

S.P Mandali's
RAMNARAIN RUIA AUTONOMOUS COLLEGE
(Affiliated to University of Mumbai)



Syllabus for UG

Program: TYBSC Biotechnology

Program Code: RUSBTK

**(Credit Based Semester and Grading System
for Academic Year 2023–2024)**

GRADUATE ATTRIBUTES

GA	Description
	A student completing Bachelor's Degree in Science program will be able to:
GA 1	Recall and explain acquired scientific knowledge in a comprehensive manner and apply the skills acquired in their chosen discipline. Interpret scientific ideas and relate its interconnectedness to various fields in science.
GA 2	Evaluate scientific ideas critically, analyse problems, explore options for practical demonstrations, illustrate work plans and execute them, organise data and draw inferences.
GA 3	Explore and evaluate digital information and use it for knowledge upgradation. Apply relevant information so gathered for analysis and communication using appropriate digital tools.
GA 4	Ask relevant questions, understand scientific relevance, hypothesize a scientific problem, construct and execute a project plan and analyse results.
GA 5	Take complex challenges, work responsibly and independently, as well as in cohesion with a team for completion of a task. Communicate effectively, convincingly and in an articulate manner.
GA 6	Apply scientific information with sensitivity to values of different cultural groups. Disseminate scientific knowledge effectively for upliftment of the society.
GA 7	Follow ethical practices at work place and be unbiased and critical in interpretation of scientific data. Understand the environmental issues and explore sustainable solutions for it.
GA 8	Keep abreast with current scientific developments in the specific discipline and adapt to technological advancements for better application of scientific knowledge as a lifelong learner

PROGRAM OUTCOMES

PO	Description
PO 1	<p>A student completing Bachelor's Degree in Science program in the subject of Biotechnology will be able to:</p> <p>Adept in basic sciences along with a thorough understanding of biotechnology principles and chemical sciences to create a foundation for higher education with the insights into interdisciplinary approach.</p>
PO 2	<p>Demonstrate the applications of fundamental biological processes from the molecular, cellular, industrial and environmental perspective.</p>
PO 3	<p>Develop effective communication skills with improved individual and team work abilities in the domain of scientific research writing.</p> <p>Showcase their innovative ideas and research work efficiently.</p>
PO 4	<p>Reflect, analyse and interpret information or data for investigating the problem in fields of biotechnology. Acquire scientific and entrepreneur skills to furnish sustainable solutions to coeval problems</p>
PO 5	<p>Illustrate the relevance of ethical implications and standard laboratory practices in tissue culture techniques, forensic biology, developmental biology and other fields of biotechnology.</p>
PO 6	<p>Apply the conceptual knowledge to develop coherent, efficacious and proficient practical, technical and analytical skills.</p>

PROGRAM OUTLINE

TYBSc	V	RUSBTK501	Cell Biology	2.5
		RUSBTK502	Biochemistry	2.5
		RUSBTKP501	Practicals based on RUSBTK501 & RUSBTK502	3
		RUSBTK503	Genetics and Molecular Biology	2.5
		RUSBTK504	Industrial Biotechnology	2.5
		RUSBTKP502	Practicals based on RUSBTK503 & RUSBTK504	3
		RUSBTK505	Forensic sciences-I	2
		RUSBTKP503	Practicals Based on RUSBTK505	2
TYBSc	VI	RUSBTK601	Immunology, Virology and Instrumentation	2.5
		RUSBTK602	Developmental biology and transgenesis	2.5
		RUSBTKP601	Practicals Based on RUSBTK601 & RUSBTK602	3
		RUSBTK603	Pharmacology	2.5
		RUSBTK604	Biosafety and Plant biotechnology	2.5
		RUSBTKP602	Practicals Based on RUSBTK603 & RUSBTK604	3

		RUSBTK605	Forensic sciences-II	2
		RUSBTKP603	Practicals Based on RUSBTK605	2

Ramnarain Ruia Autonomous College

SEMESTER V

Course Code: RUSBTK501

Course Title: CELL BIOLOGY
Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	CO DESCRIPTION
CO 1	Describe components of cell cycle and the cell cycle control system
CO 2	Examine the role of apoptosis in tumour suppression
CO 3	Differentiate between normal cell and cancerous cell
CO 4	Illustrate the role of protooncogenes, tumour suppressor genes and oncogenes in cancer development.
CO 5	Elaborate the principles of cell signalling and its application in different cell types
CO 6	Examine different pathways in cellular signalling and their activation and implication
CO 7	Deduce the role of cellular transporters, cell adhesion molecules and cell junctions.
CO 8	Evaluate the role of different agents on cell membrane permeability.

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Lectures
RUSBTK501	I	<p>Cell cycle and apoptosis and cancer</p> <p>Cell cycle and programmed cell death- Overview of cell cycle, Components of cell cycle control system, intracellular control of cell cycle events,</p> <p>Programmed cell death (apoptosis)- intrinsic and extrinsic pathway of apoptosis, extracellular control of cell division, cell growth and apoptosis</p> <p>Mechanics of cell division- overview of M phase, mitosis and cytokinesis</p>	15

		Cancer: Characteristics of normal cell and cancerous cell. Cancer as a micro evolutionary process: invasion, metastasis, angiogenesis, Tumor- Benign and malignant	
	II	Cell signaling-I: Cell signaling and signal transduction: Introduction General Principles of Cell Signaling, Signaling via G-Protein-linked Cell-Surface Receptors Signaling via Enzyme-linked Cell-Surface Receptors – protein tyrosine phosphorylation	15
	II	Cell signaling-II: Response to multiple extracellular signal molecules, Morphogens, Lifetime of intracellular molecule, Binding reaction and role of Kd, Extracellular messengers and their receptors, Second messengers Role of Calcium and cAMP, Introduction, Calcium binding proteins, Role of Nitric oxide and nuclear receptors, The Logic of Intracellular Signaling: Lessons from Computer-based "Neural networks"	15
	IV	Cell permeability, transport and cell junctions: Cell permeability, principles of membrane transport, Transporters and channels; Active transport, passive transport, types of transporters, types of ATP driven Pumps, Na⁺ K⁺ pump. Cell junctions; cell adhesions and extracellular material, Microvilli tight junctions, gap junctions, cell coat and cell recognition, cellular interactions	15

References:

1. **Molecular Cell Biology. 7th Edition, (2012) Lodish H., Berk A, Kaiser C., K Reiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA**
2. **Molecular Biology of the Cell, 5th Edition (2007) Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science, USA**
3. **Cell Biology, 6th edition, (2010) Gerald Karp. John Wiley & Sons., USA**

4. **The Cell: A Molecular Approach, 6th edition (2013), Geoffrey M. Cooper, Robert E. Hausman, Sinauer Associates, Inc. USA**

Course Code: RUSBTK502

Course Title: BIOCHEMISTRY
Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	CO DESCRIPTION
CO 1	Describe the metabolism of carbohydrates and fates of various intermediates and end products
CO 2	Evaluate the levels of protein structure and types of protein interactions
CO 3	Enlist the different types of hormones, give their functions and their role as cellular messengers.
CO 4	Distinguish between type I & type II hormones.
CO 5	Describe Mechanism of action of different hormones and their role in normal metabolic process.
CO 6	Correlate the symptoms of diseases associated with different hormonal deficiencies, design a suitable method to diagnose the same and interpret the results.
CO 7	Design an experiment to purify proteins and estimate their concentration
CO 8	Design a project proposal stating the Aims, objective, rationale, methodology and expected outcome.

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Lectures
RUSBTK502	I	Carbohydrate metabolism: Biochemical pathway for Synthesis and regulation of carbohydrates in Bacteria –Peptidoglycan Plants – starch and sucrose Animals – Glycogen synthesis and breakdown Gluconeogenesis, HMP pathway	15
	II	Protein biochemistry:	15

		<p>Protein structure: Protein Tertiary and Quaternary Structures, Protein Denaturation and Folding,</p> <p>Protein Function: Reversible Binding of a Protein to a Ligand: Oxygen-Binding Proteins</p> <p>Complementary Interactions between Proteins and Ligands: Immunoglobulin's</p> <p>Protein Interactions Modulated by Chemical Energy: Actin, Myosin, and Molecular Motors -Details of Protein purification</p>	
	III	<p>Endocrinology-I:</p> <p>Introduction to endocrinology- mechanism of action of group I and group II hormones, coordination of functions by chemical messengers, chemical structure and synthesis of hormones, hormone secretion, transport and clearance from blood</p> <p>Anterior Pituitary hormones and their control by hypothalamus: functions, regulation and abnormalities in growth hormones, Adrenocorticotropin, stimulating hormones</p>	15
	IV	<p>Endocrinology-II:</p> <p>Posterior pituitary gland and its relation to hypothalamus. Hormones of Posterior pituitary gland their functions, regulation and abnormalities - Oxytocin and vasopressin, thyroid gland functions, regulation and abnormalities - Thyroxine, calcitonin, Parathyroid gland- PTH, Adrenal medulla functions, regulation and abnormalities -epinephrine and nor epinephrine,</p> <p>Adrenal cortex- Glucocorticoids,</p> <p>Pancreas- insulin and glucagon,</p> <p>Female gonads- estrogens and progesterone, Male gonads- testosterone, Placenta- hCG</p>	15

References:

1. Textbook of Medical Physiology Guyton, A.C and Hall 11th edition J.E Saunders

2. **Lehninger, principles of biochemistry, 4th edition (2005), David Nelson and Michael Cox W.H. Freeman and Company, New York.**
3. **Biochemistry, 4th edition (2010), Voet and Voet, John Wiley and sons, USA**
4. **Harper's Illustrated Biochemistry, 27th edition, RK Murray, DK Granner, PA Mayes and VW Rodwell, McGraw Hills publication.**
5. **Biochemistry, 4nd edition (2017), Satyanarayana and Chakrapani, Books & Allied (P) Ltd**
6. **General Microbiology, 5th edition- Roger Stainer**

Course Code: RUSBTKP501

Course Title: Practicals based on RUSBTK501 and RUSBTK502

DETAILED SYLLABUS

Course Code	Title	Credits
RUSBTKP501	<ol style="list-style-type: none"> 1. Cytological identification of cancer cells. 2. Osmosis 3. Lipid Solubility of membrane 4. Production of micelles 5. Study the effect of physical and chemical parameter on cell permeability using beetroot cells 6. Titration curve of amino acids 7. Estimation of starch 8. Protein estimation by Bradford's method 9. Sample preparation and Protein separation by PAGE (native/ SDS) 10. Protein purification by dialysis 11. Estimation of adrenaline 12. Proposal writing for skill-based project 	3

Course Code: RUSBTK503
 Course Title: GENETICS AND MOLECULAR BIOLOGY
 Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	CO DESCRIPTION
CO 1	Analyse the appropriate methods and parameters to be followed for selecting a particular enzyme and genetic vector
CO 2	Apply principles of recombinant DNA technology in different experiments
CO 3	State the significance of different methods of sequencing in research
CO 4	Evaluate the role of Human Genome Project and gene editing techniques in research
CO 5	Elaborate the role of different genes involved in cancer development
CO 6	Perform restriction ligation and digestion experiments for gene editing
CO 7	Perform and predict genetic maps in bacteria and bacteriophages

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Lectures
RUSBTK503	I	Enzymes and vectors: Enzymes -Sources, types, mode of action and applications of Restriction endonucleases, DNA polymerases, Ligases, Kinases, Phosphatases, Terminal transferases, Reverse transcriptases and Nucleases Vectors - Features and applications of pBR322, pUC19, cosmids, Phagemids, λ phage, M13	15

		bacteriophage vector, Shuttle vector, Expression vector pET YAC	
	II	Cloning strategies and sequencing: Methods of gene transfer in prokaryotes and eukaryotes; Recombinant selection and screening methods: genetic, immunochemical, Southern and Western analysis, nucleic acid hybridization, HART, HRT; Expression of cloned DNA molecules and maximization of expression; Cloning strategies genomic DNA libraries, cDNA libraries, chromosome walking and jumping Sequencing: Maxam Gilbert's method, Sanger's dideoxy method, Automated DNA sequencing, Pyrosequencing	15
	II	Genetic Mapping: Genetic mapping in bacteria and Bacteriophages: by conjugation, transformation and transduction. Mapping bacteriophage genes, Fine structure analysis of bacteriophage gene	15
	IV	Gene editing and human genome cancer genetics: Human genome mapping and its implications in health and disease Mechanisms and application: RNAi, ZNF (Zinc finger nucleases), TALENS(Transcription activator like effector nucleases) CRISPR cas system Molecular genetics of cancer, oncogenes and tumor suppressor genes	15

References:

1. **iGenetics A Molecular Approach 3rd Edition Peter J. Russell.**
2. **Molecular Biotechnology-Principles and Applications of Recombinant DNA Technology 3rd Edition Glick B.R., Pasternak J.J., Patten C.L.**
3. **Principles of Gene Manipulation 7th Edition Primrose S.B., Twyman R.M.**
4. **Biotechnology – Fundamentals and applications by S.S. Purohit.**
5. **Genomes 3rd Edition T.A. Brown.**
6. **Biotechnology B.D. Singh.**
7. **Gene Cloning and DNA Analysis 6th Edition T.A. Brown.**

8. **Genomics Cantor C.R., and Smith C.L. John Wiley & Sons. (1999)**
9. **TALEN and CRISPR/Cas genome editing systems: tools of discovery: A.A.Nemudryi review**
10. **Molecular diagnostics- Fundamentals, Methods and Clinical applications by Lela Buckingham**

Course Code: RUSBTK504
 Course Title: INDUSTRIAL BIOTECHNOLOGY
 Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	CO DESCRIPTION
CO 1	Distinguish between different techniques used for quality assessment of multiple dairy as well as brewery products.
CO 2	Illustrate steps involved in commercial production processes of dairy and brewery products
CO 3	Elaborate on different types of downstream processes used for product recovery
CO 4	Explore the changing trends in the bioprocess industry with respect to traditional and modern fermented drinks.
CO 5	Give Role of genetic engineering in modern day fermentation techniques.
CO 6	Describe the current trends in production of therapeutics and their quality assurance techniques as well as regulatory affairs.
CO 7	Uses of different techniques to analyse the quality of different dairy and brewery products
CO 8	Analyse role of different process parameters in development of different products
CO 9	Develop suitable protocol for production of laboratory scale fermented product

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Lectures
RUSBTK504	I	Dairy Technology: Milk: Normal flora, changes in raw milk, enumeration, Factors affecting bacteriological quality. Preservation methods, Pasteurisation. Starter Cultures, Fermented products-Production process and spoilage- Cheese: Swiss and Cheddar, Butter, Yogurt and Buttermilk.	15
	II	Brewing technology: Production and types of: Wine, Beer(Lager and Ale), Vodka, Rum, Whiskey, Tequila Malo-lactic fermentation Production	15
	III	Downstream processing: Introduction of DSP, Foam separation, Types of Precipitation, Filtration, Centrifugation, Chromatography in DSP, Cell disruption- physical and chemical methods. Solvent recovery, Membrane processes, Drying, Crystallization and Whole broth processing	15
	IV	Trends and developments in industrial productions: Brewing: Overview, Role of multinational companies, microbreweries and craft breweries, Development of new wine industries, Rise of flavoured alcoholic beverages, Calorie counting and health perception, organic and biodynamic production, Use of GM crops and microorganisms Therapeutic aspect of industrial production: production of Vitamin B12, Case study on production of vaccines Microbiological Assays for pharmaceutical products, Regulatory Microbiological testing in pharmaceuticals	15

References:

1. **Applied Dairy Microbiology Elmer H Marth and James L Steele Mercel Dekker Inc New York, 2nd edition**
2. **Microbial Technology Pepler, H.J and Perlman, D 2nd Academic Press Practicals**
3. **Industrial Microbiology Prescott and Dunn CBS publishers**
4. **Dairy technology by Yadav and Grower**
5. **Fermentation technology by Stanbury and Whittkar**
6. **Handbook of alcoholic beverages- Technical, Analytical and nutritional aspects- Alan J Buglass- Vol I Wiley**
7. **Fundamentals of Microbiology by Frobisher**
8. **Industrial Microbiology by A.H. Patel**
9. **Industrial Microbiology by Casida**

Course Code: RUSBTKP502

Course Title: Practicals based on RUSBTK503 and RUSBTK504

DETAILED SYLLABUS

Course Code	Title	Credits
RUSBTKP502	<ol style="list-style-type: none"> 1. Transformation in <i>E. coli</i>. 2. Genomic DNA Extraction: Animal cells 3. Restriction enzyme digestion and ligation (Kit maybe used). 4. Replica plate technique 5. Gradient plate technique 6. Bacterial gene expression (Kit may be used). 7. Estimation of Milk protein-Pynes method 8. Detection of calcium and phosphorus in milk 9. Production and microbiological analysis of Yoghurt/cheese/butter 10. Production of Wine/Vodka and study of its physico-chemical properties. 11. Bioassay of Vitamin B12 	3

Course Code: RUSBTK505

Course Title: FORENSIC SCIENCES-I
Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	CO DESCRIPTION
CO 1	Illustrate forensics science, its branches and give functions of its different branches.
CO 2	Apply biotechnological techniques to solve forensic cases
CO 3	Describe the process of collection and identification of different impressions and prints
CO 4	Evaluate the importance of collection and preservation of evidences
CO 5	Devise experiments to analyse different types of evidences
CO 6	Interpret the collected evidences and reconstruct the most probable scenarios associated with the crime to solve the case
CO 7	Compare and differentiate between different methods of DNA typing used in forensic analysis.

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Lectures
RUSBTK505	I	<p style="text-align: center;">Introduction to Forensics:</p> <p>Introduction to crime, Sociological aspects of crime and criminals in society</p> <p>Types of crime and its causes – property crimes, public order crimes, violent crimes, cybercrimes, juvenile delinquency</p> <p>Introduction to Forensic science – nature, need and function, history of forensic science and scope</p> <p>Criminal behaviour - Theories and literature studies, criminal inheritance and factors responsible, Laws and Principles, branches of Forensic Science (Criminalistics, Forensic Pathology, Forensic Anthropology, Forensic Odontology, Forensic Engineering, Toxicology, Behavioural Sciences,</p>	12

		Questioned Documents, Other Specialties) Introduction to IPC, Laws to combat crime: Civil and Criminal, Introduction to IPC, Structure of IPC, Indian Evidence Act	
	II	<p>Crime scene investigation:</p> <p>Types of crime scenes – primary, secondary, crime scenes based on size of evidence</p> <p>Forensic Scientists, Investigating officers and their assigned role and duties, Modus operandi</p> <p>General crime scene procedures and their management, Crime Scene survey, Crime Scene Documentation, collection and preservation of physical evidence, Packaging & Transportation of biological evidences, Blood, semen, urine, faecal matter, vomit, saliva, hair and fibre, explosive evidence (serology, Chemistry), Crime scene reconstruction.</p> <p>Role of forensic biologist (Protection of crime scene, Recognition of biological evidence)</p>	12
	II	<p>Impressions and prints:</p> <p>Footprints and shoe-prints: Importance, Gait Pattern, casting of footprints in Different medium, Taking Control samples.</p> <p>Tire Marks/prints and Skid marks, taking control samples, Forensic Significance.</p> <p>Lip Prints- Nature, Location, collection and evaluation, taking control samples, Forensic Significance.</p> <p>Bite Marks- Nature, Location, collection and evaluation, taking control samples, Forensic Significance.</p> <p>Ear Prints- Nature, Location, collection and evaluation, taking control samples, Forensic Significance.</p> <p>Tool Marks- Location, collection and evaluation, taking control samples, Forensic Significance.</p> <p>Finger Prints- Nature, Location, collection and evaluation, taking control samples, forensic significance, biometry, poroscopy and edgeoscopy</p>	12

	IV	<p>Forensic DNA biology:</p> <p>Introduction to and significance of DNA typing DNA typing methods for forensic analysis: SNPs</p> <p>Y chromosome DNA typing, Mitochondrial DNA analysis (mtDNA), X-Chromosome DNA typing, Non-Human DNA Testing, New Technologies, Automation, and Software, Proficiency Testing Lab accreditation, determination of secretor / non-secretor Lewis antigen, Bombay Blood group, Polymorphic enzymes typing – PGM, GLO, ESD, EAP, AK, ADA, etc., and their forensic significance, HLA typing, role Serogenetic markers in individualization, paternity disputes etc., Forensic cases solved using DNA typing</p>	12
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Course Code: RUSBTKP503

Course Title: Practicals Based on RUSBTK505

DETAILED SYLLABUS

Course Code	Title	Credits
RUSBTKP503	<ol style="list-style-type: none"> 1. Collection and Packaging of Toxicological samples and Petroleum samples 2. Collection and Packaging of biological samples and Homicide case samples 3. To take plain and rolled fingerprints and identify fingerprint pattern. 4. To perform ridge counting and ridge tracing, Lifting and preservation of finger print 5. Collection and Examination of Lip prints and Ear prints 6. To perform electrophoresis for separation of various polymorphic enzymes. 7. Determination of secretor / non-secretor antigen from blood/ saliva. 8. Luminol/ Phenolphthalein/ precipitin test for blood 9. Acid phosphatase for semen and Barberio test of 	2

	<p style="text-align: center;">semen</p> <p>10. Extraction, isolation and detection of DNA from blood/saliva</p> <p>11. Fingerprint analysis – powder analysis, ninhydrin spray test, Iodine development, silver nitrate</p> <p>12. Case studies</p>	
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References:

1. <https://aboutforensics.co.uk/impression-evidence/>
2. <https://www.sciencedirect.com/topics/computer-science/sociological-aspect>
3. https://saylordotorg.github.io/text_social-problems-continuity-and-change/s11-02-types-of-crime.html;
4. <https://www.justia.com/criminal/offenses/sex-crimes/public-indecency/>
5. <https://law.jrank.org/pages/12004/Causes-Crime.html>
6. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/forensic_science/general_forensic/01._introduction_to_forensic_science/et/4761_et_01et.pdf
7. <http://www.jpgmonline.com/article.asp?issn=0022-3859;year=2000;volume=46;issue=4;spage=303;epage=8;aulast=Tewari>
8. <https://sci-hub.tw/https://doi.org/10.1016/B978-0-12-802219-1.00013-4>
9. <https://pressbooks.bccampus.ca/criminalinvestigation/chapter/chapter-8-crime-scene-management/>
10. <https://scholarlycommons.law.northwestern.edu/cgi/viewcontent.cgi?article=1392&context=jclc>
11. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3722715/>
12. <http://www.latent-prints.com/images/Oliver.pdf>;
13. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000016FS/P000690/M011457/ET/1516188816FSC_P3_M35_e-text.pdf
14. <https://www.nap.edu/read/1866/chapter/4>
15. Forensically relevant SNP classes, Bruce Budwold, Forensic laboratory. DOI: 10.2144/000112806
16. Y chromosome STR typing in crime casework; Lutz Roewer. DOI: 10.1007/s12024-009-9089-5
17. Forensic typing of short tandem repeat markers on the X and Y chromosomes: DOI: 10.1016/j.fsigen.2015.03.013
18. Use of non-human DNA analysis in forensic science: A mini review; Arati Iyengar, Sibte Hadi; <https://doi.org/10.1177/0025802413487522>
19. Introduction to non-human DNA typing; 10.1016/B978-0-12-382165-2.00049-0
20. Assessment of Lewis Blood group antigens and secretor status in autopsy samples; A. Busutil, C.C. Blackwell et al.; [https://doi.org/10.1016/0379-0738\(93\)90221-U](https://doi.org/10.1016/0379-0738(93)90221-U)
21. http://ugcmoocs.inflibnet.ac.in/ugcmoocs/view_module_pg.php/692
22. http://ugcmoocs.inflibnet.ac.in/ugcmoocs/view_module_pg.php/699
23. http://ugcmoocs.inflibnet.ac.in/ugcmoocs/view_module_pg.php/690
24. <https://www.ncbi.nlm.nih.gov/pubmed/15570103>
25. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5418305/>
26. <https://juniperpublishers.com/jfsci/pdf/JFSCI.MS.ID.555755.pdf>

26. <https://www.ncbi.nlm.nih.gov/pubmed/14527299>
27. https://www.researchgate.net/publication/288174234_New_Technologies_and_Automation
28. http://www.evidencemagazine.com/index.php?option=com_content&task=view&id=1894&Itemid=9
29. https://link.springer.com/chapter/10.1007/978-3-642-77324-2_126
30. <https://www.ncbi.nlm.nih.gov/pubmed/12415830>
31. <https://www.ijser.org/researchpaper/Determination-of-Serological-Markers-Blood-group-markers-of-Biological.pdf>
32. <http://www.forensicsciencesimplified.org/fwtt/how.html>
33. https://www.sirchie.com/catalog/category/view/id/102/?store=international_english
34. <http://www.tracksceneinvestigation.com/TSI%20PDFs/CASTING.pdf>
35. <https://emedicine.medscape.com/article/320160-overview>
36. Earprints in forensic investigation; Lynn Meijerman, Andrew Thean & George Maat;
<https://link.springer.com/article/10.1385/FSMP:1:4:247>
37. Forensic Examination and Interpretation of tool marks by David Baldwin, John Birkett, Owen Facey and Gilleon Rabey.

Modality of Assessment (SEMESTER V)

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	One Assignment (Case study/Project based/Animation/ Review writing/ Video demonstration/ Pictorial or flow sheet representation, Infographs/ Industrial visit report/Presentations/ Mind-map or concept map etc.)	20
2	One class Test (multiple choice questions / objective)	20
	TOTAL	40

B) External Examination- 60%- 60 Marks

Duration - These examinations shall be of 2 hours duration. Theory question paper pattern:

- 1. There shall be 04 questions each of 15 marks. On each unit there will be one question.**
- 2. All questions shall be compulsory with internal choice within the questions (60% options)**

Paper Pattern:

Question	Options	Marks	Questions Based on
Q.1) A)	Any 5 out of 8	5	Unit I
Q.1) B)	Any 2 out of 3	10	
Q.2) A)	Any 5 out of 8	5	Unit II
Q.2) B)	Any 2 out of 3	10	
Q.3) A)	Any 5 out of 8	5	Unit III
Q.3) B)	Any 2 out of 3	10	
Q.4) A)	Any 5 out of 8	5	Unit IV
Q.4) B)	Any 2 out of 3	10	

Practical Examination Pattern:

PAPERS: RUSBTKP501, RUSBTKP502, RUSBTKP503

A) Internal Examination: 40%- 40 Marks

Particulars	Marks
Journal	10
Experimental tasks	30
Total	40

Note- Similar pattern for internal practical will be followed for all three Practical papers. B) External Examination: 60%- 60 Marks

Semester End Practical Examination:

Particulars	Marks
Laboratory work	60
2 Major practicals	20 & 25 M or 20M each
1 Minor practicals	10 M
Viva/ Spots	05 M or 10 M
Total	60

Overall Examination & Marks Distribution Pattern

Course	RUSBTK501			RUSBTK502			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Course	RUSBTKP501						
	Internal			External			

Practicals	40	60	100
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Course	RUSBTK503			RUSBTK504			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Course	RUSBTKP502						
	Internal			External			
Practicals	40			60			100

Course	RUSBTK505		
	Internal	External	Total
Theory	40	60	100
	RUSBTKP503		
Practicals	Internal	External	Total
	40	60	100

SEMESTER VI

Course Code: RUSBTK601
 Course Title: IMMUNOLOGY, VIROLOGY AND INSTRUMENTATION
 Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	CO DESCRIPTION
CO 1	Explain the structure and function of different MHC molecules
CO 2	Evaluate the role of MHC molecules in antigen presentation in different diseases
CO 3	Describe TCR, BCR and their accessory molecules structure and functions
CO 4	Elucidate CAR-T cell and give their uses in therapeutics
CO 5	Illustrate the production of traditional and modern vaccines and their significance
CO 6	Outline the general structural components of different viruses and their classification
CO 7	Elucidate the life cycle of bacteriophage, DNA virus and RNA virus.
CO 8	Determine the cytopathic effects of viruses, viroids and prions and role of viruses in cancer.
CO 9	Analyse various biomolecules using suitable spectroscopic and tracer techniques
CO 10	Design a suitable experiment to separate different biomolecules using chromatographic and centrifugation techniques
CO 11	Develop a vaccine and assess its sterility

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Lectures
RUSBTK601	I	<p>Immunology:</p> <p>MHC class I and II Structure, function, arrangement, interaction with epitopes, polymorphism, role of MHC in diseases, antigen presentation: endogenous antigen, exogenous antigens, TCR, BCR, accessory molecules: structure, function</p> <p>Introduction to CAR-T cell</p> <p>Vaccines and its types</p>	15
	II	<p>Virology:</p> <p>Introduction to viruses-Position in biological spectrum Virus properties, General structure of viruses Baltimore Classification and Taxonomy (ICTV), Cultivation of viruses, Virulent phages and Lytic cycle -T even phages, One step growth experiment Temperate phages and lysogeny -lambda phage, Reproduction of ds DNA phages Hepatitis/ssRNA (influenza), animal viruses and plant Virus (TMV) Virus purification and assays Cytocidal infections and cell damage Viruses and cancer Viroid and Prions</p>	15
	III	<p>Spectrometry and tracer techniques:</p> <p>Principle, instrumentation and working of Fluorescence, Luminometry, Infrared, Atomic absorption</p> <p>Isotopes in Biology: Detection Techniques of Radioactivity using GM counter, Scintillation counter, Applications of Tracer techniques in Biology</p>	15
	IV	<p>Chromatography and centrifugation:</p> <p>Chromatography: Principle, working and application of Affinity, Ion-exchange, Gel permeation, HPLC-Method development and validation, GC.</p> <p>Centrifugation: Types, principle, working and applications of Differential and Density Gradient</p>	15

		-Isopycnic, Rate, zonal, Gradient materials, preparation, sample application, recovery, choice of rotors.	
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References:

1. **Mim's Medical Microbiology 5th edition**
2. **Microbiology by Prescott Harley and Klein 5th edition Mc Graw Hill**
3. **Medical Microbiology Jawetz, E., Brooks, G.E, Melnick, J.L., Butel, J.S Adelberg E. A 18th edition**
4. **Medical Microbiology by Patrick Murray 5th edition**
5. **Foundations In Microbiology by Talaro and Talaro Third edition W.C Brown**
6. **Understanding Viruses by Teri Shors**
7. **Biophysics (2002) Vasantha Patabhi and N. Gautham, Kluwer Academic Publishers**
8. **Physical Biochemistry: principles and applications, 2nd edition (2009), David Sheehan , John Wiley & Sons Ltd**
9. **HPLC method validation for pharmaceuticals: a review (2013), Harshad V. Paithankar, International Journal of Universal Pharmacy and Bio Sciences 2(4): July August.**
10. **Lehninger, principles of biochemistry, 4th edition (2005), David Nelson and Michael Cox W.H. Freeman and Company, New York.**
11. **Biochemistry , 4th edition (2010), Voet and Voet, John Wiley and sons, USA**
12. **Biochemistry, 4nd edition (2017), Satyanarayana and Chakrapani, Books & Allied (P) Ltd**
13. **Biophysical Chemistry by Upadhayay and Nath**
14. **Immunology by Kuby 5th , 7th edition**
15. **Immunology by Riott**
16. **Immunology Palan and Pathak**

Course Code: RUSBTK602

Course Title: DEVELOPMENTAL BIOLOGY AND TRANSGENESIS

Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	CO DESCRIPTION
CO 1	Summarize the basic functions of gametogenesis, fertilization, post fertilization events
CO 2	Describe the different causes of infertility in humans and elaborate on ART Processes and its use for the infertility treatment
CO 3	Illustrate the factors and steps involved in development of transgenic animals and plant

CO 4	Discuss the applications of transgenesis in research
CO 5	Select a particular method of transgenesis according to their applications and advantages/limitations
CO 6	Identify the different parts of chick embryo, give their significance at different developmental stages and establish monolayer using chick embryo tissues

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Lectures
RUSBTK602	I	<p style="text-align: center;">Developmental biology:</p> <p>Mammalian embryonic development: Reproductive systems, Gametogenesis, Fertilization, Cleavage, Implantation, Gastrulation, cell fate and lineages of three germ layers, fate map</p> <p>Concept of differentiation and embryonic induction</p>	15
	I	<p style="text-align: center;">Assisted reproductive technology and Stem cell banking:</p> <p>Infertility, causes of infertility, managing infertility through ART: IVF, ICSI, GIFT and ZIFT, Artificial insemination, test tube baby, Embryo transfer New techniques in ART</p> <p>Stem cells, sources of stem cells, cord blood banking, collection and banking process, public and private banks, applications/uses of stem cell banks</p>	15
	II	<p style="text-align: center;">Genetic engineering in plants:</p> <p>Genetic engineering of plants; Methodology. Plant transformation with the Ti plasmid of <i>A tumefaciens</i>, Ti plasmid derived vector system - Transgenic plants: Physical methods of transferring, genes to plants: electroporation, microprojectile bombardment, liposome mediated, protoplast fusion, Vectors for plant cells, Improvement of seed quality protein</p>	15

	IV	<p>Transgenic animals:</p> <p>Transgenic mice- methodology-retroviral method, DNA microinjection, ES method, genetic manipulation with cre-loxP, Vectors for animal cells, Transgenic animals' recombination system, Cloning live stock by nuclear transfer, Transgenic fish</p>	15
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References:

1. Principles and techniques in biochemistry and molecular biology (2010), Keith Wilson and John Walker, 7th
2. iGenetics A Molecular Approach 3rd Edition Peter J. Russell.
3. Molecular Biotechnology-Principles and Applications of Recombinant DNA Technology 3rd Edition Glick B.R., Pasternak J.J., Patten C.L.
4. Principles of Gene Manipulation 7th Edition Primrose S.B., Twyman R.M.
5. Developmental Biology; Scott Gilbert; 9th Edition
6. Langman's medical embryology- T.W. Sadler
7. Development of chordate biology- Verma and Agarwal
8. Review article: Assisted reproductive technology: techniques and limitations- by Mr. Begum
9. Review article: Assisted reproductive technology- Simon M Kelly
10. Umbilical cord blood banking: Consensus statement of the Indian Academy of Pediatrics
11. Umbilical cord blood banking- Royal college of Obstetrician & Gynaecologists
12. Collection, Processing and Banking of Umbilical Cord Blood Stem cells for Clinical use in transplantation and regenerative medicine- David T. Harris
13. Stem cell banking for Regenerative and Personalized medicine: Biomedicines 2014 by David T. Harris

Course Code: RUSBTKP601

Course Title: Practicals Based on RUSBTK601 & RUSBTK602

DETAILED SYLLABUS

Course code	Title	Credits
	<ol style="list-style-type: none"> 1. TAB vaccine and Sterility of injectables 2. Phage assay: Demonstration 3. Separation of components from a mixture using Affinity chromatography (Kit may be used) 4. Separation of components from a mixture using ion exchange chromatography (Kit may be used) 	3

RUSBTKP601	<ol style="list-style-type: none"> 5. Separation of components from a mixture using Size exclusion chromatography (Kit may be used) 6. HPLC method validation. 7. TLC of fatty acids/plant pigments 8. Column: chalk chromatography 9. Sucrose density gradient centrifugation 10. Density gradient centrifugation for blood 11. Chick embryo candling and inoculation methods Demonstration experiment. 12. Semen analysis 13. Isolation of Protoplast and fusion 14. Skill based project 	
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Course Code: RUSBTK603

Course Title: PHARMACOLOGY

Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	CO DESCRIPTION
CO 1	Classify drugs based on different microbial targets.
CO 2	Elucidate the mode of action of different pharmacological agents.
CO 3	Describe the diagnosis, treatments and preventive measures of cancer
CO 4	Review the principles of drug action.
CO 5	Compare drugs according to safety, potency and efficacy based on dose response relationship.

CO 6	Elaborate the mechanisms of drug absorption in different tissues and causes of allergic reactions due to different drugs and poisons
CO 7	Describe the mechanism of activity of different poisons and toxins
CO 8	Evaluate antibiotic sensitivity of different microorganisms towards multiple drugs using suitable techniques

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Lectures
RUSBTK603	I	Chemotherapeutic agents: Discovery and Design of antimicrobial, Classification of Antibacterial agents, Selective toxicity, MIC, MLC, Inhibition of cell wall synthesis (Mode of action for): Beta lactam antibiotics: Penicillin, Cephalosporins; Glycopeptides: Vancomycin; Polypeptides: Bacitracin Injury to plasma membrane: Polymyxin, Inhibition of protein synthesis: Aminoglycosides, Tetracyclines, Chloramphenicol, Macrolides Erythromycin, Inhibition of nucleic acid synthesis: Quinolones, Rifampicin, Metronidazole, Antimetabolites: Sulphonamides, Trimethoprim Drug resistance: Mechanism origin, transmission, Use and misuse of antimicrobial agents, Antifungal drugs, Antiviral drugs Cancer: Introduction, Diagnosis & treatment, chemotherapy and preventive measures for cancer	15
	II	General principles of pharmacology: Mechanism of drug action, drug receptors and biological responses second-messenger systems, the chemistry of drug-receptor binding, dose-response relationship: therapeutic index, ED, LD, Potency and Intrinsic Activity, Drug antagonism	15

	II	<p>Drug Absorption and distribution:</p> <p>Absorption of drugs from the alimentary tract, factors affecting rate of gastrointestinal absorption, absorption of drugs from lungs and skin, absorption of drugs after parenteral administration factors influencing drug distribution, binding of drugs to plasma proteins, Physiological barriers to drug distribution</p>	15
	IV	<p>Basic and regulatory toxicology:</p> <p>Background Definitions</p> <p>Causation: degrees of certainty Classification, Causes Allergy in response to drugs, Effects of prolonged administration: chronic organ toxicity, Adverse effects on reproduction</p> <p>Poisons: Deliberate and accidental self-poisoning, Principles of treatment Poison-specific measures General measures, Specific poisonings: cyanide, methanol, ethylene glycol, hydrocarbons, volatile solvents, heavy metals, herbicides and pesticides, biological substances (overdose of medicinal drugs is dealt with under individual agents), Incapacitating agents: drugs used for torture, Nonmedical use of drugs</p>	15

Course Code: RUSBTK604

Course Title: BIOSAFETY AND PLANT BIOTECHNOLOGY

Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	CO DESCRIPTION
CO 1	Identify the potential hazards in laboratory or workplace and suggest first aid and safety methods
CO 2	Describe the principles of GMP, GLP and GDP

CO 3	Elaborate the role of quality assurance unit in laboratories
CO 4	Comment on different advanced techniques for storage of embryo and their uses in plant tissue culture
CO 5	Elaborate on different types of biofertilizer/biopesticide and discuss their significance in plant growth
CO 6	Design protocols for calibration of different analytical instruments
CO 7	Prepare/design SOPs of different analytical instruments

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Lectures
RUSBTK604	I	<p>Introduction to Biosafety:</p> <p>Introduction, Biological Risk Assessment, Hazardous, Genetically modified hazards, Cell cultures, Hazardous Characteristics of Laboratory Procedures, Potential Hazards Associated with Work Practices, Safety Equipment and Facility Safeguards, Pathogenic risk and management</p> <p>Biosafety in biotechnology and rDNA technology</p>	15
	I	<p>GLP, GMP and QA-QC:</p> <p>Concept of GLP and GMP, Requirements and implementation of GMP, Practicing GLP, Guidelines to GLP Documentation of Laboratory work, Documentation of GMP practices, Preparation of SOPs Calibration records, Validation of methods, Regulatory certification, Quality assurance and Quality control and: concept of QA & QC, Requirements for implementing QA & QC</p>	15

	II	<p style="text-align: center;">Introduction to plant biotechnology:</p> <p style="text-align: center;">Introduction, Micropropagation, Somaclonal Variations, Haploid Plants, Embryo Rescue, Somatic Hybrids And Cybrids, Germplasm Conservation, Molecular Markers And Maps</p>	15
	IV	<p style="text-align: center;">Biofertilizers and biopesticide:</p> <p>Biofertilizer: Nitrogen-fixing Rhizobacteria – Symbiotic Nitrogen Fixers, Nonsymbiotic Nitrogen Fixers, Plant Growth Promoting Microorganisms-Phosphate- Solubilizing Microbes (PSM), Phytohormones and Cytokinins, Induced Systemic Resistance Plant Growth Promotion by Fungi-Mycorrhizae, Arbuscular Mycorrhizae, Ectomycorrhizae Microbial Inoculants-Inocula, Carriers, and Applications, Monoculture and Co-culture Inoculant Formulations Biocontrol, Polymicrobial Inoculant Formulations Biopesticides - types, Bacillus thuringiensis, insect viruses and entomopathogenic fungi (characteristics, physiology, mechanism of action and application)</p>	15

References:

1. **Pharmaceutical Microbiology - Hugo, W.B, Russell, A.D 6th edition Oxford Black Scientific Publishers.**
2. **Biosafety in Microbiological and Biomedical Laboratories - 5th Edition, L. Casey Chosewood Deborah E. Wilson U.S. Department of Health and Human Services Centers for Disease Control and Prevention National Institutes of Health.**
3. **WHO handbook on GLP**
4. **Molecular Biotechnology-Principles and Applications of Recombinant DNA Technology 3rd Edition Glick B.R., Pasternak J.J., Patten C.L.**
5. **Plant tissue culture by K.G. Ramawat**
6. **Plant tissue culture by KK Dey**
7. **Environmental Biotechnology (Basic concepts and applications) Indu Shekar Thakur IK International**
8. **Biotechnology- expanding horizons: B D Singh**
9. **Microbial Technology Pepler, H.J and Perlman, D 2nd Academic Press Practicals**
10. **Environmental Biotechnology by M.H. Fulekar**
11. **Advances in Biotechnology by S.N. Jogdand**

Course Code: RUSBTKP602

Course Title: Practicals Based on RUSBTK603 &RUSBTK604

DETAILED SYLLABUS

Course code	Title	Credits
RUSBTKP602	<ol style="list-style-type: none"> 1. Antibiotic sensitivity test using agar cup method 2. Antibiotic sensitivity test using paper disc method 3. Antibiotic sensitivity test using ditch method. 4. Synergistic action of two drugs 5. LD 50, ED 50 evaluation using suitable models 6. First aid methods and safety in laboratory/ workplace 7. Biosafety: Signs and Symbols 8. Validation of measuring cylinders, colorimeters 9. Calibration of pH meter and weighing balance 10. Isolation of phosphate solubilising organism 11. Quantitative measurement of phosphate solubilisation 12. Isolation of Rhizobium and Azatobacter 13. Study the effect of plant growth using them as microbial inoculants 14. Extraction of biopolymer from Azatobacter 	3

Course Code: RUSBTK605
Course Title: FORENSIC SCIENCES-II
Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	CO DESCRIPTION
CO 1	Illustrate the roles of analytical instruments in evidence analysis
CO 2	Elaborate the principle of microscopic, spectroscopic and chromatographic techniques used in evidence analysis
CO 3	Summarise different blood spatter patterns and their role in solving forensic cases
CO 4	Explain the role of biological tissues and their significance in evidence analysis
CO 5	Elucidate on the significance of the different branches of forensic science during post mortem
CO 6	Comprehend the role of explosives and ballistics.
CO 7	Give role of FSLs (Forensic Science Laboratories) in crime investigation
CO 8	Utilise different analytical techniques for evidence analysis
CO 9	Identify the types of poisons found in an evidence using different chemical assays

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Lectures
RUSBTK605	I	Analytical techniques in forensic sciences: Instrumentation in Forensic Analysis (2 – 3 examples of each) Applications of Microscopy, spectroscopy (Atomic	12

	<p>absorption, Flame spectrometry, inductive coupled plasma spectrometry), electrophoresis, chromatography (GC, HPLC), gravimetric analysis and Volumetric analysis, Thermal methods (TGA, DTA, DSC), NMR, Neutron Activation Analysis</p> <p>Serological Techniques</p> <p>Electrophoretic methods: Agarose gel, SDS Nured /Denatured.</p> <p>DNA Quantification: Slot Blot Assay, Southern Northern Western blotting</p> <p>Various methods of development of fingerprints: conventional methods, physical and chemical methods, florescent method, Magnetic Powder method, fuming method, laser method.</p> <p>PCR in forensic science</p>	
II	<p>Evidence analysis:</p> <p>Determination of human and animal origin from bones, hairs, nails, skin, body tissue, and fluids strains viz. blood, menstrual blood, semen, saliva, sweat, pus, vomitetc., through immune diffusion and immune electrophoresis.</p> <p>Identification of blood: Properties Blood Grouping</p> <p>History of Bloodstain Pattern interpretation</p> <p>Target surface considerations, Size, Shape and Directionality of bloodstains</p> <p>Spattered blood, other Bloodstain Patterns</p> <p>Interpretation of Bloodstain on clothing and footwear</p>	12
III	<p>Forensic science and its branches:</p> <p>Analysis of Skeletal Remains</p> <p>Forensic Anthropology (Skeletal system & bone formation, Skeletal indicators of health & injuries, Identification of joint wear & deterioration, Estimation of Age, Sex & race, Estimation of time since death, Human v/s animal bone morphology)</p> <p>Facial Reconstruction</p> <p>Forensic Odontology</p>	12

	<p>(Development of dental structure, Estimation of Age, Sex & race)</p> <p>Forensic Pathology (Decomposition Muscular Physiology, causes of death – Asphyxia, drowning, Post mortem Examination - Wounds, injuries Digestive System & Digestive paths of macromolecules, enzymes & end products, Undigested stomach contents post mortem, Role of a Forensic Pathologist)</p> <p>Forensic Entomology (Basic principle of insect biology, Life cycle, Estimation of time since death, Dipterans Larval Development, Successional Colonization of Body, Determination of displacement and disturbance of the body)</p>	
IV	<p>Ballistics and forensic laboratories:</p> <p>Introduction of Fire arms.</p> <p>Proof marks</p> <p>Introduction to and types of Ballistics (internal, external and terminal ballistics) Role of forensic sciences in explosives</p> <p>Petroleum – Introduction and its forensic examination for adulteration</p> <p>Growth of Forensic Science Laboratories in India – Central and State level laboratories, Educational setup in Forensic Science in India</p> <p>Services and functionalities provided by various FSLs, Various divisions in the FSL – Ballistics, Biology, Chemistry Documents, Physics, Psychology, Serology, Toxicology</p>	12

Course Code: RUSBTKP603

Course Title: Practicals Based on RUSBTK605

DETAILED SYLLABUS

Course code	Title	Credits
RUSBTKP603	<ol style="list-style-type: none"> 1. Microscopic examination of hair of different animals such as Dogs, Cats, Cow, Horse, Goats, humans etc. (M-18) 2. Separation & detection of biological fluid by using HPLC. 3. Cement analysis by volumetric and gravimetric method. 4. Detection of Blood Alcohol Content. 5. Blood spatter analysis. 6. PCR analysis of given sample. 7. TLC of analgesics/ semen (M-08 Serology) 8. TLC of ink and dyes. 9. Capillary electrophoresis 10. Analysis and preservation of bite marks 11. Determination of Age, sex, occupation/habits by dental evidence 12. Detection of saliva by gel-based starch-iodide test. 13. Reinsch's test for detection of arsenic in forensic sample 14. Copper-sulphate pyridine test for detection of cyanate 15. Prussian blue test for detection of cyanide in the sample. 16. Zwikker's test for Thiobarbiturates in sample. 17. McNally's test for presence of salicylates and salicylic acid in sample. 18. Lieberman's test for detection of phenols, resorcinols as well as alpha- & beta- naphthol. 19. Ammonium Molybdate test for detection of arsenites and phosphates. 	2

	20. Case studies	
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Modality of Assessment (SEMESTER VI)

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	One Assignment (Case study/Project based/Animation/ Review writing/ Video demonstration/ Pictorial or flow sheet representation or Infograph/ Mind map or concept map / Industrial visit report/Presentations etc.)	20
2	One class Test (multiple choice questions / objective)	20
	TOTAL	40

B) External Examination- 60%- 60 Marks

Duration - These examinations shall be of 2 hours duration. Theory question paper pattern:

1. There shall be 04 questions each of 15 marks. On each unit there will be one question.
2. All questions shall be compulsory with internal choice within the questions (60% options)

Paper Pattern:

Question	Options	Marks	Questions Based on
Q.1) A)	Any 5 out of 8	5	Unit I
Q.1) B)	Any 2 out of 3	10	
Q.2) A)	Any 5 out of 8	5	Unit II
Q.2) B)	Any 2 out of 3	10	
Q.3) A)	Any 5 out of 8	5	Unit III

Q.3) B)	Any 2 out of 3	10	
Q.4) A)	Any 5 out of 8	5	Unit IV
Q.4) B)	Any 2 out of 3	10	

Practical Examination Pattern:

PAPERS: RUSBTKP601, RUSBTKP602, RUSBTKP603

A) Internal Examination: 40%- 40 Marks

Particulars	Marks
Journal	10
*Experimental tasks	30
Total	40

*Project work for semester VI in RUSBTKP601 (Internal project evaluation- 25

M) Note- Similar pattern for internal practical will be followed for all three
Practical papers.

B) External Examination: 60%- 60 Marks

Semester End Practical Examination:

Particulars	Marks
Laboratory work	60
2 Major practicals*	20 & 25 M or 20M each
1 Minor practicals	10 M
Viva/ Spots	05 M or 10 M
Total	60

*Skill based project in Semester VI (RUSBTKP601) - 50M

Overall Examination & Marks Distribution Pattern

Course	RUSBTK601			RUSBTK602			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Course	RUSBTKP601						Grand Total
	Internal			External			
Practicals	40			60			100
Course	RUSBTK603			RUSBTK604			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200

Course	RUSBTKP602		
	Internal	External	
Practicals	40	60	100

Course	RUSBTK605		
	Internal	External	Total
Theory	40	60	100
	RUSBTKP603		
Practicals	Internal	External	Total
	40	60	100

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