PET syllabus 2020

Section: Pharmacy specific subject

Modern Pharmaceutical and Medicinal Chemistry(4 h/wk)

Unit	Course Content (Topics)	Hours
1	**Drug Discovery**	**5**
1.1	Historical perspective	1
1.2	Lead Discovery	1
1.3	Lead Modification – identification of the pharmacophore, functional group modification, privileged structures and drug-like molecules, modifications to increase potency and the therapeutic index, modifications to increase oral bioavailability	3
2	**Receptors**	**10**
2.1	Basic ligand concepts – agonist, antagonist, partial agonist, inverse agonist, efficiency and potency	1
2.2	Interactions (Forces) involved in drug-receptor complexes	2
2.3	Receptor theories – occupancy theory, rate theory and activation theory	1
2.4	Receptor classification – the four superfamilies'	2
2.5	Receptor binding assays- measurement of K_d, B_{max} and IC_{50}	2
2.6	Topographical and stereochemical considerations in drug –receptor interactions	2
3	**Prodrugs and Drug Delivery Systems**	**13**
3.1	Enzyme activation of drugs, utility of prodrugs – aqueous solubility, absorption and distribution, site specificity, instability, toxicity, poor patient acceptability, formulation problems.	2
3.2	Carrier-linked prodrugs – carrier linkages for various functional groups, carrier-linked bipartite prodrugs, macromolecular drug carrier systems, tripartite prodrugs, mutualprodrugs, bioprecursorprodrugs (hydrolytic activation, elimination activation, oxidative activation, reductive activation, nucleotide activation, phosphorylation activation, sulfation activation and decarboxylation activation).	6

3.1 3.2	*Self study of specific examples of drugs that have been converted to prodrugs for solving problems related to ADME and their release mechanisms. Self study of prodrugs involving specific tissue targeting or specific activation at the target tissue.*	*5*
4	**Drug Metabolism**	**18**
4.1	Introduction to xenobiotic/drug metabolism and its relation to other defence systems (Physical barriers, excretion, immune system).	0.5
4.2	Types of reactions (I and II), consequences of drug metabolism (DM) [inactivation, bioactivation, prodrugs], organs of DM, localization of drug metabolizing enzymes, factors affecting drug metabolism.	0.5
4.3	Cytochrome P450s: Introduction to the family of enzymes, their classification and nomenclature.	1
4.4	CYP450 catalytic cycle, different types of reactions catalyzed by CYP450s and the mechanisms of catalysis.	4
4.4	Human CYP450s involved in DM, their distribution and properties, typical substrates, specific probe substrates, specific inhibitors, induction of CYPs and specific inducers	2
4.5	Discussion of glucuronosyltransferases, sulfotransferases, glutathione S-transferases, N-acetyl transferases, and FMO [on lines similar to that specified for CYPs as listed above].	4
4.5	*Self study of alcohol/aldehyde dehydrogenases, xanthine and aldehyde oxidase, epoxide hydrolase, esterases, azo and nitro reductases (reactions catalyzed be these enzymes, mechanisms of the reactions, typical substrates/inhibitors/inducers)*	*6*
5	**Enzymes**	**14**
5.1	Introduction to enzymes, binding site, specificity of enzyme catalyzed reactions and rate acceleration, MichaelisMenten kinetics and methods for plotting enzyme kinetic data	4
5.2	Mechanisms of enzyme catalysis – covalent catalysis, acid-base catalysis, electrostatic catalysis, some examples of the mechanisms of enzyme catalysis	2
5.3	Coenzyme catalysis – pyridoxal 5'-phosphate (racemases, decarboxylases, aminotransferases), nictoinamide and flavin (two-electron mechanism, one-electron mechanism and hydride transfers), folic acid and thiamine (one carbon transfer reactions).	4
5.1	*Self study of Hanes plot, Cornish-Eisenthal Bowden plot,*	*1*
5.2	*Self study of roles of coenzymes – biotin, coenzyme A, cyanocobolamine, vitamin K*	*3*

	Total	**60**

Books:

1. The Organic Chemistry of Drug Design and Drug Action, Silverman R. B., Academic Press.
2. Textbook of Drug Design and Discovery, Eds. Krogsgaard-Larsen P., Liljefors T., Madsen U., Taylor & Francis.
3. Lehninger – Prinicples of Biochemistry, 4th edition.
4. Medicinal Chemistry: An Introduction, Thomas G, Wiley.
5. Drug Discovery – A History, Sneader W, John Wiley & Sons, Ltd.
6. Comprehensive Medicinal Chemistry, Series Ed., Hansch C., Pergamon Press.
7. Wilson and Gisvold's, Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott-Raven
8. Foye's Principles of Medicinal Chemistry, Lippincott Williams and Wilkins.
9. Drug Metabolizing Enzymes-Cytochrome P450 and Other Drug Metabolizing Enzymes in Drug Discovery and Development, Lee JS, Obach SR and Fisher MB, Marcel Dekker, Fontis India, 2003
10. Pharmaceutical Profiling in Drug Discovery for Lead Selection, Borchardt RT, Kerns EH, Lipinski CA, Thakker DR and Wang B, AAPS Press, 2004
11. Drug Metabolism – Current Concepts, Ionescu C and Caira MR, Springer International Edition
12. Handbook of Drug Metabolism, Woolf TF, Marcel Dekker, 1999.

MPH_C_102_T - Modern Pharmaceutics (4 h/wk)

Unit	Course Contents (Topics)	Hours
1	**Drug Stability:**	**9**
1.1	Importance and need for stability testing	1
1.2	Revision of degradation pathways, kinetics, physical stability	2
1.3	Solution and Solid state stability, pH stability profiles, v and u graphs, package evaluation, ICH guidelines, statistical aspects in derivation of shelf life.	3
1.2	*Self study- Calculations for shelf life based on degradation kinetics*	*3*
2	**Solubilization and Dissolution:**	**14**
2.1	Importance of aqueous solubility of drugs, particularly NCEs, surfactant systems and phase diagrams, polymeric surfactants, cosolvents, complexation, solid state manipulations, cyclodextrins, drug derivatization, salt screening.	5
2.2	Revision of equations of dissolution and factors affecting dissolution, intrinsic solubility and dissolution rate, validation of testing, different equipments (emphasis on USP apparatus 4), Dissolution of TDDS, particulates, gels & ointments, comparison of profiles by f2 analysis, development of dissolution method, relevance of dissolution testing in ANDAs , bio-relevent media, BCS classification, IVIVC-	5

	study design and interpretation	
2.3	*Self study- Calculations based on various solubility parameters and equations of dissolution. Pharmacopoeial dissolution apparatus, data treatment of dissolution profiles.*	*4*
3	**Excipients and introduction to polymers:**	**7**
3.1	Role of excipients, purity, safety and toxicity with reference to routes of exposure-oral, inhalational, parenteral, others; regulatory aspects, risk assessments, Harmonization of excipient standards like residual solvents class 1,2,3.	2
3.2	Different classes of excipients - surfactants, special lipids, superdisintegrants, gelling agents, colours and flavours, sweetening agents, co-processed excipients.	2
3.3	Definition of polymers, classification; concept of properties used in characterisation, methods of polymerisation, biocompatibility evaluation, applications	2
3.4	*Self study: sources and brand names of various excipients*	*1*
4	**Optimisation Techniques:**	**8**
4.1	Definition, Need, Advantages, description of terms such as independent variable, response parameters, response surface, contour plots, polynomial equations	2
4.2	Simplex and factorial designs in optimisation	3
4.3	Application of optimisation techniques in QbD in product development	1
4.5	*Self study: Placket-Burman design, central composite designs*	2
5	**Preformulation:**	**12**
5.1	Scope of Preformulation-Role & importance in New Drug Discovery & Approval process-Lead optimization, Steps in Designing the preformulation evaluation of a new drug, critical issues and problems/constraints	3
5.2	Key Areas in Preformulation research- Bulk Characterization, Solubility Analysis, Stability Analysis, Compatibility with common excipients	4
5.3	Preformulation aspects for Tablets, Injectables, Liquid preparations, Protein & peptide drugs.	3
5.4	*Self study: case study of drug exhibiting various polymorphic forms, drug excipient compatibility*	*2*
6	**Powder Technology (Micromeritics):**	**10**
6.1	Revision of following topics: • Important definitions & Units • Importance of particle size in pharmaceutical development. • Fundamental & derived properties of powders • Particle size reduction –comminution mechanisms &equipments	2

	• Methods of particle size determination (emphasis on basic principles & interpretation of data)	
6.2	**Comminution-** Theory of comminution, milling rate (various mathematical relationships), concept of milling/grinding index, energy for comminution, distribution and limit of comminution	2
6.3	**Compaction of powders**- definitions of compression & consolidation, deformation mechanisms of matter, steps in compaction of tablets (in detail), theoretical aspects- Force Volume relationships/porosity –pressure equations (Heckel's Law & equation), Granulation of powders –theory, Effect of compaction pressure on various tablet properties, Energy for compaction & effect of lubrication of granules, instrumentation of tablet presses (principles)	3
6.4	*Self study: case studies on compaction behaviour of two excipients*	*3*
	Total	**60**

Books :

1. Drug Stability Principles and Practices by Carstensen J, Marcel Dekker, 3rdedn, Vol 107, 1990.
2. Pharmaceutical Stress testing by Baertschi SW, Taylor and Francis, Vol 153, 2005.
3. Pharmaceutical characterisation of Pharmaceutical Solids by Brittain HG, Marcel Dekker, Vol 70, 1995
4. Preformulation in Solid Dosage Form Development by Adeyeye MC, Brittain HG, Informa Healthcare, Vol 178, 2008.
5. Dissolution, Bioavailability and Bioequivalence by Abdou HM, Ed A. Gennaro, B. Migdalof, Mack Printing Company,1stedn, 1989.
6. Pharmaceutical Bioequivalence by Welling PG, Francis LST, Dighe SV, Marcel Dekker, Inc., Vol. 48, 1991.
7. Pharmaceutical Dissolution Testing by Banaker U, Marcel Dekker, Vol 49, 1992.
8. Excipient toxicity and safety by Weiner M L, Kotkoski LA , Vol 103, Marcel Dekker, 1999.
9. Martin's Physical Pharmacy and Pharmaceutical Sciences, by Sinko PJ, Ed Lea &Feiger, Lippincott Williams & Wilkins, 6thedn, 2010.
10. Modern Pharmaceutics by Banker GS, Ed Banker GS & Rhodes CT, Marcel Dekker, 4thedn, Vol 121, 2003.
11. Pharmaceutical Statistics by Bolton S, Marcel Deckker, 3rdedn, Vol 80, 1997.
12. The Theory and Practice of Industrial Pharmacy by Lachman L, Lieberman HA, Kanig JL, Varghese Publishing House, 3rdedn, 1990.
13. Pharmaceutical Dosage Forms: Tablets, Unit Operations and Mechanical Poperties Ed Augsburger LL, Hoag SW, Informa Healthcare USA, Inc., 3rdedn, Vol 1,2008.
14. Techniques of Solubilization of Drugs by Yalkowsky SH, Marcel Dekker, Vol 12, 1985.
15. Pharmaceutical Dissolution Testing by Dressman J. Ed Dressman J, Kremmer J, Tylor & Francis, 2005.
16. Controlled Drug Delivery: Clinical Applications, by Bruk SD, CRC Press Inc., Vol 2, 1983.
17. Handbook of Pharmaceutical Granulation Technology by Parikh DM ,Informa healthcare, 2nd edition, Vol 154, 2007.
18. Pharmaceutical Powder Compaction Technology by Alderborn G, Nystrom C, Marcel Dekker, Vol 71, 1996.

MPH_C_103_T - Modern Pharmacology (4 h/wk)

Unit	Course Contents (Topics)	Hours
1		**11**
1.1	Drug Absorption, distribution, metabolism and excretion.	5
1.2	• Mechanisms of transport of drug across membranes. • Transporters involved in drug absorption, distribution and excretion processes.	3
1.3	• *Self study-Drug efflux pathways and experimental methods to study drug transport.* • *Pharmacokinetic factors affecting drug action*	*3*
2	**Mechanism of drug action**	**11**
2.1	Classification of receptors and description of each class with examples.	1
2.2	• Signal transduction mechanisms. • Detailed description of signal mediation through cascades after adrenergic, muscarinic, GABAergic, insulin receptor stimulation.	4
2.3	Regulation of receptors, their involvement in various biological processes including diseases resulting from receptor malfunction and their role in pharmacotherapeutics.	1
2.4	Regulation of intracellular calcium.	2
2.5	Pharmacodynamic interactions in a multicellular context e.g. Vascular wall (interactions of physiological ligands and drugs in pathophysiological setting).	1
2.6	*Self study- Classification and characterization of receptors-IUPHAR (Eg. 5-HT receptors)*	*2*
3	**Functions of sodium and potassium channels and therapeutic potential of channel modulators.**	**3**
4	**Factors affecting drug responsiveness.** • Alteration in concentration of drug that reaches receptors. • Variation in concentration of an endogenous receptor ligand. • Alteration in number and function of receptors. • Clinical selectivity: Beneficial vs. toxic effects of drugs. a. Beneficial and toxic effects mediated by the same receptor - effector mechanism. b. Beneficial and toxic effects mediated by identical receptors but in different tissues or by different effector pathways. c. Beneficial and toxic effects mediated by different types of receptors. • Desensitization, tachyphylaxis.	**3**

	• Drug tolerance.	
5	**Cellular and molecular mechanisms of**	**4**
5.1	Drug dependence (Eg. Morphine).	
5.2	Microbial resistance.	
6	**Advances in therapy of**	**18**
6.1	CNS: Depression, Alzheimer's disease, Psychosis, Parkinson's disease, Epilepsy.	5
6.2	CVS: Hypertension, Angina Pectoris, Congestive cardiac failure, Arrhythmia.	5
6.3	Management of Diabetes Mellitus.	2
7	**Apoptosis**	**4**
7.1	Molecular biology, physiological, pharmacological implications and therapeutic prospects.	2
7.2	*Self study – Interaction between cell, growth factors and extracellular matrix.*	*2*
8	**Immunopharmacology**	**6**
8.1	Introduction to immunopharmacology, immunomodulators, Immunostimulants and Immunosuppressants.	4
8.2	*Self study-Autoimmunity*	*2*
	Total	**60**

Books:

1. Rang and Dale's pharmacology-- Elsevier Churchill Livingston.
2. Lange's Basic and clinical pharmacology, Katzung B.G. Masters S.B., Trevor A.G. Tata McGraw Hill.
3. Goodmann and Gilman's pharmacological basis of therapeutics, Edited by Laurence Brunton, Bruce Chabner and Bjorn Knollman, McGraw Hill.
4. Pharmacological reviews, Annual reviews Inc.
5. Advances in pharmacology, Academic Press.
6. Trends in Pharmacological Sciences, Cell Press Elsevier Publication.

MPH_C_104_T - Modern Analytical Techniques (4 h/wk)

Unit	Course contents (Topics)	Hours
1	**Multicomponent analysis of drugs using UV- Vis. spectroscopy:**	**6**
1.1	Simultaneous equation method, Absorbance ratio method, Difference spectroscopy, Derivative spectroscopy and Introduction to Ratio derivative spectroscopy,	4
1.2	*Self study-Pharmaceutical applications of above techniques (1.1)*	*2*
2	**F.T.I.R spectroscopy:**	**6**
2.1	Construction and working, Newer sampling techniques.	2
2.2	Interpretation of I.R. spectra in mid I.R. region (aliphatic and aromatic compounds for simple compounds such as amines, alcohols, amides, nitriles, ketones, aldehydes, esters, acids, nitro and anhydrides).	2
2.3	*Self study-Interpretation of recorded I.R spectra of drugs and organic compounds.*	*2*
3	**NMR spectroscopy:**	**10**
3.1	**^{1}H- NMR:** Basic theoretical concepts-*(Self study-chemical shift, splitting pattern and coupling constant-2 hrs)*, Non-first order spectra, methods to make complex spectra simple, FT-NMR.	6
3.2	**^{13}C-NMR:** Theory and Principle.	2
3.3	Applications of 2D-NMR (only COSY and HETCOR)	2
4	**Mass Spectrometry:**	**10**
4.1	Different ionisation techniques-EI, CI, FD, FI, MALDI, API (APPI, APCI, ESI).	4
4.2	Different analysers-Quadrupole, TOF, QTOF, Ion cyclotron, Ion trap.	2
4.3	Concepts for interpretation of mass spectra-Molecular ion peak, base peak, Isotope abundance, fragmentation pathways-α fission, β fission, MacLaffarty rearrangement, Retro Diels Alder rearrangement, Tandem mass (MS-MS).	4
5	***Terminologies of chromatography:*** *Self study-Theoretical plate, HETP, Plate theory, Rate theory, Van Deemter equation, Isocratic elution, Gradient elution, capacity factor, selectivity factor, Resolution, tailing factor, asymmetry factor.*	***3***
6	**Advances in chromatography:**	**11**

6.1	HPLC-Ion pair chromatography, Chiral chromatography (Chiral stationary phases, use of mobile phase additives, precolumnderivatisation, chiral detectors), UPLC, *Self study-Advances in HPLC detectors (1 hr).*	5
6.2	Supercritical Fluid chromatography-Principle, Instrumentation and pharmaceutical applications.	2
6.3	*Self study-HPTLC-Principles, Instrumentation and applications including fingerprint analysis.*	1
6.4	Gas chromatography-Headspace analysis.	1
6.5	Gel electrophoresis-Principle, Instrumentation and applications.	2
7	**Hyphenated techniques:**	**4**
7.1	Interfaces used in and applications- GC-MS, LC-MS, LC-MS-MS	3
7.2	Introduction to LC-NMR and MALDI-TLC.	1
7	**Thermoanalytical techniques:** Principle, instrumentation and applications including interpretation of data in pharmacy for:	**5**
7.1	*Self study-DSC and TGA*	*3*
7.2	TMA (Thermo mechanical analysis).	1
7.3	*Interpretation of DSC and TG curves of suitable compounds/drugs (Self study)*	1
8	**Microscopy: Principle, Instrumentation, sample preparation and pharmaceutical applications of-** Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Confocal microscopy.	**5**
	Total	**60**

Books:

1. Chromatographic methods by A.Braithwaite&S.J.Smith, Kluwer Academic publishers, Netherlands, London, USA.
2. Thermal Analysis of Pharmaceuticals by Craig, Informa, CRC Press, Indian Reprint.
3. Practical Pharmaceutical Chemistry by A.H.Beckett and J.B.Stenlake, fourth edition, part two, CBS Publishers and Distributors.
4. Spectrometric Identification of Organic compounds by R.M.Silverstein, F.X.Webster,D.J.Kiemle , Latest edition, John Wiley & Sons
5. Applications of absorption spectroscopy of organic compounds by John Robert Dyer

6. Organic Spectroscopy by William Kemp, PALGRAVE.
7. Textbook of Pharmaceutical Analysis by K.A.Connors, Wiley Interscience Publications.
8. Introduction to Spectroscopy by D.L.Pavia, G.M.Lampman&G.S.Kriz.
9. Remington: The Science & Practice of Pharmacy, 20th edition, Vol. 1, Lippincot Williams & Wilkins
10. Introduction to Modern Liquid Chromatography by L.R.Snyder, J.J.Kirkland 3rd edition.
11. Chiral separations by Liquid Chromatography and Related Technologies Chromatographic Science Series by Hassan Y., Imran Ali, Vol. 90.
12. Static head space gas chromatography Theory & practice by Bruno Kolb &L.S.Ettre.
13. Encyclopedia of Chromatography, by Jack Cazes, 3rd edition, Vol.1,2& 3.
14. Online LC-NMR and Related techniques by Klasu Albert, John Wiley & Sons
15. LC-MS- A Practical Users guide, by Marvin C. McMaster.

MPH_C_105_T – Study of Natural Products (4 h/wk)

Unit	Course Contents (Topics)	Hours
1	**Introduction to study and research in herbal drugs:**	**4**
1.1	Different approaches to plant selection, collection and processing for herbal drug research (Random selection, Use of ethnobotanical information, Use of chemotaxonomical classification etc).	2
1.2	Recent advances in concept of authentication & standardization - significance of chemotaxonomy and DNA finger-printing with respect to gene expression for secondary metabolites.	2
2	**Extraction of phytochemicals**	**18**
2.1	Concepts of extraction with respect to activity guided fractionation & isolation of Markers/Biomarkers.	2
2.2	Recent trends in extraction, optimization of extraction, and analysis of the phytochemicals of different classes.	2
2.3	Detail discussion of large scale extraction of the following: (1) Opium alkaloids (2) Piperine (3) Sennosides (4) Caffeine (5) Cinchona alkaloids (6) Rutin (7) Lemon grass oil (8) Patchouli oil (9) Steroids (Diosgenin from all sources)	9
2.4	*Self study- preparation of flow chart and discussion of physicochemical principles for all large scale extractions*	*5*
3	**Natural products in drug discovery and drug development**	**8**
3.1	Role of natural products as leads to the design of new drugs with case history with examples e.g., artemisinin, taxane, camptothecin and a few others.	2
3.2	Natural products derived combinatorial libraries and their significance in drugs discovery programme (HITS and leads).	2

3.3	*Self study- Discussion of lead molecules in drug discovery*	*4*
4	**Study of following excipients of natural origin in NDDS with respect to sources, preparation, composition and application**	**16**
4.1	Natural dyes & colorants, sweeteners, flavours and fragrant materials	8
4.2	Kappa carrageenans, galactomannans, glucomannans, cellulose derivatives, lecithin, & alginates.	4
4.3	*Self study- Role of excipients mentioned above, in formulations, with examples*	*4*
5	**Application of immunoglobulins from plant sources in diagnosis and therapy.**	**4**
6	**Nutraceuticals and their role in health care.**	**4**
6.1	Study of following classes of herbs with two or three suitable examples of each: (1) Antioxidants (2) Immunomodulators (3) Antihyperglycemics (4) Hepatoprotectives	4
7	**Status of natural products in official books**	**6**
7.1	Introduction to Herbal Pharmacopoeias of different countries	2
7.2	Monographs of natural products in other official books.	2
7.3	*Self study-Discussion of monograph of few substances of natural origin*	*2*
	TOTAL HOURS	**60**

Books:

1. PharmacognosyPhytochemistry – Medicinal Plants- Jean Brunetton, Lavoisier Publishing, Paris.
2. Text book of Pharmacognosy- Trease and Evans- 14th edition. Elsevier science
3. Transgenic Plants- R. Ranjan- Agro Botanica, New Delhi.
4. Transgenic Plants-A Production system for Industrial and Pharmaceutical Proteins. byMeran Owen, Jan Pen- John Wiley.
5. Medicinal Plant-Their Bioactivity, Screening and Evaluation- CSIR.
6. Homeopathic Pharmacopoeia of India- Publisher Ministry of Health.
7. The Ayurvedic Formulary of Part I & II- Publisher Ministry of Health.
8. Chinese MateriaMedica-You-Ping Zhu- Harwood Academic Publishers.
9. India Materia Medica- Nadkarni A.K. –Bombay Popular Prakashan.
10. Phytochemical Methods - J.B.Harbone - Chapman and hall
11. Cultivation's and Processing of Medicinal Plants-Ed. by L. Hornok-John Wiley.
12. Introduction to Flavanoids-Bohrn Bruce A. – Herwood Academic Publishers.
13. Cultivation and Utilization of Aromatic plants – Ed. By Atal C. K. and Kapur B.M.- CSIR.
14. Plant Tissue and Cell Culture Ed. H.E. Street – Blackwell Scientific publications.
15. Aflatoxin- Leo A. Goldblatt- Academic Press New York.
16. Microbial Toxins- Ciejler, Kadis and Ajl- Academic press.
17. Antimicrobial in Food – Alfred larryBranen, P. Michael Davidson Publishing house
18. Chemical plant Taxonomy T. Swain, 1963. Academic Press, London.

19. Plant Taxonomy and Biosystematics .C.A Stace, 1985. Edward Arnold, London.
20. Modern methods of plant analysis K. Paech, 1956., Springer-Verlag**.**
21. Indian Herbal Pharmacopoeia, Vol. 1&2, RRL, IDMA, 1998, 2000.
22. Indian Pharmacopoeia, 2010.
23. Standardization of Botanicals,V. Rajpal, 2002. Eastern Publishers, New Delhi.
24. Natural Compounds as Drugs – Vols. I & II, Editor- Frank Petersen, René Amstutz, Die Deutsche Bibliothek, Germany.
25. Quality control of Herbal Drugs: An Approach to evaluation of Botanicals, Pulok Mukherjee - Riddhi International
26. Chemicals from Plants: Perspectives on Plant Secondary Product, Walton & Braun, Imperial College Press.
27. Towards Natural Medicine Research in the 21st Century H. Ageta, N. Aimi et al ExcerptaMedica, International Congress Series 1157.

Section: Research methodology

	Research Methodology	
1	**Objectives and purpose of Research**	**2**
1.1	Types of research – Educational, clinical, experimental, basic, applied and patent oriented research	2
2	**Literature survey**	**2**
2.1	use of library, books and journals, eJournals, retrieving patents and seeking reprints.	2
3	Methods and tools used in research • Qualitiative and quantitative studies • Simple data organization, descriptive data analysis • Limitations and sources of errs • Inquiries in form of questionnaire, opinionaire or by interview • Statistical analysis of data including variance, standard deviation, standard error, mean, student's *t* test and annova, correlation of data and its interpretation, computer data analysis	**6**
4	**Scientific writing and reporting** • Different types of research papers • Title and author names • Abstract and key words • Methodology	**3**
5	**Scientific Presentation** • Importance, types and different skills • Content, format of model, introduction and ending	**3**

	• Skills for oral presentation and types of visual aids • Questionnaire	
6	**Patents and Trade marks** • The Indian patent system • Present status of intellectual property rights (IPR) • Product patents and process patent • Requirements and preparation of patent proposal • Registration of patent in foreign countries	**4**
	Total Research Methodology	**20**

Books:

1. Research in Education, John W Best and James V Khan, Prentice Hall of India Pvt. Ltd.
2. Effective Business Report Writing, Brown Leland, Prentice Hall Inc. India.
3. Presentation Skills, Michael Hatton, Indian Society for Technical Education, New Delhi.
4. Thesis and Assignment writing, Anderson Jonathan and Durston Berry H, Wiley Eastern Ltd., Bangalore.
5 Writing a Technical Paper, Donald H Menzel, McGraw Hill Book Company, Inc., New York.