St.Xavier's College(Autonomous), Kolkata

Advertisement for admission to Ph.D. Program 2019 in
(Physics/Microbiology/Biotechnology/Commerce)

Applications are invited for admission to the Ph.D. program in the Departments of (Physics/Microbiology/Biotechnology/Commerce), St.Xavier's College (Autonomous), Kolkata, affiliated to the University of Calcutta, in the prescribed proforma downloadable from the College website at **//www.sxccal.edu.** For further details, please visit the college website:**www.sxccal.edu**

The details below appear in the SXC website under link from appropriate announcement for RET

Essential qualification: (M. Sc/M.Com) in (Physics/Microbiology/Biotechnology/Commerce)

Eligibility:

- Candidates with at least 55% marks in (Physics/Microbiology/Biotechnology/Commerce) at the (M.Sc./M.Com.) level from the College or from any other UGC recognized university are eligible to take the examination in the related stream.
- The candidate has to have either NET/ SET/ INSPIRE/ MPhil (from any recognized university with 2-semester/ 1-year course work) or has to qualify in the research entrance test (RET) conducted by the department.
- Those who are expected to obtain MPhil in (Physics/Microbiology/Biotechnology/Commerce) from any UGC recognized university by August 31**, 2019** would also be exempted from RET and be eligible to appear directly in the interview.
- Those who have qualified in NET/SET/INSPIRE or already obtained M.Phil. degree would be exempted from the examination. They may directly submit a statement of purpose (SoP) indicating the area of research interest (not exceeding 1000 words) and appear in the interview.

Procedure:

- The completely filled application form along with a bank draft of Rs.1000/- only drawn in favour of St.Xavier's College is to be submitted to the Ph.D. Cell, St.Xavier's College, Kolkata, by the last date mentioned.
  Office Hours: 10 A.M.-1.00 P.M., and 2.00P.M. – 4.00P.M. (on all weekdays)
  10 A.M.-12.00 Noon (Saturday)
- All Xerox and self-attested copies of mark sheets and certificates to be submitted along with the application. Incomplete applications are liable to be cancelled.
- The Research Eligibility Test (RET) of 100 marks for the suitable candidates will be held once a year and the qualifying marks will be fixed at 50%.
- The RET syllabus for every department is available in the corresponding department site.
- The maximum number of candidates enrolled this year (**2019**) depending on their success at the written examination and interview will be in:

Physics: Four (4)

 Dr. Tapati Dutta-(1) Soft Matter , Statistical Physics, Fluid Dynamics

 Dr. Suparna Roy Chowdhury (2) Astrophysics, Biophysics

 Dr. Shubhankar Ghosh (1) a) Nano-structured energy materials b) Optical studies of industrially important Glass & Ceramics.

Microbiology: Eight (8)

1.   Dr. Xavier Savarimuthu: (1) Environmental Microbiology

2.   Dr. Sudeshna Shyam Choudhury: (2) Plant Biochemistry and General Biochemistry including food and nutrition

3.   Dr. Madhumita Maitra: (2) Medical Microbiology and General Microbiology

4.   Dr. Anindita Banerjee: (1) Plant Biotechnology. Characterization of antimicrobials.

5.   Dr. Jaydip Ghosh: (2) Bacteriology, Biochemistry and Molecular Biology

Biotechnology: Three (3)

1.   Dr. Sudipa Saha: (1)The area of interest of the supervisor: Study of structure and function of eye lens protein α-crystallin and its role in cataract.

2.   Dr. Aniruddha Banerji: 1 (only with fellowship) Cancer Biology

 3.   Dr. Ronita Nag Chaudhuri: 1 (CSIR-NET/UGC-NET/GATE qualified)

Epigenetic regulation during DNA damage response

Commerce: Eight (8)

Serial Number	Name of the Registered PhD Supervisor	Number of vacancies	Area of Specialisation
1	Dr. Samir Kumar Lobwo	1	Accounting & Finance
2	Dr. Atish Prosad Mondal	1	Accounting & Finance
3	Dr. Amitava Roy	1	Accounting & Finance
4	Dr. Sumona Ghosh	1	Accounting & Finance
5	Dr. Sumana Guha	1	Management
6	Dr. Samrat Roy	2	Accounting & Finance
7	Dr. Sreemoyee Guha Roy	1	Accounting & Finance
8	Dr. Sanjib Kumar Basu	1	Accounting & Finance

Structure of the Examination:

- Only multiple choice questions
- The details of the syllabus is available in the College Website under the corresponding Department's RET Syllabus
- The eligible candidates identified through RET/ NET/ SET/ MPhil/INSPIRE, will have to submit statement of purpose (SoP) indicating the area of research interest (not exceeding 1000 words) on which a final interview will be conducted.

- The SoP has to be submitted at the time of application itself.
- Those who are expected to obtain M.Sc./M.Com. in
  (Physics/Microbiology/Biotechnology/Commerce) from any UGC recognized university by
  August 31, *2019* would also be eligible to apply for RET. However, the final selection of these
  candidates would be contingent on their obtaining at least 55% of marks in aggregate in their
  M.Sc./M.Com. examination from the College, or any other UGC recognized university.
- The list of finally selected candidates would be posted in the Departmental Notice Board and
  in the College website;

Important Dates:

- Forms can be downloaded from the College website from: **June 9, 2019 (Sunday**)
- Application for Ph.D. program including that for the Research Entrance Test (RET)
  with SoP to be submitted between: **June 17th to 28th, 2019**
- List of eligible candidates for RET/ Direct Interview**: July 2nd, on College Website and Ph.D.
  Cell , St.Xavier's College.**
- Date of RET Examination: **July 8th, 2019 (Monday), 3.00 P.M.** in the **R.K.Hall, St.Xavier's
  College**
- Date of Publication of RET Result and List of candidates for final interview: **July 12th , 2019
  (Friday) on College Website and Ph.D. Cell , St.Xavier's College.**
- Date of final Interview: **26.7.2019, (Friday)** from **11.00.A.M.** in the **R.K.Hall, St.Xavier's
  College**

*Please bring the receipt of the payment of Rs.1000/- , along with a photo identity card
(passport/Aadhar/PAN) at the RET examination and/or Interview.*

Physics

Mathematical Methods
Vector Calculus : Gradient, Divergence & Curl, Divergence & Stokes theorem.
Differential Equations: Second order ordinary differential equations with non-constant coefficients. Inhomogeneous Differential Equations and Green's Function. Integral transforms. Complex variables theory: Cauchy-Riemann equations, Application of Residue Theorem.
Tensor Analysis: Index notation, Transformation laws, Quotient theorem.
Group Theory: Discrete groups, Basic notions of group representations and symmetries, Lie groups and Lie algebras : SU(2) as a case study.

Classical Physics
Classical Mechanics: Conservation Principles, Calculus of Variations, Lagrangian and Hamiltonian Dynamics, Poisson Brackets. Canonical Transformations, Action-angle variables, Small oscillations. Rigid bodies: Moment of Inertia Tensor, Euler equations of motion.
Electrodynamics: Maxwell's equations, Scalar and Vector potentials, Gauge transformations. Green's function for wave equation. Radiation from electric dipole and accelerated charges, Retarded potentials, Larmor formula.
Special Relativity: Lorentz-transformation, Four vectors and relativistic dynamics. Lagrangian for a point relativistic particle in an electromagnetic field.

Quantum Physics
Quantum Mechanics: Formalism: Vector Space, Operators, Time evolution (pictures), Angular momentum, Identical Particles. Bound State problems in 1D, Harmonic Oscillator, Hydrogen atom problem, Coulomb Potential. Scattering theory, Born Approximation. Approximate methods: Variational method, First order time independent perturbation theory. Time dependent perturbation and Fermi Golden rule. Relativistic theory: Klein Gordon and Dirac Equations, Elementary notions on Scalar fields and simple applications of Noether's theorem.
Solid State Physics: Crystallography: Crystallographic point group, Bragg-Laue formulation of X-Ray Diffraction, Schottky defects. Lattice vibrations: Phonon heat capacity (Einstein's and Debye's theory), Band theory of solids: Bloch equation, effective mass of electrons and holes, Fermi surfaces. Dielectric and Magnetic properties of solids. NMR and ESR (essential ideas only). Superconductivity: BCS theory, High Tc Superconductors (qualitative).
Atomic and Molecular Physics: Hydrogenic wavefunctions, Interaction with Radiation: Induced absorption and emission, Transition rates and selection rules. Fine structure splitting. Zeeman, Paschen-Back and Stark effects. Molecular Structure: bond length and dissociation energy of diatomic molecules. Molecular Rotational, Vibrational and Raman spectra of diatomic molecules. LASER: Spontaneous & Stimulated emissions, Einstein's A & B coefficients.
Nuclear and Particle Physics: Basic Properties: Size, Shape, Charge distribution, Parity, Isospin, Binding. Properties of Deuteron. Meson theory of nuclear Interactions. Fermi theory of beta decay, Nuclear models and Nuclear reactions. Symmetries and Conservation laws of particle interactions, Classification of hadrons, SU(2) and SU(3), Strange particles, CP violation, CPT invariance, elementary ideas about electroweak interactions and QCD.

Thermal Physics
Kinetic theory : Maxwell's velocity distribution, mean free path & transport phenomena.
Thermodynamics : Laws of Thermodynamics, Entropy, Phase Transition.
Statistical Mechanics: Microcanonical, Canonical and Grand Canonical Ensembles, Quantum Mechanical ensemble theory: Density matrix, Maxwell, Fermi-Dirac and Bose-Einstein Statistics. He-3 and He-4 (introductory ideas).

Electronics
Semiconductor Physics: Current components & Transistor biasing , junction band diagrams, Amplifiers (Class A, AB, B), Oscillators (RC, Hartley, Colpitts, Wien Bridge), h-parameters.

Devices: BJT, FET and MOSFETs, Tunnel Diodes, UJT and SCR. Analog Circuits: OPAMPS, Comparators and Multivibrators. Digital Circuits: Basic gates and Boolean Algebra, K-map simplifications, A/D, D/A conversion, Counters and Multiplexers. Microprocessors.

Computation & Laboratory Techniques

Algorithms involving iteration and choice. Fortran / Python / C (any one) implementation of root finding techniques (iteration, bisection, Newton-Raphson) for non linear equations in one variable, integration (Simpson and Trapezoidal rules) and Solution of ordinary differential equations (Euler and modified Euler).

Estimation & propagation of errors in experiments.

Microbiology

Syllabus

- Biological macromolecules
- Biophysical techniques, microscopy, spectroscopy, thermodynamics
- Cell biology and cell signaling, Cellular structure and function
- Enzymes, microbial metabolism, photosynthesis
- Molecular biology (DNA replication, transformation, conjugation transduction, mutation and repair)
- Environmental microbiology
- Recombinant DNA technology
- Immunology and cancer biology
- Industrial microbiology

Commerce

Unit 1: Business Environment and International Business

- Concepts and elements of business environment: Economic environment- Economic systems, Economic policies (Monetary and fiscal policies); Political environment- Role of government in business; Corporate Social Responsibility (CSR)
- Scope and importance of international business; Globalization and its drivers; Modes of entry into international business
- Theories of international trade; Government intervention in international trade; Tariff and non-tariff barriers; India's foreign trade policy
- Foreign direct investment (FDI) and Foreign portfolio investment (FPI); Types of FDI, Costs and benefits of FDI to home and host countries; Trends in FDI; India's FDI policy
- Balance of payments (BOP): Importance and components of BOP
- Regional Economic Integration: Levels of Regional Economic Integration; Trade

creation and diversion effects; Regional Trade Agreements: European Union (EU), ASEAN, SAARC, NAFTA
- International Economic institutions: IMF, World Bank, UNCTAD
- World Trade Organisation (WTO): Functions and objectives of WTO; Agriculture Agreement; GATS; TRIPS; TRIMS

Unit 2: Business Economics

- Meaning and scope of business economics
- Objectives of business firms
- Demand analysis: Law of demand; Elasticity of demand and its measurement; Relationship between AR and MR
- Consumer behavior: Utility analysis; Indifference curve analysis
- Law of Variable Proportions: Law of Returns to Scale
- Theory of cost: Short-run and long-run cost curves
- Price determination under different market forms: Perfect competition; Monopolistic competition; Oligopoly- Price leadership model; Monopoly; Price discrimination
- Pricing strategies: Price skimming; Price penetration; Peak load pricing

Unit 3: Accounting and Auditing

- Basic accounting principles; concepts and postulates
- Partnership Accounts: Admission, Retirement, Death, Dissolution and Insolvency of partnership firms
- Corporate Accounting: Issue, forfeiture and reissue of shares; Liquidation of companies; Acquisition, merger, amalgamation and reconstruction of companies
- Holding company accounts
- Cost and Management Accounting: Marginal costing and Break-even analysis; Standard costing; Budgetary control; Process costing; Activity Based Costing (ABC); Costing for decision-making; Life cycle costing, Target costing and JIT
- Financial Statements Analysis: Ratio analysis; Cash flow analysis
- Human Resources Accounting; Environmental Accounting
- Indian Accounting Standards and IFRS
- Auditing: Independent financial audit; Vouching; Verification ad valuation of assets and liabilities; Audit of financial statements and audit report; Cost audit
- Recent Trends in Auditing: Management audit; Social audit; Environment audit.

Unit 4: Business Finance

- Scope and sources of finance
- Cost of capital and time value of money
- Capital structure
- Capital budgeting decisions: Conventional and modern techniques of capital budgeting analysis
- Working capital management
- Dividend decision: Theories and policies
- Risk and return analysis
- Foreign exchange market; Exchange rate risk and hedging techniques
- International financial markets and instruments: Euro currency; GDRs; ADRs
- International arbitrage; Multinational capital budgeting

Unit 5: Business Statistics

- Measures of central tendency
- Measures of dispersion
- Measures of skewness
- Correlation and regression of two variables
- Probability: Approaches to probability; Bayes' theorem
- Probability distributions: Binomial, poisson and normal distributions
- Sampling and estimation: Concepts; Methods of sampling - probability and non- probability methods; Sampling distribution; Central limit theorem; Standard error; Statistical estimation
- Hypothesis testing: z-test; t-test; ANOVA; Chi–square test; Mann-Whitney test (U- test); Kruskal-Wallis test (H-test); Rank correlation test

Unit 6: Business Management

- Principles and functions of management
- Organization structure: Formal and informal organizations; Span of control
- Responsibility and authority: Delegation of authority and decentralization
- Motivation and leadership: Concept and theories
- Corporate governance and business ethics

Unit 7: Human Resource Management

- Human resource management: Concept, role and functions of HRM; Human resource planning; Recruitment and selection; Training and development; Succession planning
- Compensation management: Job evaluation; Incentives and fringe benefits
- Performance appraisal including 360 degree performance appraisal
- Collective bargaining and workers' participation in management
- Personality: Perception; Attitudes; Emotional Intelligence; Group dynamics; Power and politics; Conflict and negotiation; Stress management
- Organizational Culture: Organizational development and organizational change

Unit 8: Indian Financial System

- Overview of Indian financial system
- Types of banks: Commercial banks; Regional Rural Banks (RRBs); Foreign banks; Cooperative banks
- Reserve Bank of India: Functions; Role and monetary policy management
- Banking sector reforms in India: Basel norms; Risk management; NPA management
- Financial markets: Money market; Capital market; Government securities market
- Financial Institutions: Development Finance Institutions (DFIs); Non-Banking Financial Companies (NBFCs); Mutual Funds; Pension Funds
- Financial Regulators in India
- Financial sector reforms including financial inclusion
- Digitization of banking and other financial services: Internet banking; mobile banking; Digital payments systems
- Insurance: Types of insurance- Life and Non-life insurance; Risk classification and management; Factors limiting the insurability of risk; Re-insurance; Regulatory framework of insurance- IRDA and its role

Unit 9: Marketing Management

- Marketing: Concept and approaches; Marketing channels; Marketing mix; Strategic marketing planning; Market segmentation, targeting and positioning
- Product decisions: Concept; Product line; Product mix decisions; Product life cycle; New product development
- Pricing decisions: Factors affecting price determination; Pricing policies and strategies

- Promotion decisions: Role of promotion in marketing; Promotion methods - Advertising; Personal selling; Publicity; Sales promotion tools and techniques; Promotion mix
- Distribution decisions: Channels of distribution; Channel management
- Consumer Behaviour; Consumer buying process; factors influencing consumer buying decisions
- Service marketing
- Trends in marketing: Social marketing; Online marketing; Green marketing; Direct marketing; Rural marketing; CRM
- Logistics management

Unit 10: TAXATION

- Income-tax: Basic concepts; Residential status and tax incidence; Exempted incomes; Agricultural income; Computation of taxable income under various heads; Deductions from Gross total income; Assessment of Individuals; Clubbing of incomes
- International Taxation: Double taxation and its avoidance mechanism; Transfer pricing
- Corporate Tax Planning: Concepts and significance of corporate tax planning; Tax avoidance versus tax evasion; Techniques of corporate tax planning; Tax considerations in specific business situations: Make or buy decisions; Own or lease an asset; Retain; Renewal or replacement of asset; Shut down or continue operations
- Deduction and collection of tax at source; Advance payment of tax; E-filing of income-tax returns
- Goods and Services Tax (GST): Objectives and main provisions; Benefits of GST; Implementation mechanism; Working of dual GST.

Biotechnology

1. BIOLOGICAL MACROMOLECULES
A. Structure of atoms, molecules and chemical bonds.
B. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).
C. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).
D. Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).
E. Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.
F. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes
G. Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).
H. Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA).

2. CELL BIOLOGY & CELL SIGNALING
A. **Membrane structure and function:** (Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport,electrical properties of membranes).
B. **Structural organization and function of intracellular organelles** (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility).

C. **Organization of genes and chromosomes** (Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons).

D. **Cell division and cell cycle** (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle).

E. **Cancer** Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, metastasis, interaction of cancer cells with normal cells, therapeutic interventions of uncontrolled cell growth.

F. **Programmed cell death, aging and senescence**

G. **Cell signaling** General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation. Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways.

3. MOLECULAR BIOLOGY

A. **DNA replication, repair and recombination** (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination).

B. **RNA synthesis and processing** (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport).

C. **Protein synthesis and processing** (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post-translational modification of proteins).

D. **Control of gene expression at transcription and translation level** (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).

4. GENETICS

A. **Mendelian principles :** Dominance, segregation, independent assortment.

B. **Concept of gene :** Allele, multiple alleles, pseudoallele, complementation tests

C. **Extensions of Mendelian principles :** Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

D. **Gene mapping methods :** Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.

E. **Extra chromosomal inheritance :** Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

F. **Microbial genetics:** Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.

G. **Human genetics:** Pedigree analysis, karyotypes, genetic disorders.

H. **Mutation:** Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.

I. **Structural and numerical alterations of chromosomes :** Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

J. **Recombination:** Homologous and non-homologous recombination including transposition.

K. **Population genetics** – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift.

5. ECOLOGY AND EVOLUTION

A. **Ecosystem and Environment:** Physical environment; biotic environment; biotic and abiotic interactions. Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition.

B. **Population Ecology:** Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.

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

D. **Community Ecology:** Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.

E. **Mechanisms of Evolution:** Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution

F. **Molecular Evolution:** Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence.

6. METHODS IN BIOLOGY

A. **Molecular Biology and Recombinant DNA methods:** Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods.

Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, Isoelectric focusing gels.

Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems.

Expression of recombinant proteins using bacterial, animal and plant vectors.

Isolation of specific nucleic acid sequences

Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors.

In vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms.

Protein sequencing methods, detection of post translation modification of proteins.

DNA sequencing methods, strategies for genome sequencing.

Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques

Isolation, separation and analysis of carbohydrate and lipid molecules

RFLP, RAPD and AFLP techniques

B. **Microscopic techniques:** Visulization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM, image processing methods in microscopy.

C. **Biophysical Methods:** Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.

D. Statistical Methods: Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); Sampling distribution Levels of significance; Regression and Correlation; t-test; Analysis of variance; X^2 test.

7. APPLIED BIOLOGY:

A. Microbial fermentation.

B. Tissue and cell culture methods for animals. Transgenic animals.

C. Tissue and cell culture methods for plants. Transgenic plants, gene transfer methods.

D. Gene therapy.

E. Breeding in plants and animals, including marker – assisted selection

F. Bioremediation and phytoremediation, Biosensors.

8. IMMUNOLOGY

Innate and adaptive immune system Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. 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, humoral and cell-mediated immune responses, inflammation, hypersensitivity and autoimmunity, vaccines.

Histochemical and Immunotechniques: Antibody generation, Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immunofluorescence microscopy.

9. DEVELOPMENTAL BIOLOGY

A. **Basic concepts of development:** Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development

B. **Gametogenesis, fertilization and early development:** Production of gametes, cell surface molecules in gamete recognition; zygote formation, cleavage, blastula formation, gastrulation and formation of germ layers.

C. **Morphogenesis and organogenesis in animals:** Axes and pattern formation in Drosophila, amphibia and chick; eye lens induction, limb development and regeneration in vertebrates; post embryonic development-larval formation, metamorphosis; environmental regulation of normal development; sex determination.

D. **Morphogenesis and organogenesis in plants:** Shoot and root development; leaf development and phyllotaxy; flowering and floral development.

E. **Programmed cell death, aging and senescence.**