



# PhD Programme in Biotechnology

at

**Center of Innovative and Applied  
Bioprocessing (CIAB), Mohali**

with

**Regional Centre for Biotechnology (RCB)  
Faridabad**



United Nations  
Educational, Scientific and  
Cultural Organization



क्षेत्रीय जैव प्रौद्योगिकी केन्द्र  
Regional Centre  
for Biotechnology

**Center of Innovative and Applied Bioprocessing**

Sector-81 (Knowledge city), Mohali, Punjab 140306 INDIA

## Center of Innovative and Applied Bioprocessing

Center of Innovative and Applied Bioprocessing (CIAB), an autonomous institute of the Department of Biotechnology, Govt. of India, is the only institute in the country which works mainly on Secondary Agriculture and development of value added products from different types of bio resources. Its mandate fits well with the of Govt. of India's programme on "Doubling the Farmer's Income" with the same inputs. It also become more relevant in present context when Indian Agriculture is going on complete transformation with limited land resources and increasing input costs. We all are aware that the agricultural wastes are being burnt by many farmers. If this Agri-waste is used to isolate bioactive compounds with high market value, it can directly benefit the farming community by increasing their farm income. It will not only provide new avenues to establish industrial units on utilization of Agri-waste but will also provide new employment opportunities to the rural masses.

### Secondary Agriculture: Bioprocessing

#### Vision

To be a nodal research and innovation organization linking leads etc. of bioprocess and bioproduct R&D system knowledge, technology with production system, and serve as incubatorial platform for agri-process and agri-food-product related entrepreneurship along with a frontal role in translation, innovation, optimization and upscaling of approaches and technologies for bioprocessing products to catalyze agro-industrial growth through progressive functional linkages and networking/ collaborations with institutions and industries nationally and globally.

#### Mission

- To test, validate, translate, innovate, improve, up-scale and integrate approaches and technologies related to bioprocessing of agrifood/agri-mass for promotion of secondary agriculture.
- To generate bioresources related knowledge and advance R&D leads and potential for the growth of research and innovation systems towards products development, technology translation, product quality assurance etc. in the sectors of agri-food and secondary agriculture including technology demonstrations, training, clustering of entrepreneurs/stakeholders etc. in the lab-to-market chain.

## CEO's Message

**Center of Innovative and Applied Bioprocessing (CIAB)**, an autonomous institute of the Department of Biotechnology, Govt. of India, is the only institute in the country which works mainly on Secondary Agriculture and development of value added products from different types of bio resources. Its mandate fits well with the of Govt. of India's programme on "Doubling the Farmer's Income" with the same inputs. It also become more relevant in present context when Indian Agriculture is going on complete transformation with limited land resources and increasing input costs.

The institute is working very hard on meeting its goals through the well-designed four R & D programmes; (i) Value addition to primary processing residue/wastes for edible products, (ii) Valorization of crop wastes for specialty products and chemicals, (iii) Nutritionals, nutraceuticals, and upgradation of value or of use of primary processing bioproducts and (iv) Biosynthetic technology/synthetic biology for low volume-high value products and industrial enzymes.



Within its six years of establishment, institute has made substantial contributions in developing various processes to derive products from the agricultural waste. The scientists of the institute have been able to transfer two technologies and have developed several other technologies which are at different stages of scale up and commercialization.

Institute has initiated PhD programme in Biotechnology with Regional Centre for Biotechnology, Faridabad in the year 2018. The programme envisages advanced training and translational research on biotechnology and synthetic biology, food nutrition and engineering, chemical bioproducts and chemical engineering with particular emphasis on utilization of agro-residues for value added products. The specific objectives of the programme are to prepare skilled and successful professionals for research institutions, industry, and entrepreneurial pursuits as well as to contribute towards skill and innovation as well as societal uplift.

I am sure this new academic programme on PhD biotechnology will provide a unique opportunity to the young and budding scientists to make their career in research in the areas of bioprocessing and value additions to the agri-products.

**Tilak Raj Sharma**

## PhD Programme

Rules and Regulation of PhD programme are as per Regional Centre for Biotechnology (RCB) Regulation, 2017 (notified on September 15<sup>th</sup>, 2017 in The Gazette of India)

### OBJECTIVES OF PhD PROGRAMME

The programme envisages advanced training and translational research on biotechnology and synthetic biology, food nutrition and engineering, chemical bioproducts and chemical engineering with particular emphasis on utilization of agro-residues for value added products. The specific objectives of the programme are to develop researchers with the following competencies:

1. To prepare skilled and successful professionals for research institutions, industry, and entrepreneurial pursuits.
2. To prepare specialists in the field of bioprocess for value added products from biomass
3. To contribute towards skill and innovation as well as societal uplift.

### GOALS OF PhD PROGRAMME

PhD programme in Biological Sciences, Chemical Sciences, Food Science & Engineering and Chemical Engineering has been designed to develop highly skilled and specialized researchers with the goal of sustainable technological development in a contemporary, global, economical, environmental and societal context.



**All the academic rules will be as per the relevant RCB ordinances, statutes and regulations.**

**NATURE OF DOCTOR OF PHILOSOPHY PROGRAMME**

The Doctor of Philosophy Programme at CIAB shall consist of two components, namely:

- (a) PhD course work, and;
- (b) Research work leading to the submission of a doctoral thesis.

Activity	Days
<b>MONSOON SEMESTER (JULY TO DECEMBER)</b>	
Registration	Last week of July
Commencement of Semester	1 <sup>st</sup> week of August
Reporting to the Advisor(s)	2 <sup>nd</sup> week of August
Mid-Term Examination	1 <sup>st</sup> week of October
End-Semester Examination	1 <sup>st</sup> week of December
Synopsis/ Research Progress (Report and Presentation)	3 <sup>rd</sup> week of December
Submission of marks by Examiners	End of December
<b>AUTUMN SEMESTER (JANUARY TO JUNE)</b>	
Registration	1 <sup>st</sup> week of January



Semester – I		
Compulsory Course		
Course Code	Subject	Credit (4)
CIA-401	Research Methodology	2
CIA-402	Analytical Instrumentation	2
Elective Course		
Course Code	Subject	Credit (4)
CIA-301	Advances in Biosynthetic Technology	2
CIA-302	Biological Macromolecules and Enzymology	2
CIA-303	Advances in Organic and Material Chemistry	2
CIA-304	Natural Product Chemistry	2
CIA-305	Food Process Technology	2
CIA-306	Advances in Food Engineering	2
CIA-307	Process Technology	2
CIA-308	Chemical Process Design	2

**Total credits: 08**

Students entering into the PhD Programme at CIAB shall have to complete mandatory courses, CIA-401 Research Methodology and CIA-402 Analytical Instrumentation and Elective courses. Total 8 credits have to be completed in one semester for PhD candidates.

Synopsis/research progress (Report and Presentation) are mandatory activities for the PhD candidates and will be awarded as satisfactory or unsatisfactory grades evaluated by Student Advisory Committee (SAC) on the basis of students' performance.



## COMPULSORY COURSES

### CIA-401 RESEARCH METHODOLOGY 2 credit course

This course is designed to gain knowledge of the systematic research approach and planning of work based on comprehensive literature survey. The topics covered include the introduction to research methodology, literature survey and work plan, data mining and interpretations, writing and presentation skills, and research tools and regulations.

#### COURSE CONTENT

##### **Introduction to research methodology**

Definitions and characteristics of research, types of research, main components of any research work, problem identification, criteria for prioritizing problems for research.

##### **Literature survey and work plan**

Uses of literature review, source of information, organization of information on index cards, advanced search tools, analyzing the problem, formulating the problem statement, formulation of the research objectives, major components and outline of the different phases in a research process.

##### **Data mining and interpretations**

Methods of data collection, plan for data processing and analysis, ethical considerations, summary of the major components of a research proposal.

##### **Writing and presentation skills**

Introduction to presentation tool, writing research reports and manuscripts, features & functions, making presentations, customizing presentation.

##### **Research tools and regulations**

Bioinformatics, biostatistics, biosafety, criteria for good scientific practice, research reports and manuscripts preparation. Intellectual property (IP) rights and management, ethics of research and plagiarism

#### SUGGESTED READING

1. Creswell, J. W. Research design: Qualitative, quantitative and mixed methods approaches, 4th Ed. Thousand Oaks publishing.
2. C. R. Kothari. Research Methodology: Methods and Techniques, II Ed., New Age International.
3. Montgomery C. Douglas. Design and Analysis of Experiments, 5th Ed., Wiley India.
4. Krishnswamy, K.N., Shivkumar, Appa Iyer and Mathiranjan M. Management Research Methodology; Integration of Principles, Methods and Techniques, I Ed., Pearson Education.

CIA-402  
ANALYTICAL INSTRUMENTATION  
2 credit course

This course aims to provide basic knowledge and principle on a wide range of techniques required to characterize the materials produced via chemical and biological routes. The topics covered include the typical spectroscopic and microscopic techniques, elemental, structural and surface analysis methods, thermal analysis tools and techniques for (food) biotechnology.

### COURSE CONTENT

#### **Spectroscopic techniques**

Ultraviolet-visible (UV-vis), infrared (IR), nuclear magnetic resonance (NMR), mass spectrometry (MS) and electron paramagnetic resonance (EPR).

#### **Separation and microscopic techniques**

High pressure liquid chromatography (HPLC), gas chromatography (GC), atomic force microscopy (AFM), scanning electron microscopy (SEM) and transmission electron microscopy (TEM).

#### **Elemental, structural and surface analysis**

Inductively coupled plasma atomic emission spectroscopy (ICP-AES), X-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD) and chemisorption and physisorption techniques.

#### **Thermal analysis**

Thermogravimetric analysis (TGA) and Differential scanning calorimetry (DSC).

#### **Techniques in food technology**

Spray drying, fermentation, membrane filtration, dynamic light scattering, polarimeter, rancimat, rheometer, Kjeldahl for protein analysis.

#### **Techniques in molecular biology**

Polymerase chain reaction (PCR): basic principles, types, and advances, DNA and protein electrophoresis, DNA sequencing techniques, protein purification techniques.

### SUGGESTED READING

1. Bryan M. Ham and Aihui MaHam. Analytical Chemistry: A Chemist and Laboratory Technician's Toolkit, Wiley publisher, 2016.
2. G. R. Chatwal and S. K. Anand. Spectroscopy, Himalaya publishing group, 2009.
3. Sandy B. Primrose and Richard Twyman. Principles of Gene Manipulation and Genomics, 7th Ed., Wiley-Blackwell.
4. Jack Cazes. Analytical instrumentation handbook, 3rd Ed., Taylor and Francis.



## ELECTIVE COURSES

### CIA-301 ADVANCES IN BIOSYNTHETIC TECHNOLOGY 2 credit course

This course offers the insight into advances of molecular biology and synthetic biology. The topics covered include fundamentals about genes, gene expression, gene mining, metagenomics, molecular cloning, and protein synthesis as well as advances in protein engineering, directed evolution, metabolic engineering and biosystems engineering.

#### COURSE CONTENT

##### **Fundamentals of molecular biology**

Fundamentals of genome, gene structure and organization, gene expression, the central dogma of molecular biology, proteins, protein synthesis, regulatory elements of gene expression, splicing and processing of RNA molecules.

##### **Molecular cloning**

DNA modification, PCR, separation and purification of DNA, DNA sequencing, DNA vectors for gene expression, designing of different vectors, selectable marker genes, reporter genes, nonselectable marker genes, and marker-free gene expression.

##### **Biosynthetic technology**

Gene synthesis, heterologous protein expression, protein engineering, directed evolution to genes, gene mining, metagenomics, metabolic engineering and synthetic metabolism, computational protein modelling, cell free protein synthesis, biosystems engineering and biomolecule production.

#### SUGGESTED READING

1. Michael R Green and Joseph Sambrook. Molecular cloning a laboratory Manual. 4th Ed., Cold Spring Harbor.
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter. Molecular Biology of the Cell, 7th Ed., Garland Science.
3. Paul S Freemont and Richard I Kitney. Synthetic Biology a Primer, Revised Ed., World Scientific publisher.

CIA-302  
**BIOLOGICAL MACROMOLECULES AND ENZYMOLOGY**  
2 credit course

This course offers the insight into advances of biological macromolecules and enzymology aspects. This course covers basic and advance knowledge about the biological macromolecules such as protein, lipids, nucleic acid, and carbohydrates. The course also illustrates the basic concepts of enzyme kinetics and advance applications of enzymes in bioprocessing research.

**COURSE CONTENT**

**Biological macromolecules**

Amino Acids, amino acid side chains, polypeptides, primary, secondary, tertiary, and quaternary structure of proteins, lipids, carbohydrates, nucleic acid, transcription and translation.

**Structure and function of macromolecules**

General structure, properties and functions of proteins, lipids, carbohydrates and nucleic acid.

**Enzyme kinetics**

Enzymes, types of enzyme catalysts, enzyme stability (effect of temperature, pH and substrate concentration), enzyme regulation (product inhibition, feedback control, enzyme induction and repression and covalent modification), enzyme kinetics, Michaelis-Menton (forms and derivations of MM equation, significance of  $V_{max}$  and  $K_m$ ) and enzyme variants, Enzyme inhibition, types of inhibitors-competitive, non-competitive and uncompetitive and their mode of action.

**Enzymes and bioprocessing**

Enzyme engineering, applications of enzymes in biomass processing, enzyme immobilization, advancement in enzymes and bioprocess technology.

Enzyme catalysis, structure-function relations, Allosteric interactions.

**SUGGESTED READING**

1. David L Nelson and Michael L Cox, Lehninger Principles of Biochemistry, 7th Ed., WH Freeman
2. Alejandro G. Marangoni. Enzyme Kinetics: A Modern Approach, 2003 Ed., John Wiley & Sons, Inc.
3. Huimin Zhao. Synthetic Biology Tools and Applications, 1st, Academic Press, Elsevier publishing.



**CIA-303**  
**ADVANCES IN ORGANIC AND MATERIAL CHEMISTRY**  
**2 credit course**

This course is designed to give an overview regarding advances in organic and materials chemistry in order to apply the principles of organic, bio-organic, materials chemistry and nanotechnology in their research in the field of chemical sciences.

### **COURSE CONTENT**

#### **Selected reactions in organic chemistry**

Recent advances in selected metal-mediated coupling reactions and mechanisms: Suzuki, Sonogashira, Heck, and Stille coupling, selected familiar named reactions: Robinson annulation, Perkin reaction, Claisen condensation, Knoevenagel condensation, Mitsunobu reaction; Lewis acids and Lewis acid-catalyzed reactions; stereo-, chemo-, and regio-selective reactions, protective groups and their importance in synthetic organic chemistry.

#### **Selected topics of bio-organic chemistry**

Bio-catalysis, enzyme-catalyzed reactions, bio-organic related heterocycles, selected bio-organic molecules and their application, selected name reactions, rearrangements and mechanisms related to bio-organic chemistry.

#### **Special topics of materials chemistry**

Brief discussion about coordination chemistry, structure and bonding and their importance, acid and base reactions, stereochemistry basics, photochemistry overview, heterocyclic chemistry basics. Nanotechnology and its applications.

#### **Major synthetic strategies**

Top down and bottom up approach, fundamentals, characterization techniques, scopes of nanomaterial applications in various fields including biomedicine.

### **SUGGESTED READING**

1. F.A.Carey and R.J.Sundberg. Advanced Organic Chemistry Part A: Structure and Mechanism & Part B: Reactions and Synthesis, 5th Ed., Springer, New York.
2. W. Carruthers and I. Coldham. Modern Methods of Organic Synthesis, 4th Ed., Cambridge University Press.
3. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann. Advanced Inorganic Chemistry, (Indian Edition), 6th Ed., Wiley-India, Noida.
4. J. E. Huheey, E. A. Keiter, R. L. Keiter and O. K. Medhi. Inorganic Chemistry: Principles of Structure and Reactivity (Indian Edition), 4th Ed., Pearson Education, India.
5. J. Clayden, N. Greeves, S. Warren and P. Wothers. Organic Chemistry, I Ed., Oxford University Press.

CIA-304  
NATURAL PRODUCT CHEMISTRY  
2 credit course

This course aims to gain insight into carbohydrates and natural products chemistry. This course includes fundamental structures of carbohydrates, terpenoids, steroids, alkaloids and phenolics.

### COURSE CONTENT

#### Carbohydrates

Introduction to carbohydrates, classification of carbohydrates, structure of monosaccharides, disaccharides, chemistry of polysaccharides- cellulose and starch, potential transformation of carbohydrates.

#### Terpenoids

Introduction - structure and classification of terpenoids- geraniol,  $\alpha$ -pinene, camphor, zingiberene, farnesol and cadinene, application of terpenoids.

#### Steroids and alkaloids

Introduction, structure and classification of steroids and alkaloids - chemistry of cholesterol, testosterone, estrone, and progesterone, chemistry of quinine, nicotine and reserpine, and applications of steroids and alkaloids.

#### Phenolics

Introduction, definition, structure of coumarins, flavonoids, quinones, role in plants and applications.

### SUGGESTED READING

1. Michael L. Sinnott. Carbohydrate Chemistry and Biochemistry: Structure and Mechanism, 2nd Ed., RSC publishing.
2. Sujata V. Bhat, B.A. Nagasampagi, Meenakshi Sivakumar. Chemistry of Natural Products, Springer publishing, 2006.
3. Sukh Dev. Handbook of Terpenoids: Volume I: Triterpenoids, CRC press, 2018 reissue.



CIA-305  
FOOD PROCESS TECHNOLOGY  
2 credit course

This course is designed to introduce the processing technologies in food science. The topics covered include the introduction to food processing, food fermentation, food technologies, and food preservation and packaging.

### COURSE CONTENT

#### **Introduction to food processing**

Introduction of food processing and preservation, food processing techniques: drying, freezing, blanching, sterilization, pasteurization and UHT processing, dielectric heating and canning.

#### **Food fermentation**

Fermentation technology, alcoholic beverage: classification and their production, non-distilled beverages, distilled alcoholic beverages, and fermented foods.

#### **Food rheology and technologies**

Rheology of the food materials, milling technology: turbo milling, conventional wet and dry milling, baking technology, and extrusion technology.

#### **Food preservation and packaging**

Processing and preservation by non-thermal methods, food additives: permissible limits and safety aspects, biodegradable food films and coatings and applications, definitions, objectives and functions of packaging, packaging materials and food packaging system.

#### **Food bioprocessing**

Fundamentals of food biotechnology, application of biotechnology for food plant waste utilization (whey, molasses, starch substrates and others), waste treatment technologies: aerobic and anaerobic methods of treatment of food industry wastes, bioremediation, bioenergy, bio-conversation of food wastes to useful products.

### SUGGESTED READING

1. V.K. Joshi. Biotechnology: Food Fermentation, volume I., Educational Publishers & Distributors.
2. S.S. Marwaha. Food Processing: Biotechnological Applications, Asiatech Publishers Inc. 2000.
3. E.J. Pyler. Bakery Science & Technology. Vols. I & II. Sosland Publisher.
4. N.D. Frame. The Technology of Extrusion Cooking, 1st Ed., Blackie Academic.
5. Neelam Khetar Paul and Darshan Punia. Food Packaging, Daya Publishing House, 2012.
6. Robertson. Food Packaging: Principles and Practice, 3rd Ed., Taylor and Francis publishing.

CIA-306  
**ADVANCES IN FOOD ENGINEERING**  
2 credit course

This course is designed to acquaint with basic principles and advances of food engineering and processes. The topics covered include introduction to food engineering, fluid flow operations and rheology, membrane separation processing, and emerging processing technologies.

**COURSE CONTENT**

**Introduction to food engineering**

Introduction to material & energy balance: principles, processes and operations.

**Fluid flow operations and rheology**

Important properties of fluids, factors affecting the rheological parameters, viscosity monitoring and control, transportation of fluids.

**Membrane separation processing**

Theory of microfiltration, ultrafiltration and reverse osmosis, selection and types of membranes and properties, mathematical description of flow through membrane, application and use in food industry.

**Emerging process technologies**

Principles of radiation processing, microwave technology, ultrasonic technology, high pressure processing – principles, mechanism of action, advantages and disadvantages over conventional processing, equipment's and its applications in food industry, pulsed electric field processing, Ohmic heating of foods, high voltage pulse technique, aseptic processing, supercritical fluid extraction, nanotechnology: principles and application in food.

**SUGGESTED READING**

1. Toledo, R.M. Fundamentals of Food Process Engineering, 3rd Edition, Springer publishing.
2. Chandra, G.R. Essential of Food Process Engineering, BS Publications, 2006.
3. Das, H. Food Processing Operations Analysis, 1st Ed., Asian Books.
4. Smith, P.G. Introduction to Food Process Engineering, 2nd Ed., Springer publishing.
5. Fellows, P.J. Food Processing Technology: Principles and Practice, 4th Ed., Wood head publishing.
6. Barbosa-Canovas and Gustavo. Novel Food Processing Technologies, Marcel Dekker/CRC press, 2004.



CIA-307  
PROCESS TECHNOLOGY  
2 credit course

The course is designed for developing concept of chemical engineering specifically on material balance, energy balance, fluid dynamics, mass transfer. This course also includes the knowledge on techno-commercial aspect of project management.

### COURSE CONTENT

#### Basic introduction

Introduction to chemical calculations, units, dimensions, chemical equation, stoichiometry, material balance fundamentals, energy balance concepts, units, enthalpy, heat of solution & mixing, humidity chart.

#### Fluid mechanics

Basic equation of fluid flow, Newtonian, non-Newtonian fluids, Reynolds's number, continuity equation, Bernoulli equation, fluid friction, flow in pipes, Hagen-Poiseuille equation, sudden expansion and contraction, transportation and metering of fluids.

#### Heat transfer

Heat transfer- conduction, Fourier's law, convection-forced & natural convection, radiation- Kirchhoff's law, Stefan-Boltzmann law, view factors, combined heat transfer, heat exchangers.

#### Mass transfer

Phase rule & phase diagram, azeotropes, distillation, leaching, adsorption, absorption, diffusion, process diagrams, distillation systems, separation systems.

#### Project engineering

Design calculations, P&ID, utility, valves, pumps, compressors, piping and vessels, techno feasibility concepts.

### SUGGESTED READING

1. John M. Centanni and Michael J. Roy. Biotechnology Operations: Principles and Practices, 2nd Ed., CRC Press.
2. Nigel J Smart. Lean Biomanufacturing, Series No. 37, Wood head publishing, 2013.
3. Maggie Bryans, Linda Rehfuss. Introduction to Biomanufacturing, Northeast Biomanufacturing Center and collaboration, 2012.

CIA-308  
CHEMICAL PROCESS DESIGN  
2 course credit

This course is designed to introduce the basic concepts of chemical reaction engineering and process design. The topics covered include the fundamentals of chemical reaction engineering, design of chemical reactors, ideal reactor systems, solid catalyzed reactions, and stoichiometry and process calculations.

### COURSE CONTENT

#### Introduction to chemical engineering reaction

Rate equation and rate controlling steps, elementary and non-elementary reactions, reaction rate and temperature dependency theories, design equation for constant.

#### Chemical reactor design

Variable volume batch reactors, analysis of experimental kinetics data, integral and differential analysis.

#### Ideal reactor systems

Homogeneous and heterogeneous reactor systems, design of reactors for multiple reactions - consecutive, parallel and mixed reactions, temperature and pressure effects.

#### Solid catalyzed reactions

Nature of catalysts, surface area and pore-volume distribution, catalyst preparation, rate equations for heterogeneous reactions, adsorption isotherms, rates of adsorption and desorption, surface reaction.

#### Stoichiometry and process calculations

Concept of material balance, material balances with and without chemical reactions, recycle operations, energy balances.

### SUGGESTED READING

1. Levenspiel, O. Chemical Reaction Engineering, III Edition, John Wiley publishing.
2. Fogler. H. S. Elements of Chemical Reaction Engineering, III Edition. Prentice Hall of India publishing.
3. Richard M. Felder, Ronald W. Rousseau. Elementary Principles of Chemical Processes, III Ed. John Wiley and Sons.





## EVALUATIONS SYSTEM FOR THE COURSE

### Course Credit System and Structure:

Instruction will be given to the students by the respective course instructor regarding evaluation of the coursework consisting of assignments and internal and external examinations, at the start of the every course.

- Similarly, synopsis /research progress will be evaluated by Internal or external DRAC (Doctoral Research Advisory Committee) based on performance, project report and presentation.
- Answer books will be available for students for each course with respect to the score/grade awarded before finalising.
- Based on the performance of each student who has registered for the respective course, the instructor will give the corresponding letter grades as provided below.
- The grading system to be followed for course work is illustrated below:

Letter Grade	Performance	Numerical Value
A <sup>+</sup>	Outstanding	10
A	Excellent	9
B <sup>+</sup>	Very Good	8
B	Good	7
C <sup>+</sup>	Fair	6
C	Poor	4
F	Very Poor	2
I	Incomplete*	0
S	Satisfactory	-
U	Unsatisfactory	-

- After completing each semester examinations, a meeting will be held within a few days for finalising the award of grades, and a review on reassessing the awarded grade will be considered after receiving formal application with fee from the students.
- All documents related to coursework will be available for next six months since the completion of each end-semester examinations.

### Determination of Distinction and First Class Grade

- Distinction  $\geq$  8.00 CGPA
- First Class  $\geq$  7.00 CGPA
- Pass Marks  $\geq$  6.50 CGPA

### Conducting "Re-test":

Re-test can be taken in two situations:

- For passing a course i.e. course grade is  $<$  6.50 ('C' or 'F' grade, but not 'I' grade).
- For improvement in SGPA/CGPA

Candidate will be given maximum two attempts in respective course with payment of necessary fee. Final grades obtained after taking re-test shall only be mentioned on the final grade card.

## About the Institute

### Teaching faculty:

Dr. Tilak Raj Sharma, PhD (Plant Biology)  
Dr. Sudesh Kumar Yadav, PhD (Biochemistry)  
Dr. Saswata Goswami, PhD (Chemical Engineering)  
Dr. Saravanamurugan Shanmugavel, PhD (Chemistry)  
Dr. Sasikumar Elumalai, PhD (Chemical Engineering)  
Dr. Jayeeta Bhaumik, PhD (Chemistry)

### Academic committee:

Dr. Tilak Raj Sharma, CEO, CIAB (Chairman)  
Dr. Deepika Bhaskar, Registrar, RCB (Member)  
Prof. Rajat Sandhir, PU, Chandigarh (Member)  
Dr. Saravanamurugan Shanmugavel, CIAB (Member)  
Dr. Sasikumar Elumalai, CIAB (Member)  
Dr. Sudesh Kumar Yadav, (Academic Co-ordinator)



## PhD Program at CIAB with RCB

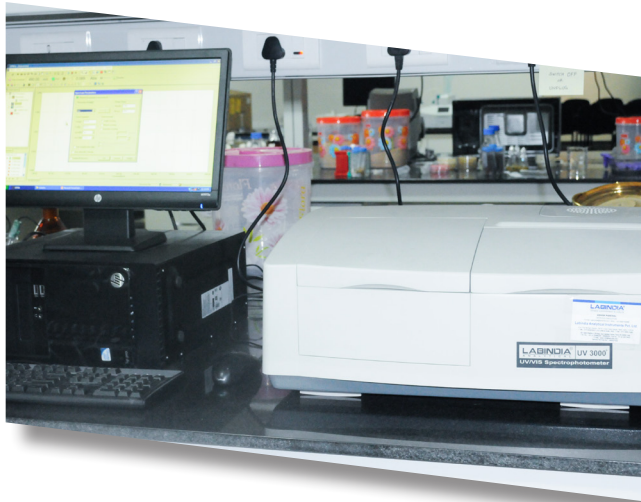
Admission session 2018-19



## Academic collaborations



# Instrumentation facilities at the Institute



# High-end equipments



# Cafeteria and Hostel

## Cafeteria



## Scholars Hostel



## Auditorium



## Infrastructure

## CIAB Product & Technologies



### नवोन्मेषी एवं अनुप्रयुक्त जैव प्रसंस्करण केन्द्र Center of Innovative and Applied Bioprocessing

(जैव प्रौद्योगिक विभाग भारत सरकार के अधीन एक स्वायत्त संस्थान, भारत सरकार)

(A National Institute under Department of Biotechnology, Ministry of Science & Technology, Govt. of India)

Knowledge City, Sector 81, SAS Nagar, Mohali 140306 (Punjab) India

**Technologies and Products available at CIAB**

- A new product for Pan-India plan to address iron deficiency (iron fortified turmeric)**  
Patent Appl. 2017111023123
- Good sugar towards replacing table sugar for healthy India\*\***  
Patent Appl. 201611003411
- Tomato based special beverage**  
Patent Appl. 201711028768
- Best flavor molecule from poorest essential oil**  
Rose oxide enriched citronella essential oil  
Patent Appl. 201611009275
- \* Note: Under IPR  
\*\* Technology transferred**
- Xylooligosaccharides from waste corn cob biomass**  
Patent Appl. 201711010199
- Levulinic acid and Levulinic ester from rice straw**  
Patent Appl. 201711010199
- D-Psicose**
- Tomato based special beverage**
- Best flavor molecule from poorest essential oil**  
Rose oxide enriched citronella essential oil  
Patent Appl. 201611009275
- Integrated process of whey utilization**  
Patent Appl. 201711024828
- Whey powder**
- Bacterial cellulose**
- Calcium citrate**
- D-tagatose**
- Xylo-oligosaccharides from rice straw and corn cob**  
(Patent Appl. 201711020622)
- Health and wealth from waste (Dietary Fibers from Kinnow waste)**  
(Patent Appl. 201711007926)
- Best nutrition from last byproduct of milk processing-whey drink\*\***  
(Patent Appl. 201711008368)
- Biovalue in bio-waste- Nano cellulose from rice straw**
- Premium Pectin (Neo-pectin) from fruit juice waste and other biomass**  
(Patent Appl. 2017111021690)
- Tomato price balancer technology value when tomato more than demand**  
(Patent Appl. 201711024694)
- A tool to take towards doubling Geranium farmers income**  
Rose-Scented Natural Tartaric Acid  
Patent Appl.1487/Del/2015



## **Chief Executive Officer**

**Center of Innovative and Applied Bioprocessing (CIAB)**

Sector-81 (Knowledge city), Mohali, Punjab 140306 INDIA

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