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

CBCS 2022-23

(Choice based Credit System for Academic year 2022–2023)

Graduate Attributes

GA	GA Description **A student completing Bachelor's Degree in Life Science program will be able to:**
GA 1	Demonstrate an understanding of biological systems across microorganisms, plants and animals. To develop necessary laboratory skills and analytical methods.
GA 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.
GA 3	Create an awareness of environmental issues, biological diversity, and how we can make a positive impact on it.
GA 4	Inculcate scientific temperament and generate problems solving approaches in students when they integrate themselves in the larger society.
GA 5	Develop necessary laboratory skills and analytical methods.

PROGRAM OUTCOMES

PO	Description **A student completing Bachelor's Degree in the subject of Life Science will be able to:**
PO1	To be able to describe the biomolecules and metabolic processes, compare developmental processes and physiological systems in plants and animals, neuroendocrine system, short term and long term memory, learning and behaviour, neurological disorders, biological evolution, human evolution of thought process, which allows for curiosity, and enhances learning process ahead.
PO2	To be able to describe interspecific interactions in the ecosystem, Plant Tissue Culture techniques and its significance in agriculture, germplasm conservation and secondary metabolites, and Animal Tissue Culture techniques, Fermentation Technology and its role in industry and society
PO3	To be able to explain DNA Cloning, use of cloning vectors like *E.coli* plasmids, cosmids, phagemids, viral vectors, significance of restriction enzymes, apply Mendel's laws, gene regulation in prokaryotes and eukaryotes, defense mechanisms in plants and animals, innate and adaptive immune system, and its disruptions in the form of allergies, autoimmune diseases and immunodeficiency disorders. applications of Monoclonal antibodies in cancer

PO4	Apply Biostatistics to analyse, Probable Chance of Occurrence, Normal Population, Student's t-test, Correlation and Regression analysis, Chi-Square test, data analysis for project work
PO5	Skills-Perform assays to identify, purify, quantify, immobilize proteins/enzymes using techniques like Centrifugation, Electrophoresis and Chromatography, dissection of animals, protocols to handle preserved animals, working in aseptic conditions, use and maintaining of diagnostic kits, pedigree analysis in humans, karyotyping in plants
PO6 **PO7**	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. Environment and Sustainability- to analyse the local biodiversity at residential sites of students and the changes occurring in the biodiversity and to conserve the same, awareness about implementation of Laws Regulations, citizens awareness to oppose under the aegis of NGO
PO8	Ethics- awareness of plagiarism in scientific work, acknowledging/ citing the work, lab ethics in handling biological materials and chemicals, to be able to apply professional and ethical principles, minimize waste and ethical waste disposal
PO9	Individual and Team Work- to be able to work independently as well as lead a team and be a team player,

PO10	Communication skills- to be able to communicate clearly through presentations as well as document, write effective reports or communicate and work in a team
PO11	Project Management- to be able to write SOPs for instruments, design experiments, analyse data, work in a team, a scientific way of thinking, a diverse approach to scientific enquiry towards an idea .
PO12	Life Long Learning- to be able to learn independently and adapt to changing needs of the society

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE	Type COURSE TITLE	CREDITS
FYBSc	**I**	RUSLSc101	CC Molecular and Cellular studies in Life Sciences I	**2**
FYBSc	**I**	RUSLSc102	CC Physiological systems, Genetics and Ecology I	**2**
FYBSc	**I**	RUSLScP101	CC Practicals in Molecular and Cellular studies in Life Sciences I	**1**
FYBSC	**I**	RUSLScP102	CC Practicals in Physiological systems, Genetics and Ecology I	**1**
FYBSc	**II**	RUSLSc201	CC Molecular and Cellular studies in Life Sciences II	**2**
FYBSc	**II**	RUSLSc202	CC Physiological systems, Genetics and Ecology II	**2**
FYBSc	**II**	RUSLScP201	CC Practicals in Molecular and Cellular studies in Life Sciences II	**1**
FYBSc	**II**	RUSLScP202	CC Practicals in Physiological systems, Genetics and Ecology II	**1**

SYBSc	**III**	RUSLSc301	CC Physiological Systems in Plants and Animals-I	**2**
SYBSc	**III**	RUSLSc302	CC Biochemical Approach to Life Processes in Plants and Animals-I	**2**
SYBSc	**III**	RUSLSc303	CC Evolutionary Biology, Biostatistics and Bioinformatics in Population Studies-I	**2**
SYBSc	**III**	RUSLScP301	CC Practicals in Physiological Systems in Plants and Animals-I	**1**
SYBSc	**III**	RUSLScP302	CC Practicals in Biochemical Approach to Life Processes in Plants and Animals- I	**1**
SYBSc	**III**	RUSLScP303	CC Practicals in Evolutionary Biology, Biostatistics and Bioinformatics in Population Studies- I	**1**
SYBSc	**IV**	RUSLSc401	CC Physiological Systems in Plants and Animals-II	**2**
SYBSc	**IV**	RUSLSc402	CC Biochemical Approach to Life Processes in Plants and Animals-II	**2**

SYBSc	**I V**	RUSLSc403	CC Evolutionary Biology, Biostatistics and Bioinformatics in Population Studies-II	**2**

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SYBSc	**I V**	RUSLScP401	CC Practicals in Physiological Systems in Plants and Animals-II	**1**
SYBSc	**I V**	RUSLScP402	CC Practicals in Biochemical Approach to Life Processes in Plants and Animals- II	**1**
SYBSc	**I V**	RUSLScP403	CC Practicals in Evolutionary Biology, Biostatistics and Bioinformatics in Population Studies- II	**1**
TYBSc	**V**	RUSLSc5 01	DSC Genetics and Immunology-I	**4**
TYBSc	**V**	RUSLSc5 02	DSC Developmental Biology and Neurosciences- I	**4**

TYBSc	**V**	RUSLSc503	DSC Biotechnology and Genetic Engineering- I	**4**
TYBSc	**V**	RUSLSc504	DSC Ecology, Conservation Biology, Assessment and Management- I	**4**
		Applied	SEC Horticulture / Marine Science or Any Other	**2L+2P**
TYBSc	**V**	RUSLScP501	DSC Practicals in Genetics and Immunology-I	**1.5**
TYBSc	**V**	RUSLScP502	DSC Practicals in Developmental Biology and Neurosciences – I	**1.5**
TYBSc	**V**	RUSLScP503	DSC Practicals in Biotechnology and Genetic Engineering – I	**1.5**
TYBSc	**V**	RUSLScP504	DSC Practicals in Ecology, Conservation Biology, Assessment and Management – I	**1.5**
TYBSc	**V**	RUSLSc6	DSC Genetics and Immunology- II	**4**
TYBSc	**I**	01	DSC Developmental Biology and Neurosciences- II	**4**
	V	RUSLSc6		

	I	02		
TYBSc	**VI**	RUSLSc603	DSC Biotechnology and Genetic Engineering- II	**4**
TYBSc	**VI**	RUSLSc604	DSC Ecology, Conservation Biology, Assessment and Management- II	**4**
		Applied	SEC Horticulture / Marine Science or Any Other	**2L+**
TYBSc	**VI**	RUSLScP601	DSC Practicals in Genetics and Immunology – II	**1.5**
TYBSc	**VI**	RUSLScP602	DSC Practicals in Developmental Biology and Neurosciences – II	**1.5**
TYBSc	**VI**	RUSLScP603	DSC Practicals in Biotechnology and Genetic Engineering – II	**1.5**
TYBSc	**VI**	RUSLScP604	DSC Practicals in Ecology, Conservation Biology, Assessment and Management – II	**1.5**

DSC - Discipline Specific Course *

SEC - Skill Enhancement Elective Courses *

Course Code: RUSLSc101

Course Title: Molecular and Cellular studies in Life Sciences I

Academic year 2022-2023

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	Students will gain insights about following;
CO1	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 2022-23

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/45Lectures**
RUSLSc 101		**Molecular and Cellular studies in Life Sciences I**	

	I	**Biomolecules within living cells I** **Physiological Role of water:** Structure of water 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 ofeach. **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.	**15** **Lectures**
	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:**	**15 Lectures**

		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.	
	III	**Cytoskeletal elements and cell wall Nucleus:** Structure and Chromosome packaging, 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	**15 Lectures**
RUSLSc102		**Physiological systems, Genetics and Ecology I**	**2 Credits/4 5Lectures**
	I	**Types of Nutrition and Nutritional adaptations for different habitats** **Autotrophic nutrition** – Importance of photosynthesis in plants and in autotrophic prokaryotes .	**15 Lectures**

		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.	
	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 genes. **Chromosomal inheritance:** Sutton's hypothesis, sex-linked inheritance, study of human pedigrees (e.g. Sex linked dominant and recessive; autosomal dominant & recessive)	**15 Lectures**
	III	**Transport, Translocation in plants and Circulation in animals** **Translocation in plants:** Transport of water and inorganic solutes – transpiration, stomatal functionand 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:**	**15 Lectures**

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		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	
		PRACTICALS	**2 Credits Total 45 lectures**
RUSLScP 101		**Practicals in Molecular and Cellular studies in 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 Microscopicmeasurements:** 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.	

RUSLScP 102		**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) **Practicals in Physiological systems, Genetics andEcology - 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

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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:

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

Theory question paper pattern:

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

Practical Examination Pattern:

A) Internal Examination: - 20 Marks

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

B) External Examination: - 30 Marks

Semester End Practical Examination:

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

Overall Examination & Marks Distribution Pattern

Semester 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 2022-23

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 2022-23

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:**	**15 Lectures**

		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).	
	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 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.	**15 Lectures**
	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).	**15 Lectures**

		Plastids: Types and functions: (Leucoplast, chromoplast, Elaioplast), chloroplast morphology, structure of thylakoid membrane, photosynthetic pigments & a brief mention of photo-phosphorylation; chloroplastDNA. **Golgi Apparatus** - Structure, origin and relation toER . Role in synthesis, storage and secretion of zymogen and glycoprotein. **Peroxisomes and Glyoxisomes:** Structure and functions	

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:**	**15 Lectures**
		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)	
	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.	**15**

	III	**Mutations:** Point Mutations Chromosomal aberrations: Structural: deletion, duplication, inversion, translocation. Numerical: euploidy & aneuploidy (e.g. Downs, Turners. Klienfelter's, Cri- du-chat) **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:** 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	**Lectures** **15** **Lectures**

Course Code/ Unit	**Unit**	**Course/ Unit Title** **PRACTICALS**	**Credits/ Lectures**

			2 Credits
			Total 45 lectures
RUSLSc P 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	
RUSLSc P 202		**Practicals in Physiological systems, Genetics and Ecology - II**	**2 Credits Total 45 lectures**

		1. Study of Barr Body **2. Animal Biodiversity:**	

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		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 beused 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)

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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.

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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

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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	16 Unit I
Q2	Answer any 2 questions out of 3	16 Unit II
Q3	Answer any 2 questions out of 3	16 Unit III

Q4	Short notes on topics of all 3 units; Answer any 3 out of 5;			12 Unit I, II, III
			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	**Total**
Main question to perform Experimental task/Estimation/ dissection/ statistical analysis	**Paper** 15
Identifications	10
	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 2022-23

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.

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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 2022-23

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

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	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 2022-23

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 orderfeedback mechanisms. Hormones of Pineal, Hypothalamus, Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal gland, Testis and Ovary. Plant Hormone- Auxins, Gibberellic 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 andAction 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 (b) Animals: Role of SRY gene and Aromatase (c) Role of environmental factors – Temperature and Parthenogenesis in insects Eg. Wasp/Honey bee/Ants	**15 Lectures**

		(d) Plant-animal interaction for reproduction Figwasp / 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	**I**	**Biochemical Approach to Life Processes in Plants and Animals-I** **Enzymology** Strategies for Isolation and purification of enzymes,measurement of specific activity and purification fold. Classification of enzymes (With an example ofeach). Effect of pH and Temperature. Coenzymes and cofactors : NAD, FAD, Mn, Mg, Zn and Cu (one example each). Kinetics (Michealis Menten, Lineweaver Burk plots). Enzyme Inhibitors, Activators and feed-backinhibition. Allosteric enzymes (Kinases in Glycolysis) and their significance in metabolic regulation. Concept of Isoenzymes: LDH.	**2 Credits Total 45 lectures** **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. Electron Transport	**15 Lectures**

		System: Localisation and Sequence of electron transporters.	

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		Oxidative Phosphorylation: Mitchell's Chemiosmotic Hypothesis, ATP synthesis, Control of respiration, uncoupling and metabolic poisons.	
RUSLSc 303	**III**	**Lipids and Proteins Metabolism.** Lipids - Catabolism : Lipolysis, Role of Carnitine inmitochondrial permeability, Beta– Oxidation of fatty acids and integration into Kreb's cycle, Ketonebodies and their significance. Amino Acids – Catabolism: Protein Degradation liberating amino-acids', Deamination, Transamination & ammonia disposal by Urea cycle,Decarboxylation & integration into Kreb's cycle. **Evolutionary Biology, Biostatistics and Bioinformatics in population studies-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 the context of human genetic diseases. (BRCA1 / Huntington's/ Thalassemia). Populations and allelic frequencies, Hardy	**15** **Lectures** **2 Credits Total 45 lectures** **15 Lectures**

		Weinberg Equilibrium, change in gene frequencies due to selection, mutation, migration and genetic drift (Founder's effect). Origin of variability, polymorphism, kinds of selection – directional, stabilizing and disruptive, selectionist vs neutralist.	

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	II	**Biostatistics** 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 RankCorrelation Coefficient. Regression equations and their uses.	**15 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 CreditsTotal45 lectures**
RUSLScP 301	**I**	**Practicals in Physiological Systems in Plants andAnimals-I** 1.Good Laboratory Practices.	

RUSLScP 302	**II**	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. **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 buf ering using Glycine / titration curve). c) Phosphate buffer preparation using HendersonHasselbalch 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 canbe estimated by colour reaction).* 7.Colorimetric Cholesterol Estimation / total Lipid Estimation from egg. *(Lipid metabolism is an important component of our systems, content can beestimated 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)	

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		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.

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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

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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

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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 questions out of 3 questions 16 Unit I
Q2	Answer any 2 questions out of 3 questions 16 Unit II
Q3	Answer any 2 questions out of 3 questions 16 Unit III
Q4	Short notes on topics of all 3 units; Answer any 3 out of 5; 12 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:

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	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	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

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Course Code: RUSLSc401

Course Title: Physiological Systems in Plants and Animals-II

Academic year 2022-23

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 2022-23

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 **CO 5**	Explain the transcription and translation process in prokaryotes and regulation of gene expression in prokaryotes. 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 2022-23

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

15 Lectures

Adaptations in plants to extreme thermal conditions.

Adaptations in animals to extreme thermal conditions.

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		Fever, Hyperthermia, heat exhaustion and heat stroke. Thermogenesis: shivering and nonshivering thermogenesis, Hyperthermia induced by pyrogens. Regulation of energy stores: control of food intake, Role of Leptin, Ghrelin and Kisspeptin. Eating disorders: Anorexia and Bulimia Nervosa, Obesity, Diabetes.	
	II	**Homeostasis during infections** Innate Immunity and Adaptive Immunity. Mechanisms of Innate Immunity – In invertebrates (hemocytes) and in Vertebrates. (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.	**15 Lectures**

	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.	**15 Lectures**

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		Helminthic Diseases– Filariasis. **Diseases in Plants:** Tobacco Mosaic Virus, Crown gall bacterial infection, Puccinia fungal infection with crops.	
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 b) Glutamine synthesis Synthesis of purines & pyrimidines with Significance. Photosynthesis, Light reaction and Calvin cycle Photorespiration in plants: C3 and C4 plants	**15 Lectures**
	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 kinselection. Evolution of the Society: Cultural vs biological evolution, social Darwinism, eugenics, reproductivetechnologies 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.	**15 Lectures**

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		(b) Genetic code and Frame translation to aminoacids, concept of six frame translation. Phylogenetic Analysis. (a) Concept of paralogous and orthologous genes (b) Nucleic acid based phylogenies Nucleotide sequence comparisons and homologies (d) Phylogenetic Trees (e) Parsimony principle and limitations of molecular phylogenetic trees. (f) Globin gene analysis	

RULScP 401		**PRACTICALS** **Practicals in Physiological Systems in Plants andAnimals-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 microorganisms 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.	**3 Credits** **45** **Lectures**
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 basedon electrophoretic mobility)* 7.Interpretation of pathological reports based on biochemical analysis.	
RULScP 403		**Evolutionary Biology, Biostatistics and Bioinformatics in Population Studies-II** Comparative Anatomy of the 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 Globingene 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 7	Vander's Human Physiology Widmaier, Raff, Strand (10th edition,) (2006) McGraw Hill Int. Edition. Principles of Animal Physiology C Moyes and Schulte 2nd edition (2007) Pearson Education.

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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 ofbiochemistry 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

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	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

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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	16 Unit I
Q2	Answer any 2 questions out of 3	16 Unit II

Q3	Answer any 2 questions out of 3	16 Unit III
Q4	Short notes on topics of all 3 units; Answer any 3 out of 5;	12 Unit I, II, III

Total 60

Practical Examination Pattern:

G) Internal Examination:20 Marks

Particulars

Journal 05

Experimental tasks 15

Total 20

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H) External Examination:30 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 IV

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

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Course Code: RUSLSc 501

Course Title: Genetics and Immunology -I

Academic year 2022-23

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

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	function are related, describe the activity of cytokines and immune responses.

Course Code: RUSLSc 502

Course Title: Developmental Biology and Neurosciences- I

Academic year 2022-23

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 2022-23

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 **CO 5**	Understand how Isolation of cloning vectors, selection of gene cloning organisms, isolation of desired DNA to be cloned is important. Explain the techniques like Immunological method, Nucleic acid hybridization method, Hybrid arrest and Hybrid release method(HART and HRT) for screening and selection of the desired clones.

Course Code: RUSLSc 504

Course Title: Ecology, Conservation Biology, Assessment and Management-I Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	Students will gain insights about following;

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

DETAILED SYLLABUS : -

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
		T.Y.BSc. LIFE SCIENCE (Theory)	
RUSLSc 50 1		**Genetics and Immunology - I**	**4 Credits Total 60 Lectures**
	I	**The Genetic material** **Introduction - Discovery of the genetic:** Griffith's experiment of 1928; Avery, McLeod and McCarty's experiment of 1944; Hershey-Chase's experiment of 1952; and Fraenkel-Conrat and B. Singer's experiment of 1956. *To be given as Assignment/Presentations. **Molecular aspects:** Sequence complexity of DNA -Unique and repetitive sequences of DNA; Denaturation kinetics and 'CoT' value; Satellite DNA **Genomes:** Structural organization of a prokaryotic genome Structural organization of a eukaryotic genome Higher orders of chromosome packing; 'C value paradox' **Introduction to gene regulation in Prokaryotes Gene regulation in eukaryotes**	**15 Lectures**

		Chromatin condensation, Modification and remodelling by acetylation and methylation Transcriptional regulation (promoters and enhancers and Transcription Initiation complex, GAL4-UAS system)	
	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, Antigenic drift and shift ii) Antibody-Structure, Functions and variations iii)Monoclonal and polyclonal antibodies (Hybridoma Technique) iv)Organization and expression of Immunoglobulin genes v)Antigen-antibody interactions –Cross reactivity, Precipitation Immunoelectrophoresis, Agglutination, Radioimmunoassay, ELISA, Immunofluorescence	**15 lectures**
	IV	**Antigen recognition and Effector Mechanisms Major Histocompatibility Complex** i) MHC-I and MHC-II molecules ii) MHC allelic polymorphism iii) MHC restriction iv) Antigen processing and presentation- endogenous and exogenous pathways **Maturation and activation of Lymphocytes** B- cell recombination, maturation, Activation and Differentiation T- cell maturation, Activation and Differentiation and T- cell receptor **Immune Effector Mechanisms**	**15 lectures**

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

	II	**Animal Development** Amphibian development Germ cell and Fertilization Cleavage, Morula and blastula and stem cells, Gastrulation. Chick development : Germ cells and Fertilization Cleavage, Morula and blastula, Gastrulation.	**15 Lectures**

		Neurulation. - neural induction, Neural tube formation in amphibians and Chick Organogenesis – Eye / limb Neural Crest Cells	
	III	**Nervous system and its functional organization** Embryonic development of the Brain Vertebrate nervous system: Central Nervous System Nervous system. Functional organization of the human central nervous System Subdivisions of the CNS Forebrain:cerebrum: cerebral hemispheres,cerebral Cortex functional areas,White Matter Diencephalon.; The midbrain ,the Pons,the Medulla Oblongata: The Brain-Stem Cerebellum The spinal Cord Limbic System and the Reticular formation	**15 Lectures**

	IV	**Cellular organization and communications in the nervous system** Chemical Basis of Neural transmission- Introduction Ionic basis of Resting Membrane Potential: Donnan's equilibrium experiments, Nernst's Potential Goldman's equation, Sodium –Potassium pump Action Potential & propagation of Action Potential Synaptic potential and synaptic integration [Electrical and Chemical Synaptic Potential] Excitatory Postsynaptic Potential (EPSP), Inhibitory PostSynaptic Potential (IPSP) Neuro – muscular junctions Synapse and synaptic transmission Synapse: Structure, Types – chemical and electrical, Neurotransmitters – General Introduction Biosynthesis, physiological role, pharmacological significance, (examples of one agonist and one antagonist for each Neurotransmitter mentioned below Acetylcholine (Nicotinic and muscarinic receptors), Dopamine (D1 and D2 receptors), GABA and Glutamate, Neuropeptide (Endorphin and Enkephalin).	**15 Lectures**
RUSLSc 503		**BIOTECHNOLOGY AND GENETIC ENGINEERING -I**	**4 Credits** **60 lectures**

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

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

RUSLSc 504		**cDNA technology** Isolation of mRNA, cDNA synthesis, cloning of double stranded cDNA in plasmid or phage vector, screening a library with nucleic acid probe to find a clone. Polymerase chain reaction : An alternative to cloning (Method , limitations of PCR, Application of PCR, Reverse transcriptase PCR) **Methods of expressing cloned genes** Expression vectors with examples Screening and selection of the desired clone : i) Immunological method ii) Nucleic acid hybridization method iii) Hybrid arrest and Hybrid release method(HART and HRT) **ECOLOGY, CONSERVATION BIOLOGY, ASSESSMENT AND MANAGEMENT-1**	**4 Credits** **60 Lectures**

	I	**Introduction to Fundamentals of environmental science** **Structure of Ecosystem- Biosphere** concept of biotic communities- food chain , food web, Ecological Pyramids , Trophic categories i.e. Producer Consumer, Detritus feeders and decomposers. Mutually supportive relationships as in interspecific interactions eg. Symbiosis, Commensalism Competitive relationship - Ecological Niche, Resource partitioning with eg.	**15 Lectures**

		Abiotic factors with suitable eg. , Optimum zones of stress Limit of Tolerance- Law of limiting factor **Population Dynamics** :- S and J shaped growth curve , r and k selected species with example BioGeochemical cycling C, N, P,S,O, H_2O Primary succession (soil formation).	

	II	Basic introduction about Pests, Pesticides and Environm ent Pesticide toxicity: Bioaccumulation and Biomagnification and Bioremediation of OP pesticide, persistence, Resistance and pollution health of farmers. Biological pest control: predators, parasites, and pathogens. Genetically Engineering and pest control Bioremediation of OP pesticide: using Bacillus Sps. (eg. Malathion Pesticide) Phytoremediation of Organochlorine pesticide (Chloropyrifos) using plants Pesticide regulation: eg. Endosulphan issue.	
	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
RUSLSc P 501	**I**	**Genetics and Immunology - I** Experiments to be performed by students 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.	
RUSLSc P 502		**DEVELOPMENTAL BIOLOGY AND NEUROSCIENCE – I**	**Credits - 1.5, Lectures-60**

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

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

		5. Analysis of soils types for pH, moisture and give significance 6. Water analysis for physicochemical characteristics: DO, BOD,COD, Salinity (compare with Toxicity Limits) 7. Vegetation studies by Quadrat Methods their analysis during biodiversity field visit 8. A visit to aquatic ecosystem and methods for water and plankton collection/ Plankton identification and quantification from river / lake water samples	

References :-

RUSLSc 501	
	Units I and II Genetics
1.	Principles of Genetics bySnustad and Simmons 4th edn. 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. 7. 8.	Principles of Gene Manipulation and Genomics by S. B. Primrose and R. M. Twyman 7th edn., Blackwell publication, asianedn Oxford publishers 2007 Concepts of Genetics W. S. Klug and M. R. Cummings 7th edn. Pearson 2003. 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, 3rdedn. Garland Science pub. 2004.
10.	Principles of Genetics by R. Tamarin 7thedn 2002

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	Units III and IV Immunology
11	Immunology 7thedn. R.A.Goldsky, T. J. Kindt, B. A. Osborne, J. Kuby 2018.
12	Immunology: The immune system in health and disease 6thedn. C. A. Janeway, P. Travers, M. Walport, M. Shlomchik Garland Science Pub. 2005.
13	Cellular and Molecular Immunology, 2ndedn. A. K. Abbas, A. H. Litchman, 5th~~edn 2000.~~
14	Basic Immunology: Functions and disorders of the immune system, 2ndedn. ~~A. K. Abbas, A. H. Litchman, 2nd edn 2004.~~
15	Roitt's Essential Immunology 11thedn. Blackwell publication 2006.
16	Immunology 7thInternational 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.

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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

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	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