Program

M Sc - Nanomedical Sciences

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M. Sc. NANOMEDICAL SCIENCES

EDUCATIONAL OBJECTIVES:

The M. Sc. Nanomedical Sciences is a course designed for Bachelors students to understand in depth the science behind “nano” and to explore in depth the application of nanosciences in the biomedical area. Such applications include new implant technologies, regenerative medicine, 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, synthesis of nanomaterials, molecular and cell biology, computational biology and medical core courses such as immunology and physiology.

The program also offers laboratory exposure on nanomaterial synthesis, characterization of nanomaterials as well as in cell culture, animal experiments. The highlight of this program is a full one year intensive research experience whereby the student completes a thesis in a topic of choice in nanomedicines, diagnosis, drug delivery, tissue engineering and regenerative medicine.

PROGRAM OUTCOMES

Each graduate will be able to:-

utilize the education imparted during the program for an effectual understanding of the impact of nanotechnology in the fields of biotechnology and medical sciences

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 apply knowledge of the fundamental aspects of physics, chemistry, biology and engineering principles to analyze and interpret data and design and conduct experiments safely, as well as the ability to design a process that meets desired specifications with consideration of environmental, safety, economic and ethical criteria

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.

pursue higher learning in field of nanobiotechnology or medicine, involve in startups, be an entrepreneur or follow an academic or research career

PROGRAMME EDUCATIONAL OBJECTIVES:

- To develop effectiveness in applying the principles of nanotechnology to develop 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 to bioengineering or medical practice, or for advanced study in engineering, medicine, or other related fields.
- To develop longitude of not only opening careers in the branch of study as well as 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.

Curriculum

First Semester

Course Code	Type	Course	LTP	Credits
18MA613	FC	Statistical Data Analysis	101	2
18MM621	FC	Immunology	300	3
18MM601	FC	Cell and Developmental Biology	300	3
18MM602	FC	Basics in Human Physiology and Pathology	400	4
18NS621	SC	Science and Properties of Nanomaterials	300	3
18NS622	SC	Nanomaterials Synthesis	300	3
18HU604	HU	Amrita Values Programme	100	1
18HU602	H U	Career Competency-I		P/F
18NS623	SC	Cell Culture and Animal Lab	101	2
18NS624	SC	Lab: Nanomaterials Lab-I	102	3
		Total Credits		**24**

Second Semester

Course Code	Type	Course	LTP	Credits
18NS602	FC	Pharmacokinetics and Pharmacodynamics	200	2
18NS606	FC	Bioinformatics and Structure based Drug Design	202	4
18NS604	FC	Regenerative Medicine	300	3
18NS605	FC	Biofactors in Tissue Regeneration	300	3
18NS625	SC	Characterization of Nanomaterials	300	3
18NS626	SC	Polymeric Nanomaterials	200	2
18NS627	SC	Nanomedicine and Nanotoxicology	200	2
18NS628	SC	Drug Delivery Systems	200	2
18HU603	HU	Career Competency-II	100	1
18NS629	SC	Lab: Nanomaterials Lab-II	102	3

		Total Credits		**25**

Third Semester

Course Code	Type	Course	LTP	Credits
18RM601	FC	Ethics in Research and Research Methodology	101	2
18NS630	SC	Nanosystems in Medical Diagnostics	200	2
18NS631	SC	Scaffolds in Tissue Regeneration	200	2
18NS796		Dissertation		5
		Total Credits		**11**

Fourth Semester

Course Code	Type	Course	LTP	Credits
18NS797	P	Dissertation		10
		Total Credits		**10**
		Overall Total Credits		**70**

FIRST SEMESTER

18MA613 STATISTICAL DATA ANALYSIS 1-0-1-2

LEARNING 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*

SYLLABUS:

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.

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.

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 & Non parametric methods.

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.

Practicals- (Statistical Software to be used: SPSS & SAS): (i) Practicals 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.*

18MM621 IMMUNOLOGY 3-0-0-3

LEARNING OUTCOMES:

Students who complete the course will understand the following:

- *Principles of innate and adaptive immune system, the mucosal immune system and immunological memory.*
- *Understand the antigen receptor structure and the mechanisms of antigen recognition by B-cell and T-cells.*
- *Mechanisms of immunoglobulins,B-and T-cell receptors gene rearrangement.*
- *Gain knowledge about the major histocompatibility complex and its functions.*
- *Understand scientific principles behind T and B Cell-Mediated immune Response.*
- *Immune response against infectious agents and tumor cells.*
- *Inherited immunodeficiency diseases.*
- *Understand the mechanism of allergic responses and hypersensitivity reactions.*
- *Understand the mechanism of autoimmunity and transplantation*
- *Immunization and manipulation of the immune system to fight disease. Immunization (haptens and adjuvants) and route of immunization*
- *Techniques for immunological disease diagnosis.*

SYLLABUS:

Basic concepts in immunology: Cells and organs of the immune system, Principles of innate and adaptive immunity, The effector mechanisms of immunity, The complement system and innate immunity. The induced responses of innate immunity; Pattern recognition by cells of the innate immune system, Induced innate responses to infection.
Antigen Recognition by B-cell and T-cell Receptors: The structure of a typical antibody molecule, The interaction of the antibody molecule with specific antigen, Antigen recognition by T cells. Antigen presentation to T lymphocytes: The generation of α β T-cell receptor ligands, The major histocompatibility complex and its function, Generation of ligands for unconventional T-cell subsets.

Development of B and T lymphocytes: Development of B lymphocytes, Development of T lymphocytes, Positive and negative selection of T cells.
T cell mediated Immunity: Development and function of secondary lymphoid organs, Priming of naive T cells by pathogen-activated dendritic cells, General properties of effector T cells and their cytokines, T-cell-mediated cytotoxicity.
The humoral immune response: B-cell activation by antigen and helper T cells, The distributions and functions of immunoglobulin classes, The destruction of antibody-coated pathogens via Fc receptors.
Integrated dynamics of innate and adaptive immunity: Integration of innate and adaptive immunity in response to specific types of pathogens, Effector T cells augment the effector functions of innate immune cells, Immunological memory.
Manipulation of the immune response: Treatment of unwanted immune responses, Using the immune response to attack tumors, Fighting infectious diseases with vaccination.
Modulating the immune system through nanotechnology: Nanoparticles and the immune system, Nanoscale immune activation, Nanotechnology in vaccination, Nanoparticle-based vaccine carriers, Nanotechnology and immunosuppression, Nanoparticles as vehicles for immunosuppressants.

TEXT BOOK:
Janeway'sImmunobiology, Ken Murphy, Paul Travers, Mark Walport, 9th edition, Garland science publishing, 2016.

REFERENCE:
Cellular and Molecular Immunology, Abul K Abbas, Andrew H. Lichtman, Shiv Pillai 9th edition 2017.

18MM601 CELL AND DEVELOPMENTAL BIOLOGY 3-0-0-3

LEARNING OUTCOMES:

This course will impart vital knowledge to the students on,

- *Cell chemistry and biosynthesis*
- *Internal organization of cells*
- *Cells in their social context*
- *Germ cells and fertilization*
- *Genetic mechanisms underlying development*

SYLLABUS:

Cell Biology: Cell chemistry and biosynthesis: the chemical components of a cell, catalysis and the use of energy by cells, how cells obtain energy from food; Classification and properties of cell: Introduction to different types of cells; Membrane structure: the lipid bilayer, membrane proteins; Membrane transport of small molecules and electrical properties of membranes: principles of membrane transport, active membrane transport, ion channels; Intracellular compartments and protein sorting: compartmentalization of cells, the transport of molecules between the nucleus and cytosol,

transport of proteins to different organelle; Intracellular vesicular traffic: molecular mechanisms, transport from the ER through the golgi apparatus, transport from the trans-golgi network to lysosomes, endocytosis, exocytosis; Mechanisms of cell communication: general principles, signaling through GPCRs and enzyme-coupled surface receptors, signaling pathways dependent on regulated proteolysis of latent gene regulatory proteins; Cytoskeleton: self-assembly and dynamic structure of cytoskeletal filaments, molecular motors, cytoskeleton and cell behavior, Cell cycle: an overview, cell cycle control system, control of cell division and cell growth; Apoptosis: cell death, extrinsic and intrinsic pathways; Cell junctions, cell adhesion and extracellular matrix: cadherins and cell-cell adhesion, tight junctions, passageways from cell to cell, integrins and cell-matrix adhesion, extracellular matrix. Germ cells: Primordial germ cells, Meiosis, Eggs, Sperms. Developmental biology: Universal mechanisms of animal development, Development from the perspective of a single cell, The molecular genetics of pattern formation, The patterning of anteroposterior axis, Organogenesis and patterning of appendages, The shaping of the vertebrate body, The mouse development, Neural development.

TEXT BOOK:

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

REFERENCE:

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

18MM602 BASICS IN HUMAN PHYSIOLOGY AND PATHOLOGY 4-0-0-4

LEARNING OUTCOMES:

This course will provide basic knowledge to the students to -

- *Articulate what is meant by extracellular and intracellular compartments, and how to measure them.*
- *Be able to differentiate between serum and plasma, and each of their components.*
- *Be able to articulate the underlying principle of the haemoglobin saturation curve.*
- *Articulate the mechanisms of the four different types of cellular adaptation.*
- *Outline the different routes available for a cell to respond under condition of various stressors, with examples.*
- *Be able to succinctly explain the cellular steps involved in inflammation.*
- *Articulate the mechanism of cellular regeneration of liver cells.*
- *Explain the pressure-volume relationship in the context of electrophysiological changes in the cardiac cycle.*
- *Explain the role of calcium ion in cardiomyocyte function and during ischemia.*

- *Understand the overall mechanics of respiration in relation to lung volume and transpulmonary pressure, and how these are affected in obstructive lung disorders.*
- *Discuss the process involved in urine formation, and how this process is affected in glomerular injury.*
- *Understand the diverse functions of the GI tract and the underlying principle of the peristaltic wave.*
- *Understand the uniqueness of hepatic blood supply, and functioning of the hepatic lobule.*
- *Discuss the mechanism of hepatic scar formation.*
- *Articulate the endocrine function of the pancreas.*
- *Understand the ionic basis of an action potential and its manifestation in the form of neurotransmitter release for signal transmission in a neuron.*
- *Describe neuronal excitotoxicity in glutaminergic neurons.*
- *Describe features of a neurons in a degenerating disease with Alzheimer's disease as an example.*
- *Describe the overall architecture of the eye ball and explain the signal transduction in the retina*
- *Explain the mechanism of sound perception in humans. Student should also be able to explain some of the defects of hearing.*
- *Identify some of the receptors involved in taste and smell.*
- *Identify the main endocrine glands, their secretions and their regulating hormones, along with function.*
- *Explain the functioning of the thyroid, pancreatic and the adrenal glands.*

SYLLABUS:

Physiology: This module pertains to the study and understanding of organ-based physiological processes in the human body during homeostasis. The module covers the following topics: Body water and distribution, regulation of water within extracellular, transcellular and intracellular compartments, determination of compartmental fluid volumes, blood and lymphatic system, function-regulation of the cardiovascular system, the cardiac cycle, hepato-biliary system, pancreas physiology, regulation and processes involved in urine formation, the musculoskeletal system and calcium regulation, control of respiration, lung volumes and flow, nervous system – generation of action potential, role of voltage gated ion channels, synapse physiology, and basics of neural networks in brain, special senses, and reproductive physiology. *Pathology:* This module is divided into two segments: The first segment covers the basic pathological processes such as inflammation, compensatory cellular changes – Hypertrophy, hyperplasia, atrophy and metaplasia, fluid handling

disturbances, malignant cellular changes, immunological & metabolic responses, and healing. The second segment covers the study of diseases based on organ systems: Cardiovascular, pulmonary, gastrointestinal, hepato-biliary, renal, musculoskeletal and nervous system disorders. Changes at the level of tissues and cells will be studied within each disease. Conditions such as diabetes, obesity, and hypertension, that are estimated to form the bulk of healthcare load in the next few years, will be given special emphasis. Aetiological and mechanistic basis of these conditions will be discussed in detail.

TEXT BOOK

Kim E, Barrett, Susan M, Barman, Scott Boitano, and Heddwen Brooks, "Ganong's Review of Medical Physiology", 24th Edition, McGraw-Hill Medical, 2012

Vinay Kumar, Abul Abbas, Jon Aster, "Robbins &Cotran Pathologic Basis of Disease"9thEdition.,Elsevier 2014

REFERENCE:

John E. Hall, "Guyton and Hall Textbook of Medical Physiology", 13e Elsevier, 2015

18NS621 SCIENCE AND PROPERTIES OF NANOMATERIALS 3-0-0-3

LEARNING 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.*

SYLLABUS:

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

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.

Inclusion and importance of surface energy, equations of thermodynamics with surface energy
Equilibrium Particle size, internal pressure and stability, nucleation processes

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

TEXT BOOKS:

1. *Materials Science and Engineering – An Introduction, William D Callister, 12th Edition, John Wiley (Available in Amazon India, Rs. 287)*

Nanomaterials – An introduction to synthesis, properties and applications, D. Vollath, Wiley-VCH, Second Edition 2013.

18NS622 NANOMATERIALS SYNTHESIS 3-0-0-3

LEARNING OUTCOMES:

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

- *Understand various chemical and physical methods for the synthesis of diverse types of nanomaterials (0D, 1D and 2D)*
- *Decipher information on the specific details of both bottom up and top-down synthesis*
- *Gather information on the different types of nanomaterials and their potential applications*

SYLLABUS:

Synthesis Methods of Nanomaterials: Top down : Milling; Bottom up approaches – Synthesis of zero dimensional metal, metal oxides, semiconductor nanoparticles by different routes – Colloidal method, Sol-gel, Electrodeposition; Kinetically Confined Synthesis of Nanoparticles - Aerosol synthesis, Micellar growth, Spray pyrolysis, Template-based synthesis; Synthesis of one dimensional

nanosystems by different routes – VLS and SLS methods, Electrospinning; Synthesis of two dimensional nanosystems – Fundamentals of Film Growth; Vapor phase deposition methods - Physical and chemical methods; Superlattices; Self Assembly; Langmuir-Blodgett Films; Electrochemical Deposition; Special Nanomaterials – Core/shell structures, Carbon-based Nanomaterials, Micro and Mesoporous Materials, Organic-Inorganic Hybrids

TEXT BOOK

G. Cao, Nanostructures and Nanomaterials – Synthesis, Properties and Applications, Imperial College Press 2006.

REFERENCE

Nanostructured materials: Processing, Properties and Potential Applications, Edited by Carl. C. Koch, Noyes Publications, 2002.

18HU604 AMRITA VALUES PROGRAMME 1-0-0-1

LEARNING OUTCOMES:

Students who complete the course will have demonstrated the following:

- *The basic concept of culture and values*
- *The relationship of culture with education, research, spirituality*
- *How culture is linked with gender, especially women*
- *The influence of media and politics in culture*

SYLLABUS:

Culture – definition and scope. Values and culture, cultural freedom
Culture and Education
Culture of Research – creativity and responsibility in research
Spirituality and Culture – spirituality as a way of life, spirituality and religion
Culture and women – gender oppression, motherhood
Culture and the Media
Culture and Politics – national values and political harmony
Philosophy and Culture, epistemology

18NS623 CELL CULTURE AND ANIMAL LAB 1-0-1-2

LEARNING OUTCOME:

Upon successful completion of the module 'Cell culture', the students will have adequate knowledge about

- *Theoretical and practical aspects of a safe cell culture practice*
- *Aseptic techniques that need to be followed in cell culture facility*
- *Hands on experience of culturing mammalian cells*
- *Cell viability assays and how to plan a cell viability experiment.*

SYLLABUS:

Cell culture module introduces the students to the basics of cell culture. The course provides students with sufficient knowledge and laboratory skills needed in the academia and industry for carrying out basic cell culture techniques properly and safely. On completion of the course, the student should be able to: account at a general level for the function, maintenance and working of Bio-safety Cabinets (BSC) and be able to work in BSCs with a good sterilisation technique, account for different preventive measures to avoid contamination of cell cultures and how a contaminated cell culture may be treated, account in detail for sterilisation equipment and sterilisation techniques, account for different cell-culture media and important components in the media; be able to apply basic cell-culture techniques, such as cell counting using hemocytometer and harvesting of cells. Explain different factors of significance in the cultivation of cells *in vitro* and be able to maintain cell lines in culture for a longer period of time without contamination.
Contents-The course starts with theory i.e. basic lecture about a general lay out of a cell culture lab, physical environment needed for the cell culture, growth media and its composition, Biosafety cabinets (BSC), 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. After qualifying the Biosafety examination, students start working in the cell culture lab. The laboratory work starts in small groups. In the practical laboratory work, the students will have hands-on experience in counting, harvesting, culturing and maintaining cell lines.
Animal handling techniques – animal feed, gavage, different routes of injection, ethical treatment of animals and Institutional Animal Ethics Committee policies.

TEXT BOOK:
R. Ian Freshney. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 6th ed. 2010. Wiley-Blackwell.

REFERENCES:
1. CPCSEA Guidelines for Laboratory Animal Facility, 2004.
2. Guide for the Care and use of Laboratory Animals – 8th Edition, 2011, The National Academic Press.

18NS624 LAB: NANOMATERIALS LAB-I 1-0-2-3

LEARNING OUTCOMES:

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*

SYLLABUS:

1. Metal Nanoparticles : Synthesis of plasmonic silver nanoparticles
2. Metal-oxide Nanoparticles: Synthesis of ZnO nanoparticles through non-aqueous route.
3. Absorption Spectroscopy of metal oxide (ZnO) nanoparticles and particle size calculation using Brus equation
4. Semiconductor Nanoparticles: Synthesis of doped ZnS nanoparticles through aqueous method; characterize fluorescence property using spectrofluorimeter
5. Silica Nanospheres: Synthesis and characterization by sol-gel chemistry
6. Surface Plasmon Resonance (SPR) analysis of differently shaped and sized gold nanoparticles by absorption spectroscopy

Nanoparticle imaging by Atomic Force Microscope for size and shape analysis

18HU602 CAREER COMPETENCY I Credits: Pass/Fail

LEARNING OUTCOME:

- Effectively improve employability in the professional world. Gives training to assist the student to prepare for interviews

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 building: introduction to the methods and practices of learning vocabulary, learning through practice sets to face questions on antonyms, synonyms, spelling error, analogy, wrong form of words, frequently confused words, understanding the nuances of spelling changes and wrong use of words.

Grammar: Analyzing subject verb agreement, pronoun agreement, tense consistency, and misplaced or dangling modifiers, parallel construction, active and passive voices, faulty comparison

Students take a few online practice tests to understand the test taking strategy and work on their specific areas of improvement.

Aptitude

Introduction to numbers – number line, classification of numbers, prime and composite numbers, co-prime numbers, number of zeros in an expression, LCM, HCF, remainder theorem, rules of divisibility, base system

Basics of equations- introduction to simple and quadratic equations, roots of an equation, word problems, problems on ages, consistency of equations

Percentages, profit and loss: introduction to percentages, percentage change, value appreciation and depreciation, comparison observations, fundamentals concepts of business/commercial terminologies like cost price, selling price, profit, loss, marked price and discount

Ratio proportion and variation/partnership – fundamentals of ratios, duplicate ratio, triplicate ratio, sub duplicate ratio and sub triplicate ratio, direct and inverse proportion, joint variation, partnership and profit sharing

Averages and mixtures – mean, median and mode, measure of central tendency, concept of assumed average and weighted average, AM, GM and HM – relationship between AM, GM and HM, cheaper quantity and dearer quantity, rule of allegation, profit v/s quality of items getting mixed.

Simple interest and compound interest – time value of money, capital/principle, period of investment, rate of return, period of compounding, SAGR and CAGR

Data interpretation – representation of data using tables, bar charts, pie charts, case study, line graph, scatter diagram – analyzing the data for decision making

Venn diagrams- set theory – concept of sets, types of set, forms of set representation, power set, sub set and super set, 2 and 3 variable venn-diagrams, familiarity with words like AND, OR, atleast, atmost, exactly ‘n’ elements

Cubes – importance of aligning cuts to minimize/maximize the number of pieces of small cubes, painting a cube and cutting the cube, disintegration and integration of cubes, diagonal cutting, volume/LSA/TSA of cubes

References

Communication and listening skills:

- Andrew J DuRbin , “Applied Psychology: Individual and organizational effectiveness”, Pearson- Merril 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

- Lewis Norman, “Word Power Made Easy”, Goyal Publishers, Reprint edition, 1 June 2011
- S. Upendran, “Know Your English”, Universities Press (India) Limited, 2015
- Green, Sharon, and Ira K. Wolf, “Barron's New GRE”, Barron's Educational Series, 2011
- Kaplan, “New GMAT Premier”, Kaplan Publishing, U.K., 2013
- www.merriam-webster.com
- www.bbc.co.uk/learningenglish
- www.cambridgeenglish.org

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, 3nd 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
- SarveshVerma, “Quantitative Aptitude-Quantum CAT” , Arihant Publications, 2016
- www.mbatious.com
- www.campusgate.co.in
- www.careerbless.com

SECOND SEMESTER

18NS602 PHARMACOKINETICS AND PHARMACODYNAMICS2-0-0-2

LEARNING OUTCOMES:

Students who attend this course will learn -

- *To articulate the general process of drug development*
- *To define basic PK parameters of a drug such as volume of distribution,*
- *clearance terms, extraction ratio, elimination half- life, unbound fraction and to understand how these are related.*
- *To understand the role of compartment models in elucidating the time course of plasma concentration of drug molecules in the body.*
- *To describe the effect of plasma and tissue protein binding on pharmacokinetic parameters*
- *To understand the time course of drug accumulation in the body during a constant rate infusion and the concept of steady state.*
- *To formulate a compartmental model for a given drug*
- *To understand the roles of transporters in drug absorption, distribution and elimination*
- *To understand the functional outcome of a drug action based on receptor ligand binding*
- *To articulate drug-receptor interaction and downstream events for atleast 3 model drugs*
- *To understand the role of non-receptor mediated drug outcomes and toxicity*
- *To discuss generic drug formulations and bioequivalence.*

SYLLABUS:

Nature of drugs, drug-body interactions, permeation of drugs, drug groups, macromolecular nature of drug receptors, drug concentration and response, drug distribution and elimination of single and multiple drugs in single and multi-compartment models, derivation of relationships between various pharmacokinetic parameters like clearance, volume of distribution, elimination rate constant, half-life etc. Fundamental principles guiding absorption, distribution, metabolism and elimination of drug molecules, basics of population pharmacokinetics, pharmacogenomics, and single-gene pharmacokinetic disorder.Pharmacodynamic concepts related to affinity and efficacy of drug molecules, drug binding, receptor actions, transport proteins, enzyme action, ion channel function and extrusion mechanisms using specific drugs – acetaminophen, warfarin, certain antibiotics, and anti-

malignant drugs. Mechanism of action of selected drugs will be discussed.

TEXT BOOK

KatzungB.G., Masters S.B., Trevor A.J., "Basic and Clinical Pharmacology", 13th Edition, McGraw Hill, 2014

REFERENCE:

Malcolm Rowland, Thomas Tozer, "Clinical Pharmacokinetics and Pharmacodynamics, Concepts and Applications", 4th Edition, WoltersKluver, 2011

18NS606 BIOINFORMATICS AND STRUCTURE BASED DRUG DESIGN 2-0-2-4

LEARNING OUTCOMES:

Students who complete the course will have demonstrated the following:

- *Relate protein sequence-structure and folding relationship.*
- *Understand the dogma and paradox of protein folding.and provide idea of scientific workflow towards structural bioinformatics in drug discovery program.*
- *Introductory understanding of the concepts towards structure-based drug design with some case studies.*
- *Importance of protein databank and macromolecular 3D structure-function relationships. And molecular modeling strategies towards ligand-based and structure-based drug design.*
- *Basic concepts on amino acids, peptide bond, structure-property relationships and understanding on different scientific software used in computational biology.*
- *Understanding the importance of different biologically important databases/ Chemoinformatics databases etc.*
- *Distinctions between primary, secondary and tertiary databases and integration of different databases and its significant outcomes in data retrieval.*
- *Skills in working in Linux environment; Linux operating system update. Different linux commands and linux editor will be taught.*
- *Origin and importance of sequence alignment, comparison, evolution. Dot plot algorithm. And understand sequence identity, similarity and homologous concepts for its biological significance.*
- *Pairwise sequence alignment using BLAST, FASTA etc. Basic concepts of dynamic programming and algorithm parameter details of program function.*
- *Understanding the concept of sequence alignment gaps, penalty, scoring matrices (BLOSUM,*

PAM), local and global sequence alignment.

- *Different BLAST sub programs like PSI-BLAST, PHI-BLAST etc. algorithm and applications in sequence alignment.*
- *Basic concepts in phylogenetic study, its methodology and building different evolutionary trees using Maximum parsimony, Distance and Maximum likelihood methods for phylogenetic analysis.*
- *Basic concepts in Chemoinformatics methods: Combinatorial library generation, Geometry optimization, Molecular modeling, virtual screening techniques*
- *Molecular docking, pharmacophore modeling, protein ligand complex interactions and its mechanism of action, QSAR, QSPR, QSTR techniques used in computer aided drug design.*
- *Different computational biology software usage, relevance and management will be taught for general awareness.*
- *How these chemoinformatics techniques can be integrated with the wet-lab (in vitro or in vivo) experiments will be discussed and importance of sequence pattern recognition and matching.*
- *Application in protein families and pattern databases ex. PROSITE database of protein families and domains.*
- *Structural genomics consortium and its mission towards structure-based drug design and basic concepts on eXtensible Markup Language (XML) and its applications in bioinformatics/chemoinformatics.*
- *Multiple sequence alignment methods, algorithms and applications, Clustal W and Clustal omega program for multiple sequence alignment (MSA) of different protein families.*
- *Display of MSA using different software Jalview etc. and understanding the sequence conservation for protein sequence-function relationships.*

SYLLABUS:

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.

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.
Pharmacy Informatics: Medical databases and clinically relevant drug-drug interactions, Pharmacy information system, Telemedicine and Telehealth.

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. Pairwise and multiple sequence analysis techniques, Sequence alignment studies of protein family to understand its conserved residues including the percentage similarity/identity and its function relationship using BLAST/FASTA and ClustalW software. 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. Basic molecular modeling and optimization techniques, Molecule drawing in ChemDraw.Molecular structure optimization to get the least stable form and other physico-chemical property calculations. Molecular visualization and analysis study using PyMOL software.

TEXT BOOK:
Mount D W, "Bioinformatics Sequence and Genome Analysis", Cbs Publishers & Distributors (2003), ISBN: 8123909985

REFERENCE:

Practical Bioinformatics; Editors: Bujnicki, Janusz M. (Ed.), Series: Nucleic Acids and Molecular Biology, Springer publisher, 10.1007/978-3-540-74268-5, 2008.

18NS604 REGENERATIVE MEDICINE 3-0-0-3

LEARNING 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*

SYLLABUS:

Biologic and molecular basis for regenerative medicine: Molecular organisation of cells, Cell -extra-cellular matrix interactions in repair and regeneration, How cells change their phenotype, Somatic cloning and epigenetic reprogramming in mammals.
Cells and tissue development: Embryonic stem cells; derivation and properties, Induced pluripotent stem cells, Mesenchymal stem cells in regenerative medicine, Multipotent adult progenitor cells, Hematopoietic stem cell properties, markers, and therapeutics, Cardiac stem cells: biology and therapeutic applications, Skeletal muscle stem Cells, Stem cells derived from fat, Peripheral blood stem cells, Pancreatic stem cells, Determinants of tissue development, Angiogenesis, Morphogenesis of bone, Physical stress as a factor in tissue growth and remodeling, organoids.
Inherent regenerative mechanisms: Blood regeneration, Wound healing and skin regeneration, Bone regeneration, Liver regeneration, Peripheral nerve regeneration, The multifactorial role of peripheral nervous system in bone growth.
Decellularized scaffolds in tissue regeneration: Decellularization of tissues and organs, Repopulation of decellularized scaffolds using stem cells, Decellularized scaffolds as a platform for regenerating tissues and organs.
Therapeutic applications: Cell therapy for bone repair and regeneration, Cell therapy for articular cartilage regeneration, Cell therapy for heart diseases, Bone marrow transplantation, Myoblast transplantation in skeletal muscles, Islet transplantation, Stem cell derived secretome. Exosomes for regenerative medicine.

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

18NS605 BIOFACTORS IN TISSUE REGENERATION 3-0-0-3

LEARNING OUTCOMES:

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

- *Understand about Tissue Regeneration and Repair*
- *Understand the role of extracellular matrix proteins in tissue regeneration*
- *Understand hemostasis phase and the role of coagulation factors in tissue regeneration*
- *Understand the relevance of inflammatory cues in tissue regeneration*
- *Understand proliferative phase in tissue regeneration*
- *Understand the role of growth factors in tissue regeneration*
- *Understand about growth factors and angiogenesis*
- *Understand the role of small molecules in tissue regeneration*

SYLLABUS:

Relevance of Biofactors in Tissue Regeneration-Types of Biofactors in extracellular matrix, Interaction between biofactors and cells, Factors affecting biofactor interaction with cells
Inflammatory Cues and Regeneration-Inflammatory response in injury, immune cells and its secretory factors; Inflammatory and anti-inflammatory cytokines, Homeostatic chemokines
Platelets and growth factor secretion-Platelet activation cascade, peptidic growth actors present in PRP, PRP preparation and its regeneration potential
Growth factors in tissue regeneration-Cross talk between growth factor and cells, impact of growth factors on cell viability, proliferation, migration and differentiation; Angiogenic cascade, Angiogenic stimulators and inhibitors
Small molecules in Tissue Regeneration-Natural and synthetic phytochemicals, Applications of small molecules in tissue regeneration
Case studies-Transforming Growth factor β signalling, Bone morphogenetic protein signalling; Vascular endothelial growth factor signalling; Nerve Growth factor signalling, Fibroblast growth factor signalling, Platelet derived Growth Factor signalling, Epidermal growth factor, Hepatocyte Growth Factor

TEXT BOOKS

1. *Thomas R Ziegler, Glenn Pierce, David N Herndon. Growth Factors and Wound Healing Basic Science and Potential Clinical Applications, Springer-Verlag New York 1997.*
2. *Sang Jin Lee, Anthony Atala, JamesYoo. In Situ Tissue Regeneration 1st Edition, Host Cell Recruitment and Biomaterial Design – (Chapter 5, 6 and 7), Academic Press 2016.*

18NS625 CHARACTERIZATION OF NANOMATERIALS 3-0-0-3

LEARNING OUTCOMES:

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

- *Diffraction data analysis (especially X-ray diffraction) for identification of crystal structure of nanomaterials and thin-films*
- *Understanding working principles and analysis of size, topography and morphology analysis of nanomaterials based on SEM/TEM and scanning probe microscopies (AFM and STM).*
- *Understand fundamentals of spectroscopy techniques and nanomaterials chemical analysis using Micro-wave, IR and X-ray photoelectron spectroscopies*

SYLLABUS:

X-ray diffraction and Reciprocal lattice, Bragg's law, Ewald's sphere construction, XRD of

nanolayers, effects of nanosize and shape anisotropy of nanostructures, texture and strain measurements, SEM: scattering of electrons, secondary and backscattered electrons, electron sources, imaging modes in SEM and its use for nanomaterials size and shape analysis, TEM: Interaction of high energy electrons with matter, elastic and inelastic scattering, TEM instrumentation, imaging and diffraction modes of operation, imaging and contrast in TEM, HRTEM, Energy dispersive analysis of x-rays, Nanomaterials size and size distribution analysis, shape and structural analysis, SPM: Principle of operation, contact and non-contact AFM, dynamic force microscopy, and various other modes of SPM including STM. Chemical Characterization – Optical Spectroscopy, IR spectroscopy: vibrational modes, theory of IR spectroscopy, infrared spectrometers, single and group frequencies, advantages of FTIR. Raman spectroscopy, surface enhanced Raman spectroscopy, X-ray photoelectron spectroscopy.Use of these techniques for nanomaterials and biomaterials analysis.

TEXT BOOKS

1. *Harold P. Klug and Leroy E. Alexander, "X-Ray Diffraction Procedures: For Polycrystalline and Amorphous Materials", Second Edition, Wiley-Interscience, 1974*
2. *C. N. Banwell and E. McCash, Fundamentals of Molecular Spectroscopy, McGraw Hill Education (2017).*

REFERENCE:

N. Yao and Z. L. Wang, Handbook of Microscopy for Nanotechnology, Springer Science and Business Medi (2005).

18NS626 POLYMERIC NANOMATERIALS 2-0-0-2

LEARNING OUTCOMES:

Upon successful completion, students will have the

- *Introduction and Basic Concepts on Polymers*
- *Polymers in Solid State*
- *Partially Crystalline Polymers*
- *Polymer Analysis: Molar Mass Determination*
- *Polymerization mechanism and kinetics*
- *Nano Polymers and related Materials*

- *Polymeric nanoparticles: the future of nanomedicine*
- *Biopolymers*
- *Biopolymers for Specific Applications*

SYLLABUS:

Basic Concepts of Polymer Science-Classification of polymers–chain polymerization–mechanism of free radical, cationic, anionic and co-ordination polymerization–ring opening polymerization-Copolymerization-preparation of block and graft copolymers, Techniques of polymerization–bulk, solution, emulsion, suspension, interfacial, gas phase and melt polycondensation.
Biopolymers-Natural and Synthetic biopolymers; Biopolymer composites-both degradable and non-degradable; Dendrimers-Structure, Preparation; Types of hydrogels, in situ/injectable hydrogels, thermo-sensitive polymers-LCST properties.
Polymeric Nanomaterials-Polymeric nanoparticles-preparation methods; Nanogels-Preparation methods; Different types Nanofibers and nanocomposite scaffolds preparations. Biomedical applications of nanoparticles, nanogels, nanofibers and nanocomposite scaffolds.

TEXT BOOK

V. R. Gowariker, N. V. Viswanathan and JayadevSreedhar, "Polymer Science" New Age International (p) Ltd., New Delhi, 2015.

REFERENCES

1. *Michael Niaounakis , "Biopolymers: Applications and Trends", 1st Edition, Elsevier, 2015.*
2. *Challa S. S. R. Kumar, "Polymeric Nanomaterials", Wiley, 2011.*

18NS627 NANOMEDICINE AND NANOTOXICOLOGY 2-0-0-2

LEARNING OUTCOMES:

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

- *Design concepts of nanomedicines*
- *Various types and preparation methods of nanomedicines*
- *Specific features of nanomedicines required for various disease conditions*
- *Mechanisms of how nanomaterials can cause toxicity and various methods of measuring the same.*

SYLLABUS:

Nanomedicine: Basic concepts in the design of nanomedicine, specification and desired features of nanomedicine, nanomaterials and general process steps involved in the preparation of nanomedicines. Nanomedicines for various disease conditions: infectious diseases, neurological diseases: (challenges of blood brain barrier), pulmonary disorders, cardiovascular diseases, cancer: nano-chemotherapy, -radiation therapy, -immunotherapy, -nuclear medicine therapy, -photodynamic therapy, -photothermal and RF hyperthermia therapy, -scintillation therapy, gene-therapy: DNA, RNA delivery. Theranostic nanomedicines: Basic concept, multifunctional nanomedicines for theranosis.

Nanotoxicology: basics of cellular and organ level toxicity, effect of nanosize, shape, surface properties and composition on toxicity of nanomedicines, Case studies: Ag, ZnO, TiO_2, Quantum dots, carbon-based nanomaterials, polymeric, protein and lipid nanoparticles.

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, RohitSrivastava, 2017*
2. *Nanotoxicology, Materials, Methodologies, and Assessments, Editors: Durán, Nelson, Guterres, Silvia S., Alves, Oswaldo Luiz (Eds.),*

18NS628 DRUG DELIVERY SYSTEMS 2-0-0-2

LEARNING OUTCOMES:

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

- *Understand the different routes of drug administration*
- *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*
- *Nanotechnology Challenges; Regulatory Considerations and Clinical Issues in Advanced Drug Delivery*

SYLLABUS:

Different types of Drug Delivery Systems based on the Administration Routes: Oral Drug Delivery, Features of Gastrointestinal tract (GI), Targeting of drugs in the GI tract, Design and fabrication of oral systems - Dissolution controlled, diffusion controlled, osmotic controlled, chemically controlled release, Intravenous Drug Delivery - Factors controlling pharmacokinetics of IV formulations, Concept of opsonization, Transdermal Drug Delivery, Structure of human skin and theoretical advantages of the transdermal route, Transdermal penetration of drugs, adhesion, bioactivity, Examples of transdermal drug delivery systems, Intranasal Drug Delivery - Nasal physiology and intranasal Drug Administration, Nasal drug delivery devices, examples, Ocular Drug Delivery: Structure of human eye, Examples of Ocular Drug Delivery devices; Miscellaneous Drug Delivery

Strategies for Advanced Drug Delivery: Concept of Drug Targeting; Prodrug and Bioconjugation; Nanoscale Drug Delivery Systems - Advantages of nanodrug delivery – Improvements in

pharmacokinetics, bioavailability, biodistribution; Concepts of controlled and sustained drug delivery, How nanoparticles pass barriers; Surface modification of nanoparticulate carriers; Nanocarriers for drug delivery - Lipid based pharmaceutical nanoparticles – Liposomes, Solid Lipid Nanoparticles, Nanostructured Lipid Carriers, Cubosomes and Hexosomes, Polymeric Micelles, DNA- Based Nanomaterials, Dendrimers, Polymeric nanoparticles, Inorganic nanoparticles, Hydrogels for controlled drug delivery; Active and passive nanocarriers – Concept of targeting, Site Specific Drug delivery utilizing Monoclonal Antibodies, Peptides, Other Biomolecules, Stimuli-Responsive Target Strategies; Implants; Protein and Peptide Drug Delivery; Delivery of Nucleic Acids; Delivery of Vaccines; Aptamers in Advanced Drug Delivery; Biomimetic Self-Assembling Nanoparticles
Nanotechnology Challenges; Regulatory Considerations and Clinical Issues in Advanced Drug Delivery

TEXTBOOKS:

1. *Drug Delivery Systems, Pieter Stroeve and MortezaMahmoudi, World Scientific Series: From Biomaterials towards Medical Devices, Vol I, 2018.*
2. *Nanoparticulates as Drug Carriers, Vladimir Torchillin, Imperial College Press, 2006*

REFERENCE:

Drug Delivery Systems, Third Edition, Vasant V Ranade, John B. Cannon, by CRC Press, 2011

18NS629 LAB: NANOMATERIALS LAB-II 1-0-2-3

LEARNING OUTCOMES:

Students who complete the course will have demonstrated the following:

- *Understand the synthesis of polymeric nanoparticles and the role of reaction parameters that varies the particle size*
- *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 basics of vibrational spectroscopy (FTIR & Raman) in characterizing samples and how the spectral data can be interpreted.*
- *Understand the electrospinning technique and parameters that influence the formation of micro and nano sized fibers.*
- *Understand the thermal and mechanical characterization of polymeric samples*
- *Understand the basics of XRD in characterizing crystalline and amorphous samples.*

SYLLABUS:

1. Polymeric Nanoparticles: Synthesis of alginate nano and micro particles; characterization of particle size by Dynamic Light Scattering (DLS) and Zeta analysis
2. Fourier Transform Infra-red Spectroscopy(FTIR): Preparation of Chitosan Nanoparticles and characterization using FTIR
3. Electrospinning: Fabrication of electrospunPVAnanofibres and microfibers; characterization of fibers morphology and diameter using SEM
4. Thermal characterization of polymers using Thermogravimetric – Differential thermal Analysis (TGA-DTA)
5. X-ray diffraction spectrometer (XRD): Structural characterization of crystalline and amorphous nanomaterials
6. Raman spectroscopy: Characterization of polymeric and inorganic samples using Raman Spectroscopy
7. Mechanical Testing and Rheology: Characterization of materials mechanical properties by studying stress-strain curve.

18HU603 CAREER COMPETENCY II Credits: 1-0-0-1

LEARNING OUTCOME:

- To provide skills and techniques to clear and interview to get employed.
- Gives training to assist the student to prepare resumes and attending of interviews

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

Reasoning: Introduction to higher order thinking skills and deductive reasoning through critical thinking and syllogisms exercises. Students are trained to think critically and analyze an argument critically. They practice these skills extensively.

Logical ordering of sentences: to improve logical thinking and ability to put ideas cohesively.

Reading comprehension: intermediate & advanced level reading passages are provided to the students for practice. Students are taught techniques to read a dense passage in a fast & accurate manner.

Punctuation and e-mail writing: students hone their e-mail writing skills and are taught the essentials of punctuation and e-mail etiquette.

Aptitude

Time and distance: speed, distance, displacement, relative speed, average speed, races, boats and streams-upstream and down-stream movement, problems on trains, concept of relative speed, motion in circular track – clockwise and anti-clockwise rotations

Time and work- unitary method, concept of man-days, efficiency in task completion, sharing of wages proportionately, questions on pipes and cisterns

Geometry, mensuration-line/ray/angles, length of segments, area and properties of geometrical figures, properties of angles, diagonals, LSA, TSA and volume of solids

Seating arrangements/ puzzles- linear arrangements, circular arrangements, selection, comparison and distribution of objects under given constraints, analysing given constraints and present definitive or probable solutions for a given problem.

Permutations and combinations- fundamental principle of counting-selection and arrangement of objects, factorial notations, permutations with/without repetition, rank of a word, sum of all permutations, team formation with certain constraints

Probability- chances, odds in favour and odds against favour, events-independent and mutually exclusive types, conditional probability

Nonverbal reasoning – picture based series, mirror image, water image, paper folding, paper cutting, grouping of figures, figure matrix

Quant Based Reasoning – case study, application oriented problems

References

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

- Kaplan GMAT 2012 & 13
- www.campusgate.co.in
- www.indiabix.com
- www.bristol.ac.uk/arts/skills/grammar/grammar_tutorial/page_55.htm

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, 3nd 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
- SarveshVerma, “Quantitative Aptitude-Quantum CAT” , Arihant Publications , 2016
- www.mbatious.com
- www.campusgate.co.in
- www.careerbless.com

THIRD SEMESTER

18RM601 ETHICS IN RESEARCH AND RESEARCH METHODOLOGY 1-0-1-2

LEARNING 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*

Plagiarism, regulatory principles, safety in research, ethics in stem cell research, ethics in clinical research, ethics in nanomaterials based research Principles of data documentation, protocol development, research questions and hypothesis driven research.

TEXTBOOKS:

1. Research Ethics for Scientists, C. Neal Stewart Jr., Wiley-Backwell Publishers, 2011
2. Ethics in Science, Ethical Misconduct in Scientific Research, John D'Angelo, CRC Press, 2012.

18NS630 NANOSYSTEMS IN MEDICAL DIAGONOSTICS2-0-0-2

LEARNING OUTCOMES:

Students on completion of this course will –

- *Understand the fundamentals of medical instrumentation and types of biological samples*
- *Understand the basics of physiological transducers (pressure transducers, temperature transducers, photoelectric transducers, optical fiber sensors, smart sensors)*
- *Understand the principles, functioning and limitations of medical imaging techniques- MRI, CT, Ultrasound, Nuclear Medicine imaging, Thermal imaging)*
- *Understand the basics and challenges of clinical laboratory diagnostic techniques (optical microscopy and fluorescence-based assays, spectrophotometric and colorimetric tests,*

Pathological analysis of cells and tissues)

- *Understand the applications of nanosystems as platforms for advanced diagnostics*
- *Understanding about various nanostructures based bio-sensors and microfluidic sensors*
- *Understanding the regulatory framework for diagnostic medical devices*
- *Understanding the current status of nanotechnology based diagnostic devices commercially available and under clinical trials*

SYLLABUS:

Module I-Medical Diagnosis- from biomarkers to cells and tissues, Classical clinical diagnostic imaging tools: MRI, PET, CT, Ultrasound, Optical- principles, methods and challenges; Molecular techniques- principles, methods and challenges

Module II-Bringing in nanoscale materials and devices for diagnosis: Application in MRI, CT, NIR, Ultrasound, Nuclear and Optical imaging; Nanobio-sensors in diagnosis- cantilever based sensors, enzymatic and non-enzymatic sensors, electrochemical sensors, piezo electric biosensors, Lab-on-a-chip concept, Bio- microelectromechanical systems (Bio-MEMS), Microfluidics, surface enhanced Raman spectroscopy based diagnostics, surface plasmon based bio sensors; Current nanotechnology based diagnostics in use and under clinical trials.

TEXT BOOK:
Emerging nanotechnologies for diagnostics, drug delivery and medical devices, Kishore Cholkar, AbhirupMandal, AshimMitra, Elsevier (2017)

REFERENCES:

1. Nanobiosensors and Nanobioanalyses, Vestergaard MC, Kerman K, Hsing IM, Tamiya E, Springer 2015
2. Current Medical Diagnosis and Treatment, Maxine A Papadakis, McGraw Hill Education, 2017

18NS631 SCAFFOLDS IN TISSUE REGENERATION 2-0-0-2

LEARNING OUTCOMES:

Students on completion of this course will –

- *Understand the requirements and functions of a scaffold in tissue regeneration*
- *Comprehend the different types of nanomaterials useful for developing scaffolds*
- *Understand the diverse properties of scaffolds that influence their interactions with tissues*
- *Decipher the need for biocompatibility evaluation of scaffolds*
- *Look into specific case studies towards the developments of scaffolds for regenerating various*

organs in the human body

SYLLABUS:

Definition and requirements of a scaffold, functions of a scaffold, structure of a scaffold, materials for scaffolds and their influence on scaffold properties, scaffold structure. Use of nanomaterial in scaffolds, scaffold influence on cellular behavior- role of scaffoldporosity, mechanical strength, surface chemistry, scaffold rigidity; surface topography, hydrophobicity/hydrophilicity, degradation behavior.

Fundamental aspects of tissue response to nanomaterials-Protein adsorption on nanomaterials, Cellular response to nanomaterials; Blood-material interactions, Inflammatory and immune response to nanomaterials, Angiogenic response to nanomaterials.
Biocompatibility of nanomaterials, *In vitro* and *in vivo* biocompatibility tests as per ISO
Case Studies-Applications of nanomaterials in Skin regeneration, Bone regeneration, Liver regeneration, Vascular tissue regeneration, Cartilage regeneration

TEXT BOOK:

Ying Deng and Jordan Kuiper, Functional 3D Tissue Engineering Scaffolds: Materials, Technologies, and Applications (Woodhead Publishing Series in Biomaterials), 2017

REFERENCE:

Cato T. Laurencin, Lakshmi S. Nair. Nanotechnology and Regenerative Engineering: The Scaffold, Second Edition, CRC Press 2017