rs. 287)

24NB602

NANOMATERIALS: SCIENCE & PROPERTIES

3 0 0 3

Pre-requisites: Basic level Physics & Chemistry

Total number of classes: 45

COURSE OUTCOMES:

Students who complete the course will have demonstrated the following:

- *Relate electronic bonding to material properties and materials classification*
- *Map crystal directions and planes in crystalline structure*
- *Relate crystalline structure to density and ease of deformation*
- *Quantify imperfections in crystalline structure and its role on properties*
- *Quantify diffusion within solids using Fick's First and Second Laws*
- *Quantify Mechanical properties of solids in terms of stress and strain and their relationship to each other*
- *Be able to predict failure from deformation behavior and geometry*
- *Relate composite properties to the individual materials combined and their architecture*
- *Define and quantify unique polymer properties and their relationship to polymer structure*
- *Predict phase composition from composition and temperature*
- *Quantify surface area and volume in nanosystems in comparison with microsystems*
- *To be able to develop and utilize equations for the thermodynamics of nanosystems*
- *Be able to quantitatively derive and relate particle size to physical properties, including, melting point and internal pressure*
- *Predict mechanical properties of nanoparticles and nanocomposites*
- *Quantify structural and mechanical parameters of classical nanomaterials classes.*

COURSE CONTENT:

Unit 1

(No. of classes = 15)

Basic Materials Science:

Materials classification by bonding, amorphous and crystalline materials, crystal lattices, Miller indices, defects in crystal structure, principles of dislocations, theory of diffusion, mechanical properties, phase diagrams, polymeric materials, composite materials, electrical and optical properties

Unit 2

(No. of classes = 15)

Nanomaterials science:

Types of Nanomaterials, definition of nanoscale, surfaces and particle size, surface energy and surface tension and relation to size, phase transformation in nanomaterials, specific heat and heat capacity of nanomaterials, mechanical properties of nanomaterials, optical properties of nanomaterials, electrical and magnetic properties of nanomaterials.

Unit 3

(No. of classes = 10)

Inclusion and importance of surface energy, equations of thermodynamics with surface energy

Equilibrium Particle size, internal pressure and stability, nucleation processes

Unit 4

(No. of classes = 5)

Kinetics of reactions at nanoscale, Diffusion at nanoscale, ripening among nanoprecipitates.

TEXTBOOKS:

1. *Materials Science and Engineering – An Introduction, William D Callister, 12th Edition, John Wiley (Available in Amazon India, Rs. 287)*
2. *Nanomaterials – An introduction to synthesis, properties and applications, D. Vollath, Wiley-VCH, Second Edition 2013.*

Amrita Values Program

1 0 0 1

Amrita University's Amrita Values Program (AVP) is a new initiative to give exposure to students to the richness and beauty of the Indian way of life. India is a country where history, culture, art, aesthetics, cuisine, and nature exhibit more diversity than anywhere else in the world. Amrita Values Programs emphasize making students familiar with the rich tapestry of Indian life, culture, arts, science, and heritage which has historically drawn people from all over the world. Post-graduate students shall have to register for any one of the following courses, in the second semester, which may be offered by the respective school.

Courses offered under the framework of the Amrita Values Program:

22AVP501 Message of Śrī Mātā Amritanandamayī Devi

Amma's messages can be put into action in our life through pragmatism and attuning of our thought process in a positive and creative manner. Every single word Amma speaks, and the guidance received in matters which we consider trivial are rich in content and touches the very inner being of our personality. Life gets enriched by Amma's guidance, and She teaches us the art of exemplary life skills where we become witness to all the happenings around us keeping the balance of the mind.

22AVP502 Insights from the Ramayana

The historical significance of Ramayana, the first Epic in the world, influence of Ramayana on Indian values and culture, storyline of Ramayana, study of leading characters in Ramayana, influence of Ramayana outside India, misinterpretation of Ramayana by colonial powers and its impact on Indian life, relevance of Ramayana for modern times.

22AVP503 Insights from the Mahabharata

The historical significance of Mahabharata, the largest Epic in the world, influence of Mahabharata on Indian values and culture, storyline of Mahabharata, study of leading characters in Mahabharata, Kurukshetra War and its significance, importance of Dharma in society, message of the Bhagavad Gita, relevance of Mahabharata for modern times.

22AVP504 Insights from the Upanishads

Introduction: Sruti versus Smṛti, overview of the four Vedas and the ten Principal Upanishads, the central problems of the Upanishads, ultimate reality, the nature of Atman, the different modes of consciousness, Sanātana Dharma and its uniqueness, The Upanishads and Indian Culture, relevance of Upanishads for modern times, a few Upanishad Personalities: Nachiketas, Satyakama Jabala, Aruni, Shvetaketu.

22AVP505 Insights from Bhagavad Gita

Introduction to Bhagavad Gita, brief storyline of Mahabharata, context of Kurukshetra War, the anguish of Arjuna, counsel by Sri. Krishna, key teachings of the Bhagavad Gita,

Karma Yoga, Jnana Yoga, and Bhakti Yoga, theory of Karma and Reincarnation, concept of Dharma, idea of the self and realization of the self, qualities of a realized person, concept of Avatar, relevance of Mahabharata for modern times.

22AVP506 Message of Swami Vivekananda

Brief sketch of Swami Vivekananda's life, meeting with Guru, disciplining of Narendra, travel across India, inspiring life incidents, address at the parliament of religions, travel in the United States and Europe, return and reception in India, message to Indians about our duties to the nation.

22AVP507 Great Spiritual Teachers of India

Sri Rama, Sri Krishna, Sri Buddha, Adi Shankaracharya, Sri Ramanujacharya, Sri Madhvacharya, Sri Ramakrishna Paramahansa, Swami Vivekananda, Sri Ramana Maharshi, Mata Amritanandamayi Devi

22AVP508 Indian Arts and Literature:

The aim of this course is to present the rich literature, culture of ancient India, and help students appreciate their deep influence on Indian life, Vedic culture, the primary source of Indian culture, brief introduction, and appreciation of a few of the art forms of India, arts, music, dance, theatre, paintings, sculpture and architecture, the wonder language, Sanskrit, and ancient Indian Literature.

22AVP509 Yoga and Meditation

The objective of the course is to provide practical training in YOGA ASANAS with a sound theoretical base and theory classes on selected verses of Patanjali's Yoga Sutra and Ashtanga Yoga. The coverage also includes the effect of yoga on integrated personality development.

22AVP510 Appreciation of Kerala's Mural Art Forms:

A mural is any piece of artwork painted or applied directly on a wall, ceiling, or another large permanent surface. In the contemporary scenario, Mural painting is not restricted to permanent structures and is being done even on canvas. A distinguishing characteristic of mural painting is that the architectural elements of the given space are harmoniously incorporated into the picture. Kerala mural paintings are frescos depicting mythology and legends, which are drawn on the walls of temples and churches in South India, principally in Kerala. Ancient temples, churches, and places in Kerala, South India, display an abounding tradition of mural paintings mostly dating back to the 9th to 12th centuries CE when this form of art enjoyed Royal patronage. Learning Mural painting through the theory and practice workshop is the objective of this course.

22AVP512 Ancient Indian Science and Technology

Science and technology in ancient and medieval India covered all the major branches of human knowledge and activities, including mathematics, astronomy, physics, chemistry, medical science and surgery, fine arts, mechanical, civil engineering, architecture, shipbuilding, and navigation. Ancient India was a land of sages, saints, and seers as well as a land of scholars and scientists. The course gives awareness of India's contribution to science and technology.

Pre-requisite: An open mind and the urge for self-development, basic English language skills and knowledge of high school level arithmetic.

Course Objectives:

- Help students transit from campus to corporate and enhance their soft skills
- Enable students to understand the importance of goal setting and time management skills
- Support them in developing their problem solving and reasoning skills
- Inspire students to enhance their diction, grammar and verbal reasoning skills

Course Outcomes:

CO1: Soft Skills - To develop positive mindset, communicate professionally, manage time effectively and set personal goals and achieve them.

CO2: Soft Skills - To make formal and informal presentations with self-confidence.

CO3: Aptitude - To analyze, understand and employ the most suitable methods to solve questions on arithmetic and algebra.

CO4: Aptitude - To analyze, understand and apply suitable techniques to solve questions on logical reasoning and data analysis.

CO5: Verbal - To infer the meaning of words and use them in the right context. To have a better understanding of the nuances of English grammar and become capable of applying them effectively.

CO6: Verbal - To identify the relationship between words using reasoning skills. To understand and analyze arguments and use inductive/deductive reasoning to arrive at conclusions and communicate ideas/perspectives convincingly.

CO-PO Mapping

PO	PO1	PO2	PO3
CO1	2	1	-
CO2	2	1	-
CO3	2	1	-
CO4	2	1	-
CO5	1	2	-
CO6	2	2	-

Syllabus

Soft Skills

Introduction to 'campus to corporate transition':

Communication and listening skills: communication process, barriers to communication, verbal and non-verbal communications, elements of effective communication, listening skills, empathetic listening, role of perception in communication.

Assertiveness skills: the concept, assertiveness and self-esteem, advantages of being assertive, assertiveness and organizational effectiveness.

Self-perception and self-confidence: locus of control (internal v/s external), person perception, social perception, attribution theories-self presentation and impression management, the concept of self and self-confidence, how to develop self-confidence.

Goal setting: the concept, personal values and personal goals, goal setting theory, six areas of goal setting, process of goal setting: SMART goals, how to set personal goals

Time management: the value of time, setting goals/ planning and prioritizing, check the time killing habits, procrastination, tools for time management, rules for time management, strategies for effective time management

Presentation skills: the process of presentation, adult learning principles, preparation and planning, practice, delivery, effective use of voice and body language, effective use of audio visual aids, dos and don'ts of effective presentation

Public speaking-an art, language fluency, the domain expertise (Business GK, Current affairs), self-confidence, the audience, learning principles, body language, energy level and conviction, student presentations in teams of five with debriefing

Verbal

Vocabulary: Familiarize students with the etymology of words, help them realize the relevance of word analysis and enable them to answer synonym and antonym questions. Create an awareness about the frequently misspelt words, commonly confused words and wrong form of words in English.

Grammar: Train students to understand the nuances of English Grammar and thereby enable them to spot grammatical errors and punctuation errors in sentences.

Reasoning: Stress the importance of understanding the relationship between words through analogy questions and learn logical reasoning through syllogism questions. **Emphasize the importance of avoiding the gap (assumption) in arguments/ statements/ communication.**

Oral Communication Skills: Aid students in using the gift of the gab to improve their debating skills.

Writing Skills: Introduce formal written communication and keep the students informed about the etiquettes of email writing. **Make students practise writing emails especially composing job application emails.**

Aptitude

Numbers: Types, Power Cycles, Divisibility, Prime, Factors & Multiples, HCF & LCM, Surds, Indices, Square roots, Cube Roots and Simplification.

Percentage: Basics, Profit, Loss & Discount, and Simple & Compound Interest.

Ratio, Proportion & Variation: Basics, Alligations, Mixtures, and Partnership.

Averages: Basics, and Weighted Average.

Time and Work: Basics, Pipes & Cistern, and Work Equivalence.

Time, Speed and Distance: Basics, Average Speed, Relative Speed, Boats & Streams, Races and Circular tracks.

Statistics: Mean, Median, Mode, Range, Variance, Quartile Deviation and Standard Deviation.

Data Interpretation: Tables, Bar Diagrams, Line Graphs, Pie Charts, Caselets, Mixed Varieties, and other forms of data representation.

Equations: Basics, Linear, Quadratic, Equations of Higher Degree and Problems on ages.

Logarithms, Inequalities and Modulus: Basics

References

Soft Skills

Communication and listening skills:

- Andrew J DuRbin , “Applied Psychology: Individual and organizational effectiveness”, Pearson- Merrill Prentice Hall, 2004
- Michael G Aamodt, “An Applied Approach, 6th edition”, Wadsworth Cengage Learning, 2010

Assertiveness skills:

- Robert Bolton, Dorothy Grover Bolton, “People Style at Work..and Beyond: Making Bad Relationships Good and Good”, Ridge Associates Inc., 2009
- John Hayes “Interpersonal skills at work”, Routledge, 2003
- Nord, W. R., Brief, A. P., Atieh, J. M., & Doherty, E. M., “Meanings of occupational work: A collection of essays (pp. 21- 64)”, Lexington, MA: Lexington Books, 1990

Self-perception and self-confidence:

- Mark J Martinko, “Attribution theory: an organizational perspective”, St. Lucie, 1995
- Miles Hewstone, “Attribution Theory: Social and Functional Extensions”, Blackwell, 1983

Time management:

- Stephen Covey, “The habits of highly effective people”, Free press Revised edition, 2004
- Kenneth H Blanchard , “The 25 Best Time Management Tools & Techniques: How to Get More Done Without Driving Yourself Crazy” , Peak Performance Press, 1st edition 2005
- Kenneth H. Blanchard and Spencer Johnson, “The One Minute Manager” , William Morrow, 1984

Verbal

- Erica Meltzer, “The Ultimate Guide to SAT Grammar”
- Green, Sharon, and Ira K. Wolf, “Barron's New GRE”, Barron's Educational Series, 2011
- Jeff Kolby, Scott Thornburg & Kathleen Pierce, “Nova’s GRE Prep Course”
- Kaplan, “Kaplan New GRE Premier”, 2011-2012
- Kaplan’s GRE Comprehensive Programme
- Lewis Norman, “Word Power Made Easy”, Goyal Publishers, Reprint edition, 1 June 2011
- Manhattan Prep, “GRE Verbal Strategies Effective Strategies Practice from 99th Percentile Instructors”
- Pearson- “A Complete Manual for CAT”, 2013
- R.S. Aggarwal, “A Modern Approach to Verbal Reasoning”
- S. Upendran, “Know Your English”, Universities Press (India) Limited, 2015
- Sharon Weiner Green, Ira K. Wolf, “Barron's New GRE, 19th edition (Barron's GRE)”, 2019
- Wren & Martin, “English Grammar & Composition”
- www.bbc.co.uk/learningenglish
- www.cambridgeenglish.org
- www.englishforeveryone.org
- www.merriam-webster.com

Aptitude

- Arun Sharma, “How to Prepare for Quantitative Aptitude for the CAT Common Admission Test”, Tata Mc Graw Hills, 5th Edition , 2012
- Arun Sharma, “How to Prepare for Logical Reasoning for the CAT Common Admission Test”, Tata Mc Graw Hills, 2nd Edition, 2014
- Arun Sharma, “How to Prepare for Data Interpretation for the CAT Common Admission Test”, Tata Mc Graw Hills, 3rd Edition, 2015
- R.S. Aggarwal, “Quantitative Aptitude For Competitive Examinations”, S. Chand Publishing, 2015
- R.S. Aggarwal, “A Modern Approach To Verbal & Non-Verbal Reasoning”, S. Chand Publishing, Revised -2015
- Sarvesh Verma, “Quantitative Aptitude-Quantum CAT” , Arihant Publications, 2016

- www.mbatious.com
- www.campusgate.co.in
- www.careerbless.com

Evaluation Pattern

Assessment	Internal	External
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50
Pass / Fail		

*CA - Can be **presentations, speaking activities and tests.**

24NB681

NANOMATERIALS LAB I

0 0 4 2

Pre-requisites: Basic understanding of experimental research

Total number of lab sessions: 15

COURSE OUTCOME:

After successful completion of the course, students will be able to:

- *Understand the preparation of standard solutions in different concentration units: Molarity, Molality and Normality*
- *Understand the synthesis of metal nanoparticles.*
- *Learn synthesis of plasmonic silver nanoparticles and observe its color change with varying size & shape of nanoparticles.*
- *Understand the principle and working of UV -Vis absorption spectroscopy technique and relation of absorption peak of silver nanoparticles with size and shape changes.*
- *Understand the synthesis of nanoparticles in non-aqueous route and observe its luminescence under UV lamp to understand quantum confinement effect.*
- *Understand the synthesis of nanoparticles in aqueous route and study the fluorescence properties of nanoparticles using spectrofluorometer*
- *Understand the UV-VIS absorption properties of nanoparticles and estimation of particle size using Brus equation*
- *Understand the principles of Atomic Force Microscope (AFM) and hands on experience in use of AFM in nanoparticle size characterization*
- *Understand the principles of Scanning Electron Microscope (SEM) and its use in characterizing nanoparticles*

Unit 1 (Lab sessions = 4)

Introduction to Nanolab and standard solution preparation, Synthesis of plasmonic silver nanoparticles *study its color change with varying size & shape of nanoparticles using UV -Vis absorption spectroscopy*

Unit 2 (Lab sessions = 5)

Preparation of metal oxide ZnO nanoparticles (Non-Aqueous route) and observe its luminescence under UV lamp, UV-VIS absorption properties of ZnO nanoparticles and estimation of particle size using Brus equation

Unit 3 (Lab sessions = 2)

Synthesis of Mn doped ZnS nanoparticles in aqueous route and study the fluorescence properties of nanoparticles using spectrofluorometer

Unit 4 (Lab sessions = 4)

Synthesis of Iron oxide nanoparticles by aqueous route and study its magnetism

Unit 5 (Lab sessions = 5)

Nanoparticle imaging for size and shape analysis using *Atomic Force Microscope (AFM) and Scanning Electron Microscope (SEM) characterizing nanoparticles*

References:

- A Handbook of Laboratory Solutions, M H Gabb, Scientific Publishers, 2013
- Nanostructures & Nanomaterials: Synthesis, Properties & Applications; Guozhong Cao, Imperial College Press

22AVP103

Mastery Over Mind (MAOM)

1-0-2 2

1. Course Overview

Master Over the Mind (MAOM) is an Amrita initiative to implement schemes and organise university-wide programs to enhance health and wellbeing of all faculty, staff, and students (UN SDG -3). This program as part of our efforts for sustainable stress reduction gives an introduction to immediate and long-term benefits and equips every attendee to manage stressful emotions and anxiety facilitating inner peace and harmony.

With a meditation technique offered by Amrita Chancellor and world-renowned humanitarian and spiritual leader, Sri Mata Amritanandamayi Devi (Amma), this course has been planned to be offered to all students of all campuses of AMRITA, starting off with all first years, wherein one hour per week is completely dedicated for guided practical meditation session and one hour on the theory aspects of MAOM. The theory section comprises lecture hours within a structured syllabus and will include invited guest lecture series from eminent personalities from diverse fields of excellence. This course will enhance the understanding of experiential learning based on university's mission: "Education for Life along with Education for Living", and is aimed to allow learners to realize and rediscover the infinite potential of one's true Being and the fulfilment of life's goals.

2. Course Syllabus

Unit 1

(4 hours)

Causes of Stress: The problem of not being relaxed. Need for meditation -basics of stress management at home and workplace. Traditions and Culture. Principles of meditation– promote a sense of control and autonomy in the Universal Human Value System. Different stages of Meditation. Various Meditation Models. Various practices of Meditation techniques in different schools of philosophy and Indian Knowledge System.

Unit 2

(4 hours)

Improving work and study performance. Meditation in daily life. Cultivating compassion and good mental health with an attitude of openness and acceptance. Research and Science of Meditation: Significance of practising meditation and perspectives from diverse fields like science, medicine, technology. philosophy, culture, arts, management, sports, economics, healthcare, environment etc. The role of meditation for stress and anxiety reduction in one's life with insights based on recent cutting-edge technology. The effect of practicing meditation for the wholesome wellbeing of an individual.

Unit 3

(4 hours)

Communications: principles of conscious communication. Relationships and empathy: meditative approach in managing and maintaining better relationships in life during the interactions in the world, role of MAOM in developing compassion, empathy and responsibility, instilling interest, and orientation to humanitarian projects as a key to harness intelligence and compassion in youth. Methodologies to evaluate effective awareness and relaxation gained from meditation. Evaluating the global transformation through meditation by instilling human values which leads to service learning and compassion driven research.

TEXT BOOKS:

- 1.Mata Amritanandamayi Devi, "Cultivating Strength and vitality," published by Mata Amritanandamayi Math, Dec 2019
- 2.Swami Amritaswarupananda Puri , "The Color of Rainbow " published by MAM, Amritapuri.

REFERENCES:

- 1.Craig Groeschel, "Winning the War in Your Mind: Change Your Thinking, Change Your Life" Zondervan Publishers, February 2019
- 2.R Nagarathna et al, "New Perspectives in Stress Management "Swami Vivekananda Yoga Prakashana publications, Jan 1986
3. Swami Amritaswarupananda Puri "Awaken Children Vol 1, 5 and 7 - Dialogues with Amma on Meditation", August 2019
4. Swami Amritaswarupananda Puri "From Amma's Heart - Amma's answer to questions raised during world tours" March 2018
5. Secret of Inner Peace- Swami Ramakrishnananda Puri, Amrita Books, Jan 2018.
6. Mata Amritanandamayi Devi "Compassion :The only way to Peace:Paris Speech", MA Center, April 2016.
7. Mata Amritanandamayi Devi "Understanding and collaboration between Religions", MA Center, April 2016.
8. Mata Amritanandamayi Devi "Awakening of Universal Motherhood: Geneva Speech" M A center, April 2016.

3. Evaluation and Grading

Internal		External		Total
Components	Weightage		Practical (attendance and class participation) 60%	100%
Quizzes(based on the reading material)	20%	40%		
Assignments (Based on webinars and lecture series)	20%			

4. Course Outcomes (CO)

CO1: Relate to the causes of stress in one's life.

CO2: Experiment with a range of relaxation techniques

- CO3: Model a meditative approach to work, study, and life.**
CO4: Develop appropriate practice of MA-OM technique that is effective in one's life
CO5: Inculcate a higher level of awareness and focus.
CO6: Evaluate the impact of a meditation technique

***Program Outcomes (PO)** (As given by NBA and ABET)

- PO1:** Engineering Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Engineer and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

CO – PO Affinity Map

PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
CO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO 1	3	3	3	2		-	2	3	-	3	-	3	-	-	-
CO 2	3	3	3	2	2	-	2	3	3	3	-	3	-	-	-
CO 3	3	3	2	2	2	2	2	3	3	3	-	3	-	-	-
CO 4	3	3	3	2	-	2	3	3	3	3	-	3	-	-	-
CO 5	3	2	2	2	-	2	-	3	2	2	-	2	-	-	-
CO 6	3	2	2	2	3	2	-	3	2	2	-	2	-	-	-

ELECTIVE I (Any ONE from below)

24NB631

ADVANCED CELL BIOLOGY

3 0 0 3

Pre-requisites: Basic level biology

Total number of classes: 45

COURSE OUTCOMES:

After completion of course, student would be able:

- *To comprehend cell as the basic unit of life by studying the universal features of cells that distinguish the living and nonliving*
- *To understand the internal organization of cells, molecular bases of membrane transport, intracellular membrane traffic, cell communication, cytoskeleton and cell death*

- *To perceive about a cell in its social context by studying cell – cell adhesions and cell – matrix associations*
- *To understand cancer as a microevolutionary process from a cellular perspective*
- *To appreciate the ability of cells to reproduce and sustain genetic diversity on earth*
- *To understand how cells undergo dynamic changes during development to attain shape and form*

LECTURE WITH BREAKUP:

Unit-1

8 Lectures

Cellular basis of life: Universal features of cells and how these features separate the living world from non-living world, Cells and laws of thermodynamics; Cell membrane: Membrane structure and how it supported origin of life, Role of membrane asymmetry in cellular functions, Membrane proteins and how they support cellular diversity, Transport of small molecules across the membranes and electrical properties of membranes, Types of membrane transport and examples of molecular mechanisms involved in transport;

Unit-2

9 Lectures

Internal organization of cells: Intracellular compartments and protein sorting: Compartmentalization of cells, Transport of proteins between intracellular compartments, Molecular mechanisms underlying protein sorting and transport across intracellular compartments, Glycosylation and its significance; Intracellular membrane traffic: Intracellular vesicular transport and underlying molecular mechanisms, Maintenance of compartmental diversity, Molecular mechanisms underlying specificity of molecular transport, Molecular mechanisms underlying transport into the cell from the plasma membrane and transport from trans-golgi network to cell exterior;

Unit-3

8 Lectures

Communication between cells and the exterior: Cell signaling: General principles governing cell signaling, Types of cell communication, Negative feedback, Positive feedback, Signaling through GPCRs and enzyme-coupled surface receptors; Cytoskeleton: Types of cytoskeletal filaments, Molecular mechanisms involved in self-assembly and dynamic structure of cytoskeletal filaments, Polymerization and depolymerization of cytoskeletal filaments coupled to cellular functions, Molecular motors and their significance in intracellular transport, Cytoskeleton in cell division;

Unit-4

8 Lectures

Cellular reproduction, the basis of sustenance of life on earth: Cell cycle: Role of templated polymerization of DNA in cellular reproduction and sustenance of life, Cell cycle control system in each phase of cell cycle, Regulation of cell cycle control system in different phases of cell cycle, Molecular mechanisms underlying cell cycle regulation, Control of cell growth; Apoptosis: Different types of cell death, Molecular pathways underlying cell death, Biological significance of cell death; Cancer from a cell's perspective: Cancer as a microevolutionary process resulting from failure of cellular surveillance system;

Unit-5

4 Lectures

Cells in their social context: Contacts between cell to cell and cells to extracellular matrix: Cell adhesions, Extracellular matrix, Types of junctions between cells and cells and matrix, Role of junctions in tissue formation and functions of organs;

Unit-6

4 Lectures

How cells ensure continuity of life as well as genetic diversity on earth: Germ cells and sexual reproduction: Germ cells as the cells equipped to transfer genetic information between generations, Sexual reproduction as a cellular process ensuring genetic diversity at the organismal levels

Unit-7

4 Lectures

Cells during development: Developmental dynamics of cells: How cells undergo commitment, specification and lineage diversification during development, Contribution of cells in pattern formation, Developmental biology of cells from the perspective of diseases and tissue maintenance;

TEXT BOOK:

Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P, "Molecular Biology of the Cell", Fifth and Sixth Editions, Garland Publishing Inc. 2008.

REFERENCE:

Gerald Karp, "Cell and Molecular Biology", Fifth Edition, John Wiley, 2008

24NB632

MOLECULAR BIOLOGY

3 0 0 3

Pre-requisites: Basic level biology

Total number of classes: 45

LECTURE WITH BREAKUP:

Unit I

Lectures 10

DNA: Structure and function, Chromosome and chromatin, Genetic code, wobble hypothesis, RNA and types of RNA, Proteins and their structure

Unit II

Lectures 10

DNA replication and its regulation, Homologous and site specific recombination, DNA repair

Unit III

Lectures 10

Transcription and its regulation, Translation and its regulation, Gene structure, Repeats and clusters, Gene expression regulations: operon, Epigenetics

Unit IV

Lectures 5

Types of mutations, Genetic system of mitochondria

Unit V

Lectures 10

Gene identification, promoter identification, Molecular biology techniques: Isolation and Quantification of DNA/RNA, PCR, Reverse transcriptase PCR, Real Time PCR, DNA Sequence analysis, hybridization (southern, northern and western) and Sanger sequencing.

TEXT BOOK:

Lewin's Essential Genes, Jocelyn E. Krebs, Benjamin Lewin, Elliott S. Goldstein, Stephen T. Kilpatrick, Jones & Bartlett Publishers, 2013 - Science - 847 pages

REFERENCES

Molecular Biology of the Gene, Seventh Edition, James D. Watson, Cold Spring Harbor Laboratory; Tania A. Baker, Massachusetts Institute of Technology; Alexander Gann, Cold Spring Harbor Laboratory; Michael Levine, University of California, Berkeley; Richard Losick, Harvard University, 2013

ELECTIVE II (Any ONE from below)**24NB642 BIOINFORMATICS & STRUCTURE BASED DRUG DESIGN 2-0-1-3**

Pre-requisites: Basic understanding of computer and biology

Total number of classes: 45

Course Outcome

- Basic concepts on amino acids, peptide bond, Genomics basics, database analysis and structure-property relationships.
- Pairwise and Multiple sequence alignment methods, algorithms and applications and understanding the sequence conservation for protein sequence-function relationships
- Molecular docking, pharmacophore modeling, protein ligand complex interactions and its mechanism of action, QSAR, QSPR, QSTR techniques used in Chemoinformatics field.
- Different techniques in Machine learning and deep learning, concepts taught to make awareness in molecular modeling studies. Its integration with wet lab studies will be discussed.
- Skills working in Linux environment; Different linux commands and linux editor will be taught; Sequence alignment studies; Macromolecule sequence-structure and function studies and visualization using different software.

Syllabus**Unit 1****Lectures 12**

Introduction to Concept of Genomics, Proteomics and Bioinformatics; Databases on web: Genome, Proteome and Molecular biology; Sequence alignment: Near-optimal sequence alignment; Global pair wise sequence alignment; Multiple sequence alignment; Genome rearrangement; Evolutionary Bioinformatics: Phylogenetic tree construction and analysis. Different methods used for protein evolution; Protein Modeling: Protein structure prediction and analysis, Protein visualization software, Protein dynamics and Protein structure validation tools.

Unit 2**Lectures 12**

Chemoinformatics: Basic idea of molecule design, Visualization and generation of 2D and 3D molecular structures, Chemical databases and its implications, Pharmacophore model, Virtual screening, Ligand based and structure-based molecular design; Commands and Languages: Basic Unix and Linux commands,

Extensible markup language and its use in Bioinformatics; Sequence similarity and database search: Pattern recognition and matching; Quantitative and probabilistic pattern matching; Sequence pattern databases, Spectral pattern matching, String matching algorithm.

Unit 3

Lectures 6

Machine learning, Deep learning and Artificial Intelligence in Drug discovery; Few case studies of integrating this methodology towards in vitro/in vivo model systems in understanding the molecular basis of the disease.

Unit 4

Lectures 15

Lab course work: Basic linux commands and linux editors, X-windows and linux environment used for learning different linux commands and text editors like vi, xedit etc. Exposure to different useful databases, virtual screening and Data mining, Different biologically important databases were explored. Structural similarity search of drug like molecules were mined from different small molecular databases. Sequence alignment studies of protein family using BLAST software.

TEXT BOOKS:

1. Mount D W, "Bioinformatics Sequence and Genome Analysis", Cbs Publishers & Distributors (2003), ISBN: 8123909985
2. Jenny G and Philip E B, "Structural Bioinformatics", Second Edition, Wiley-Blackwell publisher (2011). ISBN: 978-1-118-21056-7
3. Practical Bioinformatics; Editors: Bujnicki, Janusz M. (Ed.), Series: Nucleic Acids and Molecular Biology, Springer publisher, 10.1007/978-3-540-74268-5, 2008.

REFERENCES:

Mohan CG, "Structural Bioinformatics- Applications in Preclinical Drug Discovery Process", Springer Nature Publisher, 2019. ISBN 978-3-030-05282-9.

22NB641 NANOBIMATERIALS AND TISSUE INTERACTIONS

3 0 0 3

Pre-requisites: Undergraduate level basic physics, chemistry and biology

Total number of classes: 45

COURSE OUTCOMES:

Students on completion of this course will –

- Understand the basic concept of a biomaterial and its applications in medicine
- Comprehend the different types of biomaterials useful in diverse biomedical applications, with their specific properties
- Decipher the interactions of biomaterials with tissues and how nanoscale size effects influence the biological interactions
- Learn about the diverse biofabrication techniques for developing biomaterial scaffolds

LECTURE WITH BREAKUP:

UNIT I:

15 lectures

Introduction to Biomaterials: Basic concepts of biomaterials science, definition, Concept of biocompatibility.

Classes of biomaterials in Medicine: Metals, Ceramics, Polymers, Composites; Bioresorbable; Bioinert, Bioactive and Biomimetic Materials, Materials at the Nanoscale – nanoparticles, nanofibers, nanocomposites

UNIT II: **15 lectures**

Biomaterials Fabrication: Solvent casting, salt leaching and lyophilisation, Electrospinning, Hydrogels, Cryogels, Surface modified biomaterials, 3D printing, 3D bioprinting-Cell encapsulation, Current advances and challenges in 3D printing.

UNIT III: **15 lectures**

Material-tissue interactions: Protein and Cell-Material interactions, Blood - material interactions, Inflammatory and immune response to biomaterials, Angiogenic response to biomaterials

Influence of Nanoscale Properties on Cellular Interactions - Porosity, Mechanical strength, Surface characteristics & modifications, Degradation

TEXTBOOKS/REFERENCES:

1. Biomaterials Science: An Introduction to Materials in Medicine, Edited by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons. 2020
2. Ying Deng and Jordan Kuiper, Functional 3D Tissue Engineering Scaffolds: Materials, Technologies, and Applications (Woodhead Publishing Series in Biomaterials), 2017
3. Cato T. Laurencin, Lakshmi S. Nair. Nanotechnology and Regenerative Engineering: The Scaffold, Second Edition, CRC Press 2017

SECOND SEMESTER

24NB611

NANOMEDICINE: DIAGNOSIS & THERAPY

3 0 0 3

Pre-requisites: Basic level physics, chemistry and biology

Total number of classes: 45

COURSE OUTCOMES:

Upon successful completion, students will have the knowledge and skills to:

- *Understand the fundamental concepts of nanomedicine*
- *Comprehend the factors controlling the pharmacokinetics of various drug formulations*
- *Understand the benefits of nanodrug delivery*
- *Various types of advanced drug delivery systems based on nanotechnology*
- *Concepts of targeted drug delivery*
- *An overview of the medical diagnostic tools*
- *Introduction to the nanomaterials in medical diagnostics*
- *Understanding about various nano bio-sensors and microfluidic sensors*

- *Understanding the current status of nanotechnology based diagnostic devices commercially available and under clinical trials*

LECTURE WITH BREAKUP:

Unit-1 15 lectures

Concepts of Nanomedicine – Controlled drug delivery, Advantages of nanotechnology in drug delivery, Design, fabrication, evaluation and applications of the nanosystems for drug and gene delivery – Polymeric Nanoparticles, Liposomes, Micelles, Solid Lipid Nanoparticles, Dendrimers, Implants and inserts, General characteristics of nanomaterials used in drug/gene delivery – Drug encapsulation, Drug release, Effect of particle size/surface charge in drug delivery

Unit-2 10 Lectures

Nano Drug Delivery via Different Routes: Oral Drug Delivery - Concepts of Mucoadhesion; Intravenous Drug Delivery using nanoparticles - Concept of opsonisation; Transdermal, Intranasal and Ocular Drug Delivery using Nanoparticles, Strategies for Advanced Drug Delivery:-Prodrug and Bioconjugation; Concept of Drug Targeting, Site Specific Drug delivery utilizing Monoclonal Antibodies, Peptides and other biomolecules, Nanovaccines

Unit-3 10 Lectures

Medical Diagnosis- from biomarkers to cells and tissues; Clinical diagnostic imaging tools: MRI, PET, CT, Ultrasound, Nuclear and Optical imaging –an overview; Diagnostic nanoscale materials in imaging; Molecular imaging techniques

Unit-4 10 lectures

Nanobiosensors in diagnosis- electrochemical sensors, enzymatic and non-enzymatic sensors, cantilever based sensors, piezoelectric biosensors, Lab-on-a-chip concept, Microfluidics, surface enhanced Raman spectroscopy based diagnostics, surface plasmon based biosensors; Current nanotechnology based diagnostics in use and under clinical trials.

TEXT BOOKS/ REFERENCES:

1. *Drug Delivery Systems, Pieter Stroeve and Morteza Mahmoudi, World Scientific Series: From Biomaterials towards Medical Devices, Vol I, 2018.*
2. *Nanoparticulates as Drug Carriers, Vladimir Torchillin, Imperial College Press, 2006*
3. *Emerging nanotechnologies for diagnostics, drug delivery and medical devices, Kishore Cholkar, Abhirup Mandal, Ashim Mitra, Elsevier (2017)*
4. *Nanobiosensors and Nanobioanalyses, Vestergaard MC, Kerman K, Hsing IM, Tamiya E, Springer 2015*
Current Medical Diagnosis and Treatment, Maxine A Papadakis, McGraw Hill Education,

Pre-requisites: Undergraduate level biology, biotechnology and physiology

Course code:

Course name: REGENERATIVE MEDICINE & TISSUE ENGINEERING

Credits: 3

Pre-requisites: Undergraduate level basic physics, chemistry and biology

Total number of classes: 45

COURSE OUTCOMES:

Upon successful completion, students will have the

- *Understanding on the molecules and signalling pathways that regulate epithelial and mesenchymal states of tissues and cell – extracellular matrix interactions*
- *Knowledge on the various types and sources of stem cells and their role in tissue growth, repair and regeneration*
- *Understanding on the importance of vascularisation and the challenges associated with establishing vascularisation in tissue engineered constructs*
- *Knowledge on the inherent regenerative mechanisms in human body*
- *Knowledge on the therapeutic applications of cells, and cells derived products in regenerative medicine*

LECTURE WITH BREAKUP:

Unit-1

9 Lectures

Biologic and Molecular Basis for Regenerative Medicine: Current perspectives in Regenerative Medicine; Types of Tissues; Molecular organisation of cells; Extracellular Matrix; Cell-extracellular matrix interactions

Unit-2

9 Lectures

Cellular aspect of Regenerative Medicine: Stem cells and progenitors; Types of stem cells, Embryonic stem cells, induced pluripotent stem cells, Mesenchymal stem cells, Hematopoietic stem cells, Adult stem cells

Unit-3

12 Lectures

Different Stages of Tissue Regeneration: Basic cell structure and functions; Tissue organisation and functions; Organ structure and functions, Scar and Regeneration; Different stages of regeneration - Hemostasis, Inflammation, Proliferation, Angiogenesis, Remodelling; Case studies - Skin regeneration, Bone regeneration, Liver regeneration.

Unit-4

15 Lectures

Tissue Engineering: Relevance of tissue engineering; Triad of Tissue engineering - Scaffolds Types (Ceramics, Polymers, Composites Biomimetic scaffold); Cells, Growth factors; Case Studies: Ectoderm derived tissues (*Nerve tissue, Cornea*), Endoderm derived tissues (Liver, Pancreas), Mesoderm (Bone, Cartilage, Muscle, blood vessels, ligament, Tendon). Recent advances in biofabrication; 3D bioprinting

TEXT BOOK

Principles of Regenerative Medicine, Anthony Atala, Robert Lanza James, Thomson Robert Nerem, 2nd Edition, Elsevier -2010

REFERENCES:

1. Ying Deng and Jordan Kuiper, *Functional 3D Tissue Engineering Scaffolds: Materials, Technologies, and Applications (Woodhead Publishing Series in Biomaterials)*, 2017
2. Cato T. Laurencin, Lakshmi S. Nair. *Nanotechnology and Regenerative Engineering: The Scaffold, Second Edition, CRC Press 2017*

24NB682

IMMUNOLOGY & MICROBIOLOGY LAB

0 0 4 2

Pre-requisites: Basic understanding of experimental research

Total number of lab sessions: 15

COURSE OUTCOME:

- *Provide the students the knowledge about practical skills on basic microbiology.*
- *Students will learn about different antimicrobial activity assays.*
- *Students will develop an understanding about components of immune system and their function.*
- *The students will learn about different antigen and antibody interaction assays.*

Lab Contents:

Unit 1 (Lab sessions = 2)

Bacterial and fungal culture medium preparation, Pure culture technique (eg: streaking and sub culturing), Gram staining, Fungal staining, Motility assay

Unit 2 (Lab sessions = 3)

Bacterial growth curve by measuring turbidity and viable count

Unit 3 (Lab sessions = 5)

Antibiotic sensitivity assay; MIC and MBC determination, Biofilm assay, MBIC and MBEC determination, Phage titration assay

Unit 4 (Lab sessions = 7)

Observation & Identification of Immune Cells, Observation and identification of the structure of lymphoid organs, Blood grouping, Separation of Mononuclear cells using density gradient centrifugation, Isolation of Monocytes from the Mononuclear Cells, Induction of Monocytes to M1 and M2 Macrophages, Evaluation of inflammatory and anti-inflammatory cytokines produced by M1 and M2 macrophages through ELISA.

TEXT BOOKS:

1. Practical Handbook of Microbiology-Lorrence H Green, Emanuel Goldman by CRC Press, 4th Edition, ISBN 9780367567637.
2. Practical Immunology-Frank C. Hay, Olwyn M.R. Westwood, Fourth Edition, Blackwell Science.

24NB683

NANOMATERIALS LAB-II

0 0 4 2

Pre-requisites: Basic understanding of experimental research

Total number of lab sessions: 15

COURSE OUTCOME:

After successful completion of the course, students will be able to:

- *Understand the principles of Dynamic Light Scattering technique in estimating the particle size and zeta potential. How zeta potential is related to the particle stability*
- *Understand the synthesis of polymeric Alginate nanoparticles and the role of reaction parameters that varies the particle size*
- *Understand the synthesis of Chitosan Nanoparticles and characterization using DLS and Zeta Potential.*
- *Understand the basics of vibrational spectroscopy FTIR and characterize alginate and chitosan.*
- *Understand the synthesis of ceramic Silica Nanoparticles and characterization using TEM.*
- *Understand the basics of XRD in characterizing crystalline and amorphous samples.*
- *Understand the thermal and mechanical characterization of polymeric samples CaCO_3 and chitosan.*
- *Understand the electrospinning technique and parameters that influence the formation of micro and nano fibers.*
- *Understand the basics of Raman spectroscopy in characterizing in polymers and inorganics samples (chitosan and TiO_2).*

Lab Content:

Unit 1 (Lab sessions = 5)

Polymeric Nanoparticles: Synthesis of alginate nano and micro particles; characterization of particle size by Dynamic Light Scattering (DLS) and Zeta analysis

Synthesis of chitosan nanoparticles; characterization of particle size by Dynamic Light Scattering (DLS) and Zeta analysis

Unit 2 (Lab sessions = 5)

Synthesis of ceramic Silica Nanoparticles and characterization using TEM. Structural characterization of crystalline and amorphous nanomaterials using X-ray diffraction spectrometer (XRD), Thermal characterization of polymers using Thermogravimetric – Differential thermal Analysis (TGA-DTA)

Unit 3 (Lab sessions = 5)

Electrospinning: Fabrication of electrospun PVA nanofibres and microfibers; characterization of fibers morphology and diameter using SEM. Characterization of polymeric and inorganic samples (chitosan and TiO_2 using Raman Spectroscopy Using Raman spectroscopy)

References:

- Polymer Nanoparticles for Nanomedicines: A Guide for their Design, Preparation and Development; Christine Vauthier, Springer
- Nano: The Essentials; T. Pradeep, Tata McGraw-Hill

- Nanostructures & Nanomaterials: Synthesis, Properties & Applications; Guozhong Cao, Imperial College Press

ELECTIVE III (Any TWO from below)

24NB651 DRUG DELIVERY, PHARMACOKINETICS & PHARMACODYNAMICS 3-0-0-3

Pre-requisites: Basic level biology and biochemistry

Total number of classes: 45

COURSE OBJECTIVES

- *Be able to articulate the drug-intrinsic and extrinsic factors that determine drug molecule movement across biological membranes*
- *To demonstrate understanding in concepts that determine dosage, absorption, distribution, and excretions of drugs, along with model systems connected with these concepts and apply pharmacokinetic principles to explain variation in drug disposition*
- *To understand the basic concepts of drug delivery and physiochemical properties of the drug*
- *To demonstrate understanding of different routes of drug administration and different drug delivery systems.*
- *To understand basics of pharmacodynamics.*

Syllabus

Unit-1 (8 lecture)

Fundamental concepts of drug delivery: Physicochemical Properties of Drugs, Effects of fundamental physicochemical properties on the biopharmaceutical behavior of drugs, Concentration-time curve of pharmacokinetics; Fundamentals of controlled drug delivery, Pharmacokinetic and pharmacodynamic basis of controlled drug delivery, Physicochemical and biological factors influencing design and performance of controlled release products.

Unit-2 (15 lecture)

Routes of Drug Delivery: Enteral – Oral, Sublingual, Buccal, Rectal; Parenteral – Intravenous, Intramuscular, Intra-arterial, Intra-theal, Intradermal; Topical – Transdermal, Intranasal, Conjunctival; Conventional drug delivery systems; Concept of active and passive targeting of drugs

Unit-3 (15 lecture)

Introduction to pharmacokinetics; Route of administration of drugs; Pharmacokinetic Parameters – bioavailability, biological Half-life, volume of distribution and clearance; Absorption of drugs; Mechanism of drug absorption; Factors affecting drug absorption; Distribution of drugs; Protein binding of drugs; Factors affecting distribution of drugs; Metabolism of drugs; Excretion of drugs; Kinetic models

Unit-4 (7 lecture)

Introduction to pharmacodynamics, drug-receptor interaction, body compartment systems, Drug Action – Action and effect, Excitation and Inhibition, Selectivity of drug action, Therapeutic effect and adverse reaction, Principles of Drug action- Dose effect relationship, Time effect relationship, structure activity relationship, Mechanism of drug action- Simple physical and chemical property, involving or interfering physiological and biochemical process of living system.

TEXT BOOKS / REFERENCES:

1. Robert E. Notari; Biopharmaceutics and Clinical Pharmacokinetics: An Introduction, Fourth Edition, 2017
2. Leon Shargel, Susanna Wu-Pong, Andrew Yu; Applied Biopharmaceutics & Pharmacokinetics 5th edition, McGraw-Hill Medical 2004
3. Rowland and Tozer, Clinical Pharmacokinetics: Concepts and Applications, 1995.
4. Drug Delivery: Fundamentals and Applications, Second Edition, CRC Press 2017.
5. Drug Delivery Systems, Pieter Stroeve and Morteza Mahmoudi, World Scientific Series: From Biomaterials towards Medical Devices, Vol I, 2018.
6. Rosenbaum SE, editor. Basic pharmacokinetics and pharmacodynamics: An integrated textbook and computer simulations. John Wiley & Sons; 2016

24NB652

IMMUNOLOGY

3 0 0 3

Pre-requisites: Undergraduate level basic physics, chemistry and biology

Total number of classes: 45

Course Outcomes

- Develop a comprehensive understanding of immunology by encompassing both innate and adaptive immune systems, focusing on fundamental concepts.
- Recognize and understand the crucial cells and organs of the immune system, exploring their roles in immune responses.
- To understand how innate and adaptive immunity work, applying their principles to bolster host defence
- To learn about the mechanisms driving diversity in immunoglobulins and the rearrangement of T-cell receptor genes.
- To learn about the intricate processes guiding the development and survival of lymphocytes, including their formation in the bone marrow and thymus.
- To understand the humoral immune response, including B-cell activation, functions of immunoglobulin types, and how pathogens are destroyed through Fc receptors.
- To understand the mechanisms underlying autoimmune conditions, allergies, hypersensitivity, and immunodeficiency disorders.

- To acquire comprehensive knowledge in advanced immunological diagnostics, cutting-edge applications in immunotherapy and vaccines, insights into immunology's role in infectious diseases, and an understanding of immune response manipulation.

LECTURE WITH BREAKUP:

Unit 1 **3 lectures**
Basic Concepts in Immunology, Cells and organs of the immune system, Principles of Innate and Adaptive Immunity

Unit 2 **5 lectures**
Innate Immunity: Recognition and effector mechanisms, Inflammation and its regulation, Complement system.

Unit3 **6 lectures**

Adaptive Immunity: Antigen recognition and processing, B and T cell development and activation, Immune memory, Antigen Recognition by B-cell and T-cell Receptors

Unit 4 **5 lectures**
The Generation of Lymphocyte Antigen Receptors, the generation of diversity in immunoglobulins, T-cell receptor gene rearrangement, Structural variation in immunoglobulin constant regions.

Unit 5 **6 lectures**
The development and survival of Lymphocytes: Generation of lymphocytes in bone marrow and thymus, the rearrangement of antigen-receptor gene segments controls lymphocyte development, interaction with self-antigens selects some lymphocytes for survival but eliminates others, survival and maturation of lymphocytes in peripheral lymphoid tissues.

Unit 6 **5 lectures**
T cell-mediated immunity: Production of armed effector T cells, General properties of armed effector T cells, T cell-mediated cytotoxicity, Macrophage activation by armed CD4 TH1 cells.

Unit 7 **5 lectures**
Immunopathology: Autoimmunity, Allergy and hypersensitivity, Immunodeficiency disorders

Unit 8 **5 lectures**
Immunotherapy and Vaccines: Monoclonal Antibodies: Production and Applications, Adoptive Cell Therapy and Immunomodulation, Vaccine Development and Immunization Strategies, Currently available vaccines. Immunotherapy in Autoimmune Diseases and Cancer

Unit 9 **5 Lectures**
Immunological Diagnostics: Serological Techniques: ELISA, Western Blotting, Flow Cytometry and Immunophenotyping, Molecular Diagnostics in Immunology, Point-of-Care Testing in Immunodiagnostics

TEXT BOOK:

1. Janeway's Immunobiology, Ken Murphy, Paul Travers, Mark Walport, 9th edition.

REFERENCES:

1. "Kuby Immunology" by Judy Owen, Jenni Punt, and Sharon Stranford , 2018
2. "Clinical Immunology: Principles and Practice" by Robert R. Rich, Thomas A. Fleisher, William T. Shearer, Harry W. Schroeder, Jr., and Anthony J. Frew, 2018

24NB653

REGULATORY ASPECTS IN TRANSLATIONAL MEDICINE

3 0 0 3

Pre-requisites: Basic level biology and chemistry

Total number of classes: 45

COURSE OUTCOMES:

Upon successful completion, students will have the knowledge to the:

- *Product Lifecycle and quality considerations of medical devices or nanomedicine*
- *Regulatory requirement for approval of medical devices or nanomedicine*
- *Good Manufacturing Practice Requirement and Quality Assurance*
- *Clinical investigation of medical devices or nanomedicine*

LECTURE WITH BREAKUP:

Unit-1

15 lectures

Medical Devices and Nanomedicine: Introduction; Risk based classification; Product Lifecycle: Design and Development, Biological evaluation (both *in vitro* and *in vivo* studies) as per ISO 10993, Phase 1 to Phase 3 clinical Trials; Marketing; Regulators bodies like CDSCO, FDA and EU; Good Laboratory Practice (GLP) and Good Manufacturing Practice (GMP)

Unit-2

15 lectures

Quality System Regulations of Medical Devices: ISO 13485; Schedule Y for drugs; Standard Operating Procedures; Validation and Verification Process; Quality Control System; Documentation and Records; Quality Risk Management: ISO 14971

Unit-3

15 lectures

Clinical Investigation of Medical Devices and nanomedicine; New Drug or Device Application and its approval; Good Clinical Practice for Clinical Investigation of medical devices (ISO 14155:2011); Medical Device Rule 2017; Adverse Event Reporting.

TEXTBOOKS

- Medical Device Development: A Regulatory Overview by Jonathan S. Kahan, Parexel Intl Corp; 3rd edition, 2014
- Medical Product Regulatory Affairs: Pharmaceuticals, Diagnostics, Medical Devices by John J. Tobin and Gary Walsh, Wiley-Blackwell (1st edition), 2008
- Compliance Handbook for Pharmaceuticals, Medical Devices and Biologics by Carmen Medina, CRC Press, 2019

ELECTIVE IV (Any ONE from below)

24NB662

MOLECULAR BASIS OF DISEASES

3-0-0-3

Pre-requisites: Basic understanding of biology and biochemistry

Total number of classes: 45

Course Outcome

- To demonstrate ability to approach a scientific report in a systematic manner
- To be able to identify scientific hypothesis and understand the rationale behind the research approach in a scientific report
- Be able to summarize disease pathogenesis and connect it to clinical signs and symptoms associated with the particular disease
- Be able to work with team and put together in depth information related to disease mechanism at the cellular and molecular level, treatment options and current developments in the field

Syllabus

Unit 1

(Lectures 3)

Introduction to disease pathogenesis, clinical terminologies, concept of prognosis, evidence-based treatment approach, bench-to-bedside approach in medicine, and introduction to a holistic approach in treating diseases

Unit 2

(Lectures 6)

The process of growth, differentiation and cell death and its molecular organization in cellular homeostasis and diseases such as cancer, neurodegenerative diseases and diabetes. Significance of molecular changes in controlling a normal homeostasis condition compared to disease.

Unit 3

(Lectures 6)

Pathological changes in diseases such as cancer, neurodegenerative diseases, autoimmune diseases and diabetes. The role of molecules and molecular changes in the pathological manifestation of disease.

Unit 4

(Lectures 7)

Significance of environmental chemicals in modifying normal homeostasis and leading to pathological changes at molecular level by controlling different signaling mechanisms. Significance of epidemiology, etiology in pathogenesis of diseases

Unit 5

(Lectures 10)

Inflammation in normal and pathological state. Molecular mechanisms driving the immunopathology in cancer, neurodegenerative diseases, autoimmune diseases and diabetes. Interdependence of molecular pathways in controlling homeostasis and disease pathology-

Unit 6

(Lectures 7)

How the molecular changes can be targeted to reverse the pathology and the contribution of drugs in this respect cancer, neurodegenerative diseases, autoimmune diseases and diabetes.

Unit 7

(Lectures 6)

DNA modifications and mutations in diseases and its significance in the pathology associated with cancer, neurodegenerative diseases, autoimmune diseases and diabetes. Role of environment in (lifestyle) in modifying DNA and the molecular landscape associated with homeostasis and disease in cancer, neurodegenerative diseases, autoimmune diseases and diabetes.

TEXT BOOK

Robbins Basic Pathology, 9th edition, Kumar, Abbas, Fausto and Mitchell; Saunders, Publication, ISBN-13: 978-1437717815.]

Selected research articles will be provided before each class

24NB661

CANCER NANOTECHNOLOGY

3 0 0 3

Pre-requisites: Undergraduate level Physics, Chemistry, & Biology

Total number of classes: 45

Course objectives

- *To understand distinguishing features of normal medicine versus nanomedicine*
- *To understand design aspects of nanomedicine, considering cancer as a model disease*
- *To understand various types of nanomedicines depending on the cancer types and their methods of preparation*
- *To understand methods of studying the safety aspects of nanomedicines*
- *Decipher information about how nanomedicine formulations are regulated by Govt agencies for its safe application in human after preclinical and clinical trials*
- *Case studies on currently used nanomedicines for various cancer types*

Course content

Unit 1 (No. of classes = 5)

Nanomedicine: Basic concepts in the design of nanomedicine, Basics of cancer biology, treatment options, desired specifications and features of cancer-nanomedicine, Concept of SMART nanomedicine

Unit 2 (No. of classes = 5)

Nanomedicines for chemotherapy, cytotoxic drugs for cancer therapy, their merits and demerits, how nanomedicines improve efficacy and safety of cytotoxic drugs, case studies: Abraxane, Doxil, Daunosome,

Unit 3 (No. of classes = 5)

Important considerations of nanomaterials used for cancer-nanomedicine: Nanomedicines using polymers, lipids, liposomes, proteins, inorganic material systems, nano-injectables, oral delivery systems, nano-implants, case study: nano-implant/gel for brain tumor

Unit 4: (No. of classes = 5)

Nanomedicine using Molecularly targeted drugs, methods of targeting multiple cancer mechanisms using single nanomedicines, Case study: Core-shell systems for leukemia and liver cancer

Unit 5 (No. of classes = 5)

Nanomedicine for radiation therapy: Basics of radiation therapy, mechanisms, image guided radiation therapy, IGMRT, methods of improving radiation therapy using nanoparticles

Unit 6 (No. of classes = 5)

Nano-photodynamic therapy, nano-photothermal therapy and nano-RF hyperthermia therapy, nano-scintillation therapy,

Unit 7: (No. of classes = 5)

Nanoparticles based cancer immunotherapy, basic immunology, nanoparticle-vaccines, mRNA and Peptide vaccines, emerging trends in nano-immunotherapy of cancer , CAR-T cell therapy, toxicity concerns in immunotherapy

Unit 8: (No. of classes = 5)

Nano-bio-therapeutics in cancer, nanoparticle mediated cell therapy, CART cell DC vaccines, use of nanoparticles in gene-therapy: DNA, RNA delivery.

Unit 9: (No. of classes = 5)

Safety aspects of nanomedicine: How to study safety of nanomedicines, *in vitro*, *in vivo*, toxicity assays, regulatory guidelines

TEXT BOOK

Understanding Nanomedicine: An Introductory Textbook Rob Burgess, CRC Press, 2012.

REFERENCE:

1. Nanomedicine for Cancer Therapy: From Chemotherapeutic to Hyperthermia-Based Therapy, Springer, Piyush Kumar, Rohit Srivastava, 2017
2. Nanotoxicology, Materials, Methodologies, and Assessments, Editors: Durán, Nelson, Guterres, Silvia S., Alves, Oswaldo Luiz

THIRD SEMESTER

ELECTIVES V (Any ONE from below)

24NB732

ORGANOIDS AND ORGANS-ON-CHIPS

2 0 0 2

Pre-requisites: Basic level biology

Total number of classes: 30

COURSE OUTCOME

After completing the course, the student should be able to

- Describe different types of *in vitro* model systems and their advantages over conventional 2D cell culture systems
- Describe basic principles and components of microfluidic cell culture systems
- Describe organs-on-chips and their advantages as *in vitro* model systems
- Account for organoid development procedure, organoid types, advantages and challenges
- Account for the working principle and components of 3D bioprinting
- Compile, critically analyse and evaluate research results in the area of organoids and organs-on-chips and present these both orally and in writing

Syllabus

Unit -1

(6 Lectures)

In vitro model systems in medicine; basic concepts in developing *in vitro* models, biofabrication strategies for developing *in vitro* models, impact of *in vitro* models in disease modeling and drug testing, basics in 3D cell culture

Unit-2

(6 Lectures)

Microfluidic cell culture systems; Introduction to microfluidic systems, the design concept and key components, fundamentals of organs-on-chips as *in vitro* microphysiological systems, applications of organs-on-chips in disease modelling, and safety and efficacy testing

Unit-3

(6 Lectures)

Organoids; Basics of organoid development, experimental strategies, essential reagents and choice of 3D matrices, characterization of organoids, technical challenges.

Unit-4

(6 Lectures)

3D Bioprinting in organoid development; Basics and importance of 3D printing of living cells for medical applications, choice of bio-inks, current advances and challenges in 3D bioprinting.

Unit-5

(6 Lectures)

Organoids as *in vitro* model systems; cerebral organoids, liver organoids, intestinal organoids, pancreas and salivary gland organoids. Applications of organoids in cancer research, drug development and testing

TEXT BOOKS:

1. *Microfluidics: Fundamentals, Devices, and Applications*, Wiley, 2018
2. *Organ-on-a-chip, Engineered Microenvironments for Safety and Efficacy Testing*, Academic Press, 2018
3. *Jamie Davies and Melanie Lawrence, Organoids and Mini Organs*, Academic Press, 2018

24NB731

MOLECULAR DIAGNOSTICS

2-0-0-2

Pre-requisites: Basic understanding of biology and biotechnology

Total number of classes: 30

Course Outcome

- Understand the molecular diagnostic aspects, its significance and goal
- Understand the technology behind the various molecular techniques used in the clinical diagnostic laboratory for the diagnosis of various pathogenic situations
- Develop awareness of sample types, preparation, and storage for molecular diagnostic tests.
- Understand the Quality assurance that needs to be followed in the molecular diagnostic lab
- Develop awareness of ethical issues related to genetic testing

Syllabus

Unit 1

(Lectures 6)

Introduction: An Historical Perspective on the Clinical Diagnostic Laboratory. Molecular Techniques for diagnosis – Methods for extracting nucleic acids (DNA & RNA); Methods for Nucleic Acid Amplification: PCR, Modifications of PCR (Multiplex-PCR, SSP-PCR, Nested PCR, Reverse transcriptase PCR [RT-PCR], Realtime PCR)

Unit 2

(Lectures 6)

Methods for mutation detection: PCR-RFLP, DNA Sequencing, Reverse Hybridization Assay, Multiplex ligation-dependent probe amplification [MLPA], Allele specific PCR; NGS Applications, Global review of NGS platforms, Clinical NGS in practice. Other Clinical Diagnostic Technologies: Flow Cytometry, Fluorescence In Situ Hybridization, Immunohistochemistry, Laser Capture Microdissection (FFPE).

Unit 3

(Lectures 6)

Quality Assurance in the Molecular Diagnostics Laboratory: Framework for Quality Assurance in Molecular Diagnostics, Verification of Molecular Assays, Standards and Standardization of Molecular Diagnostics, Laboratory-Developed Tests in Molecular Diagnostics.

Unit 4

(Lectures 7)

Applications of Molecular Diagnostics for Genetic Diseases, Molecular diagnostics of Coagulation, Cystic Fibrosis; Prenatal Genotyping for Identification of Fetuses at Risk for Immune Cytopenic Disorders. Applications of Molecular Diagnostics for Human Cancers. Applications of Molecular Diagnostics for Infectious Diseases, Identity-Based Testing: HLA Typing Using Molecular Methods. Molecular Analysis for Forensic Casework and Parentage Testing, Molecular Assessment of Bone Marrow Transplant Engraftment. Personalized Medicine.

Unit 5

(Lectures 5)

Genetic Counseling Considerations in Molecular Diagnosis, Ethical, Social, and Legal Issues Related to Molecular Genetic Testing.

TEXTBOOKS:

Molecular Diagnostics: For the Clinical Laboratorian. William B. Coleman (Editor), Gregory J. Tsongalis (Editor) Publisher: Springer-Verlag New York, LLC.

REFERENCES:

Buckingham and Flaw's, "Molecular Diagnostics: Fundamentals, Methods and Clinical Applications", F.A. Davis Company; First edition, 2007.

24NB701 STATISTICAL DATA ANALYSIS 200 2

Pre-requisites: Undergraduate level basic maths, physics, chemistry and biology

Total number of classes: 30

COURSE OUTCOMES:

Students who complete the course will understand the following:

- *The basic concepts of statistics and the need for statistical methods in research*
- *Data Analysis Methods*
- *The fundamental theory of probability and standard distributions*
- *Tests of Significance used in Statistical analysis*
- *The different types of multivariate analysis used in research*
- *Practical analysis of data using standard softwares like SPSS, SAS*
- *Practical understanding of Descriptive Data Analysis, Sampling Theory, Biostatistical Inference, Testing of Hypotheses, Nonparametric Methods and Multivariate Regression Analysis*

LECTURE WITH BREAKUP:

Unit-1 6 Lectures

Introduction to Statistics-Need for Statistical Methods –Their uses and Misuses, Types of Variables, Data collection Methods, Population and Sample.

Descriptive Data Analysis Methods- Statistical Tables, Diagrams & Graphs, Measures of Averages, Measures of Dispersion, Correlation Analysis Methods, Regression Analysis Methods.

Unit-2 6 Lectures

Theory of probability and Standard Distributions - Binomial, poisson& Negative Binomial, Standard univariate continuous distributions – Normal, Log normal & Exponential. Sampling distributions – Chi- square distribution and F & 't' distributions.

Unit-3 6 Lectures

Tests of Significance of Statistical Hypotheses- Concept of Statistical Hypotheses –Null and Alternative hypotheses, Type I and Type II errors, Significance level, Critical region and Power of a test, P- value and its interpretation; Large and Small Sample Test – Normal test, Student's 't' test, Chi-square tests, Analysis of variance.

Unit-4 6 Lectures

Nonparametric methods-Non-parametric methods for estimation, Methods for tests of significance for the independent and correlated samples, Nonparametric Methods for more than two populations.

Multivariate analysis Methods- Principles of Multivariate analysis, Multivariate regression analysis, Multivariate logistic regression analysis.

Unit-5 6 Lectures

Practicals- (Statistical Software to be used: SPSS & SAS): (i) Practical in Descriptive Data

Analysis Methods, (ii) Practicals in Sampling Theory, (iii) Practicals in Biostatistical Inference, (iv) Practicals in Testing of Hypotheses, (v) Practicals in Nonparametric Methods, (vi) Practicals in Multivariate Regression Analysis.

TEXT BOOKS/REFERENCES:

1. *Statistical Techniques for data Analysis: J.K. Taylor & Cheryl C, 2004 Chapman & Hall (CRC).*
2. *Performing Data Analysis Using IBM SPSS: Lawrence S Meyers, 2015, John Wiley.*

24NB781

CELL CULTURE AND ANIMAL LAB

0 0 4 2

Pre-requisites: Basic understanding of experimental research

Total number of lab sessions: 15

COURSE OUTCOME:

After successful completion of the course, students will be able to:

- *To demonstrate a general level of understanding towards the function, maintenance and working of Bio-safety Cabinets (BSC) and be able to work in BSCs with a good sterilization technique*
- *To identify culture contamination and methods involved to maintain sterility*
- *Able to prepare media and maintain adherent cells in culture for atleast a week*
- *To recognize the importance of animal and ethical standards of animal use in research and able to handle small animals*

LAB CONTENT:

Unit 1

(Lab sessions = 3)

General lay out of a cell culture lab, physical environment needed for the cell culture, growth media and its composition, BSC and its use in cell culture and how to work in a BSC, contamination during cell culture and how to control it, culturing and splitting of cell lines, cryopreservation of cells and cell viability assays.

Unit 2

(Lab sessions = 7)

Hands-on cell culture work, media changes, seeding, splitting adherent cells, cell counting, reseeding, and safe disposal

Unit 3

(Lab sessions = 5)

Animal handling techniques, animal feed, gavage, different routes of injection, ethical treatment of animals and Institutional Animal Ethics Committee policies

REFERENCES:

- R. Ian Freshney. *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications*, 6th ed. 2010. Wiley-Blackwell.
- CPCSEA Guidelines for Laboratory Animal Facility, 2004.

- Guide for the Care and use of Laboratory Animals – 8th Edition, 2011, The National Academic Press.

24NB702 ETHICS IN RESEARCH AND RESEARCH METHODOLOGY 2 0 0 2

Pre-requisites: Basic level biology

Total number of classes: 30

COURSE OUTCOMES:

Students on completion of this course will –

- *Understand the basic concepts of ethics in proper conduct of research*
- *Understand about plagiarism in research and how it should be avoided*
- *Gain a clear idea about the importance of proper data documentation*
- *Students will have a clear idea about the research methodologies that need to be adopted during their research*

LECTURE WITH BREAKUP:

Unit-1

15 Lectures

Plagiarism, regulatory principles, safety in research, ethics in stem cell research, ethics in clinical research, ethics in nanomaterials based research, Case studies

Unit-2

15 Lectures

Principles of data documentation, protocol development, research questions and hypothesis driven research.

TEXTBOOKS:

Research Ethics for Scientists, C. Neal Stewart Jr., Wiley-Backwell Publishers, 2011

Ethics in Science, Ethical Misconduct in Scientific Research, John D'Angelo, CRC Press, 2012

24NB798

DISSERTATION -I

Credits: 14

Initiation of research on a selected research topic under the guidance of a faculty, with meticulous experimentation for the generation of data. Manuscript writing on the research work conducted thus far, for a possible publication by the end of the final semester. Mid-thesis presentation to judge the progress of the research work done.

FOURTH SEMESTER

24NB799

DISSERTATION -II

Credits: 17

Full-time research on the proposed research, meticulous experimentation, generation of data, interpretation of data and conclusion of the research outcome. Manuscript writing on

the research work conducted for publication, followed by manuscript submission by the end of the semester. Dissertation preparation and presentations.

23HU611

Career Competency II

L-T-P-C: 0-0-3-1

Pre-requisite: Willingness to learn, team spirit, basic English language and communication skills and knowledge of high school level arithmetic.

Course Objectives:

- Help students to understand the importance of interpersonal skills and team work
- Prepare the students for effective group discussions and interviews participation.
- Help students to sharpen their problem solving and reasoning skills
- Empower students to communicate effectively by using the correct diction, grammar and verbal reasoning skills

Course Outcomes:

CO1: Soft Skills - To demonstrate good interpersonal skills, solve problems and effectively participate in group discussions.

CO2: Soft Skills - To write technical resume and perform effectively in interviews.

CO3: Aptitude - To identify, investigate and arrive at appropriate strategies to solve questions on arithmetic by managing time effectively.

CO4: Aptitude - To investigate, understand and use appropriate techniques to solve questions on logical reasoning and data analysis by managing time effectively.

CO5: Verbal - To be able to use diction that is more refined and appropriate and to be competent in knowledge of grammar to correct/improve sentences

CO6: Verbal - To be able to examine, interpret and investigate passages and to be able to generate ideas, structure them logically and express them in a style that is comprehensible to the audience/recipient.

CO-PO Mapping

PO	PO1	PO2	PO3
CO			
CO1	2	1	-
CO2	2	1	-
CO3	2	1	-
CO4	2	1	-
CO5	1	2	-
CO6	2	2	-

Syllabus

Soft Skills

Interpersonal skill: ability to manage conflict, flexibility, empathetic listening, assertiveness, stress management, problem solving, understanding one’s own interpersonal needs, role of effective team work in organizations

Group problem solving: the process, the challenges, the skills and knowledge required for the same.

Conflict management: the concept, its impact and importance in personal and professional lives, (activity to identify personal style of conflict management, developing insights that helps in future conflict management situations.)

Team building and working effectively in teams: the concept of groups (teams), different stages of group formation, process of team building, group dynamics, characteristics of effective team, role of leadership in team effectiveness. (Exercise to demonstrate the process of emergence of leadership in a group, debrief and reflection), group discussions.

Interview skills: what is the purpose of a job interview, types of job interviews, how to prepare for an interview, dos and don'ts of interview, One on one mock interview sessions with each student

Verbal

Vocabulary: Help students understand the usage of words in different contexts. Stress the importance of using refined language through idioms and phrasal verbs.

Grammar: Enable students to identify poorly constructed sentences or incorrect sentences and improvise or correct them.

Reasoning: Facilitate the student to tap her/his reasoning skills through critical reasoning questions and logical ordering of sentences.

Reading Comprehension: Enlighten students on the different strategies involved in tackling reading comprehension questions.

Public Speaking Skills: Empower students to overcome glossophobia and speak effectively and confidently before an audience.

Writing Skills: Practice closet tests that assess basic knowledge and skills in usage and mechanics of writing such as punctuation, basic grammar and usage, sentence structure and rhetorical skills such as writing strategy, organization, and style.

Aptitude

Sequence and Series: Basics, AP, GP, HP, and Special Series.

Geometry: 2D, 3D, Coordinate Geometry, and Heights & Distance.

Permutations & Combinations: Basics, Fundamental Counting Principle, Circular Arrangements, and Derangements.

Probability: Basics, Addition & Multiplication Theorems, Conditional Probability and Bayes' Theorem.

Logical Reasoning I: Arrangements, Sequencing, Scheduling, Venn Diagram, Network Diagrams, Binary Logic, and Logical Connectives, Clocks, Calendars, Cubes, Non-Verbal reasoning and Symbol based reasoning.

Logical Reasoning II: Blood Relations, Direction Test, Syllogisms, Series, Odd man out, Coding & Decoding, Cryptarithmic Problems and Input - Output Reasoning.

Data Sufficiency: Introduction, 5 Options Data Sufficiency and 4 Options Data Sufficiency.

Campus recruitment papers: Discussion of previous year question papers of all major recruiters of Amrita Vishwa Vidyapeetham.

Miscellaneous: Interview Puzzles, Calculation Techniques and Time Management Strategies.

References

Soft Skills

Team Building

- Thomas L.Quick, "Successful team building", AMACOM Div American Mgmt Assn, 1992
- Brian Cole Miller, "Quick Team-Building Activities for Busy Managers: 50 Exercises That Get Results in Just 15 Minutes", AMACOM; 1 edition, 2003.
- Patrick Lencioni, "The Five Dysfunctions of a Team: A Leadership Fable", Jossey-Bass, 1st Edition, 2002

Verbal

- "GMAT Official Guide" by the Graduate Management Admission Council, 2019
- Arun Sharma, "How to Prepare for Verbal Ability And Reading Comprehension For CAT"
- Joern Meissner, "Turbocharge Your GMAT Sentence Correction Study Guide", 2012
- Kaplan, "Kaplan GMAT 2012 & 13"
- Kaplan, "New GMAT Premier", Kaplan Publishing, U.K., 2013
- Manhattan Prep, "Critical Reasoning 6th Edition GMAT"
- Manhattan Prep, "Sentence Correction 6th Edition GMAT"
- Mike Barrett "SAT Prep Black Book The Most Effective SAT Strategies Ever Published"
- Mike Bryon, "Verbal Reasoning Test Workbook Unbeatable Practice for Verbal Ability, English Usage and Interpretation and Judgement Tests"
- www.bristol.ac.uk/arts/skills/grammar/grammar_tutorial/page_55.htm
- www.campusgate.co.in

Aptitude

- Arun Sharma, "How to Prepare for Quantitative Aptitude for the CAT Common Admission Test", Tata Mc Graw Hills, 5th Edition, 2012
- Arun Sharma, "How to Prepare for Logical Reasoning for the CAT Common Admission Test", Tata Mc Graw Hills, 2nd Edition , 2014
- Arun Sharma, "How to Prepare for Data Interpretation for the CAT Common Admission Test", Tata Mc Graw Hills, 3rd Edition , 2015
- R.S. Aggarwal, "Quantitative Aptitude For Competitive Examinations", S. Chand Publishing , 2015
- R.S. Aggarwal, "A Modern Approach To Verbal & Non-Verbal Reasoning", S. Chand Publishing , Revised -2015
- Sarvesh Verma, "Quantitative Aptitude-Quantum CAT" , Arihant Publications , 2016
- www.mbatious.com
- www.campusgate.co.in
- www.careerbless.com

Evaluation Pattern

Assessment	Internal	External
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50

***CA - Can be presentations, speaking activities and tests.**