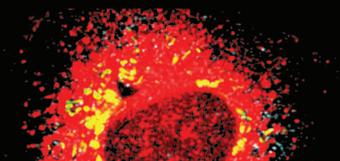
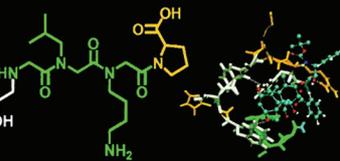
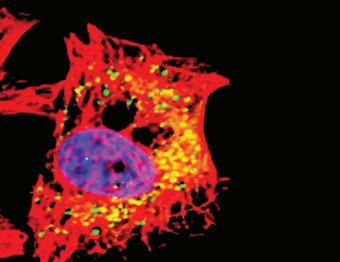
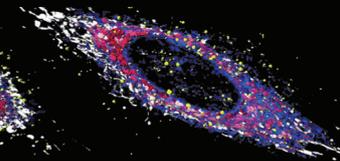
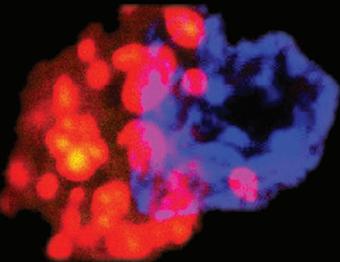




# CSIR - Indian Institute of Chemical Biology



## CSIR-IICB PhD Course Work 2023-24 Course Contents





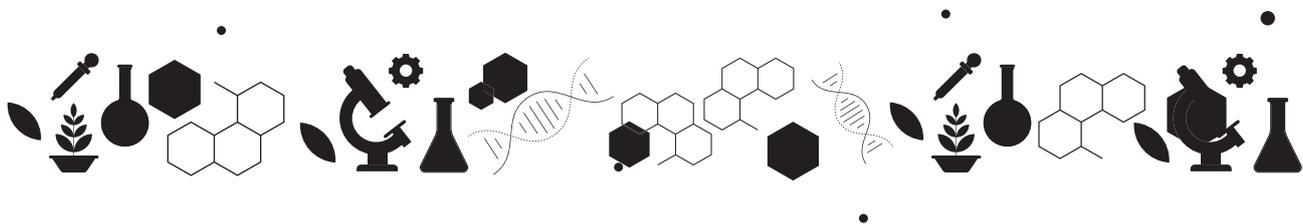


# **CSIR - Indian Institute of Chemical Biology**

## **CSIR-IICB PhD Course Work 2023-24**

### **Course Contents**





# Few information:

Mode of Instruction: Physical (Offline) OR Online classes,

Internal assessment /Mid-Sem: 60%,

End-Sem examination: 40%,

Review and Seminars during the course work.

Mode of Examination will preferably be Offline.

Classroom Instructions:

- ❖ 1 credit is equivalent to 15 lecture-hour
- ❖ 2 credit is equivalent to 30 lecture-hour

Explanation of the Course code:

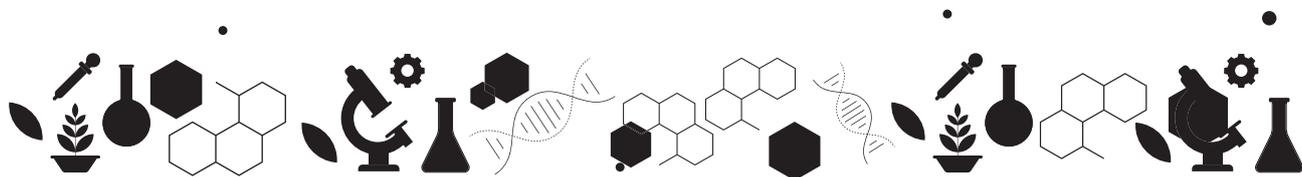
The Course Codes in this Course Catalogue are presented as per AcSIR courses.

# Mode of Evaluation:

In order to qualify in the course, every PhD student must meet following minimum requirements:

- ❖ A grade point of at least 6.00 has to be secured in all mandatory subjects in a scale of 10.
- ❖ A minimum of 60% has to be secured in each course and overall 65% in all courses for qualifying the PhD course work.
- ❖ Every student has to maintain 80% or more attendance in taught courses and delivered seminars. The 20% allowed absence is inclusive of any authorised leave.
- ❖ If any sort of Plagiarism in any Course Work examination is found, the whole semester is to be repeated by the concerned student/ necessary disciplinary action may be taken.
- ❖ Failure to attain any of above requirements shall call for a review about subsequent continuance of the PhD Student in the programme.
- ❖ The final decision regarding any matter in connection with the PhD Course work will be recommended by the Academic Affairs Committee and thereafter Director's approval.

Details about courses and requirements are available in this Course Catalogue. In order to earn required number of course credits, certain 'compulsory' and 'optional' courses are to be undertaken depending on the Fellow's research area and recommendation of associated guide/supervisor.



The course structure and contents are developed following the Guidelines of UGC/AcSIR and duly recommended by CSIR-IICB Academic Affairs Committee (AAC) and approved by the Director, CSIR-IICB.

Academic Affairs Committee:

Dr. Jayati Sengupta, Chairperson, AAC

Dr. Chinmay Chowdhury, Member

Dr. Krishnananda Chattopadhyay, Member

Dr. Subrata Adak, Member

Dr. Saikat Chakrabarti, Member

Dr. Rupasri Ain, Member

Dr. Indu Bhusan Deb, Member

Dr. Amitava Sengupta, Member

Dr. Sanjay Dutta, Member - Convener AAC & Head HRG

AcSIR Coordinator for CSIR-IICB: Dr. Jayati Sengupta

All guidance relating to the CSIR-IICB PhD course work such as selection of course Faculty members and Evaluation procedure are as per recommendation of CSIR-IICB AAC and approval from Director, CSIR-IICB.

As per AAC recommendations, the contents of the course catalogue have been designed in consultation of the CSIR-IICB Faculty members and team IICB Academic Affairs / HRG.

Inspiration & overall Advice:

**Dr. Arun Bandyopadhyay**

Director, CSIR-IICB

For CSIR-IICB PhD Course Work related affairs please contact HRG  
(Academic Affairs) Division:

**Dr. Sanjay Dutta**

Email: sanjaydutta@iicb.res.in

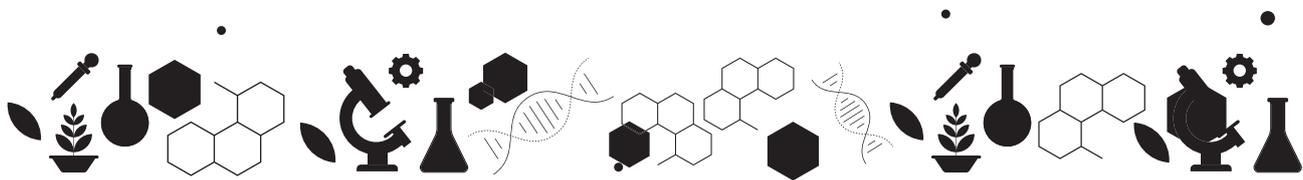
Tel: 033-24995913/702/814

For technical assistance

**Ms. Debasree Das**

Email: debasree@iicb.res.in

Tel: 033-24995702



CSIR-IICB PhD Course Work Catalogue : 2023-24

# Director's Note



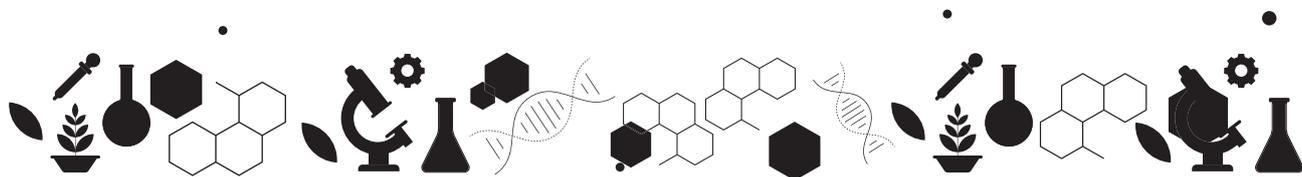
CSIR-IICB was born about eighty years ago, in difficult times. Only a dream kept it alive and idealism sustained it. That dream was to offer affordable healthcare to all the citizens of the country. Despite all odds, the dream did not die – it is transforming itself today; slowly and inexorably to reality.

In order to strengthen the basic research and to attain a translational objective very recently a second campus, the CSIR-IICB Translational Research Unit of Excellence (TRUE) was established at Saltlake, Kolkata. The overall mandate of TRUE being translation of the state-of-the-art fundamental and indigenous innovations to affordable technology for social benefits of the common man.

Millenniums ago, Indian civilization was the leader of world science. After a lull of several countries, we are on the threshold of becoming a world leader again. Thus, today, we aspire to create future leaders of Indian science. For that to happen we need to prepare you in ways that are different from the past. You have to not only know your research area; you have to know other areas as well. You have to communicate your ideas, dreams, aspirations and abilities to others. You have to create an eco-system where your colleagues, friends and mentors are comfortable at the same time feel inspired. With that in mind we bring you a significantly different doctoral program, which will help you to become a complete scientist and teacher and create the future leaders that this country needs.

**Dr. Arun Bandyopadhyay**

Director



CSIR-IICB PhD course work catalogue 2023-24

# Chairperson's Note



Dive into the world of groundbreaking chemical biology research at the esteemed CSIR-Indian Institute of Chemical Biology, situated in the vibrant eastern region of our country. Within these walls, the pursuit of knowledge is not just a mission; It's a passion.

At the heart of our research institute, an invaluable resource takes centre stage: our students, enrolled in PhD program. They're not just learners; they're the driving force behind our relentless pursuit of excellence, and we recognize their pivotal role in shaping the future of scientific discovery. Through a meticulously crafted approach, we empower these budding researchers with a strategic and focused training regimen, a precursor to their laboratory explorations.

Our course work for PhD program is more than just a curriculum; it's a vibrant canvas upon which scientific dreams come alive. Through a comprehensive and rigorous curriculum we present a wealth of exhilarating prospects. These opportunities are strategically designed to synergize with doctoral endeavours in the expansive domains of chemical and biological sciences.

The foundation of our program lies in its innovative design, a fusion of distinctive academic surroundings and expert pedagogical methodologies. This harmonious blend undoubtedly empowers our aspirants, fostering their innate creativity in scientific inquiry while rekindling their enthusiasm for uncharted research territories.

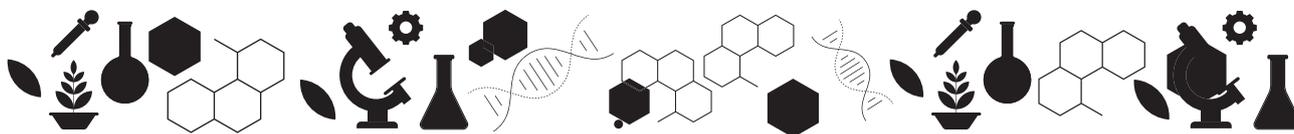
By immersing you in this coursework, we aim to not only expose you to the exigencies of contemporary research but also equip you with the tools to excel in the vanguard fields of biology and chemistry. This transformative experience will galvanize your intellectual horizons, an indispensable asset as you journey toward becoming a triumphant young scientist.

Envision a faculty invested in your growth, dedicating their time, ideas, and energy to kindle the flames of discovery within you. We assure you of an environment that will nurture, challenge, and celebrate you among exceptional researchers. Your aspiration is the cornerstone of our commitment to realizing your scholarly ambitions and identity in an atmosphere that beckons you to flourish. We stand ready, united, and eager to guide you on this educational odyssey, crafting a future leader in the realm of science.

**Dr Jayati Sengupta**

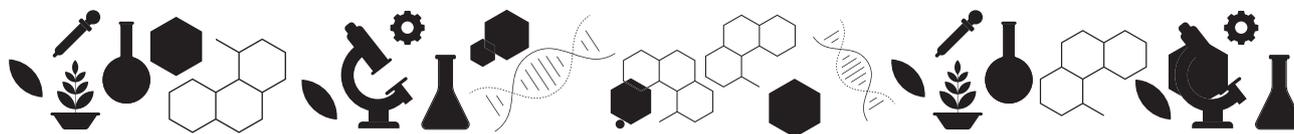
Chairperson

Academic Affairs committee



## CSIR-IICB PhD Course Work: 2023-24

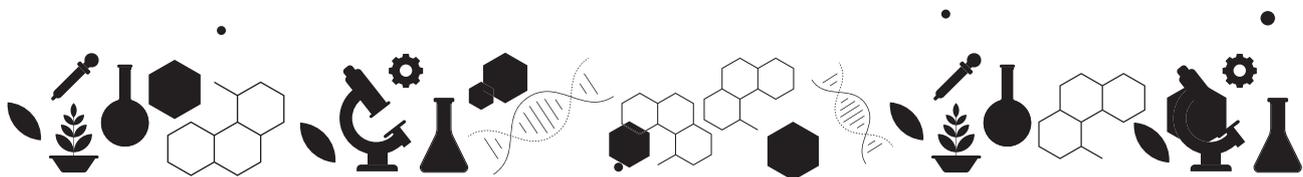
Course Code	Course name	Credit/s	Remarks
<b>First Semester</b>			
<b>Course 1 : 04 + 02 = 06 credits</b>			
1A. AcSIR-17-RM	Research Methodology	04 credits	Compulsory for all
1B. AcSIR-17-RPE	Research and Publication Ethics	02 credits	Compulsory for all
<b>Course 2: Inter-disciplinary Learning: 01 + 01 = 02 credits</b>			
AcSIR-17-ID-001:	Basic Biology	01 credit	Compulsory for Chemistry students
AcSIR-17-ID-002:	Basic Chemistry	01 credit	Compulsory for Biology students
<b>Second Semester</b>			
AcSIR-17-ID-003:	Biological Data Analysis	01 credit	Any one of four courses by one student
AcSIR-17-ID-004:	Cell and Tissue Engineering	01 credit	
AcSIR-17-ID-005:	Chemical Biology	01 credit	
AcSIR-17-ID-006:	Supramolecular chemistry and green chemistry	01 credit	
<b>Course 3 : Advanced Course : 02 + 02 + 02 = 06 credits</b>			
<i>Any three of following courses by one student</i>			
<b>Biology Courses :</b>			
AcSIR-17-BS-AD-001:	Biology of Macromolecules	02 credits	Any three of Six biology courses by one student
AcSIR-17-BS-AD-002:	Cancer Biology	02 credits	
AcSIR-17-BS-AD-003:	Cell Biology and Cell Signaling	02 credits	
AcSIR-17-BS-AD-004:	Eukaryotic Gene Regulatory Mechanisms	02 credits	
AcSIR-17-BS-AD-005:	Molecular and Cellular Immunology	02 credits	
AcSIR-17-BS-AD-006:	Protein Science and Proteomics	02 credits	
<b>Chemistry Courses:</b>			
AcSIR-17-CS-AD-001:	Advanced Analytical Chemistry	02 credits	Any three of Four Chemistry courses by one student
AcSIR-17-CS-AD-002:	Advanced Organic Chemistry	02 credits	
AcSIR-17-CS-AD-003:	Natural Products and Drug Discovery	02 credits	
AcSIR-17-CS-AD-004:	Total Synthesis	02 credits	
<b>Course 4: 'Societal program: Problem Understanding and Analysis' : 04 Credits</b>			



## COMPULSORY COURSES

### Course 1A: AcSIR-17-RM : Research Methodology : 04 credits

Module Title	Course contents
Safety and Behavior at Workspace, Laboratory and Institutional Campus	General safety and accident prevention guidelines, Good personnel safety practices, Laboratory safety practices (Do's and Don'ts), Fire safety principles and fire handling, Care in handling chemicals, Understanding materials safety data sheet (MSDS), Storing and indexing of materials & chemicals, Disposal of materials, chemicals and biological wastes, First aid, Reporting accidents and requisitioning help, Combating accidents. Awareness about members of the Institutional Safety Committee and emergency contact numbers. Lab bench co-operation with colleagues and co-workers, cultivating practice of collectivism, shared responsibilities and team-spirit among fellow researchers, Advancing culture of scientific sharing and discussion in campus and lab.
Research Problem Identification and Research Design/Plan	Scientific methods, Types of reasoning (Logics) - Induction - Deduction - Abduction, Identifying a topic/area of research, Reviewing literature, Identifying a question to be answered/ solution of a problem to be sought, Critically weighing investment (time, money and efforts) to reward (size and scale of answer/solution), Finalizing the research question/problem to be worked on, Cross-disciplinary thoughts and inter-disciplinary research approaches of addressing the question. Design of experiment/research work process and its implementation, Serendipity research.
Good Experimental, Observational and Data Analysis including Computer Applications ** Aligned with 'Computation / Bioinformatics' & 'Biostatistics'	Maintenance of laboratory records & e-Note books, Management of data and self-navigation of research project and academic program progress (objectives, milestone as well as timeline compliance), Data integrity & archiving of observational data for re-tracing, Basic mathematical and statistical treatments of data for appropriate/rational interpretation, Reporting data in inference perspectives, Common computational tools like Process flow diagram, Chemical structure drawing, statistical analyses, Data tabulation and figure presentation (graph, bar diagram, Venn Diagram, heat maps etc.)
Intellectual Property, Patent Database Search and Patent Writing	Innovation, Intellectual Property Rights (IPR), Pre-IPR system of intellectuality/trade protection: Secrecy/Trade guilds/Cartels, Basic forms of IPRs: Patent, Copyright, Trademark, Designs, Evolution of IP statutes, Major patent databases/offices, CSIR-TKDL, Searching and indexing of patents from different databases, IPR for new technologies, Process patent versus product patent, Art of writing a patent/innovation and claims, Preliminary patent, White space mapping, CSIR & its patents strength.
Writing & Communication of Research Results and Inferences	Scientific writing (including Language proficiency), State-of-the-art scientific literature comprehension, Art and ethics of writing research report/paper, writing of an abstract for scientific community and general public, Skills of making Powerpoint presentations, Art of web-meeting interactions & presentations using latest video-meeting modes. Letter writing and official correspondence.
Analytical Tools and Techniques in Research - A General Crossdisciplinary Exposure	'Biotechniques and Instrumentation' course details: Chromatography : different chromatographic techniques, HPLC. Centrifugation: principles and uses, application in modern biology. Electrophoresis: theory and hypothesis, SDS-PAGE, Western Blot, 2D gel electrophoresis. Mass spectrometry and Protein identification: principles and theory, application in Proteomics. Colorimetry : ITC, DSC, determination of protein stability, analysis of binding Properties. Surface Plasmon resonance: Techniques and its use in biology. Optical spectroscopy: absorption, fluorescence, FT-IR, Raman and other techniques. FACS: principles and application. Imaging: Electron microscopy, Confocal microscopy, Atomic force microscopy, In vivo imaging. NMR: 1D NMR, 2D NMR and application in structural biology. X-Ray crystallography: Basic theory and its application in structural biology.



## COMPULSORY COURSES

Module Title	Course contents
CSIR Guidelines (2020) for “Ethics in Research and in Governance” Adopted by AcSIR.	Full awareness about the guidelines ( <a href="https://acsir.res.in/wpcontent/uploads/2020/08/OM-Ethics-Guidelines.pdf">https://acsir.res.in/wpcontent/uploads/2020/08/OM-Ethics-Guidelines.pdf</a> ) and their compliance and practice.

### **\*\*Computation /Bioinformatics**

Computers: introduction, evolution and classification of computers. Fundamentals of computing. Bit and Byte, introduction to types of Hardware and Software. Components of computer, introduction to operating systems, introduction to Computer Viruses.

Network: introduction, network structure and architecture, hierarchical networks, Ethernet and TCP/IP family of protocols, transport protocol design, types of network, topologies of network, router, switch, data communication, concept of wireless networking, LAN, WAN, MAN, security of the network, fire-walls, network applications.

Information Technology: concepts of client server architecture, concept of search engine, database search engines, introduction to Internet.

Introduction to Word, PowerPoint and Excel.

Introduction to Bioinformatics: history of Bioinformatics, genome sequencing projects, Human Genome Project, applications of Bioinformatics.

Introduction to databases: type and kind of databases, applications and limitations.

Literature Search Databases, nucleic acid and protein databases, animal and plant databases, Ensemble Genome project TIGR database, biotechnological databases, motifs and pattern databases, databases for species identification and classification, structural databases, database retrieval and deposition systems.

Web tools and resources for sequence analysis: pairwise and multiple sequence alignment, sequence similarity search: BLAST, pattern recognition, motif and family prediction, restriction map analysis, primer design, gene prediction, phylogenetic tree, protein structure prediction and visualization.

### **Biostatistics**

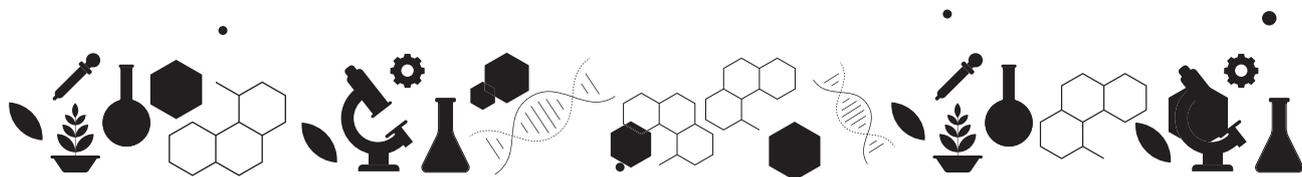
Summarization of Data: measures of center, dispersion, skewness Dependence of variables: correlation, linear regression, logistic regression.

Basic probability distributions: Binomial, Normal, Chi-squares.

Estimation of parameters: method of moments, maximum likelihood Testing of hypotheses:

(a) parametric tests: t-test, z-test, chi-squares test, ANOVA.

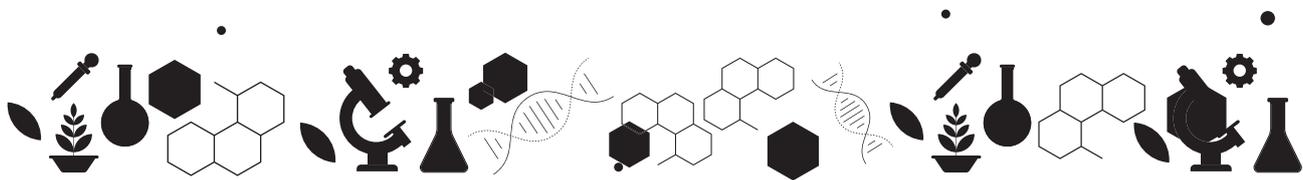
(b) non-parametric tests: Mann-Whitney, Kruskal Wallis, Kolmogorov-Smirnov.



## COMPULSORY COURSES

### Course 1B : AcSIR-17-RPE: Research and Publication Ethics: 02 credits [Compulsory]

Module Title	Course contents
Philosophy and Ethics	<ol style="list-style-type: none"> <li>1. Introduction to philosophy: definition, nature and scope, concept, branches</li> <li>2. Ethics: definition, moral philosophy, nature of moral judgments and reactions</li> </ol>
Scientific Conduct	<ol style="list-style-type: none"> <li>1. Ethics with respect to science and research</li> <li>2. Intellectual honesty and research integrity</li> <li>3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)</li> <li>4. Redundant publications: duplicate and overlapping publications, salami slicing</li> <li>5. Selective reporting and misrepresentation of data</li> </ol>
Publication Ethics	<ol style="list-style-type: none"> <li>1. Publication ethics: definition, introduction and importance</li> <li>2. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.</li> <li>3. Conflicts of interest</li> <li>4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types</li> <li>5. Violation of publication ethics, authorship and contributorship</li> <li>6. Identification of publication misconduct, complaints and appeals</li> <li>7. Predatory publishers and journals</li> </ol>
Open Access Publishing	<ol style="list-style-type: none"> <li>1. Open access publications and initiatives</li> <li>2. SHERPA/RoMEO online resource to check publisher copyright &amp; self archiving policies</li> <li>3. Software tool to identify predatory publications developed by SPPU</li> <li>4. Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc</li> </ol>
Publication Misconduct	<p>A. Group Discussions (2 hrs.)</p> <ol style="list-style-type: none"> <li>1. Subject specific ethical issues, FFP, authorship</li> <li>2. Conflicts of interest</li> <li>3. Complaints and appeals: examples and fraud from India and abroad</li> </ol> <p>B. Software tools (2 hrs.)</p> <ol style="list-style-type: none"> <li>1. Use of plagiarism software like Turnitin, Urkund and other open source software tools</li> </ol>
Databases and Research Metrics	<p>A. Databases (4 hrs.)</p> <ol style="list-style-type: none"> <li>1. Indexing databases</li> <li>2. Citation databases: Web of Science, Scopus, etc.</li> </ol> <p>B. Research Metrics (3 hrs.)</p> <ol style="list-style-type: none"> <li>1. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score</li> <li>2. Metrics: h-index, g index, i10 index, altmetrics</li> </ol>



## INTER-DISCIPLINARY COURSES

### Course 2: Inter-disciplinary Learning: 01 + 01 = 02 credits

*Any one of following two by one student:*

#### **AcSIR-17-ID-001: Basic Biology : 01 credit**

*(for Chemistry students)*

Introduction to Chemical Biology; Macromolecular Structure: Protein, DNA, RNA, lipid, polysaccharide structures; detection, quantification and stability of the molecules and their interactions.

Enzymes Overview & Enzyme Kinetics: enzyme structure and functions, substrate recognition, mechanism and inhibitions, Kinetics of enzyme reactions, types of inhibitions, allostericity and regulation.

Nucleic Acids & Protein Synthesis: DNA replication, transcription (mRNA synthesis) and translation (protein synthesis).

Cell Communication and Signaling: ligand-receptor interaction, autocrine and paracrine modes of signaling, communication through adherens junctions;

Metabolic Pathways: protein, lipid and carbohydrate metabolism, amino acid and nucleotide metabolism.

Drug Discovery: drugs from nature and their interaction. Drug target identification and validation

#### **AcSIR-17-ID-002: Basic Chemistry: 01 credit**

*[for Biology students]*

Thermodynamics, Solutions and Ions; Chemical bonding and molecular structure; Chemical Kinetics; Stereochemistry; Introduction to drug discovery (medicinal chemistry approach);

Drug target, discovery and development (forward and reverse approach).

*Any one of following four courses by one student:*

#### **AcSIR-17-ID-003: Biological Data Analysis: 01 credit**

Genomics: concepts, tools and techniques. Data analysis and probable interpretation

Epigenomics: concepts/techniques/analysis/interpretation.

Metagenomics: concepts/techniques/analysis/interpretation.

Transcriptomics (mRNA): concepts, tools and techniques. Data analysis and probable interpretation.

Transcriptomics (miRNA): concepts, tools and techniques. Data analysis and probable interpretation

Proteomics: concepts, tools and techniques. Data analysis and probable interpretation

Metabolomics: concepts, tools and techniques. Data analysis and probable interpretation

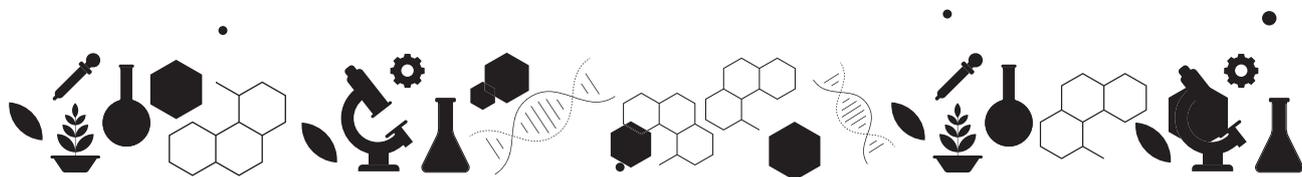
Immunomics/immune phenotyping

Multi-omics: concepts, tools and techniques. Data analysis and probable interpretation

#### **AcSIR-17-ID-004: Cell and Tissue Engineering : 01 credit**

##### **Module 1:**

1. Introduction to Cell & Tissues: definition of cells, tissues and organs.
2. Tissue development, degeneration (hyperplasia, hypertrophy, atrophy, dysplasia, metaplasia), regeneration (wound healing and angiogenesis)
3. Tissue architecture (Vascular system, liver, breast) and human disease (atherosclerosis, chronic liver disease, cardiovascular disease)



## INTER-DISCIPLINARY COURSES

### Module 2:

1. Stem cells: Mammalian development (embryonic and extra-embryonic development till formation of germ lines). Various types of stem cells, their origin. ES cell establishment, methods of directed differentiation into various lineages. Molecular regulation of self-renewal and differentiation into various cell types.
2. iPS cells: Cellular reprogramming, Molecular regulation of induced pluripotency.
3. Genome Engineering: Transgenic technology, Targeted transgenics, Knockout, knock-in technology, Recombination methodologies, recombinase mediated cassette exchange, Genome Editing; Zn finger nucleases, TALENs, CRISPR-Cas9

### Module 3:

1. Introduction to tissue engineering
2. Bio-materials used for tissue engineering: Processing and Fabrication
3. Properties of scaffolds - surface and mechanical
4. Application of tissue engineering in skin, bone and cartilage regeneration
5. Commercially available products

### AcSIR-17-ID-005: Chemical Biology :01 credit

An overview of Chemical Biology

Small molecules probes for proteins and nucleic acids and their applications in biological spectroscopy and biophysics

Protein-protein and protein-nucleic acids interactions and inhibitors.

Chemical Genetics

Synthetic and semi synthetic proteins

Applications of chemical biology, enzyme based biosensors, catalytic antibody

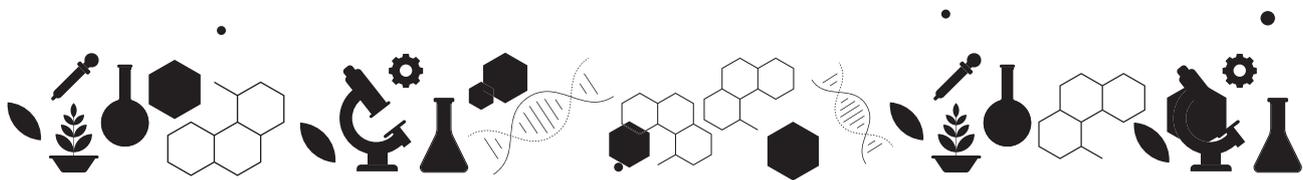
### AcSIR-17-ID-006: Supramolecular chemistry and green chemistry : 01 credit

#### Supramolecular Chemistry:

Molecular recognition. Non-covalent interactions. Self-assembly. Host-guest complexes. Supramolecular polymers. Synthetic receptors. Molecular probes and sensors. Crystal engineering. Analytical techniques.

#### Green Chemistry:

Basic Principles and applications of Green Chemistry; Environmental factors, atom economy, energy efficiency; Green reagents, green catalysts, green solvents, Biocatalysis; Green Chemistry in pharmaceutical industries.



## ADVANCE COURSES

### Course 3: Advance course : 02+02+02=06 credits

**BIOLOGY courses: Any three of the following six courses by one student**

#### **AcSIR-17-BS-AD-001: Biology of Macromolecules : 02 credit**

Interplay between protein & nucleic acid in cellular function.

3D structure of biological macromolecules involved in important cellular function (e.g. Transcription, Translation and degradation).

Protein folding and role of chaperons.

Functional role of protein flexibility, domain motions and domain swapping in large macromolecular complexes.

Functional mechanism of enzymes regulation and its cooperativity.

Cutting edge methods for the determination of macromolecular 3D structures such as Raman Spectroscopy, NMR, X-ray Crystallography, CryoEM.

Modification of macromolecules for efficient function in transcription, translation, signaling and other fields of cell biology.

Structure and evolution of important protein motifs and folds. [e.g. Coiled-coil proteins, helical bundles, Immunoglobulin-like proteins, kinases, TIM barrels, DNA/RNA binding motifs signaling domains (sh2, sh2, pdz etc)].

Modulating protein structure for alternative function.

Sequence to structure and its implication to function.

Biological structural databases, modeling of macromolecular structure and structure-based drug design.

#### **AcSIR-17-BS-AD-002: Cancer Biology : 02 credit**

**Cancer Immunology:** the immunological status of adaptive and innate immune cells in cancer, cellular interactions between immune and cancer cells in tumor progression or rejection, immunological mechanisms, regulation and function involved in host responses to tumors, anti-tumor immunity, cancer-induced immune tolerance, immunosuppression, dysregulation of the immune system and poorer outcome in the disease.

**Cancer stem cells:** Origin/Hypothesis/Concept; signaling pathways in cancer stem cells.

**Cell signaling in cancer:** description of major classes of cell signaling: cell death signaling, cell survival signaling and developmental/ stem cell signaling; signal networking and chemotherapy.

**Oncogenesis and epigenetics in cancer :** Oncogenes and their regulation in signaling aberration; acetylation/methylation in DNA and histones; silencing/de-silencing of gene expression.

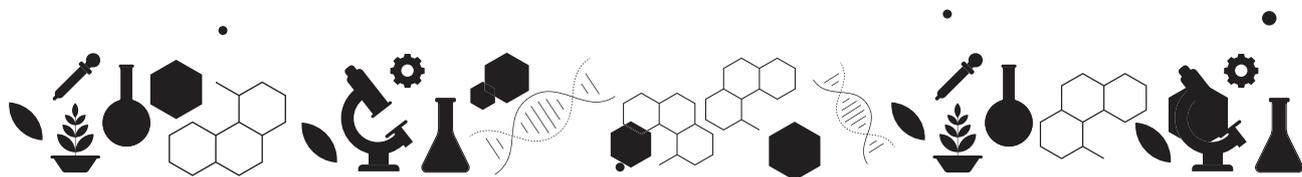
**Metabolic Engineering in cancer;** metagenomics and cancer.

**Cancer biomarkers and diagnosis :** selection of clinical specimens, recent advancement for identification of biomarkers through different approaches like genomics, proteomics and glycomics in combination with molecular pathology with potential clinical value; application of biomarkers for cancer staging and personalization of therapy at the time of diagnosis to improve patient care.

**Cancer drug discovery :** identification of lead molecules, target identification in cancer cells; combined approaches (in vitro, in vivo and in silico) for validation, various steps involved towards successful drug discovery; immunotherapeutic approaches e.g. cancer vaccines, monoclonal antibodies, adoptive immune cell transfer etc. and combination strategies to treat malignancies.

Angiogenesis and metastasis.

Project writing.



## ADVANCE COURSES

### AcSIR-17-BS-AD-003: Cell Biology and Cell Signaling: 02 credit

In each topic, the study material will consist of a 1-2 original research papers covering some of the latest developments in the field, to be chosen by the instructors for open discussion in the class. Students are expected to refresh their post graduate knowledge of these topics before attending the lectures.

1. Cell division and cytoskeletal structures: regulation of cell cycle, checkpoints, role of cytoskeletal proteins in movement.
2. Cell adhesion, cell junction and Extra Cellular Matrix: cell adhesion molecules; cell junction; Extracellular matrix; cell-cell recognition.
3. Intracellular sorting of proteins: nuclear import and export mechanism; organelle targeting; transport of protein to cell surface; soluble protein sorting. \
4. Autophagy: ways to detect autophagic flux. Specialised autophagy for mitochondrial quality control.
5. Signal transduction pathways: signals, receptor, second messengers and effectors. 6. Different types of cell death modalities including apoptosis, autophagy and ER stress.
7. Metabolic disorder and signalling aberrations in cancer and diabetes: Implication in therapy.

### AcSIR-17-BS-AD-004: Eukaryotic Gene Regulatory Mechanisms : 02 credits

In each module the study material will consist of a few original research articles covering some of the latest developments in the field, to be chosen by the instructors for open discussion in the class. Discussion may include one or more of the following topics. Students are expected to brush up their post graduate knowledge of these topics before attending the lectures.

**Chromatin Structures and Epigenetics:** nucleosome assembly and the modification of nucleosomes and of DNA/ the assembly of chromatin into higher order structures/ different aspects of heritable patterning of gene expression and the biological importance of epigenomes/ mechanisms of inheritance as well as imprinting, X inactivation and the role of RNA in establishing silent chromatin/ the impact of chromatin structure on differentiation, cell plasticity and development.

**Transcriptional Regulation and Gene Expression:** regulatory interplay between transcription factors: regulatory DNA sequences (promoters, enhancers, locus control regions) /general transcription machinery/transcription factors: cell-specific and ubiquitous regulatory factors/ mechanistic aspects of transcription activation / chromatin, histones, DNA methylation /gene regulatory networks /transcription factors in health and disease/ transcription factors as the final integrators of signaling cascades.

**Structure, Processing, Trafficking and Function of RNA:** chemistry and structure of RNA/ major lectures of cellular RNAs (mRNAs, tRNAs, rRNAs, snRNAs, and the newly discovered small regulatory RNAs/pre-mRNA processing with emphasis on splicing and polyadenylation/ biogenesis of tRNA and rRNA/biochemistry and function of RNA interference (RNAi) and microRNAs/ RNA trafficking in the cell/ RNA quality control and RNA degradation/regulation of mRNA translation during development/ RNA-protein interactions and major lectures of ribonucleoprotein particles; RNA granules and bodies /evolution of RNAs: the RNA world.

**Translational Control and Post-translational Protein Modification:** the translational control: codons and frame shifting, attenuation, phosphorylation, and transformation/the role of translational control in the regulation of cell growth and differentiation.

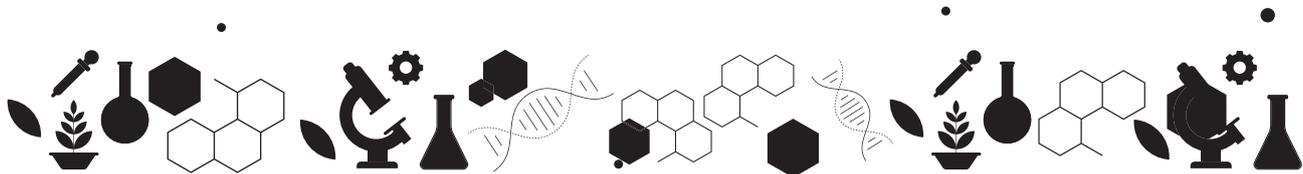
### AcSIR-17-BS-AD-005: Molecular and Cellular Immunology: 02 credits

History of immunological ideas and cellular components of immune system.

Transplantation antigens: structure, function, genetics, transplantation.

Phagocytosis and antigen presentation Fc receptor and scavenger receptor mediated phagocytosis, markers to follow phagocytosis, presentation of endogenous and exogenous antigens, cross-presentation.

Antibody structure, antigen-antibody interactions, binding site, affinity, avidity, Fc functions, molecular biology of immunoglobulins; B cell triggering: Tcell-B cell Interactions, Antigen Presentatin, MHC I, II.



## ADVANCE COURSES

Humoral immune response and cytokines: signaling through B cell receptors, plasma cell differentiation, proinflammatory / antiinflammatory effects of cytokines, transcriptional control of cytokine synthesis.

Structure of lymphoid organs, ontogeny of lymphoid cells; complement system and disease: classical and alternative pathways of complement activation, complement regulation and deficiencies.

Immune response to parasitic infections: cell mediated immunity: delayed reactions, immunodeficiency; allergy, Arthus reaction, serum sickness, inflammation.

Autoimmunity: regulation of immune response and autoimmune diseases, immunity to virus.

### AcSIR-17-BS-AD-006: Protein Science and Proteomics : 02 credit

#### **Protein Science:**

Basic building blocks of protein and their composition, chemical behavior, properties.

Peptide bond, geometry and parameters; Backbone geometry and parameters, side chain geometry and parameters, Ramachandran plot.

Classification of Protein & description of domain structure.

Protein structure stabilizing forces – hydrogen bond, electrostatic bond or salt bridges; hydrophobic forces.

Protein folding, dynamics, thermodynamics, structure function relation.

Protein: from gene to function.

Protein and diseases.

Some important proteins in cellular functions, cytoskeleton and functional protein.

#### **Proteomics:**

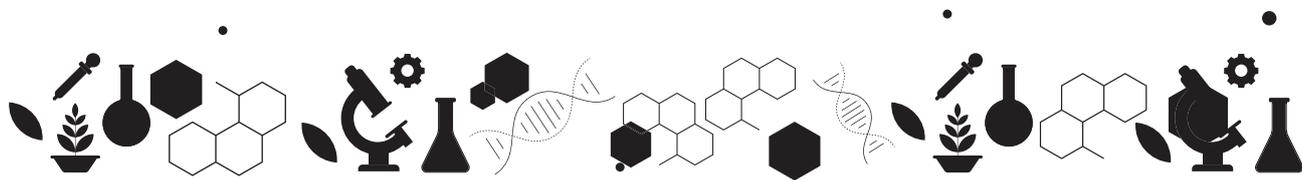
Protein cloning, expression and purification in heterologous system and in Baculovirus mediated SF9 insect cells, post translational modification.

Protein chromatography systems and purification procedures – HPLC, FPLC etc.

Bioinformatics of protein sequences – sequence analysis, comparison, alignment etc.

Mass spectrometry – introduction to mass spectroscopy, gel mass spectroscopy, LC-MS, LC-MS-MS, MALDI-TOF.

Protein crystallography.



## ADVANCE COURSES

### CHEMISTRY Courses: Advance courses : 02+02+02 = 06 credits

CHEMISTRY Courses : Any three of the following four courses by one student

#### AcSIR-17-CS-AD-001: Advanced Analytical Chemistry : 02 credits

**Chemical Techniques:** chromatography- general principles, classification of chromatographic techniques, normal and reversed phase, bonded phase, separation mechanisms, short-column chromatography, flash chromatography, vacuum liquid chromatography (VLC), medium pressure liquid chromatography, high pressure liquid chromatography (HPLC), TLC, HPTLC. X-RD analysis and its applications.

**Basic Principles of Mass Spectrometry:** methods of ionization (EI, CI, FAB/LSIMS, ESI, MALDI, DART, DESI) and high resolution MS; application of MS in structure elucidation of organic molecules; basic principles and applications of GC-MS, LC-MS and high resolution MS.

**Principles and Applications of NMR Spectroscopy:** Introduction to 1D and 2D NMR spectroscopy, Structure determination of molecules from 1D and 2D NMR.

#### AcSIR-17-CS-AD-002: Advanced Organic Chemistry : 02 credits

**Stereoselective C-C bond formation:** nucleophilic addition to C=X (X=C, O, S, N), pericyclic reaction- asymmetric induction in [3+2] and [2+2] cycloaddition, stereoselective hydroformylation, stereoselective carbene addition, chirality transfer in sigmatropic rearrangements.

**Named Reactions and Rearrangements:** Strecker, Mannich, Biginelli, Passerini, and Ugi reactions. Baker-Venkataramana, Curtius, Schmidt, Wolf, Hofmann, and Brook rearrangements.

**Lactonization:** Yamaguchi, Corey-Nicolaou, Heck, Masamune, Mitsunobu, and Yamamoto's Macrolactonizations. Mukaiyama Esterification.

Ring-closing metathesis (RCM) using Grubbs and Schrock catalyst, Buchwald-Hartwig C-N bond and C-O bond formations, Baylis-Hillman Reaction, Evans aldol reaction, Ugi-reaction, Click reaction, Corey-Bakshi-Shibata (CBS) reduction, Corey-Kim oxidation, Nozaki-Hiyama-Kishi Reaction, Payne rearrangement, Prins reaction, Japp-Klingmann reaction.

#### AcSIR-17-CS-AD-003: Natural Products and Drug Discovery : 02 credits

1. Occurrence, isolation, chemistry and biosynthesis of mono-, sesqui- and di-terpenoids, flavonoids and alkaloids.
2. **Free radicals and Antioxidants:** important free radicals in living systems, sources, chemistry and reactivity of important free radicals in biological systems, natural antioxidants of different classes.
3. **Steroids & Saponins:** sources, biological significance and structure elucidation of saponins; and of steroids – ergosterol, stigmaterol,  $\beta$ - sitosterol and diosgenin, squalene biosynthesis
4. Role of natural products in drug discovery, role of advanced hyphenated techniques in natural product research, structure elucidation of natural products .
5. DNA damage by natural products: Role of natural products in drug discovery.
6. **Drug Delivery & Actions:** Basic concepts on absorption, distribution, metabolism and excretion (ADME) of drugs

#### AcSIR-17-CS-AD-004: Total Synthesis: 02 credits

General concepts on various types of cycloaddition reactions, application of cycloaddition reactions in the synthesis of chiral compounds and industrially important molecules.

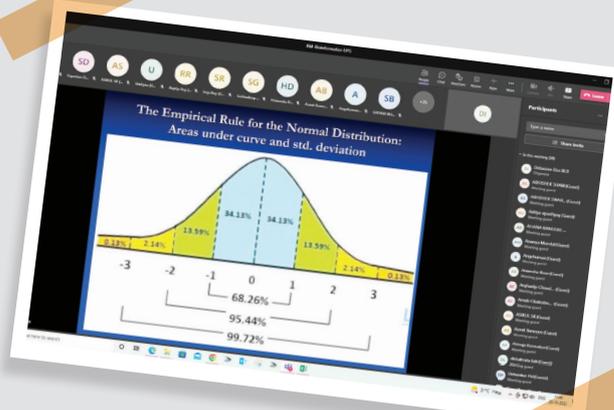
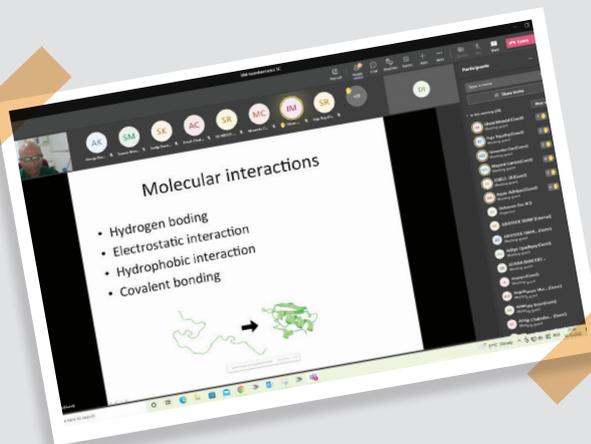
Synthesis of complex organic molecules – planning and execution; concepts of retrosynthetic analysis; total synthesis of natural products: retrosynthesis, disconnection, synthons, linear and convergent synthesis.

#### Course 4: 'Societal program: Problem Understanding and Analysis' : 04 Credits

In this program, the following will be included:

- ❖ Lectures series / Webinar held at CSIR-IICB (students will be notified)
- ❖ Students to participate in the JIGYASA / Skill development program

# CSIR - Indian Institute of Chemical Biology





# CSIR-INDIAN INSTITUTE OF CHEMICAL BIOLOGY KOLKATA

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