Resolution No. : AC/II(18-19).2.RPS8

S.P. Mandali's

RAMNARAIN RUIA AUTONOMOUS COLLEGE

Syllabus for: **M.Sc. Part – I**

Semester I

Program: M.Sc. Life Science

Course Code: LIFE SCIENCE (RPSLSc)

(Semester based credit and grading system with effect from academic year 2017-2018)

M.Sc. Part - I Life Sciences Syllabus
Choice based Credit and Grading System
The Academic year 2019-20

SEMESTER I

COURSE CODE	UNIT	TOPIC HEADINGS	CREDITS	L / WEEK
Paper I	**Environmental Biology, Evolution, Genetics**			
RPSLSc 101	I	Environmental biology	4	4
	II	Biodiversity		4
	III	Evolution		4
	IV	Genetics		4
Paper II	**Cell and Molecular Biology**			
RPSLSc 102	I	Cell Biology	4	4
	II	Cell cycle and cell death		4
	III	Basics of life Processes I		4
	IV	Basics of life Processes II		4
Paper III	**Biochemistry**			
RPSLSc 103	I	Proteins and Lipids	4	4
	II	Carbohydrates, vitamins and minerals		4
	III	Enzymology		4
	IV	Thermodynamics and Electron Transport Chain		4
Paper IV	**Biostatistics and Instrumentation**			
RPSLSc 104	I	Biostatistics I	4	4
	II	Biostatistics II		4
	III	Instrumentation I		4
	IV	Instrumentation II		4

SEMESTER I

PAPER – RPSLSc 101

Environmental Biology, Evolution, Genetics

Unit I: Environmental biology (15L)

Ecosystems: Types of ecosystems [terrestrial (Tropical evergreen forests, Tropical deciduous forests, Deserts, Chaparral, Temperate grasslands, Savannahs and thorn forests, Temperate deciduous forests, Boreal forests/ Taiga, Tundra) and aquatic (Lentic, Lotic, Oceans, Estuaries, Coral reefs)], Habitat fragmentation and niche overlap, Competitive exclusion principle, resource partitioning, character displacement, ecosystem modelling and resource management and conservation.

Community ecology: Nature of communities; fundamental properties of biological communities (Productivity, Diversity, Complexity, Resilience, Stability, Structure); levels of species diversity and its measurement – Simpson's diversity index, Shannon index; edges and ecotones, Succession, disturbances and invasion.

Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation, demes and dispersal.

Renewable energy: Types and advantages over non-renewable sources.

Environmental health: Environmental stress and adaptation, effects of pollution on living systems, environmental pollutants related human disorders, biomonitoring indicators, Climate change

Toxicology: Basic principles of toxicology including LD_{50} and ED_{50}, management of acute intoxication, Biochemical and Genetic mechanism of natural detoxification.

Unit II: Biodiversity Management and GMOs (15L)

Biodiversity: Concept, characterization, generation, maintenance and loss, Magnitude and distribution of biodiversity, economic value, bioprospecting, ecotourism and biodiversity management approaches.

Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

Conservation biology: Principles of conservation, major approaches to management, conservation strategies and cryopreservation.

Genetically modified organisms (GMOs): Definition of GMOs, applications in food and agriculture, Release of GMO in environment – risk analysis, risk assessment and risk management, Identification of GMO in environment and their impact, emergence of drugs/ pesticide/ herbicide resistance and disease burden.

GMO and GMO product detection and analysis: Detection and analysis of GMOs and GMO products: modified gene copy number determination, detection of chromosomal changes, toxicological studies, residual DNA analysis, product analysis – microbial, biochemical and molecular, toxicological evaluation

Unit III: Evolution (15L)

Emergence of evolutionary thoughts: Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Types of selection; Speciation – Punctuated equilibrium and phyletic gradualism; Modern evolutionary synthesis.
Origin of cells and unicellular evolution (For Assignment)
Paleontology and evolutionary history: Introduction to time scales, origins of unicellular and multicellular organisms; major groups of plants and animals; Mass extinction events; Adaptive radiation, convergent evolution and coevolution; stages in primate evolution, Carbon dating, fossils.
Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks; origin of new genes and proteins; gene duplication and divergence, molecular taxonomy.
Astrobiology: Concepts, planetary habitability, extremophiles, abiogenesis, research on surviving extreme habitats, evolution of advanced life, astrobiology of Mars.

Unit IV: Genetics (15L)

Extensions of Mendelian principles: Codominance, incomplete dominance, Multiple alleles, Lethal and Essential Genes.
Non Mendelian Inheritance: Cytoplasmic inheritance, organelle genetics, maternal inheritance.
Microbial genetics: transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating.
Quantitative genetics: Pleiotropy and epitasis, polygenic inheritance, heritability and its measurements, QTL mapping, linkage and crossing over.
Population Genetics: gene pool, gene frequency, Hardy Weinberg Law and its role in evolution and speciation, Pedigree analysis.
Gene mapping methods: Linkage maps and lod score for linkage testing, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.
Human Genome Project and Genome wide associated studies. SNPs

PRACTICALS: RPSLScP 101

1. Study of animal interaction (For identification):
2. Determination of population density (Daphnia or any suitable organism) by sub sampling method.
3. Comparison of two population of a species collected from two areas.
4. Effect of toxicity on *Daphnia / C. elegans / Yeast /Pollen grains.* Apply biostatistical analysis
5. Production/ Extraction of biofuel from plant source and characterization.
6. Problems in Genetics
   a. Problem solving: Multiple alleles, Lethal genes
   b. Problem solving: Hardy Weinberg equation, Pedigree analysis.
7. Practical on fossil specimen (ID)
8. Bioinformatics problem on evolutionary/ phylogenetic time scale, using Mega 7

9. Residual DNA analysis
10. Determination of phosphorous by Fiske-Subbarao method.
11. Honey analysis.

References:

- The Cambridge Encyclopedia of Human Evolution (Cambridge Reference Book) by Steve Jones
- Evolution by Monroe W. Strickberger, CBS publishers and distributors
- Astrobiology: An Introduction by Alan Longstaff, CRC Press.
- Astrobiology: A brief introduction by Kevin W. Plaxco and Michael Gross, The Johns Hopkins University Press.
- Biodiversity, Wilson E.O. (Ed.), National Academy Press, Washigton, D. C.
- Understanding Biodiversity by David Zeigler (May 30, 2007): Amazon Press
- Fundamentals of Ecology by E.P. Odum, Cengage publishers
- Ecology and environment by P.D. Sharma, Rastogi publications
- Elements of Ecology by Smith and Smith, Pearson publishers
- Environmental Biology edited by Mike Calver*et al*: Cambridge University Press
- Molecular Environmental Biology by Seymour J. Garte, Lewis Publishers (1994)
- Basic Environmental Toxicology, Lorris G. Cockerham& Barbara S. Shane, CRC Press.
- David Wright and Pamela Welbourn, Environmental Toxicology, Cambridge university press
- Principles of Genetics- Tamarin
- Microbial Genetics- Freifelder
- iGenetics- Russell
- Genetics- Benjamin Pierce
- Introduction to Genetics- T.A. Brown

PAPER – RPSLSc 102

Cell and Molecular Biology

Unit I: Cell Biology (15L)

Plasma membrane: Different model membrane and their structures, lipid bilayer.
Endoplasmic reticulum: RER and SER, synthesis and transport of protein into the lumen of the ER and its control. Oil bodies and protein bodies in plants.
Golgi complex: Cisternal progression, secretory pathway – transport to the plasma membrane and the extracellular space.
Nucleus: including nuclear pore, lamins, chromatin.
Other organelles: Lysosomes, peroxisomes, mitochondria, chloroplasts and vacuoles.
Cytoskeleton: Filaments and concept of cellular architecture and motility.

Unit II: Cell cycle and Cell Death: (15L)

Introduction: Stages of the cell cycle – G0, G1, S, G2 and M. Molecular events in the various cell cycle stages.
Concept of cyclin and CDKs; activation of the cyclin-CDK complexes.
G1 cyclins: Cln1, Cln2 and Cln3 and its relevance in commitment to cell division.
S phase and G2 phase: S phase cyclin, its inhibitors and pre-replication complex and its significance in DNA replication in the cell cycle.
M phase: Prophase, Metaphase, Anaphase and Telophase, condensins, securin, separase and the end of mitosis.
Checkpoints (unreplicated DNA, spindle attachment, segregation of chromosomes) Meiosis (special division; Ime2, Rec8 and monopolin) Cell-cell fusion in normal and abnormal cells.
Apoptosis: Concept of programmed cell death, Comparison with necrosis, Function of apoptosis in development and maintenance (formation of digits, removal of old cells etc.); Extrinsic and intrinsic pathways of Apoptosis, effects of aberrant apoptosis. Practical- Visit to ~~ACTREC~~ for Flow Cytometry.

Unit III: DNA Replication, Repair and Recombination ~~Basics of Life processes I~~ (15L)

DNA replication: Unit of replication and enzymes, replication origin and replication fork, fidelity and processivity of replication, extrachromosomal replicons (plasmid).
DNA repair: Direct repair, Excision of base pair, Post replicative, SOS.
Recombination: Homologous and Non Homologous.

Unit IV: Transcription and Translation ~~Basics of Life processes II~~ (15L)

Transcription: Classes of RNA molecules - structure and function.
Basic features of RNA synthesis: Transcription factors and machinery.
Transcription in prokaryotes: *E. coli* RNA polymerase, transcription activators and repressors, initiation, elongation and termination, processing of tRNA and rRNA in *E. coli*.
Transcription in Eukaryotes - formation of initiation complex, capping, elongation & termination, RNA processing, RNA editing, major and minor splicing systems,

polyadenylation, Eukaryotic rRNA genes, formation of eukaryotic tRNA molecules, RNA Polymerases of eukaryotes, RNA polymerase II Promoters, Eukaryotic Promoters for RNA polymerase III, Hypersensitive sites, Upstream activation sites and enhancers.
Translation: Outline of Translation.
The Genetic Code: The Decoding System, Codon -Anticodon interaction.
Ribosomes: the special properties of the prokaryotic and eukaryotic ribosomes, ribosome biogenesis.
Translation process: initiation, elongation and termination factors of prokaryotes and eukaryotes mechanisms to overcome premature translation termination, role of suppressor tRNAs.
Inhibitors of protein synthesis: Prokaryotic and eukaryotic protein synthesis inhibitors and their significance.

PRACTICALS: RPSLScP 102

1. Electron Micrographs of cell organelles and cytoskeletal elements.
2. Localization of cytoskeleton elements using Fluorescence staining.
3. Isolation of chloroplasts and chlorophyll estimation from spinach or any other suitable system.
4. Cell stages of mitosis – Onion root tip/meiosis.
5. Inhibition of cell division by colchicine.
6. Isolation and estimation of RNA from Yeast or a suitable system.
7. PCR amplification of 16s rRNA for genus/strain identification.
8. Effect of UV exposure on bacterial colonies to understand DNA repair mechanism.

Reference:

- Principles of Biochemistry- Lehninger, Nelson and Cox
- Gene VIII- Lewin
- Principles of Genetics- Tamarin
- Microbial Genetics- Freifelder
- iGenetics- Russell
- Genetics- Benjamin Pierce
- Introduction to Genetics- T.A. Brown
- Molecular Cell biology: 5th Edition and above. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell

PAPER – RPSLSc 103

Biochemistry

Unit I: Protein and Lipids (15L)

Protein: Primary structure elucidation, secondary structure structures eg. Keratin, Collagen, tertiary structure and the underlying interactions/ forces, quaternary structure (example: haemoglobin), protein folding, domains and motifs, cytoskeletal and extracellular proteins.

Lipids: structure, classification and properties of lipids, lipid assembly, model membranes, formation of liposomes and drug targeting.

Unit II: Carbohydrates, Vitamins, Minerals (15L)

Carbohydrate: Classification and stereochemistry, structure, properties and biological roles of storage and structural polysaccharides such as, starch, glycogen cellulose, pectin, hemicelluloses, chitin, mucopolysaccharides. Biosynthesis and role of N and O- linked glycoprotiens and proteoglycans.

Vitamins: Structure and biological roles of water soluble and lipid soluble vitamins. Hypervitaminosis and deficiency.

Minerals: Structure and biological roles of bulk and trace elements

Unit III: Enzymology (15L)

Enzyme: enzyme and enzyme substrate interactions, enzyme kinetics, chemical modification, and identification of active site amino acids, mechanism of enzyme catalysis with reference to chymotrypsin, lysozymes, metalloenzymes and the role of metals in catalysis with reference to carboxypeptidase.

Regulation of enzyme activity: theory of allostery with reference to AT case, Isozymes with reference to LDH: Co-enzymes and their roles, types of enzyme inhibitors and activators and their kinetics, ribozymes and abzymes.

Unit IV: Thermodynamics and Electron Transport Chain (15L)

Thermodynamics: The laws of thermodynamics, enthalpy, entropy and free energy concepts and their relevance to biological systems.

ET: electron transport chain (ETC) and oxidative/photophosphorylation: structure and function of mitochondrial and chloroplast ETC proteins and light harvesting complex, mechanism of oxidative and photophosphorylation, F_0 F_1 ATPase, theories of ATP synthesis.

PRACTICALS: RPSLScP 103

1. Estimation of sugar by DNSA method from a biological source.
2. Enzyme kinetics, effects of pH, temperature, time and substrate concentration, determination of Km and Vmax using phosphatase/Amylase.
3. Estimation of protein by Folin Lowry and Biuret methods. Compare sensitivity by using Folin Lowry method, Biuret method and UV absorbance at 280nm.
4. Lipid extraction and estimation by Bligh and Dyer method.
5. Estimation of ascorbic acid from vegetable source by colorimetric method.
6. Estimation of Ca, Fe, Mg etc from samples using Atomic Absorption Spectroscopy.
7. Extraction of isoenzymes of LDH from different tissues in chicken and separation by SDS PAGE.

References

Name :Principle of Biochemistry
Author :Lehninger, Albert L. (III Ed. 2000 worth pub)
Publisher :CBs publishers and distributors

Name :Biochemistry
Author :Stryer, Lubert
Publisher :W. H. Freeman

Name :Student's companion for Stryer's biochemistry
Author :Gumport, Richard I, Jonas, Ana, Mintel, Richard, Rhodes,Carl
Publisher :W. H. Freeman

Name :Biochemistry and Molecular biology
Author :Elliott, Willam H, Elliott, Daphne C
Publisher :Oxford University Press

Name :Oxford dictionary of biochemistry and molecular biology
Publisher :Oxford University Press

Name :Proteins- Structures and molecular properties
Author :Creighton, T. E
Publisher :Freeman and Co

Name :Biochemistry of cell membranes: a compendium of selected topics
Author :Papa S., ed. Tager, J. M., ed
Publisher :Birkhauser Verlag

Name :Membrane protein models
Author :Findlay, J. B. C., ed
Publisher :IOS scientific publishers

PAPER – RPSLSc 104

Biostatistics and Instrumentation

Unit I: Biostatistics I (15L)

Introduction: Introduction, scope, application and uses of statistics, collection and classification of data, census and sampling, graphs and diagrams, arithmetic mean, median, standard deviation.

Correlation and regression: for ungrouped data, scatter diagram, calculation and interagtion of correlation coefficient, linear regression coefficient and equation of the lines of regression, non-linear relationship transformable to linear form ($Y=ab^X$, $Y=a^xb$).

Probability: definition, addition and multiplicative laws (without proof). Random variable and its distribution, binomial probability distribution, examples and conditions, means and variance, poisson probability distribution, examples and conditions, means and variance, continuous variable, normal distribution, use of normal probability table for finding probabilities.

Population Statistics: Population parameters and sample statistics, sampling techniques, simple random sampling, stratified random sampling, systematic sampling, standard error of mean.

Estimation, point and interval, confidence interval for population, mean and proportion.

Unit II: Biostatistics II (15L)

Hypothesis testing: type-1 and typr-2 errors, levels of significance, one tailed and 2 tailed tests, application to single mean and single proportion, equality of two population means and two population proportions.

Chi-test: for independent attributes in rxc table, special case 2x2 table.

Students test for significance for correlation, coefficient r for P=0 (small sample tests). Fishers Z transformation coefficient for getting rp=0 in large samples, test of significance for r (p=0).

Design of experiment: principles and concepts of completely randomised design, randomized block design and Latin square design.

Variance ratio F tests: analysis of variance in one way classification.

Non-parametric tests: distribution free methods, sign test for method pairs, Willcoxon test for unpaired data, run test.

Unit III: Basic Instrumentation (15L)

pH, Buffers: Principles and theory, pH meters.

Colorimetry and spectroscopy: Basic principles, nature of electromagnetic radiation, Beer- Lambert laws, colorimetric methods and instruments, principles of spectroscopy ,types of spectra- absorbance, emission, fluorescence and action spectra, single and double beam spectrophotometers, densitometers, circular dichroism and their applications.

Microscopy: Basic principles, instrumentation, sample preparation for optical, phase-contrast, interference, polarisation, inverted, fluorescence, confocal and electron microscopes and their applications.

Microtomy: Principles and types, sample preparation and sectioning parameters.

Centrifugation: Principles and types, simple and differential, ultracentrifugation – preparative and analytical.
Visits to Research Institutes

Unit IV: Advanced Instrumentation (15L)

Chromatography: Principle, methodology and applications of chromatography using (paper, thin layer, column(gel filtration, ion exchange, affinity, gas, HPLC,FPLC etc).
Electrophoresis: Principles and types of electrophoresis and their applications for proteins, nucleic acids, including gradient gel and pulse-field gel electrophoresis, gel matrices-polyacrylamide, agarose etc, critical parameters for optimum separation and resolution , two dimensional electrophoresis(IEF).
X-ray crystallography, Nuclear Magnetic Resonance (NMR) spectra, Magnetic Resonance Imaging (MRI – fMRI) lasers in biology and medicines.
Radioisotope methods and tracer techniques in biology: Basic principles of radioactivity, properties and handling of radioisotopes in biology and medicine, radiation units, Geiger- Muller and scintillation counters, autoradiography, radionucleide imaging, CT Scan and PET scan
Techniques: Histology, ELISA, RIA, Immunoprecipitation - single and double, Primers, PCR and its types, RFLP, RAPD, AFLP, Blotting techniques: Southern, Western and Northern, In- situ Hybridization: FISH, GISH SKY, Chromosome Painting

PRACTICALS: RPSLScP 104

1. Preparation of Phosphate, Tris, citrate buffers of various molarity.
2. Determination of lambda max of $KMnO_4$, $CoCl_2$, methylene blue by spectrophotometer.
3. Verification of Beer-lamberts law by UV Visible spectrophotometer
4. Separation of amino acids by paper chromatography.
5. Separation of lipids by TLC.
6. Separation of plant pigments by column chromatography.
7. Analyzing the data using Students t-Test, ANOVA and Regression analysis.

References:

- Practical biochemistry – Principles and Techniques- Wilson K and Walker J
- Essentials of Biophysics- Narayanan P.
- Analytical Techniques in Biochemistry and Molecular Biology by Rajan Katoch,
- Modern Analytical Biochemistry; Rodney Boyer (3rd Edition)
- Principles of Instrumental Analysis: Skoog
- Methods in Biostatistics- Mahajan P.K