

## **Certificate Course:**

Title: **Basics of Biotechnology**

### **Course overview/description:**

This course aims to provide an interdisciplinary edge to young professional aiming to make a career in Biotechnology related industries. It has been found that graduates from non-life sciences background find it difficult to gain footing in such industries. This course will provide such individuals a basic understanding of biomolecules, microbiology, molecular biology and techniques used in biotechnology. This will give them advantage over traditional degree holders. The nature of this course is broad based and will give a good insight into modern biology and important component of hands-on training to the students.

### **Objectives:**

- Working professionals and non-life science candidates may gain an appreciation and understanding of core principles of Biotechnology.
- Understanding the role of Biotechnology in present scenario.
- Understanding the basic principles of different aspects of Biotechnology: Molecular biology, Biomolecules, Microbiology, Immunology, Instrumentation etc.
- Develop a scientific temperament and a problem solving approach using biotechnological methods.
- To gain a practical knowledge about Instrument working and Industrial methods w.r.t. biotechnology.

**No of seats:** 20

**Minimum Eligibility:** Graduation in any Science/Technology field.

**Time Period:** 6 months

**Course Fees (Rs):** 20,000/-

### **Course Timings:**

Weekends (15 hours a week)

**No. of Credits:** 20 (8 credits: Field work/Training)

1. Theory Hours: 180 (12 credits)
2. Practical Hours (Demonstration): 30 (2 credits)
3. Assignments, presentations, project and industrial visit hours:90 (6 credits)

Total hours:  $1 + 2 + 3 = 300$

## Course Overview:

Module	Module Code	Module Name	Credits	Hours
I	CBB01	Cell- a basic unit of life	0.5	7.5
II	CBB02	Biomolecules	0.5	7.5
III	CBB03	Introduction to Microbiology	2	30
IV	CBB04	Instrumentation and Techniques	2	30
V	CBB05	Fermentation Technology.	2	30
VI	CBB06	Introduction to Genetic engineering and RDT Products	1	15
VII	CBB07	Industrial Enzymes	1	15
VIII	CBB08	Biotechnology Products	1	15
IX	CBB09	Bioethics and IPR	1	15
X	CBB10	Biotechnology Solutions.	1	15
XI	CBBP 1	Biotechnology Lab	2	30
XII	CBBA	Assignment	1	15
XIII	CBBS	Seminar	1	15
XIV	CBBI	Industrial Visit	2	30
XV	CBBP	Project	2	30
		Total	20	300

## References:

1. Lehninger, A., Cox, M.M., & Nelson, D. L., (2008). Principles of Biochemistry, 5<sup>th</sup> Edition, W. H. Freeman, New York.
2. Willey, J. M. Sherwood, L. M. & Woolverton, C. J. (2008). Prescott, Harley & Klein's Microbiology, 7<sup>th</sup> Edition McGraw Hill International Edition.
3. Watson, J. (2007). Molecular Biology of the Gene, 5<sup>th</sup> Edition, Pearson Edition.
4. Whittaker
5. Campbell (2013). Bioethics : The Basics
6. Gerald Karp. Cell Biology
7. De Robertis. Cell and Molecular Biology
8. Wilson and Waker. Principle and technique of Biochemistry and Molecular Biology.
9. Skoog Douglas. Instrumentation Analysis.
10. P.K.Gupta. Elements of Biotechnology
11. R.C.Dubey. Textbook of Biotechnology.
12. P.S.Verma. Cell Biology, Genetics, Molecular Biology-Evaluation and Ecology.

## **Course Content:**

### **Module 1: Cell- a basic unit of life**

Origin of life-prokaryotic cell-eukaryotic cell-plant cell-animal cell-cell organelles- Introduction to heredity and genetics

### **Module II: Biomolecules**

Structure and function: Carbohydrates-lipids-proteins-nucleic acid

### **Module III: Introduction to Microbiology**

Classification of microorganisms-growth and cultivation-media requirements- Application of Microbiology

### **Module IV: Instrumentation and Techniques**

Principles and applications of instruments used in the field of biotechnology: Microscopes (Light, Phase contrast, Fluorescent, Confocal, Electron), Spectroscopy (Spectrophotometer, IR, AAS, X Ray Diffraction, NMR), Chromatography (TLC, Column: Gel Permeation, Ion Exchange, Reverse Phase, Hydrophobic, Affinity, HPLC), Electrophoresis (Agarose, PAGE, IE, Capillary, PFGE) etc, Next Generation Techniques

### **Module V: Fermentation Technology.**

Basic principles of fermentation, role of media, growth kinetics, media optimization, fermenter design, primary and secondary metabolites, downstream processing.

### **Module VI: Introduction to Molecular biology and RDT Products**

Basic principles of RDT, Overview of GMOs, GMFs, and GMPs produced in recent times, specific case studies of 5 major products

### **Module VII: Industrial Enzymes**

Enzymes currently being used in different industries: sources, isolation, production, downstream processing, application, specific case studies of 5 major industries.

### **Module VIII: Biotechnology Products**

Animal, plant and microbiological products other than enzymes, specific case studies of 5 major products.

### **Module IX: Bioethics and IPR**

IPR, IPR case studies, RDT product controversies, ethical issues in biotechnology.

### **Module X: Biotechnology Solutions.**

Each student will be asked to identify an existing problem related to their field of expertise in the beginning of the course and solutions with biotechnological approach will be deliberated and discussed. A report will have to be submitted by the student to earn the credits for this module.

### **Module XI: Biotechnology Lab.**

Hands on training for basic biotechnology experiments, Demonstration of advanced experiments

**Microbiology:** Sterilization techniques, Media Preparation, Isolation of Microorganisms, Primary screening.

**Molecular Biology:** Isolation and purification of nucleic acids and proteins.

**Biochemistry:** Quantitative and qualitative assays of major biomolecules.

**Fermentation:** Production and downstream processing of any two fermentation products.

### **Module XII: Seminar.**

Each student is required to deliver a seminar on any biotechnology application topic approved by the coordinator.

### **Module XIII: Assignment.**

Each student will have to submit a review of minimum 20 papers as an assignment on a topic approved by the coordinator.

### **Module XIV: Industrial Visit**

Four industrial visits of 0.5 credit each. Students will have to be present and submit a report to earn the credit.

### **Module XV: Project**

The last one month of the course the students will be required to do a project in any topic approved by the coordinator. They may be asked to do a feasibility analysis or practicability of solutions identified in Module X or sent to industries for their projects as decided by the course coordinator.

# **Certificate course: Basics of Biotechnology**

## **Syllabus**

**Module: I**

**Module Code: CBB01**

### **Module Name: Cell – a basic unit of life**

#### **UNIT 1: Overview of Cell**

History, cell theory, overview of prokaryotic and eukaryotic cells, Archaeobacteria, origin of eukaryotic cell (endosymbiotic theory), plant and animal cells, exceptions to cell theory, overview of cell cycle, apoptosis, cancer

#### **UNIT 2: Cell wall and Plasma membrane**

Functions and variations in prokaryotic and eukaryotic cells (primary and secondary wall), structure and function of plant cell wall, overview of membrane function, fluid mosaic model, chemical composition of membranes, membrane transport – passive, active and facilitated transport, endocytosis and exocytosis

#### **UNIT 3: Cell Organelles: Structure and function**

Nucleus, Mitochondria, Chloroplasts, Ribosomes, Peroxisomes, Endoplasmic Reticulum, Golgi Bodies, Lysosomes

#### **UNIT 4: Heredity and genetics**

Mendel's work on transmission of traits, genetic variation, molecular basis of genetic information, principles of inheritance, chromosome theory of inheritance, pedigree analysis, incomplete dominance and co-dominance, multiple alleles, pleiotropy

#### **Suggested Reading:**

1. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
2. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
3. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA
4. D.P. Snustad, and M.J. Simmon , Genetics, 6 th Ed., John Wiley & Sons. (Singapore)

# Certificate course: Basics of Biotechnology

## Syllabus

**Module: II**

**Module Code: CBB02**

### **Module Name: Biomolecules**

#### **UNIT 1: Carbohydrates**

Classification and biological roles of carbohydrates, structure and function of monosaccharides- hexoses and pentoses, disaccharides-sucrose, lactose, maltose, storage and structural polysaccharides -glycogen, starch and cellulose

#### **UNIT 2: Proteins**

Overview of structure and classification of amino acids, peptide bonds, levels of protein structure-primary, secondary, tertiary and quaternary, isoelectric point, biological roles of proteins, enzymes: Isozyme, Zymogen, Ribozyme

#### **UNIT 3: Nucleic Acids**

Role of nucleic acids in living system, structure of nitrogenous bases, structure and function of nucleotides, types of nucleic acids, structure of A, B, Z types of DNA, Types of RNA

#### **UNIT 4: Lipids**

Role of lipids in cellular architecture and functions, definition and classification of lipids, structure and function of fatty acids, triacylglycerols, phospholipids and sterols, vitamins

#### **Suggested Reading:**

1. Nelson, D. L. and Cox, M.M. Lehninger, Principles of Biochemistry, 5th Ed., W.H. Freeman and Company (N.Y., USA.), 2008.
2. Voet, D. and Voet, J.G. Biochemistry, 3rd Ed., John Wiley & Sons, Inc. USA., 2004.

# **Certificate course: Basics of Biotechnology**

## **Syllabus**

**Module: III**

**Module Code: CBB03**

### **Module Name: Introduction to Microbiology**

#### **UNIT 1: Classification of Microorganisms**

Classification of microorganisms on the basis of its morphology, cell wall composition, internal as well as external morphology and functions

#### **UNIT 2: Growth and Cultivation**

Reproductive strategies, growth curve: Lag phase, Exponential phase, Stationary phase, Senescence and Death phase, Mathematics of growth, Measurement of Microbial Growth, Influence of Environmental Factors on Growth: Solutes and Water activity, pH, Temperature, Oxygen concentration, Pressure, Radiation, Isolation of Pure Cultures: Streak Plate, Spread plate and Pour Plate

#### **UNIT 3: Media Requirements**

Nutritional Types of Microorganisms, Requirement of Nitrogen, Phosphorus and Sulfur, Requirement of Growth Factors, Uptake of Nutrients, Culture Media

#### **UNIT 4: Applications of Microbiology**

Applications of Microbiology in Food Technology, Industrial Microbiology, Agricultural Biotechnology, Microbes as a product, Applied Environmental Microbiology

#### **Suggested Reading:**

1. Willey, J. M. Sherwood, L. M. & Woolverton, C. J. (2008) Prescott, Harley & Klein's Microbiology, 7<sup>th</sup> Edition McGraw Hill International Edition.

# Certificate course: Basics of Biotechnology

## Syllabus

Module: IV

Module Code: CBB04

### Module Name: Instrumentation and Techniques

#### UNIT 1: Microscopy and Spectroscopy

Principles and applications of: Light microscope, Phase contrast Microscope, Fluorescent Microscope, Confocal Microscope, Electron Microscope, UV-Vis Spectrophotometer, IR Spectrophotometer, AAS, X Ray Diffraction, NMR, Flow cytometry, Biosensors, pH meter

#### UNIT 2: Chromatography

Basic principles of chromatography: Partition coefficient, concept of theoretical plates, Principles and applications of TLC, Column chromatography: Gel Permeation chromatography, Ion Exchange chromatography, Reverse Phase chromatography, Hydrophobic chromatography, Affinity chromatography, HPLC

#### UNIT 3: Electrophoresis

Basic Principle of electrophoresis, Paper electrophoresis, Gel electrophoresis, discontinuous gel electrophoresis, PAGE, SDS-PAGE, Native and denaturing gels, Agarose gel electrophoresis, IE, Capillary electrophoresis, PFGE

#### UNIT 4: Centrifugation

Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient, various types of centrifuges, different types of rotors, differential centrifugation, density gradient centrifugation (Rate zonal and Isopycnic)

#### Suggested Reading:

1. Freifelder, D., Physical Biochemistry: Applications to Biochemistry and Molecular Biology 2nd ed., W.H. Freeman and Company (New York). 1982
2. Plummer D. T, An Introduction to Practical Biochemistry, 3rd ed.,, Tata McGraw Hill Education Pvt. Ltd. (New Delhi), 1998



# Certificate course: Basics of Biotechnology

## Syllabus

Module: V

Module Code: CBB05

### Module Name: Fermentation Technology

#### **UNIT 1: Introduction to Bioprocess**

Historical development of bioprocess technologies, concept of Bioprocess, outline of an integrated bioprocess and the various (upstream and downstream) unit operations involved in bioprocesses, general requirements of fermentation processes, different types of fermentations, Basic design and construction of fermenter and ancillaries

#### **UNIT 2: Media and sterilization**

Criteria for good medium, medium requirements for fermentation processes, design of various commercial media for industrial fermentations – medium optimization methods, Thermal death kinetics of microorganisms, filter sterilization of liquid media, air sterilization

#### **UNIT 3: Growth Kinetics:**

Phases of cell growth in batch cultures, simple unstructured kinetic models for microbial growth, Monod model, growth of filamentous organisms, Growth associated (primary) and non-growth associated (secondary) product formation kinetics, substrate and product inhibition on cell growth and product formation.

#### **UNIT 4: Downstream Processing**

Cell disruption for product release – mechanical, enzymatic and chemical methods, Pretreatment and stabilization of bioproducts, methods of product extraction, purification and polishing

#### **Suggested Reading**

1. Pauline.M.Doran ., “Bioprocess Engineering Principles”;Academic press ..
2. Peter F.Stanbury, Allan Whitaker, “Principles of Fermentation Technology”
3. Michael L.Shuler and Fikret Kargi, “Bioprocess Engineering Basic concepts”, Prentice Hall, 1992.

# **Certificate course: Basics of Biotechnology**

## **Syllabus**

**Module: VI**

**Module Code: CBB06**

### **Module Name: Introduction to Genetic engineering and RDT products**

#### **UNIT 1: Introduction to Recombinant DNA Technology**

Overview of recombinant DNA technology, Restriction and modification systems, restriction endonucleases and other enzymes used in manipulating DNA molecules, Plasmid vectors, phage vectors, cosmids, YAC and expression vectors, Joining of DNA fragments: ligation of DNA molecules. DNA ligases, sticky ends, blunt ends, linkers and adapters

#### **UNIT 2: Basic methods of RDT**

Gene Cloning (Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning); Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; Probes-oligonucleotide, heterologous, PCR, Methods of gene transfer- Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics-selectable marker and reporter genes (Luciferase, GUS, GFP)

#### **UNIT 3: Genetically Modified Plants**

Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations)

#### **UNIT 4: RDT Products:**

Other Role of transgenics in bioremediation (Superbug); edible vaccines; Genetically Engineered Products-Human Growth Hormone; Humulin

#### **Suggested Reading**

1. Brown, T.A., Gene Cloning and DNA Analysis, 6th ed., Wiley-Blackwell publishing (Oxford), 2010
2. Primrose, S.B., and Twyman, R. M., Principles of Gene Manipulation and Genomics, 7th ed., Blackwell publishing (Oxford), 2006
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.

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## Syllabus

Module: VII

Module Code: CBB07

### Module Name: Industrial Enzymes

#### **UNIT 1: Introduction to Industrial Enzymes**

Description of enzymes, Types of Enzyme, Present India enzyme market, Requirement of industrial enzymes

#### **UNIT 2. Production of Enzymes**

Sources of enzymes: animal, plant and microbial source, Isolation of industrially important enzymes, commercial production of enzymes, Improvement of enzymes by immobilization, GE and its stability, Formulation of medium, recovery and purification of enzyme

#### **UNIT 3. Applications of Industrial Enzymes**

Applications of Industrial Enzymes in Food industry, Beverage industry, Detergent industry, Leather industry, Textile industry, Agricultural industry, Paper industry

#### **UNIT 4: Case study of Industrial Enzymes**

Cellulases, Amylases, Lipases (esterases), Xylanase, Proteases

#### **Suggested Reading:**

1. Pelczar M Jr., Chan ECS and Kreig NR, Microbiology, 5th Edition, Tata McGraw Hill, 1993.
2. Maloy SR, Cronan JE Jr, and Freibfelder D, Microbial Genetics, Jones Bartlett Publishers, Sudbury, Massachusetts, 2006
3. Crueger and A Crueger, (English Ed., TDW Brock); Biotechnology: A textbook Industrial Microbiology, Sinaeurb Associates, 1990
4. G Reed, Prescott and Dunn's, Industrial Microbiology, 4th Edition, CBS Publishers, 1987

# Certificate course: Basics of Biotechnology

## Syllabus

Module: VIII

Module Code: CBB08

### Module Name: Biotechnology Products

Technology involved in the production of the following products

#### **UNIT 1: Animal Products**

Growth hormone, Organ generation through stem cells, Biopharm animals, Therapeutic proteins

#### **UNIT 2: Plant Products**

GM Foods (Soyabean, Papaya, Bt Brinal), Stress tolerant plants, Plant secondary metabolites (Stevia etc.)

#### **UNIT 3: Microbial Products**

Antibiotics (Penicillin), Amino acids (Lysine), Organic acids (Citric acid), SCP, ethanol

#### **UNIT 4: Fermented food products**

Probiotics, Prebiotics, fermented beverages (wine, beer, fermented milk), fermented foods (idli, sauerkraut, cheese, bread), vinegar.

Detailed case study of any 5

#### **Suggested reading:**

1. H J. Peppler and D. Perlman (Editors), Microbial Technology, Vol. II: Fermentation Technology (2nd Edition)
2. H. J. Peppler and D. Perlman (Editors), Microbial Technology, Vol.1: Fermentation Technology (2nd Edition)
3. Prescott and Dunn' s industrial microbiology, 4th edition. Edited by Gerald Reed, Globe Bookservices,
4. Brown, T. A., Gene Cloning and DNA Analysis, 6th ed, Wiley«Blackwell publishing (Oxford), 2010
5. Primrose, S B., and Twyman, R. M. Principles of Gene Manipulation and Genomics, 7th ed., Blackwell publishing (Oxford), 2006

# Certificate course: Basics of Biotechnology

## Syllabus

Module: IX

Module Code: CBB09

### Module Name: Bioethics, Biosafety and IPR

#### UNIT 1: Introduction to Bioethics

Introduction to bioethics: Social and ethical issues in biotechnology. Principles of bioethics, Ethical conflicts in biotechnology interference with nature, unequal distribution of risk and benefits of biotechnology, bioethics vs business ethics

#### UNIT 2: IPR and Patents

Concept of IPR, Designs, Trademarks TM, Trade Secret (TS), Domain Names, Geographical Indications, Copyright, forms of IPR and Intellectual property protection. Concept of property with respect to intellectual creativity, Tangible and Intangible property

#### UNIT 3: Biosafety

Definition of biosafety, Biotechnology and biosafety concerns at the level of individuals, institutions, society, region, country and world with special emphasis on Indian concerns, Bio safety regulation: handling of recombinant DNA products and process in industry and in institutions (Indian context), Good Laboratory biosafety practices ,Importance of good laboratory practices, General good laboratory practices

#### UNIT 4: Regulatory bodies

National regulatory bodies, Biosafety of Genetically engineered products, Genetically engineered “products and Recombinant -DNA. technology, Risk assessment of RDT products Regulating recombinant DNA technology, Permit for movement and import of GMOs, Web based information of biosafety on GMO

#### Suggested Reading:

1. Fleming, D.A., Hunt, D.L., (2000): Biotechnology and Safety Assessment (3rd Ed) Academic press. ISBN -1555811804,9781555811808.
2. Thomas, J. A, Fuch, R L. (1999) Biotechnology and safety assessment (3rd Ed). CRC press, Washington.ISBN: 1560327219, 9781560327219
3. Law and Strategy of biotechnological patents by Sibley. Butterworth publication (2007) ISBN: 075069440, 9780750694445.

# Certificate course: Basics of Biotechnology

## Syllabus

Module: XI

Module Code: CBBP01

### Module Name: Biotechnology Lab

Hands on training for basic biotechnology experiments, Demonstration of advanced experiments

**Microbiology:** Sterilization techniques, Media Preparation, Isolation of Microorganisms, Primary screening.

**Molecular Biology:** Isolation and purification of nucleic acids and proteins.

**Biochemistry:** Quantitative and qualitative assays of major biomolecules

**Fermentation:** Production and downstream processing of any two fermentation products