Resolution Number: AC/II(23-24).2.RUS7

S. P. Mandali's

Ramnarain Ruia Autonomous College

(*Affiliated to Mumbai University*)

RUIA COLLEGE
Explore • Experience • Excel

Syllabus for T.Y.B.Sc.

Program: Bachelor's Degree in Life Science

Program Code: RUSLSc

(Choice based Credit System for Academic year 2024–2025)

Graduate Attributes for BSc Life Science

GA	GA Description **A student completing Bachelor's Degree in Life Science program will be able to:**
GA1	Demonstrate an understanding of biological systems across microorganisms, plants and animals. To develop necessary laboratory skills and analytical methods.
GA2	Employ critical thinking and scientific knowledge to design experiments, record observations, analyse data and interpret results. They can further build their career in research.
GA3	Create an awareness of environmental issues, biological diversity, and how we can make a positive impact on it.
GA4	Inculcate scientific temperament and generate problems solving approaches in students when they integrate themselves in the larger society.
GA5	Develop necessary laboratory skills and analytical methods.

PROGRAM OUTCOMES

PO	Description **A student completing Bachelor's Degree in the subject of Life Science will be able to:**
PO1	To be able to describe the biomolecules and metabolic processes, compare developmental processes and physiological systems in plants and animals, neuroendocrine system, short term and long term memory, learning and behaviour, neurological disorders, biological evolution, human evolution of thought process, which allows for curiosity, and enhances learning process ahead.
PO2	To be able to describe interspecific interactions in the ecosystem, Plant Tissue Culture techniques and its significance in agriculture, germplasm conservation and secondary metabolites, and Animal Tissue Culture techniques, Fermentation Technology and its role in industry and society
PO3	To be able to explain DNA Cloning, use of cloning vectors like *E.coli* plasmids, cosmids, phagemids, viral vectors, significance of restriction enzymes, apply Mendel's laws, gene regulation in prokaryotes and eukaryotes, defense mechanisms in plants and animals, innate and adaptive immune system, and its disruptions in the form of allergies, autoimmune diseases and immunodeficiency disorders. applications of Monoclonal antibodies in cancer
PO4	Apply Biostatistics to analyse, Probable Chance of Occurrence, Normal Population, Student's t-test, Correlation and Regression

	analysis, Chi-Square test, data analysis for project work
PO5	Skills-Perform assays to identify, purify, quantify, immobilize proteins/enzymes using techniques like Centrifugation, Electrophoresis and Chromatography, dissection of animals, protocols to handle preserved animals, working in aseptic conditions, use and maintaining of diagnostic kits, pedigree analysis in humans, karyotyping in plants
PO6	Skills- Apply Bioinformatics to understand the evolution of macromolecules, the genomic status of organisms , to compare the phylogenetic relationships, to analyse nucleotide and protein sequences, to annotate nucleotide sequences and derive structure function relationship.
PO7	Environment and Sustainability- to analyse the local biodiversity at residential sites of students and the changes occurring in the biodiversity and to conserve the same, awareness about implementation of Laws Regulations, citizens awareness to oppose under the aegis of NGO
PO8	Ethics- awareness of plagiarism in scientific work, acknowledging/ citing the work, lab ethics in handling biological materials and chemicals, to be able to apply professional and ethical principles, minimize waste and ethical waste disposal
PO9	Individual and Team Work- to be able to work independently as well as lead a team and be a team player,
PO10	Communication skills- to be able to communicate clearly through presentations as well as document, write effective reports or communicate and work in a team
PO11	Project Management- to be able to write SOPs for instruments, design experiments, analyse data, work in a team, a scientific

	way of thinking, a diverse approach to scientific enquiry towards an idea,
PO12	Life Long Learning- to be able to learn independently and adapt to changing needs of the society

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS
TYBSc	**V**	RUSLSc501	DSC Genetics and Immunology-I	**4**
TYBSc	**V**	RUSLSc502	DSC Developmental Biology and Neurosciences- I	**4**
TYBSc	**V**	RUSLSc503	DSC Biotechnology and Genetic Engineering- I	**4**
TYBSc	**V**	RUSLSc504	DSC Ecology, Conservation Biology, Assessment and Management- I	**4**
		Applied Component	SEC Horticulture / Marine Science	**2L+2P**
TYBSc	**V**	RUSLScP501	DSC Practicals in Genetics and Immunology-I	**1.5**
TYBSc	**V**	RUSLScP502	DSC Practicals in Developmental Biology and Neurosciences – I	**1.5**
TYBSc	**V**	RUSLScP503	DSC Practicals in Biotechnology and Genetic Engineering – I	**1.5**
TYBSc	**V**	RUSLScP504	DSC Practicals in Ecology, Conservation Biology, Assessment and Management – I	**1.5**
TYBSc	**VI**	RUSLSc601	DSC Genetics and Immunology- II	**4**
TYBSc	**VI**	RUSLSc602	DSC Developmental Biology and Neurosciences- II	**4**
TYBSc	**VI**	RUSLSc603	DSC Biotechnology and Genetic Engineering- II	**4**
TYBSc	**VI**	RUSLSc604	DSC Ecology, Conservation Biology, Assessment and Management- II	**4**
		Applied Componet	SEC Horticulture / Marine Science	**2L+**
TYBSc	**VI**	RUSLScP601	DSC Practicals in Genetics and Immunology – II	**1.5**
TYBSc	**VI**	RUSLScP602	DSC Practicals in Developmental Biology and Neurosciences – II	**1.5**
TYBSc	**VI**	RUSLScP603	DSC Practicals in Biotechnology and	**1.5**

			Genetic Engineering – II	
TYBSc	**VI**	RUSLScP604	DSC Practicals in Ecology, Conservation Biology, Assessment and Management – II	**1.5**

DSC - Discipline Specific Course *

SEC - Skill Enhancement Elective Courses *

TYBSc

Course Code: RUSLSc 501

Course Title: Genetics and Immunology -I

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	Students will gain insights about following;
CO 1	Explain the discoveries of genetics. Understand the Structural organization of a prokaryotic genome. Explain structural organization of a eukaryotic genome. Compare unique and repetitive sequences of DNA. Explain chromosomal condensation. Justify the role of acetylation and methylation in methylation and remodelling.
CO2	Compare the Life Cycle of lytic and lysogenic phages. Explain the processes of Conjugation, Transformation. Distinguish between generalized and specialized Transduction.
CO 3	To explain the role of different immune cells and organs, to distinguish between innate and adaptive immunity.
CO4	To explain the experimental design to obtain monoclonal antibodies and their applications
CO5	To explain the techniques to estimate Antibody or Antigen concentrations, to describe the genetic recombination theory for generating a vast array of antibodies.
CO6	To construct the ontogeny flow chart of B cells and T cells, to connect innate and adaptive pathways of complement system activation, explain how structure of MHC molecules and function are related, describe the activity of cytokines and immune responses.

Course Code: RUSLSc 502

Course Title: Developmental Biology and Neurosciences- I

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	Students will gain insights about following;
CO 1	Role of the germinal layers of the developing embryo and the expression of specific genes, life cycle of model organisms like amphibians & Arabidopsis
CO 2	Communications between the CNS and the PNS with the help of Neurotransmitters for memory and learning

Course Code: RUSLSc 503

Course Title: Biotechnology and Genetic Engineering- I

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Students will gain insights about following;
CO 1	To explain and summarize the history of fermentation technology, to demonstrate ways of strain improvement, to design and compare media for various purposes, to formulate methods for downstream processing of different industrially important end products.
CO 2	To explain specifications for production of food and beverages, to justify the importance of different procedures of Quality Assurance in each of the production techniques.
CO 3	Understand the history of Gene cloning. Explain the role of different restriction enzymes in molecular cloning. Understand the concept of recombination mapping.
CO 4	Understand how Isolation of cloning vectors, selection of gene cloning organisms, isolation of desired DNA to be cloned is important.
CO 5	Explain the techniques like Immunological method, Nucleic acid hybridization method, Hybrid arrest and Hybrid release method(HART and HRT) for screening and selection of the desired clones.

Course Code: RUSLSc 504

Course Title: Ecology, Conservation Biology, Assessment and Management- I

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Students will gain insights about following;
CO 1	Study of the biogeochemical cycles of nature,interaction of the biotic community and the abiotic resources, loss of biodiversity, disturbed ecological web of life.
CO 2	Citizens action for conservation , restoration significance in protection GMO,IPR for sustainable living, reducing demands and reducing conflicts towards sustainable development

DETAILED SYLLABUS : -

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
		T.Y.BSc. LIFE SCIENCE (Theory)	
RUSLSc 50 1		**Genetics and Immunology - I**	**4 Credits Total 60 Lectures**
	I	**The Genetic material** **Introduction - Discovery of the genetic:** Griffith's experiment of 1928; Avery, McLeod and McCarty's experiment of 1944; Hershey-Chase's experiment of 1952; and Fraenkel-Conrat and B. Singer's experiment of 1956. *To be given as Assignment/Presentations. **Molecular aspects:** Sequence complexity of DNA -Unique and repetitive sequences of DNA; Denaturation kinetics and 'CoT' value; Satellite DNA **Genomes:** Structural organization of a prokaryotic genome Structural organization of a eukaryotic genome Higher orders of chromosome packing; 'C value paradox' **Introduction to gene regulation in Prokaryotes Gene regulation in eukaryotes** Chromatin condensation, Modification and remodelling by acetylation and methylation Transcriptional regulation (promoters and enhancers and Transcription Initiation complex, GAL4-UAS system)	**15 Lectures**
	II	**Mechanisms of Inheritance and variation in Prokaryotes and Eukaryotes** **Genetic recombination in Bacteriophages:** Life Cycle of lytic and lysogenic phages Complementation in phages (Intra- and Inter-genic) Recombination mapping – Two- and three- factor crosses	**15 Lectures**

		Genetic recombination in Bacteria: The processes of; Conjugation, Transformation, Transduction Mapping the genome by each method	
	III	**Overview and cells and organs of immune system Overview of the Immune system -** Innate Vs Adaptive Immunity innate immunity* to be given as assignment/ presentations i)Anatomical, Physiological, Phagocytic, Inflammatory barriers ii)Concept of Apoptosis vs Necrosis ii) Concept of PAMP, PRR and TLR **Cells and organs of the immune system** i) Primary and secondary lymphoid organs ii) Cells Myeloid cells- structure and functions Lymphoid cells, NK cells **Recognition of antigens** i)Antigen-Specificity, avidity, affinity, immunogenicity, antigenic variations, Antigenic drift and shift ii) Antibody-Structure, Functions and variations iii)Monoclonal and polyclonal antibodies (Hybridoma Technique) iv)Organization and expression of Immunoglobulin genes v)Antigen-antibody interactions –Cross reactivity, Precipitation Immunoelectrophoresis, Agglutination, Radioimmunoassay, ELISA, Immunofluorescence	**15 lectures**
	IV	**Antigen recognition and Effector Mechanisms Major Histocompatibility Complex** i) MHC-I and MHC-II molecules ii) MHC allelic polymorphism iii) MHC restriction iv) Antigen processing and presentation- endogenous and exogenous pathways **Maturation and activation of Lymphocytes** B- cell recombination, maturation, Activation	**15 lectures**

		and Differentiation T- cell maturation, Activation and Differentiation and T- cell receptor **Immune Effector Mechanisms** **Cytokines** - - IL-1, IL-2, IL-4, IFNs and TNFs **Complement** i) Classical, alternative and lectin pathways and comparison ii) Biological consequences of complement activation iii) Complement fixation test **Cell-mediated effector responses** Cell-mediated cytotoxicity of T cells Role of TH1, TH2,TH17 and Tc cells	
RUSLSc 502	**I**	**DEVELOPMENTAL BIOLOGY AND NEUROSCIENCE – I** **Concepts of Developmental Biology** Basic Concepts of Development Sea Urchin : Mosaic vs. Regulative Development *Dictyostelium* : acquisition of multicellularity *Drosophila* : mutation series and early development. Amphibians and hen (chick) : fate maps and chimeras. *Arabidopsis* as the model System Life cycle of *Arabidopsis* – sporophytic and gametophytic generation Formation of different organs – leaf, flower, androecium [including development of anthers, pollen grain, pollen tube etc.] and gynoecium [development of pistil - up to formation of embryo sac] Fertilization, Double fertilization and embryo development, Formation of meristems (root and shoot) , seed formation fruit formation Role of Homeotic genes specifying parts of a flower Plant genome project *(Arabidopsis* and *Oryza*)	**4 Credits 60** **Lectures** **15** **Lectures**
	II	**Animal Development** Amphibian development Germ cell and Fertilization Cleavage, Morula and blastula and stem cells, Gastrulation. Chick development : Germ cells and Fertilization Cleavage, Morula and blastula, Gastrulation.	**15 Lectures**

		Neurulation. - neural induction, Neural tube formation in amphibians and Chick Organogenesis – Eye / limb Neural Crest Cells	

	III	**Nervous system and its functional organization** Embryonic development of the Brain Vertebrate nervous system: Central Nervous System Nervous system. Functional organization of the human central nervous System Subdivisions of the CNS Forebrain:cerebrum: cerebral hemispheres,cerebral Cortex functional areas,White Matter Diencephalon.; The midbrain ,the Pons,the Medulla Oblongata: The Brain-Stem Cerebellum The spinal Cord Limbic System and the Reticular formation	**15 Lectures**
	IV	**Cellular organization and communications in the nervous system** Chemical Basis of Neural transmission- Introduction Ionic basis of Resting Membrane Potential: Donnan's equilibrium experiments, Nernst's Potential Goldman's equation, Sodium –Potassium pump Action Potential & propagation of Action Potential Synaptic potential and synaptic integration [Electrical and Chemical Synaptic Potential] Excitatory Postsynaptic Potential (EPSP), Inhibitory PostSynaptic Potential (IPSP) Neuro – muscular junctions Synapse and synaptic transmission Synapse: Structure, Types – chemical and electrical, Neurotransmitters – General Introduction Biosynthesis, physiological role, pharmacological significance, (examples of one agonist and one antagonist for each Neurotransmitter mentioned below Acetylcholine (Nicotinic and muscarinic receptors), Dopamine (D1 and D2 receptors), GABA and Glutamate, Neuropeptide (Endorphin and Enkephalin).	**15 Lectures**
RUSLSc 503		**BIOTECHNOLOGY AND GENETIC ENGINEERING -I**	**4 Credits** **60 lectures**

	I	**Fermentation technology – Principles** History and development of Food & Fermentation Technology *PresentationFermentation technology & Instrumentation *Presentation Principles of microbial growth, Screening (primary & secondary) Strain improvement (mutation & selection using auxotrophy & analogue Resistance. The Bioreactor / Fermenter – Types & accessories (Stirred tank & Airlift) Media design for fermentation (include molasses, corn steep liquor) Downstream processing (use ex of Penicillin and an enzyme? for cell Disruption) Instrumentation: Principles and technique of Centrifugation, Spectrophotometry and chromatography.	
	II	**Fermentation technology - Food and Beverage Production** Batch vs Continuous fermentation Technological aspects of industrial production of Cheese Alcoholic beverages – Beer, wine Vinegar Single Cell Protein Mushroom, Yoghurt. Food quality assurance: Regulatory & social aspects of food biotechnology	
	III	**Gene Cloning – Principles** **Introduction to the history of Gene cloning** *Presentation	

		Methods in Molecular Biology : Molecular cloning methods Cutting and joining DNA molecules: DNA ligase, Homopolymer tailing, Adaptors, Linkers, Use of Alkaline Phosphatase. Role of Restriction enzymes, Type I, II ,III, patterns of DNA cutting by restriction enzymes. Restriction Mapping – concept and numerical problems. **Vectors: The cloning vehicles** Vectors for gene cloning (Plasmids, Bacteriophages as vectors example M13 vector, cosmid as vector). Plasmids and other advanced vectors. pBluescript II. Viral vectors – Adenovirus and Lentivirus Expression of Insulin and somatostatin gene in *E.coli* using pBR322.	
	IV	**Gene Cloning – Technology** **Cloning of genes** Isolation of cloning vectors, selection of gene cloning organisms, isolation of desired DNA to be cloned. Identifying a specific clone with a specific probe, construction of recombinant DNA, transformation, culture and isolation of recombinant DNA from non recombinant one. Chromosome walking, jumping and painting and Shotgun cloning. Making genomic and cDNA libraries in *E. Coli.*	

RUSLSc 504		**cDNA technology** Isolation of mRNA, cDNA synthesis, cloning of double stranded cDNA in plasmid or phage vector, screening a library with nucleic acid probe to find a clone. Polymerase chain reaction : An alternative to cloning (Method , limitations of PCR, Application of PCR, Reverse transcriptase PCR) **Methods of expressing cloned genes** Expression vectors with examples Screening and selection of the desired clone : i) Immunological method ii) Nucleic acid hybridization method iii) Hybrid arrest and Hybrid release method(HART and HRT) **ECOLOGY, CONSERVATION BIOLOGY, ASSESSMENT AND MANAGEMENT-1**	**4 Credits** **60 Lectures**
	I	**Introduction to Fundamentals of environmental science** **Structure of Ecosystem- Biosphere** concept of biotic communities- food chain , food web, Ecological Pyramids , Trophic categories i.e. Producer Consumer, Detritus feeders and decomposers. Mutually supportive relationships as in interspecific interactions eg. Symbiosis, Commensalism Competitive relationship - Ecological Niche, Resource partitioning with eg.	**15 Lectures**

		Abiotic factors with suitable eg. , Optimum zones of stress Limit of Tolerance- Law of limiting factor **Population Dynamics** :- S and J shaped growth curve , r and k selected species with example BioGeochemical cycling C, N, P,S,O, H_2O Primary succession (soil formation).	
	II III	Basic introduction about Pests, Pesticides and Environm ent Pesticide toxicity: Bioaccumulation and Biomagnification and Bioremediation of OP pesticide, persistence, Resistance and pollution health of farmers. Biological pest control: predators, parasites, and pathogens. Genetically Engineering and pest control Bioremediation of OP pesticide: using Bacillus Sps. (eg. Malathion Pesticide) Phytoremediation of Organochlorine pesticide (Chloropyrifos) using plants Pesticide regulation: eg. Endosulphan issue. **Toxicology Management** Toxicology : Basic concepts, toxicity and its impacts, industrial toxicants and hazardous materials, toxic and hazardous waste management, measurement of toxicity (LC50, LD50 and ED50), TLM and lethality studies, *Only in brief. Limitation of Toxicological studies: Comparison of animal toxicological models and Toxicity in Humans with an example Human clinical trials: Concept of Clinical trial phases - I, 2, 3 and 4. Ethical issues of clinical trials: e.g. Thalidomide / Human Papillomavirus Vaccine trials	
	IV	**Sustainable Development** SDG, Ecological and economic growth factor for sustainable development, integrating Environmental concerns in economic decisions Economic cost of environmental degradation.	

		Costs benefit analysis Awareness of citizen on environmental legal provisions to protect the environment	
Course Code/ Unit	**Unit**	**Course / Unit Title**	**Credit/ Lectures**
		PRACTICALS	**Credits 1.5, Lectures-60**
RUSLSc P 501	**I**	**Genetics and Immunology - I** <u>Experiments to be performed by students</u> 1. Extraction of chromosomal DNA from chicken liver / goat spleen 2. Streak plating of saliva on two different media 3. Viable count for enumeration of bacteria by – Bulk seed method 4. Viable count for enumeration of bacteria by - Surface spread method <u>Demonstration experiments:</u> a) Study of *Drosophila* mutants from specimen / slides / photographs Study of UV-Visible Spectrophotometer *Video presentation and GD **<u>Immunology</u>** **I)**<u>Experiments to be performed by students:</u> 1. Study of ABO Blood groups and quantitative Coomb's Test. 2. Study of Isohemagglutinin titre in blood. 3. Quantitative Widal Test. 4. <u>Demonstration experiments:</u> a) Dissect and expose the lymphoid organs of rat / photograph b) Study of Thymus, Spleen, and Lymph node tissue sections c) Observation of Blast cells in bone marrow of any mammal from slides / photographs.	
RUSLSc P 502		**DEVELOPMENTAL BIOLOGY AND NEUROSCIENCE – I**	**Credits - 1.5, Lectures-60**

		Animal developmental Biology 1)Temporary mount of chick embryo and its developmental stages. 2) Cytochrome C- oxidase activity in a developing chick embryo. **Plant Developmental Biology** 1)Root and shoot development in sections of plant. I,C,T,R. eg. *Scoparia sps* /any other role of GA as a hormone in seed germination. C,T 3) Study of Root and shoot meristematic tissues in plants and significance of the various plant hormones.(.Identification) **Neurobiology** 1)Differential staining of white and grey matter of the vertebrate brain. 2)Dissect & display of Nervous system in Invertebrates – earthworm/cockroach or any other suitable animal C,T,R 3)Dissect & display of Nervous system in vertebrates – Hen brain or any other suitable system C,T , 4) Identifications: Permanent slides/photograph of: C,R a)Medullary nerve fibre: b)TS of Spinal cord c)Hodgkin and Huxley model d)Electron micrographs of neural tissue Demonstration Experiments Study of the Nervous system of *Sepia* with special reference to Giant axon and stellate ganglia T,C,R. Mammalian brain – eg. Goat brain	
RUSLSc P 503		**BIOTECHNOLOGY AND GENETIC ENGINEERING I**	**Credits - 1.5, Lectures-60**

		1. Extraction of enzyme: (Amylase from sweet-potato / salivary amylase /egg white lysozyme or any other convenient enzyme) 2. Purification of enzyme : Above enzyme extract used for purifying by salting-out method 3. Determination of - i) enzyme activity ii) specific activity 4. Determination of the effect of pH and Temperature on Enzyme activity (Amylase / any other convenient enzyme). 5.Determination of the K_m of amylase/any other convenient enzyme. 6.Immobilization of enzyme by Sodium Alginate method (Amylase/ any other convenient enzyme) 7.Enzyme activity staining/ Zymogram of amylase using starch agar plates. 8.Non-denaturing Polyacrylamide Gel Electrophoresis of Serum proteins / Saliva / Egg white any other suitable sample/Amylase	
RUSLSc P 504		**ECOLOGY, CONSERVATION BIOLOGY, ASSESSMENT AND MANAGEMENT-1**	**Credits - 1.5, Lectures-60**
		1. Identification of minimum 5 plants and animals that form mangrove ecosystem, pneumatophores	

		vivipary adaptations eg., *Kandelia kandel*, *Heritiera littoralis* 2. Visit to mangrove 3. Study of fecundity from the given sample of freshwater/marine fish 4. Isolation and culturing of *Rhizobium* from the given sample. 5. Analysis of soils types for pH, moisture and give significance 6. Water analysis for physicochemical characteristics: DO, BOD,COD, Salinity (compare with Toxicity Limits) 7. Vegetation studies by Quadrat Methods their analysis during biodiversity field visit 8. A visit to aquatic ecosystem and methods for water and plankton collection/ Plankton identification and quantification from river / lake water samples	

References :-

RUSLSc 501	
	Units I and II Genetics
1.	Principles of Genetics bySnustad and Simmons 4thedn. John Wiley and sons 2006.
2.	Genetics; A Molecular approach by Peter Russel 2ndedn. Pearson 2006.
3.	Genetics; AMendelian approach by Peter Russel 2ndedn. Pearson 2006
4.	Introduction to Genetic Analysis by Griffiths et al 8thednFreeman and co. 2005
5.	Genes IX by Benjamin Lewin; Jones and Bartlett publishers, 2008.
6.	Principles of Gene Manipulation and Genomics by S. B. Primrose and R. M. Twyman 7thedn., Blackwell publication, asianedn Oxford publishers 2007
7.	Concepts of Genetics W. S. Klug and M. R. Cummings 7thedn. Pearson 2003.
8.	Concepts of Genetics W. S. Klug, M. R. Cummings, C. A. Spencer 8thedn. Pearson 2006.
9.	Human Molecular Genetics by Tom Strachan and Andrew Read, 3rdedn. Garland Science pub. 2004.
10	Principles of Genetics by R. Tamarin 7thedn 2002

.	
	Units III and IV Immunology
11	Immunology 7thedn. R.A.Goldsky, T. J. Kindt, B. A. Osborne, J. Kuby 2018.
12	Immunology: The immune system in health and disease 6thedn. C. A. Janeway, P. Travers, M. Walport, M. Shlomchik Garland Science Pub. 2005.
13	Cellular and Molecular Immunology, 2ndedn. A. K. Abbas, A. H. Litchman, 5thedn 2000.
14	Basic Immunology: Functions and disorders of the immune system, 2ndedn. A. K. Abbas, A. H. Litchman, 2ndedn 2004.
15	Roitt's Essential Immunology 11thedn. Blackwell publication 2006.
16	Immunology 7th International edn. D. Mole, J. Bronstoff, D. Roth, I. Roitt, Mosbey Elsevier publication, 2006.
17	An Introduction to Immunology C. V. RaoNarossa Publishers 2002
18	Gene cloning and DNA analysis T.A. Brown Wiley Publishing House.
19	Immunology by David Male Jonathan Brostoff David Roth Ivan M. Roitt | 1 January 2012

RUSLSc 502

	UNIT l and II Developmental Biology (Latest editions recommended)
	1. Instant Lecture Notes- Developmental Biology, R.M.Twyman, Viva Books Private Limited, New Delhi, Latest Edition (First Edition – 2001) 2. Developmental Biology, T.Subramaniam, Narosa publishing House, Mumbai, Latest Edition (First Edition-2002) 3. Principles of Development L. Wolpert, R. Beddington, J. Brockes, T. Jesell and P. Lawrencel Oxford University Press. 4. Developmental Biology. W.A. Miller Springer – Verlag. 5. Molecular Biology 3rd Ed., H.Lodish, D.Baltimore, A.Berk, S.L. Zipurski, P.Matsudaira and J. Darnell. Scientific American Book, W.H. Freeman, N.Y. 6. Molecular Biology of the Cell 3rd Edition. B. Alberts, D. Bray, J.Lewis, M. Raff, K. Roberts and J.D.Watson. Garland Publishing Inc., N T and London.

7. Plant Cell and Tissue Culture I. Vasil and T.A. Thorpe. Kluwer Academic Publishers.

8. Practical Zoology 2nd Edition. K.C. Ghone and B. Manna. New Central Book Agency Publishers.

9. Developmental Biology 4th edition. S.F. Gilbert. Sinauer Associates Inc. Publishers.

10. Pollen Analysis 2nd edition. P.D.Moore, J.A.Webb and M.E. Collinson Blackwell Scientific Publishers.

11. Pollen Biology – A laboratory manual (1992) K.R. Shivanna and N.S. Rangaswamy, Narosa Publishing, Calcutta.

11. Developmental Biology 2nd edition, L.W.Browder, Saunders College Publishing Co.

12. An Introduction to Embryology 5th Ed B. I. Ballinsky' Saunders, College Publishing Co.

13. Developmental Biology – Patterns, Problems and Principles. J. W. Saunders. J. R. MacMillan Publishing Co.,

14. An Introduction To the Embryology of Angiosperms. P. Maheshwari.

15. An Atlas Of Descriptive Embryology 2nd ed. W.W.Mathews. MacMillan Publishing Co.

16. Essential Developmental Biology – A Practical Approach Ed C.D. Stern and P.W.H. Holland. Oxford University Press

UNIT III and IV – Neuroscience (Latest Editions Recommended).

17. Neuroscience: Exploring the brain M.F.Baer, B.W.Connors&M.A.Paradiso, William & Wilkins, Baltimore, Latest Edition (First Edition1996)

18. Neurobiology 3rd edition G.M. Shepherd Oxford University Press.
19. Principles Of Neural Science. E.R.Kandel, J.H.Schwartz and T.M. Jessel. Prentice Hall International.

20. Instant Notes – Neurosciences, A.Longstaff Viva Books Pvt Ltd., New Delhi, 2002

21. TextBook Of Medical Physiology A.C.Guyton and J.E.Hall Saunders College Publishers.

22. Elements Of Molecular Neurobiology C.U.M. Smith J Wiley and Sons Publishers, N.Y.

23. An Introduction to Molecular Neurobiology Z.W. Hall Sinauer Associates Inc. Publishers.

24. Ion Channels – Molecules in Action D. J. Aidley and P.R. Stanfield. Cambridge University Press.

25. Comparative Neurobiology J. P. Mill Edward Arnold Publishers.

26. Physiology Of the Nervous Systems D Ottoson, McMillan Press.

RUSLSc 503

1. Principles of gene manipulation and Genomics by Primrose and Twyman, 7th edition, Blackwell publishing (2006)

2. Molecular Techniques in Biochemistry and Biotechnology by S Shrivastava (2010) Pub. New central book Agency (P) Ltd

3. Molecular Biology by Robert Weaver, second edition Pub McGraw Hill (2003)

4. Text book of cell and Molecular Biology by Ajoy Paul Pub Books and Allied (P) Ltd. Second edition (2009)

5. Cell and molecular biology by sp Vyas and Mehta (2011) CBS pub and Dist Pvt Ltd.

6. Industrial Microbiology. L.E.Casida (2003) New Age International (P) Ltd.

7. Industrial Microbiology. Prescott And Dunn's (2004) Chapman & Hall.

8. Industrial Microbiology. A H PATEL (2005) Macmillan India

RUSLSc 504

1. Misra and Pandey (2011), "Essential environmental studies ‘', Ane Books

2. Martens (1998),"Health and climate change ", Earth Scan

3. Saxena (1998), "Environmental Analysis of soil and air", Agrobotanica

4. Chakraborti (2005),"Energy efficient and environment friendly technologies for rural development " ,Allied Publishers

5. Dash M C (2004) "Ecology, chemistry and Management of environmental Pollution ",Mac Millan India

6. Nayak ,Amar(2006) "Sustainable sewage water Management ",Mc Millan India

7. Dolder, Willi (2009), "Endangered animals, Parragon

8. Gupta P K (2000)," Methods in environmental Analysis ",Agrobio (India)

9. Fumento, Michael (2003),"Bioevolution : How biotechnology is changing our world" , California encounter Books

10. Kapur (2010) "Vulnerable India ", SAGE

11. Jacob, Miriam(2004) ," Silent Invaders" , Orient Longman

12. Mc Cafferty (1998) ,"Aquatic Entomology ", Jones and Barlett

13. Subramnyam (2006),"Ecology " , 2nd ed.Narosa

14. Dilip Kumar, Rajvaidya (2004)," Environmental Biotechnology ", APH

15. Sharma and Khan (2004)," Ozone Depletion and Environmental Impacts" ,

Pointer publishers

Modality of Assessment

Theory Examination Pattern: Paper I to IV.

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1.	Written Test	20
2.	Presentation on topic from syllabus / Quiz / Open book test	10
3.	Presentation on any journal article/ newsletter/ book review/ conference/ guest lecture	10
	TOTAL	**40**

B) External Examination- 60%- 60 Marks

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

Question	Options			Marks	Based on
Q1	Answer any 2 questions out of 3 questions on Unit 1 Each question of 7.5 marks	OR	Answer any 3 questions out of 4 questions on Unit 1 Each question of 5 marks	15	Unit I
Q2	Answer any 2 questions out of 3 questions on Unit 2 Each question of 7.5 marks	OR	Answer any 3 questions out of 4 questions on Unit 2 Each question of 5 marks	15	Unit II
Q3	Answer any 2 questions out of 3 questions on Unit 3 Each question of 7.5 marks	OR	Answer any 3 questions out of 4 questions on Unit 3 Each question of 5 marks	15	Unit III
Q4	Short notes on topics of all 3 units; Answer any 3 out of 5; Each of 5 marks	OR	Short notes on topics of all 3 units; Answer any 3 out of 5; Each of 5 marks	15	Unit I, II, III
			Total	**60**	

Practical Examination Pattern:

A) Internal Examination: 20Marks

Particulars	Marks
Journal	05
Experimental tasks	15
Total	**20**

B) External Examination: 30 Marks

Semester End Practical Examination:

Particulars	Marks
Main question to perform experimental task/Estimation/ Dissection/ Statistical analysis.	15
Identifications	10
Total	**30**

Overall Examination & Marks Distribution Pattern

Semester V

Course	501			502			503			504			Grand Total
	Int	Ext	Total	Int	Ext	Total	Int	Ext	Total	Int	Ext	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	**400**
Practicals	20	30	50	20	30	50	20	30	50	20	30	50	**200**

Course Code: RUSLSc 601

Course Title:Genetics and Immunology-II

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	Students will gain insights about following;
CO 1	Explain the Life Cycle of *Neurospora.* Elaborate on genetic recombination in fungi. How mapping is done by Tetrad analysis is evaluated.. Compare tetrad analysis in *Neurospora* and Yeast. Compare the role of two and three factor crosses in mapping the genome. Explain the role of coefficient of coincidence and interference in recombination.
CO 2	Justify the role of prokaryotic Transposable elements as natural biological mutagenic agents and explain their significance. How induced mutations are created using Site-Directed mutagenesis and use of Cassette mutagenicity in mutational analysis.
CO 3	Understand the Recombinant DNA technology by comparing the mode of action of different types of restriction enzymes and use of DNA joining enzyme.Explain the role of vectors, plasmid and phage in DNA technology. Explain principle, technique and applications of PCR. Evaluate the aim and applications of the Human Genome project
CO 4	To classify Hypersensitivity Reactions, explain them with examples, analyse these conditions, to compare types of immunodeficiency disorders, explain with examples, and suggest ways to alleviate them, to categorize types of vaccines, classify passive and active immunization.
CO 5	To explain generation of tolerance, different ways by which it is achieved, to relate lack of tolerance to autoimmunity, explain types of autoimmune conditions, to explain immunology in transplantation, classify types of grafts, analyze events of graft rejection, to compare methods of analysing histocompatibility.
CO 6	To evaluate the immune response to tumors, classify types of tumor antigens, to analyse the tumor evasion tactics and demonstrate the application of different therapies against tumors.

Course Code: RUSLSc 602

Course Title: Developmental Biology and Neurosciences- II

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	Students will gain insights about following;
CO 1	Molecular basis of Growth and differentiation, totipotency, pluripotency plant tissue culture and Animal Tissue Culture
CO 2	Sensory organs with their pathways for interpretation of the environmental stimuli and relating to memory, consciousness, perception. in a different states referred as Neural Disorders

Course Code: RUSLSc 603

Course Title: Biotechnology and Genetic Engineering- II

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	Students will gain insights about following;
CO 1	Design a complete protocol for production of enzymes, differentiate between types of enzyme immobilization techniques and their applications, Design a complete protocol for production of biopharmaceuticals, vaccines, monoclonal antibodies, antibiotics and vitamins.
CO 2	To explain plant tissue culture, its media and techniques used in commercial production of crops , used in secondary metabolite production, micropropagation. To explain Animal Tissue culture techniques, media, primary culture, secondary culture, maintenance of cell lines. To explain the applications as models for toxicity testing, drug development, genetic screening.
CO 3	Explain the use of prokaryotic, eukaryotic and viral vectors in molecular biology. Explain the molecular tools for studying genes and gene activity. Compare agarose gel electrophoresis and poly-acrylamide gel electrophoresis in separation of proteins. Design an experiment for separation of proteins by two different methods.
CO 4	Understand the different techniques of molecular biology and how its applications are important in agriculture, Medicines or pharmaceuticals.
CO 5	Explain applications of recombinant DNA technology in creating transgenic animals and transgenic plants.
CO 6	Explain the applications of bioinformatics.

Course Code: RUSLSc 604

Course Title: Ecology, Conservation Biology, Assessment and Management- II

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	Students will gain insights about following;
CO 1	Understand the Global carrying capacity , depleting the quality of water, air, land ,mineral use, salinisation of lands. citizens awareness of Laws , role of NGO towards impact on environment towards development processes.

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
		T.Y.BSc. LIFE SCIENCE (Theory)	
RUSLSc601		**Genetics and Immunology II**	**2.5 Credits Total 60 Lectures**
	I	**Recombination in Eukaryotes:** Genetic recombination in Fungi – Life Cycle; recombination in Neurospora and mapping by Tetrad analysis. Tetrad analysis in yeast. Genetic recombination in Drosophila – Life Cycle; Recombination – Mapping the genome by two and three factor crosses, coefficient of coincidence and interference. Genetic recombination in Humans – Somatic cell Genetics: Use of cell hybrids and hybridomas for gene mapping; **Mutational Variation:** Natural biological mutagenic agents – Prokaryotic Transposable elements and their significance Induced mutations - Site-Directed mutagenesis using Oligomers and 'Cassette mutagenicity'; Mutagenicity	**15 Lecture**

		testing – Ames test.	
	II	**Tools and Techniques in Molecular Biology** **Recombinant DNA technology:** - Restriction Enzymes – General nature of action Major categories based on type of cut, two typical examples each and recognition sites - Restriction mapping - DNA Joining enzymes (Ligases) - Vectors in genetic engineering – i) pBR322. ii) Phages (λ) - Transformant screening by gene inactivation method - Strategy for cloning Somatostatin in E. coli **Applied genetics:** i.) Polymerase Chain Reaction and its applications ii) The Human Genome Project and beyond: aims, major features and applications iii) Genetically modified organisms	**15 Lecture**
	III	**Hypersensitivity, Vaccines and Immunodeficiency** **Hypersensitivity:** **Gell and Coombs classification:** Type I: Ag-Ab reactions viz. RIST and RAST Type II: Agglutination to be included Type III: Immunoflourescence, ELISA Type IV: Tuberculin test **Vaccines:** Passive immunization i) Preformed antibodies and problems ii) Use of Chimera / humanized antibodies. Active immunization (Different methods used): i) Whole organisms (attenuated vs. inactivated ex. Polio) ii) Purified macromolecules (Polysaccharide, toxoid and recombinant antigen vaccines) iii) Peptide vaccines iv) DNA vaccines **Immunodeficiency** Use of nude mice, SCID mice in experiments	**15 Lecture**

		i) X-linked agammaglobulinemia ii) DiGeorge syndrome iii) Combined-SCID (Severe Combined Immunodeficiency) iv) Phagocytic- Chronic Granulomatous Disease **v)** AIDS (Acquired ImmunoDeficiency Syndrome)	
	IV	**Transplantation, Tumour Immunology, Tolerance and Autoimmunity** **Transplantation** i) Types of grafts ii) Tissue typing (serological and MLR) iii) Mechanisms of graft rejection iv) Graft vs. host disease w.r.t. bone marrow or cornea **Tumor Immunology:** Role of the immune system, Cell mediated and humoral responses, i) NK cells and macrophages, ii) Tumor specific antigens, iii) Immunological surveillance, iv) Immunological escape and potential for therapy.	**15 Lecture**
		Tolerance Mechanism of T cell and B cell tolerance Immunology of pregnancy Role of T regulatory cells **Autoimmunity** i) Mechanisms for induction (Aetiology) ii) Types of Autoimmune diseases-organ specific and systemic. Eg. Myasthenia gravis, Graves' disease, SLE and Multiple sclerosis	
RUSLSc602		**Title: Developmental Biology and Neuroscience II**	**2.5 Credits Total 60**

			lectures
	I	**Cellular aspects of development:** i) Totipotency e.g. Carrot phloem, animal cell nuclei, stem cells PGD ii) Pluripotency iii) Multipotency e.g. Neural crest cells or Hematopoietic cells iv)Determination e.g. *Drosophila* imaginal disc v) Transdetermination e.g. *Drosophila* imaginal disc **Differentiation. E.g. Neural crest cells or hematopoietic cells** a. Differentiation as a change in gene expression. (e.g. β globin gene expression) b. Induction – e.g. Formation of lens in the eye Molecular basis of growth and differentiation: Genes in early development (eg. *Drosophila*) Maternal genes, Segmentation genes, Homeotic– *Drosophila*. Cell cycle and its control. Apoptosis	**15 Lecture**
	II	**Applications of developmental biology** - Assisted Human Reproduction : Congenital abnormalities - Aging- Theories of Aging - Regeneration in animal world, Regeneration of Salamander limb (dedifferentiation), Wound healing VS Regeneration - Cancer- Types of Cancer, Causes of Cancer, Angiogenesis, Oncogenes, Tumor suppressor genes, Treatment strategies for Cancer - Fundamentals of Stem cell research. Examples: eye/ skin/ leukaemia research.	**15 Lecture**
	III	**Sensory and motor system** Pheripheral Nervous system - Human Sense organs: receptors, receptor mechanisms and pathways- Introduction - Visual system: Vision - structure of the eye, retina, photoreceptors (rods and cones), phototransduction,	

		binocular vision, visual pathway (flow chart only – LGN to visual cortex), 1.2d light & dark adaptation, colour vision - Auditory System: Structure of the ear, cochlea and organ of corti receptors. Mechanism of transduction, Auditory pathway: (MGN to audio cortex) Diagrammatic representation only. - Vestibular System: Structure of the vestibular labyrinth, maculae and cristae. Mechanism of transduction. - Chemosensory system: Olfactory and Gustatory receptors structure. - Skin as sense organ: somatic receptors - Types of mechano- receptors, pain reception & Pain management (example analgesic effect by prostaglandin inhibition - aspirin) - Structure of Muscle, Types of muscles, Molecular basis of Muscle contraction - Reflexes: Simple reflex arc, mono and poly-synaptic reflexes, stretch and knee-jerk reflex, Crossed – extensor reflex, Golgi-tendon reflex.	
	IV	**Neurobiological basis of behaviour and Diseases** **-** Short term memory and Long-Term Memory - Addiction and Reward pathway in Brain, Narcotic drugs - Abnormal Behaviour and the Brain, Mood disorders -Schizophrenia- Positive and negative symptom Duchene's muscular Dystrophy Alzheimer's disease Huntington's Disease	**15 Lecture**
RUSLSc603		**Biotechnology & Genetic Engineering II**	**2.5 Credits Total 60**

			Lectures
	I	**Fermentation technology – Enzyme and Pharmaceuticals Production** **Enzyme Technology** i) Enzyme production ex. Amylase (bacterial & fungal) ii) Immobilized Biocatalyst (method of immobilization, applications – biosensors) **Application of fermentation technology in medicine** i) Production of antibiotics (Penicillin) ii) Vitamins (Vit B12) iii) Vaccines (polio, HbsAg) iv) Monoclonal antibodies v) Biopharmaceuticals (Insulin / IFN-γ)	**15 Lecture**
	II	**Tissue Culture biotechnology** **Plant Cell Culture and Animal Cell Culture** i) Animal Cell Culture– Laboratory setup, Media, Basic techniques (Disaggregation of tissue and primary culture, maintenance of cell lines) ii) Plant Cell culture – Media, Basic techniques (callus and suspension culture, organogenesis, & somatic embryogenesis, Protoplast isolation and fusion) **Application of fermentation technology – Agriculture** i) Secondary metabolites from plant tissue culture. Eg: Artemisinin, Diosgenin. ii) Biopesticides – bacteria (*B. thuringiensis*), Virus iii) (Polyhedrosis virus) and fungal (*Trichoderma*)	**15 Lecture**
	III	**Genetic Engineering** **Manipulating DNA in Microbes, plants and Animals** i) Cloning vectors in Prokaryotes: BAC (Bacterial Artificial chromosome)	**15 Lecture**

		ii) Cloning vectors in Eukaryotes: a) Yeast - Natural yeast plasmids and Yeast artificial chromosome (YAC); b) Plants – Ti plasmid; c) Animals – SV40 and Baculovirus. iii) Viral vectors – Adenovirus and Lentivirus **Molecular tools for studying genes and gene activity** Molecular separation for genes and protein: Separation of DNA and proteins by Gel electrophoresis (Agarose gel electrophoresis, Poly-acrylamide gel electrophoresis, Two-Dimensional Gel Electrophoresis) Using Nucleic acid Hybridisation Analysis of specific nucleic acids in complex mixture (Southern blotting, Northern blotting,) i) Forensic uses of DNA finger printing and DNA Typing ii) DNA sequencing by Sanger's, Maxam and Gilbert's methods, concept of automated gene sequencing iii) DNA Markers: SNP (Single Nucleotide Polymorphism), VNTR (Variable number Tandem Repeats), RFLP (Restriction Fragment Length Polymorphism), AFLP (Amplified Fragment Length Polymorphism) **Microarray** **In Situ hybridization**	
	IV	**Applications of recombinant DNA technology and Bioinformatics** **Applications of recombinant DNA technology** i) Knock out transgenic animals – Use of Zinc finger and CRISPR-CAS9 ii) Knock in transgenic animals iii) Transgenic plants: Bt cotton and herbicide resistant gene iv) Xenopus oocyte as an expression system	**15 Lecture**

		v) Giant Mouse (MMT promoter=growth hormone fusion gene) vi) Drosophila (using p element mediated technique-enhancer trap) vii) Challenges in recombinant DNA technology: viii) Applications in industry – Medical/pharmaceutical, agricultural ix) Applications in basic research – Intellectual property rights and open source biotechnology x) Gene therapy and stem cell technology of neurological disorders. **Bioinformatics** i) Biological databases ii) Sequence annotation and comparison iii) Multiple sequence alignment iv)Phylogenetic trees.	
RUSLSc604		**ECOLOGY, CONSERVATION BIOLOGY, ASSESSMENT AND MANAGEMENT-II**	**2.5 Credits Total 60 lectures**
	I	**Environmental Degradation** **Urbanization in developing countries**. Urban crisis, suburban sprawl, land use planning, urban open spaces, Global warming, Morbidity caused by air pollution, diseases of the future (cancer & respiratory diseases). **Urban growth challenges:** Water and waste management, Water shortage, using less water, pricing of water. Impact of urban areas on the environment **Rural environment:** Availability of freshwater, current status of ground water resource. Wetlands and its significance ; Ramsar Sites Status of any two Indian Rivers , Eg.Ganga and	**15 Lecture**

		Godavari or any other. Terrestrial Biome of the World, Forest types , Flora & Fauna of India Soil types and Succession, Endangered, Rare Extinct species-RED data Book. **Management of Toxic waste ,solid waste and agricultural waste :** Economics of recycling of plastic / Hazardous waste. Management of domestic waste. Toxic Waste Trading: An environmentally destructive trade activity.	
	II	**Energy** - Energy from fossil fuel Eg. Coal , Natural gas , Policy involved in supply and demand. **Energy from Nuclear Power** - how it works , Advantage and disadvantages , policy involved. **Renewable Energy-** Solar Energy Eg. Solar Heating of water and space , solar production of electricity using Photovoltaic cells - Geothermal Energy - Hydropower Energy- Dams and Large Reservoirs , advantages and disadvantages. - Tidal Energy - Wind Energy - Biomass Energy - Biofuel for transportation. Policies Involved for Renewable Energy Concept of carbon Sequestration , Carbon credit, Carbon Footprints.	**15 Lecture**
	III	**Impact of Developmental Projects on Environment** **Environmental Impact Analysis of a Development Project:** Environmental Audit: protocols and data collection and analysis- Case studies development projects. . Methodology and approach for public participation in	**15 Lecture**

		Environmental & development decision making. Example:- Plachimada struggle, Narmada Bachao andolan, Chipko andolan, Aarey Metro car shade project. Regulatory requirements and advantages and disadvantages of Public participation Eg. Jaitapur Nuclear Power Project or Enron- Dabhol power project or any other.	
	IV	**Safety of Environment :** Environment, Nuclear proliferation and war: Eg. use of Agent orange in the Vietnam war. Environment Protection Agency- Environmental Impact Assessment International cooperation - Treaties, planning for future. Vision of the world 2040 Bhopal Gas Tragedy ; lessons after 26 years Perspectives and concerns of citizens. Industrial safety and health hazards: Identification of potential safety and health hazards in industrial and development projects, reduction strategies policies and legislation, international and national perspective, Safety Standards and management systems, ISO System 18000 to the latest.	**15 Lecture**
Course Code/ Unit	**Unit**	**Course / Unit Title**	**Credit/ Lectures**
		PRACTICALS	
RUSLScP601		**Genetics and Immunology II**	**Credits -1.5, Lectures-60**
		Genetics 1) Estimation of bacteriophage titre by plaque assay 2) Effect of UV light on microorganisms 3) Determination of percent viability of an E. coli culture after UV exposure- in the absence of light repair Isolation of antibiotic resistant /	

		auxotrophic mutants using Replica plate technique. **Immunology** 4) Ouchterlony test for Immunodiffusion (Qualitative) 5) Mancini test – Single Radial Immunodiffusion (Qualitative) 6) Agarose slide gel electrophoresis of Serum. **Demonstration experiments:** 7) Separation of Mononuclear cells using a gradient and the determination of viable count of the same. 8) SDS- PAGE for separation of IgG subfraction 9) Qualitative ELISA using albumin	
RUSLScP602		**Developmental Biology and Neuroscience II**	**Credits -1.5, Lectures-60**
		Plant Developmental Biology 1) Effect of temperature on cell viability in pollen 2) grains/yeast using Trypan blue/ acetocarmine. 3) Effect of boron / calcium on pollen tube germination in *Vinca rosea* or any other suitable sample. **Demonstration experiments:** 4) Plant Tissue Culture: Initiation of plant tissue culture from germinated chickpea/any other suitable source. **Animal Developmental Biology** 5) Live Cycles and Developmental stages of C.elegans / *Dictyostelium* / *Drosophila* / *Danio*. *6)* Imaginal discs of *Drosophila.* 7) Regeneration in earthworm / any other suitable system / hydra (using permanent slide / photographs) **Neurosciences** 8) Temporary mounts : 9) Cornea of prawn / Statocyst of prawn/ Columella of bird / Ventral Nerve cord of Earthworm 10) Making clay model of Invertebrate and Vertebrate CNS **Demonstration Experiments**	

		11) Stroop test. 12) Innate and Learned Behaviour in Animal 13) Knee-jerk reflex 14) Pupillary reflex. 15) Testing for locating the Blind Spot in the retina	
RUSLScP603		**Biotechnology & Genetic Engineering II**	**Credits:1.5, Lectures:60**
		1) Thin layer chromatography of lipids/plant alkaloids/any other suitable extract 2) Bioassay of antibiotic / plant extract for antibacterial activity. 3) Assay of fermentation product / Substrate – Estimation of: a) Alcohol/Acetic/lactic acid b) Sugar 4) Extraction of plasmid DNA & Agarose Gel 5) Electrophoresis of plasmid DNA/Restriction Digest. **Bioinformatics:** 6) Introduction to databases and: use of public domain 7) Open source database and programs for studying genomics of human / mouse, yeast/ plant/ microbes or any other relevant organism. 8) Manual annotation of DNA sequence: pUC series or any convenient cloning/expression vector followed by using programmed tool 9) Blast search of genome sequence, Sequence alignment Pairwise / multiple, construction of Cladogram / phylogram **Open-ended projects**: 1) Home-Wine production / Home-Vinegar production from any convenient source & assay for fermentation products a. Culturing & biomass estimation of mushroom/ Spirulina /chlorella by cell b. Count/dry weight and estimation of percentage total protein. 2) Fingerprinting technique using electrophoresis	

		of protein/DNA digest 3) SDS PAGE with suitable marker. 4) Genomic DNA extraction, purification and estimation by UV spectroscopy.	
RUSLScP604		**ECOLOGY, CONSERVATION BIOLOGY, ASSESSMENT AND MANAGEMENT-II**	**Credits:1.5, Lectures:60**
		1) Water analysis for physico-chemical characteristics : Electrical conductivity of water, N/P/K/Sulphates/ Na/ Ca. / Estimation of Co2+ and Ni2+ by colorimetry / spectrophotometry / Estimation of Heavy metal in various samples by titrimetry or spectrometry/ Potability of the given drinking water sample by MPN. (any three of the above) 2) Remote Sensing and Geographic Information system (GIS) : Principles and its application 3) Collection and Interpretation of weather data of Mumbai city (Satellite images and statistical analysis of weather data) 4) Biodiversity field visit to National park / Sanctuaries/ Mangrove sites / lake / wastewater treatment plants/ Agro tourism sites. **Environmental Project (Any one compulsory)** a. Environmental audit of an institution eg. Electricity and water audit and preparing a report. / b. Make an ecological evaluation of a local site and interpret its ecological health. c. Make a report / Making video film on a local well-defined environmental issue along with resolving the conflict – Photographic	

		documentation of a local environmental issue and record its progress for at least three months. d. Make a report and your evaluation on environmental issue/ e. Project on a role of a chosen organism in your immediate environment or its significance to the local biodiversity. f. Measurement of sounds by DB meter in silent, industrial, residential and commercial zones/ g. A Survey related to environmental issues amongst the citizens: Data to be collected and analysed statistically with suggestions for environmental management.	
		Project Submission and viva.	

References :-

RUSLSc601	
	Units I and II Genetics
1 2 3 4 5 6 7 8 9 10	-Principles of Genetics by Snustad and Simmons 4thedn. John Wiley and sons 2006. I Genetics; A Molecular approach by Peter Russel 2ndedn. Pearson 2006. I Genetics; AMendelian Approach by Peter Russel 2ndedn. Pearson 2006. Introduction to Genetic Analysis by Griffiths et al 8thednFreeman and co. 2005. Genes IX by Benjamin Lewin; Jones and Bartlett publishers, 2008. Principles of Gene Manipulation and Genomics by S. B. Primrose and R. M. Twyman 7thedn., Blackwell publication, Asian edn Oxford publishers 2007. Concepts of Genetics W. S. Klug and M. R. Cummings 7thedn. Pearson 2003. Concepts of Genetics W. S. Klug, M. R. Cummings, C. A. Spencer 8thedn. Pearson 2006. Human Molecular Genetics by Tom Strachan and Andrew Read, 3rdedn. Garland Science pub. 2004. Principles of Genetics by R. Tamarin 7thedn 2002
	Units III and IV Immunology
1 2 3 4 5 6 7	Immunology 5thedn. R.A.Goldsky, T. J. Kindt, B. A. Osborne, J. Kuby 2003. Immunology: The immune system in health and disease 6thedn. C. A. Janeway, P. Travers, M. Walport, M. Shlomchik Garland Science Pub. 2005. Cellular and Molecular Immunology, 2ndedn. A. K. Abbas, A. H. Litchman, 5thedn 2000. Basic Immunology: Functions and disorders of the immune system, 2ndedn. A. K. Abbas, A. H. Litchman, 2ndedn 2004. Roitt's Essential Immunology 11thedn. Blackwell publication 2006. Immunology 7th International edn. D. Mole, J. Bronstoff, D. Roth, I. Roitt, Mosbey Elsevier publication, 2006 An Introduction to Immunology C. V. Rao Narossa Publishers 2002..
RUSLSc602	
	Unit l and II Developmental Biology
	1. Instant Lecture Notes- Developmental Biology, R.M.Twyman, Viva Books Private Limited, New Delhi, Latest Edition (First Edition – 2001) 2. Developmental Biology, T.Subramaniam, Narosa publishing House, Mumbai, Latest Edition (First Edition-2002) 3. Principles of Development, L. Wolpert, R. Beddington, J. Brockes, T. Jesell and P. Lawrencel Oxford University Press.

4. Developmental Biology, W.A. Miller, Springer – Verlag.
5. Molecular Biology 3rd Ed., H.Lodish, D.Baltimore, A.Berk, S.L. Zipurski, P.Matsudaira and J. Darnell. Scientific American Book, W.H. Freeman, N.Y.
6. Molecular Biology of the Cell 3rd Edition. B. Alberts, D. Bray, J.Lewis, M. Raff, K. Roberts and J.D.Watson. Garland Publishing Inc., N T and London.
7. Plant Cell and Tissue Culture I. Vasil and T.A. Thorpe. Kluwer Academic Publishers.
8. Practical Zoology 2nd Edition. K.C. Ghone and B. Manna. New Central Book Agency Publishers.
9. Developmental Biology 4th edition. S.F. Gilbert. Sinauer Associates Inc. Publishers.
10. Pollen Analysis 2nd edition. P.D.Moore, J.A.Webb and M.E. Collinson Blackwell Scientific Publishers.
11. Pollen Biology – A laboratory manual (1992) K.R. Shivanna and N.S. Rangaswamy, Narosa Publishing, Calcutta.
12. Developmental Biology 2nd edition, L.W.Browder, Saunders College Publishing Co.
13. An Introduction to Embryology 5th Ed B. I. Ballinsky' Saunders, College Publishing Co.
14. Developmental Biology – Patterns, Problems and Principles. J. W. Saunders. J. R. MacMillan Publishing Co.,
15. An Introduction To the Embryology of Angiosperms. P. Maheshwari.
16. An Atlas Of Descriptive Embryology 2nd ed. W.W.Mathews. MacMillan Publishing Co.
17. Essential Developmental Biology – A Practical Approach Ed C.D. Stern and P.W.H. Holland. Oxford University Press.

Unit III and IV – Neurobiology

1. Neuroscience: Exploting the brain M.F.Baer, B.W.Connors&M.A.Paradiso, William & Wilkins, Baltimore, Latest Edition (First Edition1996)
2. Neurobiology 3rd edition G.M. Shepherd, Oxford University Press.
3. Principles Of Neural Science. E.R.Kandel, J.H.Schwartz and T.M. Jessel. Prentice Hall International.
4. Instant Notes – Neurosciences, A.Longstaff,
5. TextBook Of Medical Physiology A.C.Guyton and J.E.Hall
6. Elements Of Molecular Neurobiology C.U.M. Smith, J Wiley and Sons Publishers,

N.Y.

7. An Introduction to Molecular Neurobiology Z.W. Hall, Sinauer Associates Inc. Publishers.

8. Ion Channels – Molecules in Action D. J. Aidley and P.R. Stanfield. Cembridge University Press.

9. Comparative Neurobiology, J. P. Mill, Edward Arnold Publishers.

10. Physiology Of the Nervous Systems D Ottoson, McMillan Press

RUSLSc603

1. Principles of gene manipulation and Genomics by Primrose and Twyman, 7th edition, Blackwell publishing (2006)

2. Molecular Techniques in Biochemistry and Biotechnology by S Shrivastava (2010) Pub. New central book Agency (P) Ltd

3. Molecular Biology by Robert Weaver, second edition Pub McGraw Hill (2003)

4. Text book of cell and Molecular Biology by Ajoy Paul Pub Books and Allied (P) Ltd. Second edition (2009)

5. Cell and molecular biology by sp Vyas and Mehta (2011) CBS pub and Dist Pvt Ltd.

6. Industrial Microbiology. L.E.Casida (2003) New Age International (P) Ltd.

7. Industrial Microbiology. Prescott And Dunn's (2004) Chapman & Hall.

8. Industrial Microbiology. A H PATEL (2005) Macmillan India.

RUSLSc604

1. Misra and Pandey (2011), "Essential environmental studies ‘', Ane Books

2. Martens (1998),"Health and climate change ", Earth Scan

3. Saxena (1998), "Environmental Analysis of soil and air", Agrobotanica

4. Chakraborti (2005),"Energy efficient and environment friendly technologies for rural development " ,Allied Publishers

5. Dash M C (2004) "Ecology, chemistry and Management of environmental Pollution ",MacMillan India

6. Nayak ,Amar(2006) "Sustainable sewage water Management ",Mc Millan India

7. Dolder, Willi (2009), "Endangered animals, Parragon

8. Gupta P K (2000)," Methods in environmental Analysis ", Agrobio (India)

9. Fumento, Michael (2003),"Bioevolution : How biotechnology is changing our world" , California encounter Books

10. Kapur (2010) "Vulnerable India ", SAGE

11. Jacob, Miriam(2004) ," Silent Invaders" , Orient Longman

12. Mc Cafferty (1998) ,"Aquatic Entomology ", Jones and Barlett

13. Subramanyam (2006),"Ecology " , 2nd ed.Narosa

14. Dilip Kumar, Rajvaidya (2004)," Environmental Biotechnology ", APH

15. Sharma and Khan (2004)," Ozone Depletion and Environmental Impacts" ,

Pointer publishers

Modality of Assessment

Theory Examination Pattern: Paper I to IV.

C) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1.	Written Test	20
2.	Presentation on topic from syllabus / Quiz / Open book test	10
3.	Presentation on any journal article/ newsletter/ book review/ conference/ guest lecture	10
	TOTAL	**40**

D) External Examination- 60%- 60 Marks

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

Question	Options			Marks	Based on
Q1	Answer any 2 questions out of 3 questions on Unit 1 Each question of 7.5 marks	OR	Answer any 3 questions out of 4 questions on Unit 1 Each question of 5 marks	15	Unit I
Q2	Answer any 2 questions out of 3 questions on Unit 2 Each question of 7.5 marks	OR	Answer any 3 questions out of 4 questions on Unit 2 Each question of 5 marks	15	Unit II
Q3	Answer any 2 questions out of 3 questions on Unit 3 Each question of 7.5 marks	OR	Answer any 3 questions out of 4 questions on Unit 3 Each question of 5 marks	15	Unit III
Q4	Short notes on topics of all 3 units; Answer any 3 out of 5; Each of 5 marks	OR	Short notes on topics of all 3 units; Answer any 3 out of 5; Each of 5 marks	15	Unit I, II, III
			Total	**60**	

Practical Examination Pattern:

C) Internal Examination: 20 marks

Particulars	Marks
Journal	05
Experimental tasks	15
Total	**20**

D) External Examination: 30 Marks

Semester End Practical Examination:

Particulars	Paper
Main question to perform experimental task/Estimation/ Dissection/ Statistical analysis.	15
Identifications	10
Total	**30**

Overall Examination & Marks Distribution Pattern

Semester VI

Course	501			502			503			504			Grand Total
	Int	Ext	Total	Int	Ext	Total	Int	Ext	Total	Int	Ext	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	**400**
Practicals	20	30	50	20	30	50	20	30	50	20	30	50	**200**

****