Resolution Number: AC/II(21-22).2.RUS7

S. P. Mandali's

Ramnarain Ruia Autonomous College

(*Affiliated to Mumbai University*)

RUIA COLLEGE
Explore • Experience • Excel

Syllabus for

Program: Bachelor's Degree in Life Science

Program Code: RUSLSc

(Credit Based Semester and Grading System
for Academic year 2021–2022)

PROGRAM OUTCOMES

PO	PO Description **A student completing Bachelor's Degree in Life Science program will be able to:**
PO 1	Demonstrate an understanding of biological systems across microorganisms, plants and animals. To develop necessary laboratory skills and analytical methods.
PO 2	Employ critical thinking and scientific knowledge to design experiments, record observations, analyse data and interpret results.They can further build their career in research.
PO 3	Create an awareness of environmental issues, biological diversity, and how we can make a positive impact on it.
PO 4	Inculcate scientific temperament and generate problems solving approaches in students when they integrate themselves in the larger society.
PO 5	Develop necessary laboratory skills and analytical methods.

PROGRAM SPECIFIC OUTCOMES

PSO	Description **A student completing Bachelor's Degree in the subject of Life Science will be able to:**
PSO1	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.
PSO2	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
PSO3	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
PSO4	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

PSO5	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
PSO6	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.
PSO7	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
PSO8	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
PSO9	Individual and Team Work- to be able to work independently as well as lead a team and be a team player,
PSO10	Communication skills- to be able to communicate clearly through presentations as well as document, write effective reports or communicate and work in a team

PSO11	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 .
PSO12	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
FYBSc	**I**	RUSLSc101	Molecular and Cellular studies in Life Sciences I	**2**
FYBSc	**I**	RUSLSc102	Physiological systems, Genetics and Ecology I	**2**
FYBSc	**I**	RUSLScP101	Practicals in Molecular and Cellular studies in Life Sciences I	**1**
FYBSC	**I**	RUSLScP102	Practicals in Physiological systems, Genetics and Ecology I	**1**
FYBSc	**II**	RUSLSc201	Molecular and Cellular studies in Life Sciences II	**2**
FYBSc	**II**	RUSLSc202	Physiological systems, Genetics and Ecology II	**2**
FYBSc	**II**	RUSLScP201	Practicals in Molecular and Cellular studies in Life Sciences II	**1**
FYBSc	**II**	RUSLScP202	Practicals in Physiological systems, Genetics and Ecology II	**1**
SYBSc	**III**	RUSLSc301	Physiological Systems in Plants and Animals-I	**2**

SYBSc	**III**	RUSLSc302	Biochemical Approach to Life Processes in Plants and Animals-I	**2**
SYBSc	**III**	RUSLSc303	Evolutionary Biology, Biostatistics and Bioinformatics in Population Studies-I	**2**
SYBSc	**III**	RUSLScP301	Practicals in Physiological Systems in Plants and Animals-I	**1**
SYBSc	**III**	RUSLScP302	Practicals in Biochemical Approach to Life Processes in Plants and Animals- I	**1**
SYBSc	**III**	RUSLScP303	Practicals in Evolutionary Biology, Biostatistics and Bioinformatics in Population Studies- I	**1**
SYBSc	**IV**	RUSLSc401	Physiological Systems in Plants and Animals-II	**2**
SYBSc	**IV**	RUSLSc402	Biochemical Approach to Life Processes in Plants and Animals-II	**2**
SYBSc	**IV**	RUSLSc403	Evolutionary Biology, Biostatistics and Bioinformatics in Population Studies-II	**2**
SYBSc	**IV**	RUSLScP401	Practicals in Physiological Systems in Plants and Animals-II	**1**
SYBSc	**IV**	RUSLScP40	Practicals in Biochemical Approach to Life Processes in	**1**

		2	Plants and Animals- II	
SYBSc	**IV**	RUSLScP403	Practicals in Evolutionary Biology, Biostatistics and Bioinformatics in Population Studies- II	**1**
TYBSc	**V**	RUSLSc501	Genetics and Immunology-I	**2.5**
TYBSc	**V**	RUSLSc502	Developmental Biology and Neurosciences- I	**2.5**
TYBSc	**V**	RUSLSc503	Biotechnology and Genetic Engineering- I	**2.5**
TYBSc	**V**	RUSLSc504	Ecology, Conservation Biology, Assessment and Management- I	**2.5**
TYBSc	**V**	RUSLScP501	Practicals in Genetics and Immunology-I	**1.5**
TYBSc	**V**	RUSLScP502	Practicals in Developmental Biology and Neurosciences – I	**1.5**
TYBSc	**V**	RUSLScP503	Practicals in Biotechnology and Genetic Engineering – I	**1.5**
TYBSc	**V**	RUSLScP504	Practicals in Ecology, Conservation Biology, Assessment and Management – I	**1.5**
TYBSc	**VI**	RUSLSc60	Genetics and Immunology- II	**2.5**

		1		
TYBSc	**VI**	RUSLSc602	Developmental Biology and Neurosciences- II	**2.5**
TYBSc	**VI**	RUSLSc603	Biotechnology and Genetic Engineering- II	**2.5**
TYBSc	**VI**	RUSLSc604	Ecology, Conservation Biology, Assessment and Management- II	**2.5**
TYBSc	**VI**	RUSLScP601	Practicals in Genetics and Immunology – II	**1.5**
TYBSc	**VI**	RUSLScP602	Practicals in Developmental Biology and Neurosciences – II	**1.5**
TYBSc	**VI**	RUSLScP603	Practicals in Biotechnology and Genetic Engineering – II	**1.5**
TYBSc	**VI**	RUSLScP604	Practicals in Ecology, Conservation Biology, Assessment and Management – II	**1.5**

Course	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	Tests/ Practicals
RUSLSc 101	CO 1,2, 3,4, 5,								group presentation	Presentations			Assignments
RUSLSc 102			CO1, 2,3							Presentations			Assignments
RUSLSc 201	CO 1,2, 3				CO4				group presentation	Presentations			Assignments
RUSLSc 202					CO1, 4								
RUSLSc 301					CO1, 2,3,4					Presentations			
RUSLSc 302	CO 5,6				CO1, 2,3,4					Presentations		Self study	Assignments
RUSLSc 303													
RUSLSc 401			CO3, 4							Presentations		Self study	Assignments
RUSLSc 402	CO 1,2									Presentations		Self study	Assignments
RUSLSc 403						CO4, 5,6							Assignments
RUSLSc 501			CO3, 4,5,6							Presentations			Assignments
RUSLSc 502													
RUSLSc 503		CO1, 2							group presentation	Presentations			Assignments
RUSLSc 504									Case Study				
RUSLSc 601			CO4, 5,6							Presentations			Assignments
RUSLSc 602									Group				

									Discussion				
RUSLSc 603		**CO2**			**CO1**				**Group project**	**presentation**	**Project work**		**Practicals**
RUSLSc 604										**Case Study**	**Project Work**		

Course Code: RUSLSc101

Course Title: Molecular and Cellular studies in Life Sciences I

Academic year 2021-2022

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	Students will gain insights about following;
CO 1	To explain structures and functions of amino acids, proteins, nucleic acids, nucleus and nuclear membrane, giant chromosomes, lampbrush chromosomes, functions of cytoskeletal elements.
CO2	To describe plant cell wall, bacterial cell wall and fungal cell wall, eukaryotic and prokaryotic cells, different microbial media, microbial preservation techniques.
CO3	To classify amino acids, proteins in different ways
CO4	To differentiate between essential nonessential amino acids, complete, incomplete proteins, different forms of DNA, Distinguish between different phases in cell cycle and cell division.
CO5	To compare different cell wall types, compare different phases of microbial growth

Course Code: RUSLSc102

Course Title: Physiological systems, Genetics and Ecology I

Academic year 2021-2022

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	Students will gain insights about following;
CO 1	Students will learn comparative physiological systems from lower to higher phyla in animals and they will also study the parallel systems in plants eg. Respiration in animals and plants.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
		F.Y.B.Sc. LIFE SCIENCES (Theory)	**2 Credits/45 Lectures**
RUSLSc 101		**Molecular and Cellular studies in Life Sciences I**	
	I	**Biomolecules within living cells I** **Physiological Role of water:** Structure of water	**15 Lectures**

		molecule, ionic interactions, ionic product of water, concept of pH, buffers and its types, Henderson Hasselbalch equation, significance of water. **Amino acids:** Classification based on R groups, essential, semi essential and non essential amino acids. **Proteins:** Classification, Functions, Incomplete and complete proteins, Structural organization- Primary, Secondary, Tertiary,Quaternary levels. One example of each. **Nucleic acids:** Structure of nucleosides and nucleotides, structure of nucleic acids (A,B,Z forms); the structure of DNA lends itself to its function as hereditary molecule.	
	II	**Features of Eukaryotic and Prokaryotic cells** **Microscopy:** Prokaryotic cell structure. E.g. *E. coli.*Eukaryotic cell structure. E.g. Yeast (Unicellular) Evolutionary origin of organelles; the endosymbiont hypothesis –E.g., Chloroplast, Mitochondria. **Virus:** Virus structure, Life cycle of bacteriophage (Lytic and Lysogenic), Plant and Animal virus (One example: TMV and Adeno virus, Corona virus). **Microbial growth:** Influencing factors, culture media (enriched and minimal), isolation, preservation, life cycle and growth curve of *E.coli.* **Cell division:** Mitosis and Meiosis with phases in cell division with significance.	**15 Lectures**
	III	**Cytoskeletal elements and cell wall** **Nucleus:** Structure and Chromosome packaging,	**15 Lectures**

		lampbrush and polytene chromosome. **Cytoskeletal elements:** Microfilaments: Structure and function in striated muscle fibers. Role in cytoplasmic streaming in plants. Microtubules: Structure as in cilia or in flagella, mechanism in movement. Function in mitotic spindle. Intermediate filaments: Structure and function. **Structure of cell wall:** Bacterial cell wall: Gram positive and Gram negative. Fungal cell wall Plant cell wall: Primary and secondary	
RUSLSc102		**Physiological systems, Genetics and Ecology I**	**2 Credits/45 Lectures**
	I	**Types of Nutrition and Nutritional adaptations for different habitats** **Autotrophic nutrition** – Importance of photosynthesis in plants and in autotrophic prokaryotes . Macro and micro nutrients for plants. Insectivorous plants **Heterotrophic nutrition** – ex. holozoic, saprophytic (fungi) and parasitic (Cuscuta, Tapeworm) i) fluid feeders (ex. Mosquito or Housefly) ii) microphagous (ex. Amoeba or Paramecium) iii) macrophagous (mammals) **Digestive systems of mammals** Human and Ruminant Digestion Evolutionary adaptation associated with diet eg. dental, stomach and intestine.	**15 Lectures**
	II	**Mendelian Inheritance:** Concept of homozygous, heterozygous, phenotype, genotype, alleles; Mendel's Laws and Mono & Dihybrid ratios with problems, chi square –for 3:1 and 1:1 ratios. Use sickle cell anemia as an example to explain the concept of	**15 Lectures**

		genes. **Chromosomal inheritance:** Sutton's hypothesis, sex-linked inheritance, study of human pedigrees (e.g. Sex linked dominant and recessive; autosomal dominant & recessive)	
	III	**Transport, Translocation in plants and Circulation in animals** **Translocation in plants:** Transport of water and inorganic solutes – transpiration, stomatal function and regulation, role of proton pumps and factors affecting ascent of xylem sap. Transport of organic solutes – mechanism and its regulation. **Circulation in animals:** Animals without a circulatory system eg. Hydra and jellyfish Open and closed circulatory system eg. insects vs worms. **Vertebrate circulatory system:** Heart; single and double circulation. Specific adaptations – mammals at high altitudes and diving mammals. Cardiovascular system in health and disease – hypertension and atherosclerosis and the role of exercise. **Respiration and Gaseous Exchange:** Gaseous exchange in small animals (across surface) and cutaneous respiration in frogs. Gaseous exchange in plants – Stomata and Pneumatophores. Gaseous exchange in invertebrates – trachea in insects, book lungs in scorpion Gaseous exchange in vertebrates – gills and lungs	**15 Lectures**
		PRACTICALS	**2 Credits Total 45 lectures**
RUSLScP		**Practicals in Molecular and Cellular studies in**	

101		Life Sciences - I (PRACTICAL – I)	
		1.Good Laboratory practices: An introduction to Laboratory discipline and GLP, SOP (in detail) and Instrument safety GLP Handling Biological/ Blood and hazardous chemicals. Documentation and validation, Industry purpose. Survey of the organization of laboratory instruments, chemicals and glassware. Lab safety (instruments and chemicals) **[incorporated into every practical].** **2.Introduction to Elementary microbial techniques :** Sterilization & Disinfection Air microflora Microbial Staining technique and Microscopy Comparative study of samples from 5 different sources to check gram positive and gram negative bacteria - Buttermilk, tap water, sewage water, food Item, soil, rotten – effect of heat using Monochrome Staining Gram Staining. Cell wall staining **3.Micrometry Eukaryotic cells and Microscopic measurements:** Staining of onion peel / plant cells to reveal structure and organization of cells Micrometry - Using the microscope to measure size of cells / nucleus/ different pollen grains . **4.Effect of temp on movements in plants and animals using any system:** Cytoplasmic streaming in Vallisneria and Hydrilla Culturing and observation of feeding in Paramoecium from Hay infusion **5.Preparation of solutions** of a given chemical compound Molar and percentage solutions – Concept and calculations only. **6.Molecular biology and Biochemistry:**	

		Isolation and Detection of DNA (by observing spools) from Onion or any other DPA detection optional / demonstration. **7.Histochemistry:** Localization of Proteins and Nucleic acids from the suitable system Proteins of peas / cockroach muscles DNA and RNA from onion peel using methyl green pyronin staining. **8.Instrumentation and techniques:** Calibration of the pH Meter with standard buffer pH4 and pH9.2 as per GLP Checking of pH for common foodstuff e.g. Milk/cola drink/Lime juice or any other relevant sample. **9.Microscopy**: Principles of light and Fluorescent Microscopy, Electron Microscopy-Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM). **Study of Electron Micrographs as listed below:** Mitochondria Lysosomes:Basement membrane/ junctions Cilia: Both normal and pathological **10.Cell division**: Determining effect of colchicine / mitotic inhibitor /environmental pollutant / mitotic activator on mitosis in onion root tip by calculating mitotic index **11.Meiosis from *Tradescantia*** (demonstration/ Photograph)	
RUSLScP 102		**Practicals in Physiological systems, Genetics and Ecology - I ((Practical -II)**	**2 Credits Total 45 lectures**
		1.**Study of Plant Tissues :** Temporary mounting/ observation of permanent slides of Mounting of Dicot /Monocot Stem,Root.	

		2.Hematology: Differential count of WBCs using Giemsa/ Lieishman stain. **3. Study of Mouth parts in insect and Comparative assessment of mouth parts:** Preparation of fresh mount of; Piercing and sucking type- eg Mosquito Sponging type- eg Housefly Biting and Chewing type- eg Cockroach (if available **4. Collection of blood group information from family and construction of pedigree charts.** **5. Diversity of Life:** Five Kingdom Classification (Outline) **6. Soil analysis:** Edaphic factors Texture, water content, soil organisms **7. Water Quality -** Effect of temperature, light, pH **8. Field study to at least one site:** To understand flora and fauna, visit a national park a century or pond or lake or marine ecosystem. To prepare a field report to be duly certified Any Industrial Visit or Invited Guest lecture with reference to FYBSc Life-Science Syllabus	

References:

	REFERENCES:
	RUSLSc 101
1.	Cell Biology, Genetics, Molecular biology, Evolution and Ecology P.S. Verma and V.K. Agarwal Publishers : S. Chand and Co.Ltd., (2009)
2.	Becker's World of the Cell: International Edition – 8th Edition Jeff Hardin Gregory Paul Bertoni, Lewis J. Kleinsmith Publishers: Pearson Dorling Kinderflay India / Pearson India (2011)

3.	Life: The Science of Biology, William K Purves, D. Sadava, G. H. Orians and H.C. Heller 7th Edn. (2003) Sinauer Associates
4.	Molecular Cell Biology – 7th Edition Ed: Harvey Lodish, Arnold Berk, Chris A. Kaiser and 5 more (2012) Pub: Macmillan
5.	Molecular Biology of the Cell Ed: Bruce Alberts, Alexander Johnson, Julian Lewis , David Morgan , Martin Raff, Keith Roberts, Peter Walter 5th Edition (2007) or 6th Edition (2014) Pub: Garland Science
6.	Essential Cell Biology Ed: Bruce Alberts, Dennis Bray, Karen Hopkin and Alexander Johnson (2009) 3rd Edition Pub: Garland Science.
7.	Fundamentals of Biochemistry Ed: Voet. and Voet 4th edition, (2010) Pub: John Wiley and Sons
8.	Lehninger Principles of Biochemistry Ed: D.L. Nelson, 5th edition, (2008) Pub: CBS Publishers and Distributors.
9.	Principles of Biochemistry Ed: Zubay G.L, Parson W.W. and Vance D.E. 1st edition (1995) Pub: W. C. Brown.

	RUSLSc 102
1.	Biological Science, Taylor, Green and Stout., 3rd edn. Ed. R. Soper .(2005) Cambridge Univ. press.

2.	An Introduction to Genetic Analysis Ed: Griffiths A.J. et al (2000,) Pub: W. H. Freeman(London) Seventh Edition
3.	Comparative Animal Physiology, Philip C.Withers,(1992), Saunders College Publishing House.
4.	Biology A Modern Introduction, B.S.Beckett (1994), GCSE Edn. Oxford Univ. Press.
5.	Essentials of Human Genetics, S.M.Bhatnagar, M.L.Kothari & L.A.Mehta, (1994), Orient Longman's Publication.
6.	Cell Biology, Genetics, Molecular biology, Evolution and Ecology – P.S. Verma and V.K. Agarwal (2009) Publishers : S. Chand and Co.Ltd.,
7.	Biological Science : - Scott Freeman (2004), Pub: Benjamin Cummings Publishing Company.
8.	Principles of Anatomy and physiology 10th edition (2003) Gerad J.Tortora and Sandra R.Grabowski John Wiley &Sons. Inc.

Modality of Assessment

Theory Examination Pattern:

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: (Deviation from the usual modality)

Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.

Semester End Theory Examination:

Duration - These examinations shall be of **02 hrs** duration.

Theory question paper pattern:

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	OR	Answer any 3	15	Unit II

	questions out of 3 questions on Unit 2 Each question of 7.5 marks		questions out of 4 questions on Unit 2 Each question of 5 marks		
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: - 20 Marks

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

B) 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 I

Course	101			102			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practicals	20	30	50	20	30	50	100

Course Code: RUSLSc201

Course Title: Molecular and Cellular studies in Life Sciences II

Academic year 2021-2022

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION

	Students will gain insights about following;
CO 1	To explain structure and functions of carbohydrates and lipids, classify lipids and carbohydrates, to illustrate stereochemistry and chemical reactions of monosaccharides.
CO 2	To classify and differentiate between different types of transport systems across cell membranes, plant and animal cell junctions.
CO 3	To explain structure and functions of cell organelles like ER, Golgi apparatus, Lysosomes, Peroxisomes, Glyoxysomes, Chloroplasts and Mitochondria.
CO 4	To differentiate between different separation techniques,like chromatography- paper and thin layer, to explain electrophoresis, differential centrifugation, salting in and out, their advantages, disadvantages and applications of all these techniques.

Course Code: RUSLSc202

Course Title: Physiological systems, Genetics and Ecology II

Academic year 2021-2022

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	Students will gain insights about following;

CO 1	Explain the concept of homozygous,heterozygous,phenotype, genotype and alleles.
CO 2	Explain the Mendelian laws, monohybrid and dihybrid ratios with problems and chromosomal inheritance.
CO 3	Interspecific interactions at ecological level and distribution of the population can be related to biodiversity visits.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
		F.Y.BSc. LIFE SCIENCES (Theory)	**Credits/45 Lectures**
RULSc 201		**Molecular and Cellular studies in Life Sciences II**	
	I	**Biomolecules within living cells II** **Lipids:** Classification, structures function and properties of lipids (simple, derived and complex with one example each) **Carbohydrates:** Structure of Monosaccharides, Disaccharides, Oligosaccharide, polysaccharides Animal and plant source starch, glycogen, cellulose and chitin. **Separation techniques:** Paper and thin layer chromatography, principle of electrophoresis, differential centrifugation, Salting in and salting out (Ammonium sulphate fractionation).	**15 Lectures**
	II	**Cell Organelles 1** **Cell membrane:** Membrane models: Unit membrane and Fluid Mosaic Model of Singer and Nicholson. Membrane junctions: Tight, gap, desmosomes, septate. Membrane Transport: Diffusion, osmosis, passive	**15 Lectures**

		and active transport, endocytosis and Exocytosis. **Endoplasmic Reticulum:** Structure (including sarcoplasmic reticulum) Role in protein synthesis (ER- Ribosome complex) and transport (Signal Hypothesis). **Ribosomes:** Subunits in prokaryotes and eukaryotes (including those within chloroplast and mitochondria); ER-Ribosome complex. **Lysosomes:** Types of lysosomes Primary and Secondary lysosomes and their functions Lysosome associated diseases - Tay Sachs , Silicosis.	
	III	**Cell Organelles 2 and cell division** **Mitochondria:** Structure of inner, outer membranes & the matrix with a brief mention of oxidative phosphorylation Mitochondria associated diseases (any one example). **Plastids:** Types and functions: (Leucoplast, chromoplast, Elaioplast), chloroplast morphology, structure of thylakoid membrane, photosynthetic pigments & a brief mention of photo-phosphorylation; chloroplast DNA. **Peroxisomes and Glyoxisomes:** Structure and functions	**15 Lectures**

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
		F.Y.BSc. LIFE SCIENCES (Theory)	
RULSc 202		**Physiological systems, Genetics and Ecology - II**	**Credits/45 Lectures**

	I	**Plant and Animal Physiology** **Excretion and Osmoregulation:** In plants – water and salt regulation under normal and stressed conditions In animals – Phylogenetic review of organs and processes - contractile vacuole, flame cells, nephridium, malpighian tubules, kidney and skin in man Concept of osmoregulation and processes associated with osmoregulation (ultrafiltration, selective reabsorption, secretion, acid-base regulation) Nitrogenous excretory products (ammonotelism, ureotelism and uricotelism) **Support and Locomotion:** Support in plants – herbaceous and woody plants Types of skeletons – hydrostatic (nematodes), exoskeleton (arthropods/molluscs) and endoskeletons (vertebrates-axial and appendicular skeleton and joints E.g., Human)	**15 Lectures**
	II	**Modifications of Mendel's laws and Mutations** **Modification of Mendel's laws:** Gene interactions: incomplete dominance, co-dominance Multiple genes; Multiple alleles: Blood group; Epistasis; Linkage: Sex limited; sex influenced. **Mutations:** Point Mutations Chromosomal aberrations: Structural: deletion, duplication, inversion, translocation. Numerical: euploidy & aneuploidy (e.g. Downs, Turners. Klienfelter's, Cri- du-chat)	**15 Lectures**
	III	**Community Ecology and Animal Behaviour** **Principles of Ecology:** Food chains, flow of energy, food webs, trophic levels, ecological pyramids & their efficiencies. **Ecosystem Types** – Terrestrial, Aquatic, Hydrothermal vents. **Ecological succession:** Lithosere and Hydrosere **Behavioural Ecology:**	**15 Lectures**

		Basic behavioural patterns – taxis, tropism, reflex, instinct & conditioned behaviour **Ecological Adaptations:** plants (any two) and animals (any two) Biological clocks and rhythms Indian Biodiversity – current status	

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
		PRACTICALS	**2 Credits Total 45 lectures**
RUSLScP 201		**Practicals in Molecular and Cellular studies in Life Sciences - II (Practical-I)**	
		1.Colorimetry: Preparation of dilutions of required concentration from a stock solution of a coloured compound Estimation of Lambda max of a coloured solution. Verification of Beer Lambert's law for a coloured solution Absorption Spectra-Colour solution, plant pigment. Lambda max **2.Localization of Carbohydrates and Lipids;** Starch grains of Potato / of seeds and other tubers Fat bodies of Cockroach/Drosophila/lipids of groundnut. **3.Enzymology :** Detection of Dehydrogenase enzyme activity using sprouting grams / beans or muscle (as a study of mitochondrial function) Estimation of Catalase enzyme activity using paper disc rising-time technique (Blood/Plant source). **4.Effect of ageing on plant leaf pigments / separation of amino acids** – using Paper Chromatography. **5.Effect of antitranspirants on stomatal movements**. (1 monocot and 1 dicot). **6.Study of Electron Micrographs as listed below:** Mitochondria / Chloroplast	

		Lysosomes Basement membrane/ junctions Cilia or Flagella	
RUSLScP 202		**Practicals in Physiological systems, Genetics and Ecology - II**	**2 Credits Total 45 lectures**
		1. Study of Barr Body **2. Animal Biodiversity:** Part II : Classification of Animals – Invertebrates Part III : Classification of Animals – Vertebrates **3. Biostatistics:** Purpose of Biostatistics: Data collection, Discrete and continuous variables, qualitative and quantitative Study of Class Intervals and calculation of frequency Representation – tabular and graphical – line graph, frequency curve, Ogive curve, histogram and pie diagram. Measures of central tendency – Mean, Median, Mode and Standard Deviation (data from experiments done in class or Field study data can be used for biostatistics). **4.Gaseous exchange & Excretion in plants** – Stomata in dicot monocot and Pneumatophores . **5. Excretion in plant**: salt glands in mangrove plant **6. Temporary mount Nephridia in earthworm** **7. Assignment:** Perform a search on any one topic using pubmed, download about ten abstracts and prepare a summary of the literature. **6. Field work and report writing**	

	REFERENCES:
	RUSLSc 101 and 201
1	Cell Biology, Genetics, Molecular biology, Evolution and

	Ecology P.S. Verma and V.K. Agarwal Publishers : S. Chand and Co.Ltd., (2009)
2.	Becker's World of the Cell: International Edition – 8th Edition Jeff Hardin Gregory Paul Bertoni, Lewis J. Kleinsmith Publishers: Pearson Dorling Kinderflay India / Pearson India (2011)
3.	Life: The Science of Biology, William K Purves, D. Sadava, G. H. Orians and H.C. Heller 7th Edn. (2003) Sinauer Associates
4.	Molecular Cell Biology – 7th Edition Ed: Harvey Lodish, Arnold Berk, Chris A. Kaiser and 5 more (2012) Pub: Macmillan
5.	Molecular Biology of the Cell Ed: Bruce Alberts, Alexander Johnson, Julian Lewis , David Morgan , Martin Raff, Keith Roberts, Peter Walter 5th Edition (2007) or 6th Edition (2014) Pub: Garland Science
6.	Essential Cell Biology Ed: Bruce Alberts, Dennis Bray, Karen Hopkin and Alexander Johnson (2009) 3rd Edition Pub: Garland Science
7.	Fundamentals of Biochemistry Ed: Voet. and Voet 4th edition, (2010) Pub: John Wiley and Sons
8 .	Lehninger Principles of Biochemistry Ed: D.L. Nelson, 5th edition, (2008) Pub: CBS Publishers and Distributors
9.	Principles of Biochemistry Ed: Zubay G.L, Parson W.W. and Vance D.E. 1st edition (1995) Pub: W. C. Brown
`	**RUSLSc 102 and 202**
1.	Biological Science, Taylor, Green and Stout., 3rd edn. Ed. R. Soper . (2005) Cambridge Univ. press
2.	An Introduction to Genetic Analysis Ed: Griffiths A.J. et al (2000)

	Pub: W. H. Freeman(London) Seventh Edition
3	Comparative Animal Physiology, Philip C.Withers, (1992), Saunders College Publishing House.
4	Biology A Modern Introduction, B.S.Beckett (1994), GCSE Edn. Oxford Univ. Press.
5	Essentials of Human Genetics, S.M.Bhatnagar, M.L.Kothari & L.A.Mehta, (1994), Orient Longman's Publication.
6	Cell Biology, Genetics, Molecular biology, Evolution and Ecology – P.S. Verma and V.K. Agarwal (2009) Publishers : S. Chand and Co.Ltd.,
7	Biological Science : - Scott Freeman (2004) Pub: Benjamin Cummings Publishing Company
8	Principles of Anatomy and Physiology 10th edition (2003) Gerard J. Tortora and Sandra R. Grabowski John Wiley & Sons, Inc.

Modality of Assessment

Theory Examination Pattern:

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: (Deviation from the usual modality)

Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.

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

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;	OR	Short notes on topics of all 3 units; Answer any 3 out of 5;	15	Unit I, II, III

	Each of 5 marks		Each of 5 marks		
			Total	**60**	

Practical Examination Pattern:

C) Internal Examination: 40%- 40 Marks

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

D) External Examination: 60%- 60 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 II

Course	**201**			**202**			**Grand Total**
	Internal	**External**	**Total**	**Internal**	**External**	**Total**	

Theory	**40**	**60**	**100**	**40**	**60**	**100**	**200**
Practicals	**20**	**30**	**50**	**20**	**30**	**50**	**100**

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Course Code: RUSLSc301

Course Title: Physiological Systems in Plants and Animals-I

Academic year 2021-2022

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	Students will gain insights about following;
CO 1	Students will understand as to how the physiological systems in the human body attain homeostasis.
CO 2	Explain the Central nervous system(CNS) and peripheral nervous system (PNS). Understand concept of action potential and resting membrane potential in Nerve Impulse. Explain the role of synapse in nerve impulse.
CO 3	Understand and compare different plant movements. To find its role in plant growth by designing an experiment to observe

	different plant movements
CO 4	Explain the Behaviour studies in animals with suitable examples. Compare between innate and learned behaviour. Elaborate on physiological aspects such as fat accumulation and thermoregulation during migration in animals
CO 5	Explain alternation of generation in plants. Elaborate on the role of environmental factor in sex determination in animals. Discuss the importance of plant and animal interaction sex determination. Basis of sex determination in plants and animals.
CO 6	Discuss physiology and explain the importance of hormones in menstrual cycle , pregnancy, parturition and menopause.
CO 7	Explain the importance of different types of ovules in plants. Compare microsporogenesis and megasporogenesis.

Course Code: RUSLSc302

Course Title: Biochemical Approach to Life Processes in Plants and Animals-I

Academic year 2021-2022

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	Students will gain insights about following;
CO1	To classify enzymes, specificity reactions of enzymes,
CO2	To explain models of enzyme action, enzyme kinetics and inhibition reactions, allostery, isoenzymes.
CO3	To propose a strategy to isolate and purify enzymes, compare

	different techniques of purification.
CO4	To explain the applications of enzymes in industry and medicine.
CO5	To describe the pathways of catabolism of carbohydrates, proteins and lipids and to evaluate bioenergetics in catabolism of carbohydrates and lipids.
CO6	To correlate and integrate metabolism of all biomolecules into the TCA cycle, and then the electron transport chain and thus summarize the sequences involved in cellular respiration and energy generation.

Course Code: RUSLSc303

Course Title: Evolutionary Biology, Biostatistics and Bioinformatics in Population Studies-I

Academic year 2021-2022

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	Students will gain insights about following;
CO 1	Evolutionary biology and genetics reveal the diversity of phyla in different geographic locations; the allelic frequencies that probably operate , correlations and other statistical applications will reveal the changes in population studies.
CO 2	To know about virtual libraries and databases

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
		S.Y.BSc. LIFE SCIENCE (Theory)	
RUSLSc 301		**Physiological Systems in Plants and Animals-I**	**2 Credits Total 45 lectures**
	I	**Role of Hormone and Homeostatic Mechanisms in Animals and Plants** Control systems in homeostasis and components of homeostatic control. Cell signalling in the nervous system and endocrine system [eg. Amines (catecholamine or thyroid hormones)] – a) Regulation of receptors (up and down regulation). b) Regulation of cell signalling: 1st, 2nd and 3rd order feedback mechanisms. Hormones of Pineal, Hypothalamus, Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal gland, Testis and Ovary. Plant Hormone- Auxins, Giberellic acid, Cytokinin, Abscisic acid, Ethylene.	**15 Lectures**
	II	**Introduction to Nervous System, Animal And Plant Movements and Behaviour** Human Nervous System – CNS and PNS overview. Types of cells: Neuronal, Glial cells Role of meninges and CSF Nature of the Nerve Impulse – Resting potential and Action Potential. Introduction to types of Synapses and Nerve impulses. a) Behaviour in animal-Innate and learned with suitable examples. b) Migration in animals.: Physiological aspect (Fat accumulation and thermoregulation). Plant movements – Tropisms, Nasties – overview and its molecular aspects with suitable examples	**15 Lectures**
	III	**Developmental Biology in Plants and Animals** 1. Basis of Sex Determination. (a) Plants: Maize	**15 Lectures**

		(b) Animals: Role of SRY gene and Aromatase (c) Role of environmental factors – Temperature and Parthenogenesis in insects Eg. Wasp/Honey bee/Ants (d) Plant-animal interaction for reproduction Fig wasp / Gall wasp (e) Sex reversal Alternation of generations in plants Eg. *Adiantum.* Ovarian and testicular functions, puberty and regulation of uterine changes in menstrual cycle, menopause, pregnancy, parturition, lactation. Artificial regulation of reproduction: Use of contraceptive methods. 1. Development of embryos in monocot and dicot plants.	
RUSLSc 302		**Biochemical Approach to Life Processes in Plants and Animals-I**	**2 Credits Total 45 lectures**
	I	**Enzymology** Strategies for Isolation and purification of enzymes, measurement of specific activity and purification fold. Classification of enzymes (With an example of each). Effect of pH and Temperature. Co-enzymes and co-factors : NAD, FAD, Mn, Mg, Zn and Cu (one example each). Kinetics (Michealis Menten, Lineweaver Burk plots). Enzyme Inhibitors, Activators and feed-back inhibition. Allosteric enzymes (Kinases in Glycolysis) and their significance in metabolic regulation. Concept of Isoenzymes: LDH.	**15 Lectures**
	II	**Carbohydrate Metabolism and Bioenergetics.** Carbohydrate Metabolism: a) Glycolysis – Process and metabolic regulation b) Pentose Phosphate Pathway c) Citric Acid Cycle: Process and regulation, Importance as a central amphibolic pathway.	**15 Lectures**

		Electron Transport System: Localisation and Sequence of electron transporters. Oxidative Phosphorylation: Mitchell's Chemiosmotic Hypothesis, ATP synthesis, Control of respiration, uncoupling and metabolic poisons.	
	III	**Lipids and Proteins Metabolism.** Lipids - Catabolism : Lipolysis, Role of Carnitine in mitochondrial permeability, Beta– Oxidation of fatty acids and integration into Kreb's cycle, Ketone bodies and their significance. Amino Acids – Catabolism: Protein Degradation liberating amino-acids', Deamination, Transamination & ammonia disposal by Urea cycle, Decarboxylation & integration into Kreb's cycle.	**15 Lectures**
RUSLSc 303		**Evolutionary Biology, Biostatistics and Bioinformatics in population studies-I.**	**2 Credits Total 45 lectures**
	I	**Evolution and Population Genetics** Darwinism: Conceptual arguments for evolution by Natural Selection given by Charles Darwin and Alfred Wallace. Evidence for evolution: Comparative anatomy and embryology, Fossil records and living fossils, Artificial selection. Study of Evolution in context of human genetic diseases. (BRCA1 / Huntington's/ Thalassemia). Populations and allelic frequencies, Hardy Weinberg Equilibrium, change in gene frequenciesdue to selection, mutation, migration and genetic drift (Founder's effect). Origin of variability, polymorphism, kinds of selection – directional, stabilizing and disruptive, selectionist vs neutralist.	**15 Lectures**
	II	**Biostatistics**	**15**

		Probability definition, Laws of Probability. Binomial Distribution-Introduction. Poisson Distribution-Introduction. Normal Distribution-Introduction. Bivariate Data, Scatter Diagram and its uses, Karl Pearson's Correlation Coefficient, Spearman's Rank Correlation Coefficient. Regression equations and their uses.	**Lectures**
	III	**Bioinformatics** Introduction to bioinformatics: Concept of information network: internet, IP address, TCP/IP, FTP, HTTP, HTML and URLs, XML, URI, E-mail, Cloud Platforms. Virtual libraries - The European Molecular Biology Network (EMBnet), The National Center for Biotechnological Information (NCBI), EMBL, UniProt, SWISS- prot, Pub Med and its applications. Introduction to general Databases a) Structured b) Semi-structured c) Unstructured d) Basic SQL (Query). Types of Databases: (a) Genome Project (b) Protein Database (PDB/ExPaSy) (c) Species Database (Yeast and Arabidopsis) (d)Structured Database	**15 Lectures**
		PRACTICALS	**3 CreditsTotal 45 lectures**
RUSLScP 301	**I**	**Practicals in Physiological Systems in Plants and Animals-I** 1.Good Laboratory Practices. 2.Demonstration of reproductive system and location of endocrine glands in Albino Mouse Male and Female (Virtual Lab). 3.Microtome and preparation of Endocrine gland slides from above dissected specimen or any suitable plant specimen.	

		4.Study of Histological features of Endocrine glands. 5.A complete study of Frog Embryology (Egg to Tadpole to Adult). 6.Study of Floral parts from the given flower accessory to essential whorls hibiscus ,vinca, canna, monocot. 7.Study of pollen germination Using *Vinca* flower (*in vitro*). 8.a) Study of pollen germination in *Vinca* (*in Vivo*) b) Tracing the path of the pollen tube along the stylar canal using Aniline blue stain. 9.Detection of activity of plant hormones (Dose dependent response). 10.Observation and Study of locally collected Leaf Gall and any other one plant disease.	
RUSLScP 302	**II**	**Practicals in Biochemical Approach to Life Processes in Plants and Animals- I** 1.A. Instrumentation / Technique - pH metry - Colorimetry - Titration. B- Process / Concept and immediate Relevance. - Extraction, Purification - Analysis / Estimation - GLP(Good Laboratory practices) incorporated into every practical Acid, bases and buffers. 2. pH meter - a) Principle & instrumentation and b) Determination of pH (titration of Acids/Bases/Buffers/ 'chameleon balls'). *(in FY the students were introduced to the concept of pH measurement of familiar liquids- here tech & details are given- practically understanding buffering using Glycine / titration curve).* c) Phosphate buffer preparation using Henderson Hasselbalch equation d) Glycine titration 3.Protein precipitation by pH manipulation	

		(Casein from Milk/ Curds) *(From previous experiments and pH manipulation, proteins can be precipitated).* 4.Study of Enzyme activity and Kinetics: Determination of K_M of an enzyme. Urease (from Jack beans) /Lipase/Protease/ (from seeds/ detergents) / amylase source *(Enzyme activity can be detected and estimated - using colorimetry).* 5.Histochemical localization of Enzymes (Acid Phosphatase) *(Enzyme activity can be localized).* 6.Estimation / Quantitation : Colorimetric Protein Estimation by Biuret Method. (Enzyme extract / Casein from previous expts) *(Proteins, such as the isolate from experiment 2 can be estimated by colour reaction).* 7.Colorimetric Cholesterol Estimation / total Lipid Estimation from egg. *(Lipid metabolism is an important component of our systems, content can be estimated by colour reaction).* 8.Titrimetric estimation of Ascorbic acid (Vit C). *(Estimation of biological materials by non-colorimetric method)*	
RUSLScP 303	**III**	**Evolutionary Biology, Biostatistics and Bioinformatics in Population Studies-I** **Biostatistics (using biological data)** 1.Probability testing 2.Normal Distribution and Normal curve 3.Correlation 4.Regression Analysis . (MS Excel Optional) **Bioinformatics**: 1.Use of various Cloud platforms – Google, Onedrive. 2.Use of various Internet Protocols – HTTPS, FTP, SMTP. 3.Demonstrate working on databases – a) Structured b) Semi-structured c) Unstructured. 4.Identify sequence and database entry of a species in various databases – Tr-EMBL, SWISS-	

		Prot, Uni-Prot.	

References

	RUSLSc 301
1.	Plant physiology Taiz and Zeiger (5th edition) (2010) Pub : Sinauer Associates.
2.	Essential Developmental Biology J.M. W. Slack (2nd edition) (2006) Pub: Blackwell Publishers
3.	Developmental Biology Scott Gilbert (9th edition) (2010) Sinauer Associates
4	Fundamentals of physiology - A Human perspective L Sherwood 5th edition (2006) Pub : Thomson Brooks
5	Embryology of Angiosperms Bhojwani and Bhatnagar 4th edition (1999) New Delhi Vikas
6	Vander's Human Physiology Widmaier, Raff, Strand (10th edition,) (2006) McGraw Hill Int. Edition.
7	Principles of Animal Physiology C Moyes and Schulte 2nd edition (2007) Pearson Education.
8	Medical Microbiology: A guide to microbial infections . Greenwood, Slack, Peutherer and Barer 17th Ed (2007) Churchill Livingstone
9	Microbiology Davis, Dulbecco and Ginsberg. (1990), Lippincott Company, Phi
10	Textbook of Microbiology. Ananthanarayanan and Panniker 5th Edition (1996). Orient Longman.
	RUSLSc 302

1	1. Lehninger's Principles of Biochemistry Eds : D.L Nelson and M.M. Cox, Pub : WH Freeman Publishers, New York. 4th edition (2005)
2	Biochemistry Eds : J.M. Berg, J L Tymencko and L. Stryer Pub : W H Freeman and co., New York. 5th edition (2002)
3	Fundamentals of Biochemistry by Eds : D.Voet , J. G. Voet Pub : John Wiley &Co., New York Pratt 1st ed (2004)
4	Principles of Biochemistry Ed: Lehninger.A Pub: CBS Publishers and Distributors, 2nd Edition (1993)
5	Principles of Biochemistry Eds: Zubay G.L, Parson W.W. and Vance D.E. Pub: W. C. Brown, First Edition (1995)
6	An Introduction to Genetic Analysis Ed: Griffiths A.J. et al, Pub: W. H. Freeman London) Seventh Edition(2000)
	RUSLSc 303
1	Strickberger's Evolution – B. Hall and B. Hallgrimsson 4th Edition (2008) Jones and Bartlett Publishers
2	Remarkable Creatures: Epic Adventures in Search of the Origin of Species Sean B. Carrol, (2009),Mariner Books,
3	Population Genetics, M.B.Hamilton, (2009). Wiely-Blackwell,
4	Population Genetics : A Concise Guide J.H.Gillespie, (2004) Johns Hopkins University Press.
5	Methods in Biostatistics of Medical students and Research Workers B.K.Mahajan, 8th Edition, (2010)
6	Fundamental concepts of Bioinformatics

7	Exploring Bioinformatics – A Project-based Approach St. Clair and Visick (2010) Jones and Bartlett Publishers
8	Bioinformatics for Dummies Jean-Michel Claverie, Cedric Notredame, 2003, John Wiley & Sons

Modality of Assessment

Theory Examination Pattern:

E) 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**

F) External Examination- 60%- 60 Marks

Semester End Theory Examination: (Deviation from the usual modality)

Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.

Semester End Theory Examination:

Duration - These examinations shall be of **02 HRS** duration.

Theory question paper pattern:

Paper Pattern:

Q.	Options			Marks	Based on
Q1	Answer any 2	OR	Answer any 3	15	Unit I

	questions out of 3 questions on Unit 1 Each question of 7.5 marks		questions out of 4 questions on Unit 1 Each question of 5 marks		
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:

E) Internal Examination: 40%- 40 Marks

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

F) External Examination: 60%- 60 Marks

Semester End Practical Examination:

Particulars	**Paper**

Main question to perform Experimental task/Estimation/ dissection/Bioinformatics statistical analysis project work	20
Identifications	10
Total	**30**

Overall Examination & Marks Distribution Pattern

Semester III

Course	301			302			303			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	200
Practicals	20	30	50	20	30	50	20	30	50	100

Course Code: RUSLSc401

Course Title: Physiological Systems in Plants and Animals-II

Academic year 2021-2022

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	Students will gain insights about following;
CO 1	Adaptive mechanism in plant and animal to extreme environmental condition
CO 2	Regulation of energy stores and various eating disorders.
CO 3	To describe defense mechanisms in plants and animals.
CO4	To differentiate between innate and adaptive immunity and describe them.
CO 4	Explain epidemiology, aetiology, pathology, diagnosis, therapy and preventive measures and vaccines for different diseases

Course Code: RUSLSc 402

Course Title: Biochemical Approach to Life Processes in Plants and Animals-II

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	Students will gain insights about following;
CO 1	To explain the anabolic pathways in carbohydrate, lipids and proteins
CO 2	To compare non- cylcic and cyclic photosynthetic pathways. To justify how photorespiration is a wasteful process and to review how C4 plants circumvent it.
CO 3	Understand the role of different enzymes in replication of

	DNA. Compare between the prokaryotic and eukaryotic replication process.
CO 4	Explain the transcription and translation process in prokaryotes and regulation of gene expression in prokaryotes.
CO 5	Compare transcription and translation process in eukaryotes. Understand the concept of post translational modifications in eukaryotes

Course Code: RUSLSc 403

Course Title: Evolutionary Biology, Biostatistics and Bioinformatics in Population Studies-II

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	Students will gain insights about following;
CO 1	Students should know;human evolution from social to cultural changes , from the Hunter gatherer type to the most sophisticated type of today.
CO 2	Concept of Species and Speciation, Mitochondrial DNA, Evolution of Humans, Concepts like altruism and selection, Society Evolution and Genetic Engineering.
CO 3	Study bio statistical concepts like student's t test F- Test, Chi-Square test.
CO 4	To explain the features of the genetic code and to apply it in translating nucleic acid sequence.
CO5	To annotate and to translate nucleic acid sequences into protein

	sequences,to evaluate protein sequence with location and function,
CO6	To compare and contrast molecular and morphological phylogenetic trees, to explain the parsimony principle and to construct phylogenetic trees.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
		S.Y.BSc. LIFE SCIENCE (Theory)	
RUSLSc 401		**Physiological Systems in Plants and Animals-II**	**2 Credits Total 45 lectures**
	I	**Adaptive Mechanisms to Environmental Changes** Adaptations in plants to extreme thermal conditions. Adaptations in animals to extreme thermal conditions. Fever, Hyperthermia, heat exhaustion and heat stroke. Thermogenesis: shivering and nonshivering thermogenesis, Hyperthermia induced by pyrogens. Antifreeze proteins in plants and animals. Regulation of energy stores: control of food intake, Role of Leptin, Ghrelin and Kisspeptin. Eating disorders: Anorexia and Bulimia Nervosa, Obesity, Diabetes.	**15 Lectures**
	II	**Homeostasis during infections** Innate Immunity and Adaptive Immunity. Mechanisms of Innate Immunity – In invertebrates (hemocytes) and in Vertebrates.	**15 Lectures**

		(Physical and Physiological barriers, Phagocytosis and inflammation). Mechanisms of adaptive immunity-T and B cells. (Mode of Recognition of Antigens). Virulence factors and toxins: virulence factors, exotoxins, enterotoxins, endotoxins. Host factors in infection: host risk factors, innate resistance. Biomolecules such as secondary metabolites, surface protectants and enzymes in plants. Parasite escape mechanisms in infection.	
	III	**Diseases in plants and animals (with respect to epidemiology, aetiology, pathology, diagnosis, therapy, preventive measures and vaccines giving the current status)** **Vector borne Diseases–** Malaria, Dengue or Chikungunya. **Viral Disease**-AIDS, Herpes, Swine flu, CoronaVirus. **Bacterial Diseases**- Tuberculosis or Typhoid , Leprosy **Fungal Diseases**– Ringworm or Candidiasis, Psoriasis. **Helminthic Diseases**– Filariasis. **Diseases in Plants:** Tobacco Mosaic Virus, Crown gall bacterial infection, Puccinia fungal infection with crops.	**15 Lectures**
RULSc 402		**Biochemical Approach to Life Processes in Plants and Animals- II**	**2 Credits Total 45 lectures**
	I	**Anabolism of Biomolecules** Anabolism of Carbohydrates: a) Gluconeogenesis b) Glycogen synthesis Anabolism of Lipids: a) Fatty acid biosynthesis b) Cholesterol and prostaglandin biosynthesis. Anabolism of Amino acids: a) Transamination and its significance	**15 Lectures**

		b) Glutamine synthesis Synthesis of purines & pyrimidines with Significance. Photosynthesis, Light reaction and Calvin cycle Photorespiration in plants: C3 and C4 plants	
	II	**Molecular Biology studies in prokaryotes** DNA replication in prokaryotes. Transcription in Prokaryotes Translation in prokaryotes Regulation of gene expression and its significance: Operon model (Lactose / Tryptophan)	**15 Lectures**
	III	**Molecular Biology studies in eukaryotes** DNA Replication in Eukaryotes Transcription in Eukaryotes and Post Transcriptional modifications Translation in Eukaryotes and post translational modification	**15 Lectures**
RULSc 403		**Evolutionary Biology, Biostatistics and Bioinformatics in Population Studies-II**	**2 Credits Total 45 lectures**
	I	**Evolutionary Adaptations and its consequences** Origin of Species: Biological species concept, morphological species, Allopatric and sympatric speciation, Isolating mechanism preventing exchange in populations. Rates of speciation-punctuated or gradual. Life history of a species, Mitochondrial DNA and tracing human phylogeny and extinctions. Human evolution: Factors in Human Origin: Bipedalism, improvement in food acquisition, improved predator avoidance and reproductive success, Hunter gatherer societies. Altruism and kin selection. Evolution of the Society: Cultural vs biological evolution, social Darwinism, eugenics, reproductive technologies and genetic engineering- impact on human culture.	**15 Lectures**

	II	**Biostatistics** Sampling variability and significance. Degrees of freedom, Statistical Hypothesis, Type I and Type-II errors , Level of Significance. Test of Significance Test for equality of two means. t-Tests - Paired and unpaired. Analysis of Variance (ANOVA) one way classification, F-test. Chi Square Test for independence 2x2 table.	**15 Lectures**
	III	**Bioinformatics** DNA sequence Data analysis- (a) Annotation of putative genes – ORF finding. (b) Genetic code and Frame translation to amino acids, concept of six frame translation. Phylogenetic Analysis. (a) Concept of paralogous and orthologous genes (b) Nucleic acid based phylogenies (c) Nucleotide sequence comparisons and homologies (d) Phylogenetic Trees (e) Parsimony principle and limitations of molecular phylogenetic trees. (f) Globin gene analysis	**15 Lectures**
		PRACTICALS	**3 Credits** **45 Lectures**
RULScP 401		**Practicals in Physiological Systems in Plants and Animals-II** 1.Extraction and detection of Plant alkaloids, saponines, tannins and volatile oils. 2.Alkaloid separation by TLC. 3.ABO Blood typing. 4.Total RBC count using a Hemocytometer. 5.Principle and working on home pregnancy test slide / Widal Test- Qualitative. 6.Streak plating (T, Pentagon and Quadrant –Any 2) to isolate microorganism from a mixed culture using differential media.	

		7.Antibiotic sensitivity of microorganisms (Plant extract, Tetracycline/ Gentamicin). 8.Study the effect of tobacco extract or caffeine or any other plant extract on heart beat of Daphnia.	
RULScP 402		Practicals in Biochemical Approach to Life Processes in Plants and Animals- II. : A. Instrumentation / Technique (I / T) (1) PAGE (Demonstration). Chromatography – Paper, Thin layer, Column. B. Process / Concept and immediate Relevance (C and R) - Extraction, Purification - Analysis / Estimation GLP(Good Laboratory practices) incorporated into every practical Separation / Extraction techniques 1.Extraction and Detection of RNA/Ribose Sugars. C, T *(Extraction of nucleic acid and detection by colour reaction)* 2.Chromatography of Sugars – Circular Paper **C, T** *(Separation of carbohydrates and detection by colour reaction)* 3.Thin Layer Chromatography for separation of Plant Pigments.(Slide technique) **C,T,R** *(Separation techniques for charged, uncharged materials based on solvent partition)* 4.Solvent Extraction of Lipids. **C, T, R** *(Extraction of lipid and proportional estimation by weight)* 5.Column Chromatography of Proteins / Pigments. **I, C, T***(Separation technique for proteins/ other materials based on charge/size)* 6.Protein separation by PAGE (Demonstration) **I, C** *(Separation techniques for charged materials based on electrophoretic mobility)* 7.Interpretation of pathological reports based on	

		the biochemical analysis.	
RULScP 403		**Evolutionary Biology, Biostatistics and Bioinformatics in Population Studies-II** Comparative Anatomy of Brain (Invertebrate to vertebrate). Study of Fossils (One Animal and One Plant) Human Karyotyping- Normal and Abnormal (Numerical and Structural) - Study of Giant Chromosome from Salivary Glands of *Chironomus* Larvae BLAST search Bioinformatics- Phylogenetic analysis using Globin gene and Mitochondrial DNA. Applications using biological data :- - Student t test - Z-test - ANOVA - Chi square test Analysis of Variance one way classification Project Report based on bioinformatics/ Biostatistics / Population Genetics / Evolution.	

References:

	RUSLSc 401
1.	Plant physiology Taiz and Zeiger (5th edition) (2010) Pub : Sinauer Associates.
2.	Essential Developmental Biology J.M. W. Slack (2nd edition) (2006) Pub: Blackwell Publishers
3.	Developmental Biology Scott Gilbert (9th edition) (2010) Sinauer Associates

4	Fundamentals of physiology - A Human perspective L Sherwood 5th edition (2006) Pub : Thomson Brooks
5	Embryology of Angiosperms Bhojwani and Bhatnagar 4th edition (1999) New Delhi Vikas Pub
6	Vander's Human Physiology Widmaier, Raff, Strand (10th edition,) (2006) McGraw Hill Int. Edition.
7	Principles of Animal Physiology C Moyes and Schulte 2nd edition (2007) Pearson Education.
8	Medical Microbiology: A guide to microbial infections . Greenwood, Slack, Peutherer and Barer 17th Ed (2007) Churchill Livingstone
9	Microbiology Davis, Dulbecco and Ginsberg. (1990), Lippincott Company, Phi
10	Textbook of Microbiology. Ananthanarayanan and Panniker 5th Edition (1996). Orient Longman.
	RUSLSc 402
1	1. Lehninger's Principles of Biochemistry Eds : D.L Nelson and M.M. Cox, Pub : WH Freeman Publishers, New York. 4th edition (2005)
2	Biochemistry Eds : J.M. Berg, J L Tymencko and L. Stryer Pub : W H Freeman and co., New York. 5th edition (2002)
3	Fundamentals of Biochemistry by Eds : D.Voet , J. G. Voet Pub : John Wiley &Co., New York Pratt 1st ed (2004)
4	Principles of iochemistry Ed: Lehninger.A Pub: CBS Publishers and Distributors, 2nd Edition (1993)
5	Principles of Biochemistry Eds: Zubay G.L, Parson W.W. and Vance D.E.

	Pub: W. C. Brown, First Edition (1995)
6	An Introduction to Genetic Analysis Ed: Griffiths A.J. et al, Pub: W. H. Freeman (London) Seventh Edition (2000)
	RUSLSc 403
1	Strickberger's Evolution – B. Hall and B. Hallgrimsson 4th Edition (2008) Jones and Bartlett Publishers
2	Remarkable Creatures: Epic Adventures in Search of the Origin of Species Sean B. Carrol, (2009),Mariner Books,
3	Population Genetics, M.B.Hamilton, (2009). Wiely-Blackwell,
4	Population Genetics : A Concise Guide J.H.Gillespie, (2004) Johns Hopkins University Press.
5	Methods in Biostatistics of Medical students and Research Workers B.K.Mahajan, 8th Edition, (2010) Jaypee.
6	Fundamental concepts of Bioinformatics
7	Exploring Bioinformatics – A Project-based Approach St. Clair and Visick (2010) Jones and Bartlett Publishers
8	Bioinformatics for Dummies Jean-Michel Claverie, Cedric Notredame, 2003.

Modality of Assessment

Theory Examination Pattern:

G) 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**

H) External Examination- 60%- 60 Marks

Semester End Theory Examination: (Deviation from the usual modality)

Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.

Semester End Theory Examination:

Duration - These examinations shall be of **2 HRS** duration.

Theory question paper pattern:

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:

G) Internal Examination:20Marks

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

H) External Examination:30 Marks
Semester End Practical Examination:

Particulars	**Paper**
Main question to perform Experimental	20

task/Estimation/ dissection/Bioinformatics statistical analysis project work	
Identifications	10
Total	**30**

Overall Examination & Marks Distribution Pattern

Semester IV

Course	**401**			**402**			**403**			**Grand Total**
	Internal	**External**	**Total**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**	
Theory	**40**	**60**	**100**	**40**	**60**	**100**	**40**	**60**	**100**	**200**
Practical	**20**	**30**	**50**	**20**	**30**	**50**	**20**	**30**	**50**	**100**

Course Code: RUSLSc 501

Course Title: Genetics and Immunology -I

Academic year 2021-2022

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.
CO 2	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 2021-2022

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 2021-22

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 2021-2022

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)	
RUSLSc501		**Genetics and Immunology - I**	**2.5 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 **Genetic recombination in Bacteria:** The processes of; Conjugation, Transformation, Transduction Mapping the genome by each method	**15 Lectures**

	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. ii) Antibody-Structure, Functions and variations iii)Monoclonal and polyclonal antibodies (HybridomaTechnique) 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 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**	**15 lectures**

		i) Classical, alternate 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		**DEVELOPMENTAL BIOLOGY AND NEUROSCIENCE – I**	**2.5 Credits 60 Lectures**
	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*)	**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. Neurulation. - neural induction, Neural tube formation in amphibians and Chick Organogenesis – Eye / limb Neural Crest Cells	**15 Lectures**

	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**	**2.5 Credits** **60 lectures**
	I	**<u>Fermentation technology – Principles</u>** 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.* **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)	
RUSLSc 504		**ECOLOGY, CONSERVATION BIOLOGY, ASSESSMENT AND MANAGEMENT-1**	**2.5 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. 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).	**15 Lectures**

	II	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) Phytoremedian of Organochlorine pesticide (Chloropyrifos) using plants Pesticide regulation: eg. Endosulphan issue.	
	III	**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**
RUSLScP 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 Demonstration experiments: a) Study of *Drosophila* mutants from specimen / slides / photographs Study of UV-Visible Spectrophotometer *Video presentation and GD **Immunology** **I)**Experiments to be performed by students: 1. Study of ABO Blood groups and quantitative Coomb's Test. 2. Study of Isohemagglutinin titre in blood. 3. Quantitative Widal Test. 4. Demonstration experiments: 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.	
RUSLScP 502		**DEVELOPMENTAL BIOLOGY AND NEUROSCIENCE – I** **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**	**Credits -1.5, Lectures-60**

		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	
RUSLScP 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	
RUSLScP 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	
	<u>Units I and II Genetics</u>
1.	Principles of Genetics bySnustad and Simmons 4thedn. John Wiley and sons 2006.

2.	Genetics; A Molecular approach by Peter Russel 2nd edn. Pearson 2006.
3.	Genetics; AMendelian approach by Peter Russel 2nd edn. Pearson 2006
4.	Introduction to Genetic Analysis by Griffiths et al 8th ednFreeman 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 7th edn., Blackwell publication, asianedn Oxford publishers 2007
7.	Concepts of Genetics W. S. Klug and M. R. Cummings 7th edn. Pearson 2003.
8.	Concepts of Genetics W. S. Klug, M. R. Cummings, C. A. Spencer 8th edn. Pearson 2006.
9.	Human Molecular Genetics by Tom Strachan and Andrew Read, 3rd edn. Garland Science pub. 2004.
10.	Principles of Genetics by R. Tamarin 7th edn 2002
	Units III and IV Immunology
11	Immunology 7th edn. R.A.Goldsky, T. J. Kindt, B. A. Osborne, J. Kuby 2018.
12	Immunology: The immune system in health and disease 6th edn. C. A. Janeway, P. Travers, M. Walport, M. Shlomchik Garland Science Pub. 2005.
13	Cellular and Molecular Immunology, 2nd edn. A. K. Abbas, A. H. Litchman, 5th edn 2000.
14	Basic Immunology: Functions and disorders of the immune system, 2nd edn. A. K. Abbas, A. H. Litchman, 2nd edn 2004.
15	Roitt's Essential Immunology 11th edn. 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. 16. An Atlas Of Descriptive Embryology 2nd ed. W.W.Mathews. MacMillan Publishing Co. 15. 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

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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:

I) Internal Examination: 20Marks

Particulars	
Journal	05
Experimental	15

tasks	
Total	**20**

J) 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 V

Course	501			502			503			504			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
Practicls	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 2021-2022

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 2021-22

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 2021-2022

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 2021-2022

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 testing – Ames test.	**15 Lecture**
	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)	**15 Lecture**

		- 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	
	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 i) X-linked agammaglobulinemia ii) DiGeorge syndrome iii) Combined-SCID (Severe Combined Immunodeficiency) iv) Phagocytic- Chronic Granulomatous Disease **v)** AIDS (Acquired ImmunoDeficiency Syndrome)	**15 Lecture**
	IV	**Transplantation, Tumour Immunology, Tolerance**	**15 Lecture**

		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.	
		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**	**15 Lecture**

		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	
	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)	**15 Lecture**

		iii) Vaccines (polio, HbsAg) iv) Monoclonal antibodies v) Biopharmaceuticals (Insulin / IFN-γ)	
	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) 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** <u>Molecular separation for genes and protein:</u> 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	**15 Lecture**

		(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 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.	**15 Lecture**

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 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.	**15 Lecture**
	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.	**15 Lecture**

		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.	
	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 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.	**15 Lecture**
	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	**15 Lecture**

		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.	
Course Code/ Unit	**Unit**	**Course / Unit Title**	**Credit/ Lectures**
		PRACTICALS	
RUSLScP601		**Genetics and Immunology II**	**Credits -1.5, Lectures-60**
	1 **2** **3** **4** **5** **6**	**Genetics** Estimation of bacteriophage titre by plaque assay Effect of UV light on microorganisms 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** Ouchterlony test for Immunodiffusion (Qualitative) Mancini test – Single Radial Immunodiffusion (Qualitative) Agarose slide gel electrophoresis of Serum. Demonstration experiments: Separation of Mononuclear cells using a gradient and the determination of viable count of the same. SDS- PAGE for separation of IgG subfraction Qualitative ELISA using albumin	
RUSLScP602		**Developmental Biology and Neuroscience II**	**Credits -1.5, Lectures-60**
	1	**Plant Developmental Biology** Effect of temperature on cell viability in pollen	

		grains/yeast using Trypan blue/ acetocarmine.	
	2	Effect of boron / calcium on pollen tube germination in *Vinca rosea* or any other suitable sample.	
		Demonstration experiments:	
	3	Plant Tissue Culture: Initiation of plant tissue culture from germinated chickpea/any other suitable source.	
	4	**Animal Developmental Biology** Live Cycles and Developmental stages of C.elegans / *Dictyostelium / Drosophila* / *Danio*.	
	5	Imaginal discs of *Drosophila.*	
	6	Regeneration in earthworm / any other suitable system / hydra (using permanent slide / photographs)	
		Neurosciences	
	7	Temporary mounts : Cornea of prawn / Statocyst of prawn/ Columella of bird / Ventral Nerve cord of Earthworm	
	8	Making clay model of Invertebrate and Vertebrate CNS	
		Demonstration Experiments	
	9	Stroop test.	
	10	Innate and Learned Behaviour in Animal	
	11	Knee-jerk reflex	
	12	Pupillary reflex.	
	13	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 Electrophoresis of plasmid DNA/Restriction Digest.	
	5	**Bioinformatics:** Introduction to databases and: use of public domain	
	6	Open source database and programs for studying genomics of human / mouse, yeast/ plant/ microbes or any other relevant organism.	
	7	Manual annotation of DNA sequence: pUC series or any convenient cloning/expression vector followed	

	8	by using programmed tool Blast search of genome sequence, Sequence alignment Pairwise / multiple, construction of Cladogram / phylogram	
	9	**Open-ended projects**: 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. Fingerprinting technique using electrophoresis of protein/DNA digest SDS PAGE with suitable marker. 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.	
	5	**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 :-

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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..
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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

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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

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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.
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Modality of Assessment

Theory Examination Pattern: Paper I to IV.

K) 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**

L) External Examination- 60%- 60 Marks

Semester End Theory Examination: (Deviation from the usual modality)

Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.

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

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:

K) Internal Examination: 20 marks

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

L) 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 V

Course	601			602			603			604			Grand Total
	Internal	Exter	Total	Internal	External	Total	Internal	Exter	Total	Inter	Exter	Total	

		nal						**nal**		**nal**	**nal**		
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**

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