



SOMAIYA
VIDYAVIHAR

K J Somaiya College of Science & Commerce

Department: Botany



TRUST

M.Sc. II. Syllabus

**K. J. Somaiya College of Science and Commerce,
Vidyavihar, Mumbai-400077**

Autonomous - Affiliated to University of Mumbai

(Reaccredited by NAAC with Grade A)

Syllabus for M.Sc.

(Autonomous- Revised)

Semester III and IV

Program: M.Sc.

Course: Botany

(Cytogenetics and Plant Biotechnology)

Credit Based Semester and Grading System

With effect from the academic year 2018-2019 & 2020-2021



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Preamble

Autonomy has given us the opportunity to frame the syllabus with a blend of Classical and Applied Botany which will open an array of opportunities in Higher Studies, Entrepreneurship, Research and Consultancy. Students will be geared up to get jobs in various industries such as Cosmetic, Pharmaceutical and Horticulture Industry.

M.Sc. Semester II Botany Syllabus

Credit Based and Grading System

To be implemented from the Academic year 2018-2020

SEMESTER III

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
18PS3B001	Paper Title: Instrumentation and Techniques			
	I	Chromatography and Spectrophotometry	4	1
	II	Tracer Techniques and Cytometry		1
	III	Centrifugation		1
	IV	Microscopy		1
18PS3B002	Paper Title: Cytogenetics			
	I	Gene Mapping	4	1
	II	Cell Cycle and Cancer Biology		1
	III	Inborn Errors of Metabolism		1
	IV	Applied Genetics		1
18PS3B003	Paper Title: Plant Biotechnology			
	I	Plant Tissue Culture	4	1
	II	Bioprocess Technology		1
	III	Metabolite Engineering		1
	IV	Applications of Plant Biotechnology		1
18PS3B004	Paper Title: Applied Biotechnology			
	I	Industrial Biotechnology	4	1
	II	Food Microbiology		1
	III	Nano-technology		1
	IV	Entrepreneurship Skills		1

Course Code	PRACTICAL HEADINGS	Credits	L / Week
18PS3BOP01	Instrumentation and Techniques	2	4
18PS3BOP02	Cytogenetics	2	4
18PS3BOP03	Plant Biotechnology	2	4
18PS3BOP04	Applied Biotechnology	2	4

M.Sc. Semester II Botany Syllabus

Credit Based and Grading System

To be implemented from the Academic year 2020-2021

SEMESTER IV

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
20PS4B001	Paper Title: Plant Breeding			
	I	Paradigm of crop production	4	1
	II	Principles and methods of crop propagation		1
	III	Polyploidy in Plant Breeding		1
	IV	Distant hybridization in Plant Breeding		1
20PS4B002	Paper Title: Molecular Genetics			
	I	Genomics	4	1
	II	Genomic Research- I		1
	III	Genomic Research -II		1
	IV	Proteomics		1
20PS4B003	Paper Title: Recent advances in Immunology and Clinical Research			
	I	Immunology	4	1
	II	Immuno-Techniques		1
	III	Stem Cell Technology		1
	IV	Clinical research		1
20PS4B004	Paper Title: Research Strategy			
	I	Research ethics	4	1
	II	Tools used in research		1
	III	Commercial aspect of research Agencies for Research funding		1
	IV	Open Unit		1

SEMESTER III, PAPER I		
Code	Title: Techniques and Instrumentation	Credits
18PS3B001	Learning Objective: Students will be able to design the experiments which involve the use of various instruments and techniques. It gives an insight about various analytical skills required in the field of research.	04
<u>Unit I:</u>	<u>Chromatography and Spectrophotometry</u>	<u>Lectures</u>
	Chromatography - Principles and applications of chromatography (Paper, TLC, Adsorption, Ion exchange, Affinity, Gel filtration, HPTLC, HPLC, GC), General idea about hyphenated techniques in chromatography Spectrophotometry - Principles, Working and applications of ; UV-visible spectrophotometer, Mass spectrometer, NMR	(15)
<u>Unit II:</u>	<u>Tracer techniques and Cytometry</u>	
	Principle and application of tracer techniques in biology, Radioactive isotopes used in Research, Medicine, Industry, Radiation Dosimetry; Geiger Muller and Liquid Scintillation Counter Principle, Working and applications of Flow Cytometer, Principle and application and working of X-ray crystallography	(15)
<u>Unit III:</u>	<u>Centrifugation</u>	
	Principle, Concept of 'g', Rotor types; Fixed Angled and Swinging Bucket, Types of centrifugation (Based on volume and speed), and their applications, Density gradient centrifugation	(15)
<u>Unit IV:</u>	<u>Microscopy</u>	
	Principles, working and applications of ; Electron microscope - Scanning and transmission electron microscopy, Biological sample preparation; Fixation, Embedding, Sectioning and Post-staining, Negative staining, Shadowing, freeze fracturing, Freeze etching, Applications of electron microscopy, Principle, working and applications of Confocal Microscopy	(15)
<u>Practicals:</u>		

1. Isolation of Plant Pigments using Column Chromatography and study of absorption spectra.
2. To estimate the amount of curcumin from given plant material using TLC/ HPTLC.
3. Demonstration of principle and working of HPLC
4. Demonstration of principle and working of GC
5. Demonstration of different rotor types – Fixed Angled and Swinging Bucket.
6. Isolation of chloroplast / mitochondria using density gradient centrifugation.
7. Study of steps of autoradiography using photomicrograph.
8. Study of electron microscope using photomicrograph (SEM and TEM)

9. Study of confocal microscope using photomicrograph.
10. Industrial visit

Reference Books

1. An introduction to practical Biochemistry – David T. Plummer, Tata Mc Graw Hill Co. Ltd., Bombay
2. Introductory Practical Biochemistry (2001). Ed. S.K. Sawhney and Randhir Singh.
3. Practical Biochemistry Sadasivam and Manickam.
4. Practical Biochemistry, Principles and Techniques (1995). Ed. Keith Wilson and John Walker.
5. Microbiology, Cell Physiology and Biotechnology (2005): P.K. Gupta Rastogi Publications.
6. Biophysical chemistry – Upadhyay and Upadhyay
7. Wiliam and Wilson, Practical Biochemsitry
8. Arora – Biophysics
9. White David – Biophysics

<u>SEMESTER III. PAPER II</u>		
Code	Title: <u>Cytogenetics</u>	Credits
18PS3B002	<u>Learning objective:</u> Recombinant DNA Technology will be effectively used by students in disease diagnostics. Use of technology at gene level will be used effectively to demonstrate the new trends in research and development.	0 4
<u>Unit I:</u>	<u>Gene Mapping</u>	<u>Lectures</u>
	Study of gene mapping in Bacteria – Mapping the genome by Transformation, Conjugation and Transduction, Problems based on Transformation, Conjugation and Transduction for Gene Mapping	(15)

Unit II:	Cell Cycle and Cancer Biology	
	Cell cycle and its checkpoints, Regulation of cell cycle, Role of cyclins and CDK, DNA damage checkpoints and their regulation, RAS-MAP kinase pathway Cancer – Characteristics of cancer cells, Causes of cancer; Radiation, Chemicals, Virus, Oncogenes; Proto-oncogenes and their conversion, Treatment	(15)
Unit III:	Inborn Errors of Metabolism	
	Inheritance Pattern, Symptoms, therapeutic options and genetic counselling of disorders of – Sugar metabolism; G-6-PD, Fructosuria, Galactosaemia Amino acid metabolism; Albinism, Alkaptonuria, Phenylketonuria Sulphur containing Amino acid; Homocysteinuria, Cystathioninuria Lipid metabolism; Tay Sachs Disease, Gaucher's Disease, Mucopolysaccharides Vitamin; Folate malabsorption, Methylmalonic aciduria Haemoglobin; Thalassemia, Sickle Cell Anaemia	(15)
Unit IV:	Applied Genetics	
	DNA sequencing – Traditional, Next generation sequencing Blotting techniques – Southern, Northern, Western, DNA blot, PCR – Types, RTPCR Karyotyping – Nomenclature, G-banding, R-banding, C-banding, High- banding Application of Molecular Markers – RAPD, RFLP, AFLP, ISSR, Microsatellites Molecular Cytogenetics Methods – Principle, Techniques and Applications of FISH, CGH, SKY	(15)
Practicals		
<ol style="list-style-type: none"> 1. Problems based on conjugation, transformation 2. Study of Barr body 		

3. Study of Dermatoglyphics; Classification of Dermatoglyphics patterns, Determination of ATD angle, Calculation of Total Ridge Count.
4. Pedigree Analysis; Meaning and Symbols used. Determination of inheritance pattern of a trait using given pedigree chart.
5. Study of characteristics of cancer cells using photomicrographs
6. Squash preparation from mutagen treated root tips for aberrations
7. Identification of genetic disorder by chemical tests
8. Identification of inborn error in metabolism using flow chart / photomicrographs
9. Study of Southern blotting
10. Study of molecular markers using photomicrographs

Reference Books

1. Lewin B. (2003): Genes – VIII, Oxford University Press, New York.
2. Primrose, S.B. (1989): Animal Cell Biology 6th Edition(2010)
3. Gerald Karp John Wiley & Sons Inc.The Cell: Fifth Edition: (2009) A Molecular Approach, Geoffrey M. Cooper Robert E.Hausman, Sinauer Associates.
4. Cell and Molecular Biology (2005)
5. P.K. Gupta Rastogi Publications.
6. Biotechnology Blackwell Scientific Publication, London.
7. Old R.W. and Primrose, S.B. (1989): Principles of Gene Manipulation, Blackwell scientific Publication, London.
8. Watson, J.D. et al. (1987): Cell and Molecular Biology, John Wiley Publications, NY
9. Freifelder, D. (1993): Molecular Biology, Jones and Bartlett, Publishers, London.

SEMESTER III. PAPER III

Code	Title: <u>Plant Biotechnology</u>	Credits
18PS3B003	<u>Learning Objective:</u> Students will be able to develop their own agricultural practices. They will be able to formulate the genetically modified varieties of plants and develop the technology which can be used transferred the research from lab to land.	04
<u>Unit I:</u>	<u>Plant Tissue Culture</u>	<u>Lectures</u>
	Micro-propagation and Clonal propagation, Somaclonal variation, Somatic Hybridization Suspension Culture – Enhancement of product formation by biotic and abiotic elicitors Biotransformation using cell cultures, Hairy root culture	(15)
<u>Unit II:</u>	<u>Bioprocess Technology</u>	

	Designing of bioreactors, Pneumatically agitated bioreactors, Comparative study of different bioreactors, Photo-bioreactors, Fed batch, semi-continuous and continuous bioreactors Genetically modified plant cells to produce valuable secondary metabolites Applications in plant improvement – Herbicide tolerance, Virus resistance, Luciferase and Gus gene, Antibiotic resistance, Nuclear male sterility	(15)
Unit III:	<u>Metabolite Engineering</u>	
	Metabolite Engineering in Plants – Introduction, Strategies for Metabolic Engineering in plants. Engineering primary metabolic pathways – Carbohydrate metabolism, Amino acid and polyamine metabolism, Lipid metabolism. Engineering secondary metabolic pathways for Alkaloids, Terpenoids, Flavanoids, Lignins, Stilbene phytoalexins Engineering novel metabolic pathways, Metabolic engineering for human health	(15)
Unit IV:	<u>Applications of Plant Biotechnology</u>	
	Food Industry – Sweeteners, Dying Industry – Madder root, Pharmaceuticals – Plantibody, Glycerol from algae, Vitamin C, Essential oil, Flavouring agent	(15)
<u>Practicals</u>		
<ol style="list-style-type: none"> 1. Isolation of protoplast using enzymes 2. Micro-propagation using suitable explant. 3. Initiation of organogenesis to study the effects of different concentrations of auxins and cytokinin's. 		

4. Establishment of callus from any plant and production of secondary metabolite.
5. Study of bioreactors using photo-micrographs.
6. Production of capsaicin using callus culture and its determination by TLC.

Reference Books

1. Stanburry Whittakar Industrial Biotechnology
2. Razdan Plant Tissue Culture
3. Ramawat K.G. Plant Biotechnology
4. Singh B.D. Biotechnology

<u>SEMESTER III. PAPER IV</u>		
Code	Title: Applied Biotechnology	Credits
18PS3B004	Learning Objective: Students will be able to correlate the theoretical principles with industrial production. This study enhances the entrepreneurial skills among students.	04
<u>Unit I:</u>	<u>Industrial Biotechnology</u>	<u>Lectures</u>
	Industrial Production and Applications of Following – Organic acids:- Citric acid, Lactic acid Amino acids:- Lysine, Aspartic acid Enzymes:- Pectolytic, Proteases Food industry:- Single Cell Protein Vitamins: - B12 Environment:- Biosensors	(15)
<u>Unit II:</u>	<u>Food Microbiology</u>	
	Food Spoilage and general principles underlying spoilage of food – Intrinsic parameter, Extrinsic parameter, Microbial spoilage of food, Food borne diseases caused by bacteria, fungi. Quality control of food – Evaluation of food quality Food preservation – Physical Methods; Radiation, Heat, Freezing, Chemical Method	(15)
<u>Unit III:</u>	<u>Nanotechnology</u>	
	Introduction, Synthesis of Nanomaterial; Particle size analyser- Principle and applications. Biological methods, Use of microbial system & plant extracts, Use of proteins & templates like DNA. Applications of Nanomaterial in Food, Cosmetics, Agriculture, Environment management and Medicine.	(15)
<u>Unit IV:</u>	<u>Entrepreneurship Skills</u>	

	<p>Concept of Entrepreneur, Entrepreneurship, Need and Importance. Factors influencing entrepreneurship, Necessities and Qualities of successful entrepreneur. Development of entrepreneur – Roll of Government and Financial institutions, Rising money from venture capitalist, Government grants, subsidies Product selection and ideas, Project planning and formulation Market Research and marketing of product</p>	(15)
Practicals:		
<ol style="list-style-type: none"> 1. Production of Citric acid using <i>Aspergillus niger</i>. 2. Production of Proteases enzymes using suitable fungi. 3. To test the quality of Milk by MBRT and RRT. 		
<ol style="list-style-type: none"> 4. To determine the quality of Milk by Phosphatase. 5. To isolate the spoilage causing organism from spoiled food by suitable technique. 6. Synthesis and Analysis of Silver nanoparticles. 7. Production of single cell protein using <i>Spirulina</i> culture by photo bioreactor. 8. Industrial Visit 		
<p>Reference Books</p> <ol style="list-style-type: none"> 1. Industrial Microbiology: Prescott and Dunn 2. Industrial Microbiology: L. E. Casida. JR. 3. Industrial Microbiology: A.H.Patel 4. Modern Food Microbiology: James Jay 5. Food Microbiology: Fraizer 6. Industrial Biotechnology: Indu Shekhar Thakur 7. Nduka Okafor: Modern Industrial Microbiology and Biotechnology, Science publishers, Enfield, New Hampshire 03748, USA, 2007. 8. Sharon Madhuri, Nanotechnology 9. Kurup – Entrepreneurship 		

SEMESTER IV, PAPER I		
Code	Title: Plant Breeding	Credits
20PS4B001	Learning Objective: 1) To identify the geographical origin of plant species. 2) To emphasize on the contribution of agricultural research institutes in modern agriculture. 3) To signify the role of plant breeding in crop improvement. 4) To outline the methods for production of hybrid varieties of plants.	04
<u>Unit I:</u>	Paradigm of crop production	<u>Lectures</u>
	i. History of plant breeding ii. Objectives of plant breeding, characteristics improved by plant breeding; iii. Patterns of Evolution in Crop Plants- Centres of Origin- biodiversity and its significance. iv. Types of gene actions and implications in plant breeding; v. Plant introduction and role of plant genetic resources in plant breeding.	(15)
<u>Unit II:</u>	Principles and methods of crop propagation	
	Development of Plant Breeding strategies- (5 L) i. Contribution of Research institute in plant breeding- ICAR, NBPGR, IARI, CDRI, CPRI, IFGTB Contribution of Scientific community in Plant Breeding. ii. Concept of plant ideotype and its role in crop improvement. iii. Contribution of male sterility in commercial exploitation. iv. Role of Molecular markers in plant breeding for marker assisted selection of specific phenotypes <i>viz.</i> , Salt tolerant, Thermo-tolerant, Disease resistance, etc. Crop propagation (10 L) i. Mass Selection-Applications of mass selection, procedure of mass selection, Merits and Demerits of mass selection ii. Pureline Selection-, Applications of pureline selection, A general procedure for pureline selection, Advantages of pureline selection, Disadvantages of pureline selection,	(15)

	<ul style="list-style-type: none"> iii. Pedigree Method- Applications of pedigree method, Procedure for pedigree method, Merits and Demerits of pedigree method. iv. Bulk Method-Applications, procedure for bulk method, Merits and Demerits of bulk method. v. Backcross Method- Selection of parents, procedure of backcross method, Applications of the backcross method, Merits and Demerits of backcross method. 	
Unit III:	Polyploidy in Plant Breeding	
	<ul style="list-style-type: none"> i. Types of changes in chromosome number, Heteroploidy, Aneuploidy, Morphological and cytological characteristics. ii. Applications in crop improvement iii. Autopolyploidy- Morphological and cytological characteristics, Role of autopolyploidy in evolution, Applications and limitations iv. Allopolyploidy- Morphological and cytological characteristics, Role of allopolyploidy in evolution, Applications and limitations v. Mutation breeding- Concept of mutation, Mutagen, Procedure of mutagen breeding, Applications and limitations of mutation breeding. 	(15)
Unit IV:	Distant hybridization in Plant Breeding	
	<ul style="list-style-type: none"> i. History, Technique of production of distant hybrids ii. Sterility in distant hybrids, Consequences of segregation, iii. Applications and limitations of distant hybridization. iv. Clonal Selection and Hybridization- Characteristics of asexually propagated crops, genetic variation within clone, Methods of improvement of asexually propagated crops, Clonal selection v. Merits and Demerits of clonal selection, vi. Hybridization- interspecific hybridization in improvement of clonal crops. 	(15)

References:

1. B D Singh. Plant Breeding, Kalyani Publications, New Delhi.
2. Kerala Agricultural University Syllabus
3. Agriculture University Kota. B.Sc. (hon.)Agriculture 2018-2019.
(<http://aukota.org/wp-content/uploads/2014/01/Syllabus-F.pdf>)
4. M. Sc. (Agri.) Syllabus in Jananayak Chandrashekhar University, Ballia, Uttar Pradesh.
5. Post graduate syllabus in Plant Sciences, Indian Council of Agriculture Research, Education Division, New Delhi, April 2009. (<https://icar.org.in/files/edu/Revised-PG-Course-Curricula-and-Syllabi/Plant%20Sciences%2030.4.2009.pdf>).
6. M.Sc. Agriculture Syllabus in Jhansi University.
(<https://www.bujhansi.ac.in/pdf/syllabus/syllabus2016/MSC AG Genetics Plant%20Breeding.pdf>)

SEMESTER IV, PAPER II		
Code	Title: Molecular Genetics	Credits
20PS4B002	<p>Learning Objective:</p> <ol style="list-style-type: none"> 1) To study the sequence of genes in human genome. 2) Determine the function of genes and the elements that regulate genes throughout the genome. 3) To get an overview of genetic variation such as SNPs in prediction of a person's risk of particular diseases and response to certain medications. 4) To summarize the types of proteomics with reference to their application. 	04
<u>Unit I:</u>	Genomics	<u>Lectures</u>
	Organization of Genome, Human Genome Project, Human Mitochondrial Genome, Comparative Genomics with suitable examples , Metagenomics, Genome evolution- case study	(15)
<u>Unit II:</u>	Genomic Research- I	
	<p>Single nucleotide polymorphisms Types, Frequency, Analytical methods for detection of SNP, Significance and Applications.</p> <p>Encyclopedia of DNA elements (ENCODE) project Introduction and project overview, Encode project data, Accessing encode data, Working with encode data, Encode data analysis, Future plan and challenge</p>	(15)
<u>Unit III:</u>	Genomic Research -II	

	<p>Pharmacogenomics Introduction, Drug metabolizing enzymes, Predictive prescribing, Applications</p> <p>Nutrigenomics Introduction-Nutrigenomics and Nutrigenetics, Nutrigenomics and disease (Jaundice), disorders - (Obesity, Diabetes, Cardiovascular disease, Osteoporosis), Cancer, Nutrigenomics and diet supplementation, Concept of personalized nutrition</p>	(15)
Unit IV:	Proteomics	
	<p>Introduction- Definitions, Proteomic Origins Protein interactions Types of proteomics - For Expression, Structure, Function Database utilization - Peptide mass fingerprinting database, amino acid sequence database, de novo peptide sequence information, Applications of Proteomics - Characterization of Protein Complexes, Expression Profiling Recent Update - any recent publication as case study {Example- Manumycin polyketides act as molecular glues between UBR7 and P53, Yosuke Isobe, Mikiko Okumura[...] Daniel K. Nomura Nature Chemical Biology, 1-10}</p>	(15)
<p>References -</p> <ol style="list-style-type: none"> https://ghr.nlm.nih.gov/primer#genomicresearch https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.1001046 A User's Guide to the Encyclopedia of DNA Elements (ENCODE) https://www.researchgate.net/publication/307607140 Overview of nutrigenomics and epigenomics: mechanisms and relevance .M. J. Dauncey Wolfson College, University of Cambridge, UK https://www.researchgate.net/publication/10824883 Nutrigenomics: goals and strategies Sandosh Padmanabhan(2014). Handbook of Pharmacogenomics and Stratified Medicine. Academic Press. 		

6. Tang BH (2016) Single Nucleotide Polymorphism (SNP) and Its Prevalence. *J Cell Signal* 1: 129.
7. V. S. Neeha and Priyamvadah Kintth. Nutrigenomics research: a review *J Food Sci Technol*. 2013 Jun; 50(3): 415–428.
8. Tawheed Amin, Hemanta Mahapatra, Suman Vikas Bhat and S P S Gulleria **Application of Nutrigenomics in Food Industry: A Review** *Indian Horticulture Journal*; 2(3-4): 54-59, July-Dec (2012) *Research Review*

SEMESTER IV, PAPER III

Code	Title: Recent advances in Immunology and Research	Credits
20PS4B003	Learning Objective: 1) To overview the sections of immune system 2) To explain biochemical aspects of antigen-antibody interactions. 3) To demonstrate different immunotechniques. 4) To explain different aspects of clinical research	04
<u>Unit I:</u>	Immunology	<u>Lectures</u>
	Phylogeny of immune system Innate and acquired immunity Cells of immune system Nature and biology of antigens Production of antibodies by plant cells and organs.	(15)
<u>Unit II:</u>	Immuno-Techniques	
	Primary Ag-Ab interaction-RIA, ELISA, Immuno-fluorescence, Western blotting, SRID, ELISpot, PCR-ELISA. Secondary Ag-Ab interaction-precipitation, Agglutination, Complement fixation reaction.	(15)
<u>Unit III:</u>	Stem Cell Technology	
	Types of stem cell, Isolation, Maintenance of stem cell, Applications, Limitations - Ethical considerations Current progress- Placenta saliva swab to create database, Embryonic stem cell banking and therapy, Dental pulp cells-isolation and culture methods, Applications Fundamentals of tissue engineering, Future of tissue engineering with stem cell research	(15)
<u>Unit IV:</u>	Clinical research	

	<p>Introduction to clinical research Ethics and guidelines for clinical research Pharmacovigilance and drug development Regulation in clinical trials Clinical trials conduct, compliance and quality assurance Clinical data analysis and management</p>	(15)
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References:

1. Immunology, Kubly, 7th Ed, W. H. Freeman and Company, New York, International Edition, ISBN-13: 978-14641-3784-6, ISBN-10: 1-4641-3784-6
2. <https://www.immunology.org/public-information/bitesized-immunology/experimental-techniques/enzyme-linked-immunosorbent-assay>
3. <https://www.bio-rad-antibodies.com/an-introduction-to-elisa.html>
4. Principles and Techniques of Biochemistry and Molecular Biology, Wilson and Walker, 7th Ed, Cambridge University Press, ISBN 978-0-521-51635-8 (hardback) – ISBN 978-0-521-73167-6 (pbk.)
5. <https://www.sciencedirect.com/topics/neuroscience/flow-cytometry>
6. <https://www.thermofisher.com/in/en/home/life-science/cell-analysis/cell-analysis-learning-center/molecular-probes-school-of-fluorescence/flow-cytometry-basics/flow-cytometry-fundamentals/how-flow-cytometer-works.html>
7. BioFiles 3-11 (2008) Innovative Solutions for Stem Cell Biology, <https://www.sigmaaldrich.com/technical-documents/articles/biofiles/innovative-solutions.html?gclid=EA1aIQobChMIpsTV0pC46gIVwRERCh3f1QLNEAAYASAAEgIaNvD BwE>
8. BMJ 319 (1999) Stem Cell Technology, Fontes and Thompson.
9. <https://www.stemcell.com/>
10. Human Reproduction Open (2019) 1-17 Two decades of embryonic stem cells- A historical overview, Eguizabal et al
11. Frontiers in cells and Developmental Biology 7 (2019) 189 A revised perspective of skeletal stem cell biology, Ambrosi et al
12. Stem Cell Research and Therapy 10-168 (2019) Stem Cells - Past Present and Future, Zkrzewski et al
13. World J of Stem Cells 11-1 (2019) 13-33 Application of stem cells and bioprinting for potential treatment of diabetes, Kumar et al.
14. <https://www.fda.gov/patients/clinical-trials-what-patients-need-know/what-are-different-types-clinical-research>
15. <https://www.nia.nih.gov/health/what-are-clinical-trials-and-studies>
16. The National Academics, The Role of Purchasers and Payers in the Clinical Research Enterprise: Workshop Summary, ISBN: 0-309-59418-9, 120 pages, 6x9, (2002), <https://www.ncbi.nlm.nih.gov/books/NBK220717/>
17. Ind J Pharm Edu Res 45-2 (2011) Gandhi, Clinical Research Methodology

18. International Journal of Clinical Medicine, 5 (2014) 1374-1383, Clinical Trial Phases, Mahan V.
19. https://www.researchgate.net/publication/331250330 , Planning and Conducting Clinical Research: The Whole Process, Chew B H

SEMESTER IV, PAPER IV		
Code	Title: Research Strategy	Credits
20PS4B00 4	Learning Objective: <ol style="list-style-type: none"> 1) To acquire knowledge of citation rules. 2) To avoid Plagiarism and identify when a work is plagiarized. 3) To acquire skill in free accessible web search engine. 4) To link between higher education and research. 5) To acquaint learner with modern research. 	04
Unit I:	Research ethics	Lectures
	Introduction, What causes plagiarism? Tools to detect plagiarism- What is a plagiarism checker? <ul style="list-style-type: none"> • Need for checkers • Benefits of using Plagiarism checkers. • Commonly used checkers like—Turnitin, Write check, Unichack Case study Kinds of plagiarism, Prevention of Plagiarism Types of Licenses, Common Creating licenses, Copyright filing	(15)
Unit II:	Tools used in research	
	Excel for data analysis, Google scholar, Jgate, ORCID Zotero, LaTeX, Google Patent, Small Seo tool Impact Factor, H- Index, I10 I 20 , G Score	(15)
Unit III:	Commercial aspect of research Agencies for Research funding	
	Academic research- universities (BCUD), UGC, DAE-BRNS. Industrial research -AYUSH, GAIL, CSIR, DBT, ICMR. Research in foreign countries-DFG (German Research Foundation). Research schemes proposed by DST, DBT,UGC, RUSA, etc Government Schemes and policies Case study	(15)



Unit IV:	Open Unit: Detail discussion on current topic	
	Example: Research in Covid 19	(15)

References:

1. J Travel Med 27-2 (2020) The reproductive number of COVID-19 is higher compared to SARS coronavirus, Liu Y et al, doi: 10.1093/jtm/taaa021. PMID: 32052846
2. Eur Rev med Pharmacol Sci 24 (2020) 2006-11 Kannan et al Covid19 Recent trends
3. Int J Infect Dis 96 (2020)710-714 From SARS to Covid19: What we have learned about children infected with COVID-19, Zhou et al
4. Monaldi Archives of Chest Diseases 90 (2020) 1298 Covid 19 A Review, Mahabhavi et al

Different Modes of Internal Assessment

- Projects
- Case Study
- Presentations
- Assignments
- Online Quizzes using Google forms
- Interactive videos
- H5P tools
- Swayam NPTEL course