Syllabus for Admission for the PhD programme in RMRIMS for the Academic Year 2015-2016 for Calcutta University

There are two part of the syllabus, part 'A' and part 'B'. Part 'A' is compulsory. Those who qualify part 'A' will be evaluated for part 'B'

Part A

This part is common to all the candidates appearing for pre Ph.D. registration test. There will be 50 objective type questions in Part 'A' of written test paper (One mark each; Total 50 marks, Time: one hour, no negative marking).

Topics
1. Questions will be asked from general awareness of science and its interface with society, aptitude of scientific and quantitative reasoning to evaluate the creativity, analytical ability and research aptitude of candidates.
2. Computer application.

Part B

Candidates have options to select only one group of part 'B'. The candidate will answer any 25 questions out of 50 very short questions from only one group. (Four marks each. Total 100 marks, Time: 2 ½ hours).

GROUP-A: *LIFE SCIENCES*:
1. Structure of atoms, molecules and chemical bonds. Structure and function of carbohydrates, lipids, proteins, nucleic acids and vitamins. Stabilizing interactions (electrostatic, hydrogen bonding, hydrophobic interaction etc.). Principles of biophysical chemistry, pH, buffer. Bioenergetics, glycolysis, oxidative phosphorylation. Principles of catalysis, enzymes and enzyme kinetics, enzyme assay, enzyme regulation.
2. Cellular Organization: Structure of membrane and function, lipid bilayer and membrane protein diffusion, osmosis, ion channels, ion pumps. Structure and function of nucleus, mitochondria, Golgi bodies and plastids. Organization of gene and chromosomes, structure of chromatin and chromosomes, heterochromatin, euchromatin. Cell division and cell cycle.
3. Bio molecules and their process: DNA replication and recombination. RNA synthesis and processing. Protein synthesis and post transcriptional modification.
4. Cellular communication and signalling: Host parasite interaction. Cell surface receptors. Signal Transduction Pathways and its regulation. Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. Epitopes, structure and function of antibody, generation of antibody diversity, monoclonal antibodies, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors. Hypersensitivity and autoimmunity. Vaccine.
5. Photosynthesis, respiration and photorespiration, nitrogen metabolism, plant hormons. Structure, function and mechanisms of action of phytochromes, stomatal movement, photoperiodism and biological clocks. Blood and circulation, blood group and blood coagulation, cardiovascular system, respiration, central and peripheral nervous system, physiology of excretion, kidney, waste elimination, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance, thermoregulation, digestion and absorption of food, endocrine glands, hormones and diseases.
6. Mendelian principles, deviation from Mendelian inheritance, concept of gene, allele, multiple alleles, pseudoallele, extensions of Mendelian principles, incomplete dominance, gene interactions, linkage and crossing over. Extra chromosomal inheritance. Microbial genetics, transformation, conjugation, transduction and sex-duction. Structural and numerical alterations of chromosomes, deletion, duplication, inversion, translocation, ploidy and their genetic implications.
7. Concepts of species and hierarchical taxa, biological nomenclature, classical and quantititative methods of taxonomy of plants, animals and microorganisms, structural organization of unicellular, colonial and multicellular forms.

8. The Environment, biotic and abiotic interactions, ecological niche, population growth curves, species interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis, community structure, species diversity, succession, concept of climax, energy flow and mineral cycling (CNP), biomes.

9. Sterilization; Media preparation; Plant and animal tissue/cell culture; Drug sensitivity assay; Fermentation.

10. Methods for isolation and purification of nucleic acids and proteins, gel electrophoresis, isoelectric focusing, HPLC, FPLC, molecular cloning of DNA/RNA in bacterial systems, expression of recombinant proteins, isolation of specific nucleic acid sequences, generation of genomic and cDNA libraries, in vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms, protein sequencing, detection of post-translation modification of proteins, DNA sequencing, micro array, RFLP, RAPD and AFLP, ELISA, RIA, western blot, immunoprecipitation, floweytometry and immunofluorescence microscopy. Analysis of biomolecules using UV/visible spectroscopy, fluorescence spectroscopy, staining techniques, different types of microscopy, immunohistochemistry. Quality Control, Good Clinical Practice (GCP), Good Laboratory practice (GLP).

11. Measures of central tendency and dispersal; probability, sampling distribution, confidence interval, errors, levels of significance, regression and correlation, t-test, analysis of variance, X2 test.

12. Nucleic acid and protein sequence databases, data mining methods for DNA and protein sequence analysis, web-based tools for sequence searches, motif analysis and presentation, multiple sequence alignments. Molecular modeling: Energy minimization, conformational analysis, global conformational analysis, approaches and problems; minimum conformations. Protein Ligand docking, QSAR, methods for protein-ligand docking, applications; Screening small molecule databases, docking of combinatorial libraries, input data, analyzing docking results software accessibility; Flexidock, creating input structures, Ligand proposition, binding pockets, flexible bonds, genetic algorithm, scoring. Protein folding and model generation; secondary structure prediction, analyzing secondary structure; protein loop searching, concept of homology modeling , homologous sequence identification; Align structure; Construction of variable and conserved region, topology fingerprint approach, alignment algorithm analysis, crystallographic databases.

GROUP-B: *BIOSTATISTICS*
1. Fundamentals of Biostatistics:
    a. Statistics: Introduction, its role and uses; Data Organization; Graphic and Pictorial representation of data; Measures of Central Tendencies and dispersion, Skewness and Kurtosis, Coefficient of variation
    b. Correlation : Bivariate distribution, Graphical presentation of two continuous variables, Karl Pearson Product Moment correlation coefficient, its statistical significance, Properties of correlation, Probable error, Partial and multiple correlation, Spearman's Rank Correlation.
    c. Regression: Linear regression, Lines of regression, Principles of least squares and curve fitting, Simple regression Model, Regression equations, Using regression equation, Multiple Linear Regression Model, Multiple Linear regression equation, fitting of regression equations, dummy variables, probit and logit transformations, Logistic regression.
2. Concepts of Probability and distribution:
    a. Definitions of probability, basic terms, Law of probability- addition and multiplication, Set theory, sample space and region, Bayes theorem, random variables, expectation.
    b. Discrete Probability Distribution: Binomial distribution, Poisson Distribution, Negative Binomial distribution, Hyper-geometric distribution.
    c. Continuous Probability Distributions: Normal Distribution, Student's t-distribution , Fisher Transformation, Beta Distribution, Uniform distribution, gamma distribution of type I and II, F-distribution
3. Theory of sampling:
    a. Population, sample, parameter and statistic, Sample distribution of mean and variance, Standard error, Point and Confidence interval, Law of large numbers, Central limit theorem.
    b. Sampling theory – Probabilistic and non-probabilistic sampling designs, Simple random sampling, stratified Random sampling, systematic sampling, cluster sampling, multi-stage sampling, Probability-proportional to size (PPS) Sampling, Snowball sampling, Respondent driven sampling.
4. Statistical Inferences:

a. Parametric Methods – Test of significance and hypothesis, type –I and II error, Power, sample size calculation, Critical value, regions of acceptance and rejection, Two-tailed tests, One-tailed tests, Test of significance based on normal distribution, student's t-distribution, Chi-square distribution, Fisher's exact test, Analysis of variance (one and two way).

b. Non-parametric Methods – Sign test, Sign test- Matched Pair, Run Test, Wilcoxon-signed-ranked test, Median Test, Mann-Whitney Test, Kruskal-Wallis one-way test, Two-way Freedman Test, Kolmogorov-Smirnov goodness of fit test, Spearman's rank test

c. Design of Experiments – Principles of design of experiment, Completely randomized design, Randomized Block Design, Latin square Design, factorial experiment (2-fators at 2 levels), Confounding.

5. Vital Statistics – Death rates and ratios, Measures of fertility, Measures of morbidity, Life tables – standard and abridged, Burden of disease (DALY's)

6. Basic Epidemiology:
   a. Definitions of epidemiology, basic epidemiological measures like prevalence, Incidence rate, Incidence risk, Relative risk, Attributable risk, rate ratio, risk ratio, odds-ratio, relation between prevalence and incidence, Standardization – direct and indirect.

   b. Epidemiological Designs - Cohort design, Case-control design, nested case-control design, cross-sectional design, survival analysis, matched-analysis, Concept of clinical trials, phases of clinical trials, concept of randomization, blinding, Randomized clinical trials, parallel designs, cross-over design, dose-response studies, statistical test for bioequivalence, statistical quality control.

   c. Epidemiological Bias and control – Confounding, Selection bias, Measurement error, Misclassifications, Sparse-data bias.

GROUP-C: *REMOTE SENSING*

1. Definition – Components of Remote Sensing – Energy, Sensor, Interacting Body - Active and Passive Remote Sensing – Platforms – Aerial and Space Platforms – Electro Magnetic Radiation (EMR) – EMR spectrum – Visible, Infra Red (IR), Near IR, Middle IR, Thermal IR and Microwave, Real and Ideal remote sensing System.

2. Platform and sensor: Satellite Basics. Types of Sensors, Resolution of Sensors – Spectral, Spatial, Radiometric and Temporal.

3. EMR interaction with atmosphere and earth materials: Atmospheric characteristics – Scattering of EMR – Rayleigh, Mie, Non-selective and Raman Scattering –Significance of Atmospheric windows – EMR interaction with Earth Surface Materials –Reflectance – Spectral Signature curves – EMR interaction with water, soil and Earth Surface.

4. Optical, thermal and microwave remote sensing: Description of Multi Spectral Scanning – Along and Across Track Scanners – Description of Sensors in Landsat, IRS series – Current Satellites - Radar – Speckle - Back Scattering – Side Looking Airborne Radar – Synthetic Aperture Radar – Radiometer – Geometrical characteristics.

5. Digital image processing: Definition of Digital Image, Source of Data, and Data formats. Image Pre-processing: Radiometric correction, Geometric Correction: Georeferencing method. Image Enhancement: Image reduction and Magnification, Contrast Enhancement, Edge Enhancement, Image Fusion. Information Extraction: Image Classification – Supervised and Unsupervised, and their uses; Land sue/ Land cover mapping.

6. Geographic information system: GIS – Components of GIS – Hardware, Software and Organisational Context – Data – Spatial and Non-Spatial – Maps – Types of Maps – Projection – Types of Projection - Data Input – Digitizer, Scanner – Editing – Raster and Vector data structures – Comparison of Raster and Vector data structure – Analysis using Raster and Vector data – Retrieval, Reclassification, Overlaying, Buffering.

7. Global positioning system: Introduction of Global Positioning System, Satellite Constellation, Geo-positioning - Basic Concept. Control segment, Space Segment, User Segment, GPS Positioning type – Absolute Positioning, and Relative Positioning. Error in GPS, DGPS- methods & application.

8. Spatial Databases for Public Health, Point Pattern Analysis of Health Data, Clustering of Health Events, Spatial prediction.