

AC - 09/04/2020

Item No - 5.1



**Rayat Shikshan Sanstha's  
KARMAVEER BHOURAO PATIL COLLEGE, VASHI.  
NAVI MUMBAI  
(AUTONOMOUS COLLEGE)  
Sector-15- A, Vashi, Navi Mumbai - 400 703**

**Syllabus for T.Y.B.Sc. Biotechnology**

**Program: B.Sc.**

**Course: Biotechnology**

**(Choice Based Credit, Grading and Semester System  
with effect from the academic year 2020-2021)**

## **Preamble of the Syllabus:**

Bachelor of Science (B.Sc.) in Biotechnology is a under graduation course of Department of Biotechnology, Karmaveer Bhaurao Patil College Vashi, Navi Mumbai, affiliated to University of Mumbai (MH).

Biotechnology is defined as the application of technological principles for the processing or manipulating biological agents to provide goods and services. It derives its strength by harnessing biological processes that sustain life. It is a technology that is more reliable and firm. Biotechnology has the potential to transform the lives of the people by impacting hugely on agriculture, animal husbandry, health and medicines, environment, sustainable development, etc. Biotechnology has accomplished tremendous applications in just a matter of time. People have just started to recognize the endless window of opportunities it has open. Biotechnology has revolutionized the recent advancements in research and development.

CBSGS: The Choice Based Semester and Grading System to be implemented through this curriculum would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities.

### **Program Education Objective:**

To prepare students to prime for-

- Higher education and research in field of Biotechnology and related subjects.
  
- Careers related broadly to Biotechnology and Life Sciences. Students will embark upon diverse career paths in Medical coding, Pharmaceutical, Biotechnology industries and use their education in a variety of related endeavours.

### **Objectives of the Course:**

- To produce students who understand Biotechnology as an interdisciplinary subject. Also they will understand fundamental as well as advanced topics in Biotechnology and apply that understanding to analyze and solve problems in Biotechnology industries.

### **Course Outcome: By the end of the course:**

1. Students will gain knowledge about concepts of Applied Chemistry, Biochemistry, Immunology, Cell Biology, Genetics, Fermentation Technology, Ecology, Evolution, Medical Microbiology, Genetic Engineering, Research Methodology and Entrepreneurship.

2. Students will be able to –

- Demonstrate knowledge of concepts of Biotechnology
  
- Understand ecology and evolution as a science and its importance in research.
  
- Possess hands on skills
  
- Demonstrate improvement in maintenance of a laboratory notebook and written reports.
  
- Understand to design a research project and proper channels to carry out research
  
- Develop oral and written communication skills.

3. Students would have adequate knowledge to understand, analyze, differentiate between expected and unexpected results, interpret results and make conclusions from experiments.

## **T. Y. B. Sc. Biotechnology**

For the subject of Biotechnology there shall be five papers for 45 lectures each, Comprising of four units of 15 L each.

### **Semester-V**

1. Paper-I Cell Biology & Chemotherapeutic Agents
2. Paper-II **Bio-analytical Techniques**
3. Paper III Regulation, Genomes and Omics
4. Paper IV Marine Biotechnology
5. Paper V **Biosafety and Intellectual Property Rights**

### **Semester-VI**

1. Paper-I Biochemistry
2. Paper-II **Industrial Microbiology**
3. Paper III Basic Pharmacology and Toxicology
4. Paper IV **Environmental Biotechnology**
5. Paper V **Agri-biotechnology**

**Scheme of examination for Each Semester:**

**Continuous Internal Evaluation: 40 Marks** (Common Test-20 Marks & 20 Marks for- Assignment, Projects, Group discussion, Open book test, online test etc.)

**Semester End Examination: 60 Marks** will be as follows –

|         |  |  |
|---------|--|--|
| I       | <b>Theory:</b>   |  |
|         | Each theory paper shall be of two and half hour duration.    |  |
|         | All questions are compulsory and will have internal options. |  |
|         | Q – I  | From Unit – I (having internal options.) 12 M  |
|         | Q – II   | From Unit – II (having internal options.) 12 M   |
|         | Q –III   | From Unit – III (having internal options.)12 M   |
|         | Q –IV  | From Unit – IV (having internal options.) 12 M   |
|         | Q –V   | Questions from all the THREE Units with equal weightage of marks allotted to each Unit. 12 M |
| II      | <b>Practical</b>   | The External examination per practical course will be conducted as per the following scheme. |
| Sr. No. | <b>Particulars of Semester End Practical Examination</b>     | <b>Total Marks</b>   |
| I       | Semester end Practical Exam                                  | 300  |

# Semester 5

**Choice Based Credit, Grading and Semester System with Effect from the  
Academic Year 2020-21**

**T. Y. B. Sc. Biotechnology**

**SEMESTER V**

| <b>Sr. No.</b> | <b>Paper Code</b> | <b>Title of Paper</b>                       | <b>Credits</b> | <b>L / Week</b> |
|----------------|-------------------|---|----------------|-----------------|
| 1.             | UGBT501           | Cell Biology & Chemotherapeutic Agents      | 2.5            | 4               |
| 2.             | UGBT502           | Bio-analytical Techniques                   | 2.5            | 4               |
| 3.             | UGBT503           | Regulation, Genomes and Omics               | 2.5            | 4               |
| 4.             | UGBT504           | Marine Biotechnology                        | 2.5            | 4               |
| 5.             | UGBTAC505         | Biosafety and Intellectual Property Rights  | 2              | 4               |
| 6.             | UGBTP501-502      | Practicals of UGBT501 and UGB502            | 3              | 8               |
| 7.             | UGBTP503-504      | Practicals of UGBT503 and UGBT504           | 3              | 8               |
| 8.             | UGBTAC505         | Practicals of UGBTAC505 (Applied Component) | 2              | 6               |

## T. Y. B. Sc. Biotechnology

### Semester V

|   |   |   |
|---|---|---|
| <b>Paper I</b>  | : | <b>Cell Biology &amp; Chemotherapeutic Agents</b> |
| <b>Paper Code</b>   | : | <b>UGBT501</b>                                    |
| <b>Learning Outcome:</b> Students will be able to understand –<br>1. Differentiation between cell cycle in prokaryotes and eukaryotes.<br>2. Mechanism which controls cell division<br>3. Mechanism of differentiation of cells<br>4. Molecular genetics of cancer and its control<br>5. Mode of action of different chemotherapeutic agents.<br>6. The concept of drug resistance and measures to prevent it.  |   |   |
| <b>Unit 1: Cell Cycle</b>   |   |   |
| Cell cycle Introduction: Prokaryotic and Eukaryotic.<br>The Early Embryonic Cell Cycle and the Role of MPF.<br>Yeasts and the Molecular Genetics of Cell- Cycle Control.<br>Apoptosis,<br>Cell-Division Controls in Multicellular Animals.  |   |   |
| <b>Unit 2: Developmental Biology</b>  |   |   |
| Overview of how the modern era of developmental biology emerged through multidisciplinary approaches; Stages of development- zygote, blastula, gastrula, neurula cell fate & commitment –potency, concept of embryonic stem cells, differential gene expression, terminal differentiation, lineages of three germ layers, fate map; Mechanisms of differentiation- cytoplasmic determinants, embryonic induction, concept of morphogen, mosaic and regulative development Pattern formation—axis specification, positional identification (regional specification), Morphogenetic movements, Model organisms in Developmental biology. Overview of assisted reproductive technology.                      |   |   |
| <b>Unit 3: Cancer Biology</b>   |   |   |
| Cancer: Introduction, Cancer as a Microevolutionary Process; The Molecular Genetics of Cancer; Cancer and Virus Cancer diagnosis and Chemotherapy, Radiotherapy and Immunotherapy   |   |   |
| <b>Unit 4: Chemotherapeutic Agents</b>  |   |   |
| Chemotherapeutic drugs, Discovery and Design of antimicrobial agents, Classification of Antibacterial agents, selective toxicity, MIC, MLC<br>Inhibition of cell wall synthesis (Mode of action for):Beta lactam antibiotics: Penicillin, Cephalosporins; Glycopeptides: Vancomycin; Polypeptide: Bacitracin, Injury to plasma membrane: Polymyxin, Inhibition of protein synthesis: Aminoglycosides, Tetracyclines, Chloramphenicol, Macrolides- Erythromycin, Inhibition of Nucleic acid synthesis: Quinolones, Rifampicin, Metronidazole, Antimetabolites: Sulphonamides, Trimethoprim drug Resistance: Mechanism, Origin and transmission of drug resistance, Use and misuse of antimicrobial agents. |   |   |



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| <b>Paper II</b>   | : | <b>Bio-analytical Techniques</b> |
| <b>Paper Code</b>   | : | <b>UGBT502</b>                   |
| <p><b>Learning Outcome:</b> Students will be able to understand –</p> <ol style="list-style-type: none"> <li>1. Principle and applications of different types of electrophoresis techniques.</li> <li>2. Principle and applications of different types of centrifugation techniques.</li> <li>3. Principle and applications of different types of spectrophotometric electrophoresis techniques.</li> <li>4. Principle and applications of different types of chromatographic techniques.</li> <li>5. Role of radioisotopes in different tracer techniques and its applications.</li> </ol> |   |                                  |
| <b>Unit 1: Electrophoresis</b>  |   |                                  |
| General principle, Support media, Electrophoresis of Proteins – Native PAGE , SDS-PAGE, Isoelectric Focusing, 2D-PAGE, Cellulose acetate electrophoresis (Principle, Instrumentation, Detection, application); Electrophoresis of nucleic acids – Agarose Gel Electrophoresis, Pulsed-field gel (Principle, Instrumentation, Detection, application)  |   |                                  |
| <b>Unit 2: Centrifugation</b>   |   |                                  |
| Basic principle of sedimentation; Types of rotors - fixed-angle rotors, vertical tube rotors and swinging-bucket rotors; Types of centrifugation – Preparative & Analytical, Differential centrifugation – Principle, Working and Applications, Density-gradient centrifugation - Principle, Working and Applications.  |   |                                  |
| <b>Unit 3: Spectroscopy</b>   |   |                                  |
| Principle, instrumentation, working and applications of: Fluorescence Spectroscopy, Luminometry, Light scattering spectroscopy, Infrared Spectroscopy, Atomic absorption Spectroscopy, Mass Spectroscopy, NMR, RAMAN, Surface plasmon resonance   |   |                                  |
| <b>Unit 4: Bioanalytical Techniques</b>   |   |                                  |
| Principle, working and applications of: Affinity chromatography, Ion-exchange chromatography, Molecular (size) exclusion chromatography; HPLC; Gas Chromatography - Method development and validation.<br>Isotopes in Biology: Nature of radioactivity; Detection Techniques using GM counter, Scintillation counter, Autoradiography; Applications of Tracer techniques in Biology.  |   |                                  |

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|--|----------|--------------------------------------|
| <b>Paper III</b>   | <b>:</b> | <b>Regulation, Genomes and Omics</b> |
| <b>Paper Code</b>  | <b>:</b> | <b>UGBT503</b>                       |
| <p><b>Learning Outcome:</b> Students will be able to understand –</p> <ol style="list-style-type: none"> <li>1. Regulation of gene expression at DNA and RNA level.</li> <li>2. Concept of epigenetic control in gene expression and its effect.</li> <li>3. The concept of physical and chemical methods of transferring genes in to plants and animals.</li> <li>4. Human genome mapping and its implications.</li> <li>5. The importance of CRISPER/CAS system and Gene therapy.</li> <li>6. History and Components of ‘Omics’.</li> <li>7. The analysis of Genomics, Epigenomics, Transcriptomics, Proteomics and Metabolomics.</li> </ol> |          |                                      |
| <p><b>Unit 1: Regulation of Gene Expression in Prokaryotes and Eukaryotes</b></p>  |          |                                      |
| <p>Prokaryotes (In Bacteria):<i>lac</i> operon of <i>E. coli</i> (revision), <i>trp</i> operon of <i>E. coli</i><br/> In Viruses: Lytic / Lysogenic Regulation<br/> In Eukaryotes: Operons in Eukaryotes, Control of Transcriptional Initiation, Gene Silencing and Genomic Imprinting, Post-Transcriptional Control, RNA interference</p>   |          |                                      |
| <p><b>Unit 2: Genetic Engineering in Plants and Animals</b></p>  |          |                                      |
| <p>Transgenic plants: Physical methods of transferring genes to plants: electroporation, microprojectile bombardment, liposome mediated, protoplast fusion; Chemical Methods for transferring genes to plants :Calcium phosphate, DEAE dextran<br/> Transgenic Animals: Transgenic mice- methodology-retroviral method, DNA microinjection, ES method; genetic manipulation with cre-loxP; Vectors for animal cells; Transgenic animals recombination system; Cloning live stock by nuclear transfer; Transgenic Livestock,<br/> Synthetic biology- improvement of seed quality proteins and transgenic fish.</p>                              |          |                                      |
| <p><b>Unit 3: Gene Sequencing and Editing</b></p>  |          |                                      |
| <p>Gene sequencing and editing, Maxam Gilbert’s method, Sanger’s dideoxy method, Automated DNA sequencing, Pyrosequencing; Next generation Sequencing;<br/> Human genome mapping and its implications in health and disease; RNAi, ZNF(Zinc finger nucleases), TALENS (Transcription Activator Like Effector Nucleases), CRISPER/Cas system (Clustered Regularly Interspersed Repeats), DNA fingerprinting, Gene therapy (Sickle cell anemia, Cystic fibrosis)</p>   |          |                                      |
| <p><b>Unit 4: Introduction to “Omics”</b></p>  |          |                                      |
| <p>Introduction and History of “Omics”, Types of Omics, Components of Omics; Goal, Principle, Techniques, Applications of – Genomics, Epigenomics, Transcriptomics, Proteomics, Metabolomics, Bioinformatics based approach for “Omics”.</p>   |          |                                      |

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| <b>Paper IV</b>  | : | <b>Marine Biotechnology</b> |
| <b>Paper Code</b>  | : | <b>UGBT504</b>              |
| <p><b>Learning Outcome:</b> Students will be able to understand –</p> <ol style="list-style-type: none"> <li>1. The concepts related to marine biotechnology and its applications.</li> <li>2. The microbes in marine aquatic environment, their role and its interaction with ecosystem.</li> <li>3. Pharmaceutical compounds from marine ecosystem and its potential applications.</li> <li>4. Marine microbial enzymes and its applications.</li> <li>5. Clinical trial and challenges associated with marine products.</li> <li>6. Emphasize on marine functional foods and nutraceuticals.</li> <li>7. Different types of marine bioresources.</li> <li>8. The concept of cosmeceuticals and its applications.</li> </ol> |   |                             |
| <p><b>Unit 1: Marine Biotechnology Introduction &amp; Bioprospecting</b></p>   |   |                             |
| <p>Introduction to Marine Biotechnology; Applications of Marine Biotechnology The marine ecosystem and its functioning: intertidal, estuarine, salt marsh, mangrove, coral reef, coastal &amp; deep sea ecosystems. Hydrothermal vents, Bioprospecting, Marine Microbial Habitats and their Biotechnologically relevant Microorganisms, Biotechnological Potential of Marine Microbes, Bioactive compounds from other Marine Organisms: fungi, Microalgae, Seaweeds, Acinimycetes, sponges.</p>  |   |                             |
| <p><b>Unit 2: Marine Drugs and Enzymes</b></p>   |   |                             |
| <p>Drugs from Marine organisms: Pharmaceutical compounds from marine flora and fauna – marine toxins, antiviral and antimicrobial agents. Approved Marine Drugs as Pharmaceuticals Marine Natural products and its Challenges; Marine Natural Products and Clinical Trials Marine Microbial Enzymes: Marine Extremozymes and Their Significance, Current Use of Marine Microbial Enzymes.</p>  |   |                             |
| <p><b>Unit 3: Marine Functional Foods and Nutraceuticals</b></p>   |   |                             |
| <p>Marine Functional Foods: Marine sources as healthy foods or reservoirs of functional ingredients, Marine-derived Ingredients with biological properties, Functional Foods Incorporating Marine-Derived Ingredients, Marine Nutraceuticals: Marine Bioactives as Potential Nutraceuticals, Functional Carbohydrates, Polyunsaturated FattyAcids, Carotenoids, Soluble Calcium, Fish Collagen and Gelatin, Marine Probiotics, Nutraceutical Market Trends and Quality Control.</p>  |   |                             |
| <p><b>Unit 4: Marine Bioresources and Cosmetics</b></p>  |   |                             |
| <p>Marine Bioresources, Marine Secondary Metabolites, Marine Proteins, Marine Lipids; Future trends in Marine Pharmaceuticals<br/>Cosmetics from Marine Sources: Scenario of Marine Sources in the Cosmetic Industry, Cosmetics: Definition and Regulations, Cosmeceuticals, Target Organs and Cosmetics Delivery Systems, Components of Cosmetics, Major Functions of Some Marine Components in Cosmetics and Cosmeceuticals, Treatments Based on Marine Resources, Products Based on Marine Resources</p>  |   |                             |

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|---|---|--|
| <b>Paper V</b>  | : | <b>Applied Component- Biosafety and Intellectual Property Rights</b> |
| <b>Paper Code</b>   | : | <b>UGBTAC505</b>   |
| <p><b>Learning Outcome:</b> Students will be able to understand –</p> <ol style="list-style-type: none"> <li>1. Risk associated with various lab procedures, protocols, apparatus etc.</li> <li>2. Biosafety issues in context with Biotechnology.</li> <li>3. Types of pharma products</li> <li>4. Regulatory procedures associated with testing of contaminants in food and pharma products.</li> <li>5. Different types of intellectual property rights and when to exercise them.</li> <li>6. Basics of patent drafting procedure and parts of patent application.</li> </ol> <p>What is infringement of patent.</p>                                      |   |  |
| <b>Unit 1: Biosafety and Bioethics</b>  |   |  |
| <p>Introduction, Biological Risk Assessment, Hazardous Characteristics of Agent, Genetically modified agent hazards, Cell cultures, Hazardous Characteristics of Laboratory Procedures, Potential Hazards Associated with Work Practices, Safety Equipment and Facility Safeguards Pathogenic risk and management.</p> <p>Ethical issues related to rDNA technology, GM crops, Gene therapy and Stem cell research.</p>   |   |  |
| <b>Unit 2: Detection and Testing in Food and Pharmaceuticals</b>  |   |  |
| <p>What is food? Food security, food supply chain, mechanism of microbial contamination at various stages- pre-harvest, during harvesting, pre-slaughter/ slaughter, post- harvest, post slaughter, food contact equipment's, contamination through food handlers, packaging, distribution, marketing and storage, health impact. Microbial Contamination in food</p> <p>Types of pharma products, Microbiological assays- Antibiotic assays, vitamin B12 assay, Some common microbial contaminants; Regulatory Microbiological testing in pharmaceuticals- Pharmacopoeia's, Microbial limit test, sterility testing, endotoxin testing, OECD guidelines.</p> |   |  |
| <b>Unit 3: Overview of Intellectual Property Rights</b>   |   |  |
| <p>Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright (meaning, subject matter of copyright), Trade Mark (Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks), Design, Geographical Indication (meaning), Plant Varieties (meaning and benefit sharing and farmers' rights) and Layout Design (meaning), Trade Secret</p> <p>WTO: agency controlling trade among nations, WTO with reference to biotechnological affairs, TRIPs. WIPO, EPO.</p>                                 |   |  |
| <b>Unit 4: Patent and Patent Drafting</b>   |   |  |
| <p>What is a Patent? Importance; Concept related to patents: novelty, non-obviousness, utility, inventive step, prior art etc. Types of patent applications, Non patentable inventions, Typical parts of patent application (claim, description, drawings, background, abstract, summary), patent claim format and types, Term of patent, Rights of patentee, Infringement of patents</p>   |   |  |

## T.Y.B.Sc. Biotechnology

### Semester V Practicals

#### UGBT501 Cell Biology & Chemotherapeutic Agents

|    |  |
|----|--|
| 1. | MIC and MLC of any one antibiotic                              |
| 2. | Antibiotic sensitivity test using agar cup method              |
| 3. | Antibiotic sensitivity test using paper disc method            |
| 4. | Antibiotic sensitivity test using ditch method                 |
| 5. | Cancer Biology: (Field visit and 2 page report in the journal) |

#### UGBT502 Bio-analytical Techniques

|    |   |
|----|---|
| 1. | Separation of components from a mixture using Affinity chromatography (Kit may be used)       |
| 2. | Separation of components from a mixture using ion exchange chromatography (Kit may be used)   |
| 3. | Separation of components from a mixture using Size exclusion chromatography (Kit may be used) |
| 4. | HPLC method validation.   |
| 5. | Separation of components using density gradient centrifugation                                |
| 6. | Separation of components using differential centrifugation                                    |
| 7. | SDS - PAGE  |

#### UGBT503 Regulation, Genomes and Omics

|    |  |
|----|--|
| 1. | Transformation in <i>E.coli</i> .                            |
| 2. | Genomic DNA Extraction: Animal cells.                        |
| 3. | Restriction enzyme digestion and ligation (Kit may be used). |
| 4. | Polymerase chain reaction. (Demonstration)                   |
| 5. | Gradient plate technique                                     |
| 6. | Bacterial gene expression (Kit may be used).                 |

#### UGBT504 Marine Biotechnology

|    |  |
|----|--|
| 1. | Study of any 5 marine bacteria and algae (Macro and micro)                 |
| 2. | DPPH assay for antioxidant extracted from marine algae                     |
| 3. | Extraction of carotenoids from marine algae/Bacteria/Fungi                 |
| 4. | Extraction and estimation of Gelatin / Collagen.                           |
| 5. | Extraction of alkaloids from marine organisms and their separation by TLC. |

### **UGBTAC505 Biosafety and Intellectual Property Rights**

|           |   |
|-----------|---|
| <b>1.</b> | Vitamin B12 bioassay                                |
| <b>2.</b> | Testing for adulterants in food; ex. Starch in milk |
| <b>3.</b> | Microbiological Analysis of food                    |
| <b>4.</b> | Assignment on IPR                                   |

## References

### **Title of Paper: UGBT501 Cell Biology & Chemotherapeutic Agents**

1. Molecular Cell Biology. 7th Edition, (2012) Lodish H., Berk A, Kaiser C., K Reiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA
2. Molecular Biology of the Cell, 5th Edition (2007) Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science, USA
3. Cell Biology, 6th edition, (2010) Gerald Karp. John Wiley & Sons., USA
4. The Cell: A Molecular Approach, 6th edition (2013), Geoffrey M. Cooper, Robert E. Hausman, Sinauer Associates, Inc. USA
5. Developmental Biology; Scott Gilbert; 9th Edition

### **Title of Paper: UGBT502 Bio-analytical Techniques**

1. Principles and Techniques in Biochemistry and Molecular Biology (2010), Keith Wilson and John Walker, 7th edition, Cambridge University Press
2. Biophysics (2002) Vasantha Pattabhi and N. Gautham, Kluwer Academic Publishers
3. Physical Biochemistry: principles and applications, 2nd edition (2009), David Sheehan, John Wiley & Sons Ltd
4. HPLC method validation for pharmaceuticals: a review (2013), Harshad V. Paithankar, International Journal of Universal Pharmacy and Bio Sciences 2(4): July-August.

### **Title of Paper: UGBT503 Regulation, Genomes and Omics**

1. iGenetics A Molecular Approach 3rd Edition Peter J. Russell.
2. Molecular Biotechnology-Principles and Applications of Recombinant DNA Technology 3rd Edition Glick B.R., Pasternak J.J., Patten C.L.
3. Principles of Gene Manipulation 7th Edition Primrose S.B., Twyman R.M
4. Biotechnology 3rd Edition S.S. Purohit.
5. Genomes 3rd Edition T.A. Brown.
6. Biotechnology B.D. Singh.
7. Gene Cloning and DNA Analysis 6th Edition T.A. Brown.
8. Genomics Cantor C.R., and Smith C.L. John Wiley & Sons. (1999)

### **Title of Paper: UGBT504 Marine Biotechnology**

1. Kim, S.K. Springer Handbook of Marine Biotechnology; Springer: Berlin, Germany; Heidelberg, Germany, 2015.
2. Nollet, Leo M. L- Marine microorganisms- extraction and analysis of bioactive compounds-CRC Press\_Taylor& Francis (2017)
3. R. S. K. Barnes, R. N. Hughes(auth.)-An Introduction to Marine Ecology, Third Edition-Wiley-Blackwell (1999)
4. Blanca Hernández-Ledesma, Miguel Herrero-Bioactive Compounds from Marine Foods-Plant and Animal Sources-Wiley-Blackwell (2013)

5. Fabio Rindi, Anna Soler-Vila, Michael D. Guiry (auth.), Maria Hayes (eds.)-Marine Bioactive Compounds\_Sources, Characterization and Applications-Springer US (2012)
6. W. Evans-Trease and Evans Pharmacognosy 15th ed.-Saunders (2010)

**Title of Paper: UGBTAC505 Biosafety and Intellectual Property Rights**

1. Pharmaceutical Microbiology - Hugo, W.B, Russell, A.D 6th edition Oxford Black Scientific Publishers.
2. Biosafety in Microbiological and Biomedical Laboratories - 5th Edition, L. CaseyChosewood Deborah E. Wilson U.S. Department of Health and Human ServicesCenters for Disease Control and Prevention National Institutes of Health.
3. Molecular Biotechnology –Principles and Applications of Recombinant DNA Glick,B.R, Pasternak, J.J Patten, C.L 3rd edition ASM press
4. WIPO Patent Drafting Manual



# Semester 6

**Choice Based Credit, Grading and Semester System with Effect  
from the Academic Year 2020-2021**

**T. Y. B. Sc. Biotechnology**

**SEMESTER VI**

| <b>Sr. No.</b> | <b>Paper Code</b> | <b>Title of Paper</b>                       | <b>Credits</b> | <b>L / Week</b> |
|----------------|-------------------|---|----------------|-----------------|
| 1.             | UGBT601           | Biochemistry                                | 2.5            | 4               |
| 2.             | UGBT602           | Industrial Microbiology                     | 2.5            | 4               |
| 3.             | UGBT603           | Basic Pharmacology and Toxicology           | 2.5            | 4               |
| 4.             | UGBT604           | Environmental Biotechnology                 | 2.5            | 4               |
| 5.             | UGBTAC605         | Agri-Biotechnology                          | 2              | 4               |
| 6.             | UGBTP601-602      | Practicals of UGBT601 and UGB602            | 3              | 8               |
| 7.             | UGBTP603-604      | Practicals of UGBT603 and UGBT604           | 3              | 8               |
| 8.             | UGBTPAC605        | Practicals of UGBTAC605 (Applied Component) | 2              | 6               |

## T. Y. B. Sc. Biotechnology

### Semester VI

|   |   |                     |
|---|---|---------------------|
| <b>Paper I</b>  | : | <b>Biochemistry</b> |
| <b>Paper Code</b>   | : | <b>UGBT601</b>      |
| <b>Learning Outcome:</b> Students will be able to understand –<br>1. Concept of protein denaturation and protein folding.<br>2. Complementary interactions between proteins and ligands<br>3. Biosynthesis pathways of carbohydrates and lipids and its importance<br>4. Role of different hormones in body and their mechanism of action.<br>5. Functions and disorders associated with different vitamins and minerals  |   |                     |
| <b>Unit 1: Protein Biochemistry</b>   |   |                     |
| Protein structure: Protein Tertiary and Quaternary Structures; Protein Denaturation and Folding ; Protein Function: Reversible Binding of a Protein to a Ligand: Oxygen-Binding Proteins ; Complementary Interactions between Proteins and Ligands: Immunoglobulins ; Protein Interactions Modulated by Chemical Energy: Actin, Myosin, and Molecular Motors ; Protein purification   |   |                     |
| <b>Unit 2: Metabolism</b>   |   |                     |
| Carbohydrate biosynthesis and its regulation: Peptidoglycan in Bacteria ; Starch and sucrose in Plants ; Glycogen in Animals ; Biosynthesis and regulation of saturated and unsaturated fatty acids Triacylglycerol, Phospholipids and Cholesterol, Atherosclerosis.  |   |                     |
| <b>Unit 3: Endocrinology</b>  |   |                     |
| Mechanism of action of group I and II hormones; Structure, storage, release, transport, biochemical functions and disorders associated with hormones secreted by Hypothalamus ; Anterior Pituitary gland - GH, stimulating hormones) ; Posterior Pituitary gland – oxytocin and vasopressin ; Thyroid gland – Thyroxine, calcitonin ; Parathyroid gland – PTH ; Adrenal medulla – epinephrine and norepinephrine ; Adrenal cortex – Glucocorticoids ; Pancreas – insulin and glucagon ; Female Gonads – estrogen and progesterone ; Male gonads – testosterone ; Placenta – hCG . |   |                     |
| <b>Unit 4: Nutrition</b>  |   |                     |
| Minerals and Vitamins; Dietary sources, bioactive form, functions and disorders associated with fat soluble (A D E K) and water soluble vitamins; Minerals - physiological and biochemical functions of principal and trace elements; Malnutrition – Over nutrition (obesity) and PEM (Kwashiorkor and Marasmus).   |   |                     |

|   |   |                                |
|---|---|--------------------------------|
| <b>Paper II</b>   | : | <b>Industrial Microbiology</b> |
| <b>Paper Code</b>   | : | <b>UGBT602</b>                 |
| <b>Learning Outcome:</b> Students will be able to understand –  |   |                                |
| <ol style="list-style-type: none"> <li>1. Normal flora of milk and factors affecting quality of milk, milk products</li> <li>2. The concept of milk preservation through pasteurization</li> <li>3. The concept and methods under downstream processing and its implications</li> <li>4. Fermentation processes using scale up and scale down approaches</li> <li>5. Industrial production of commercially important products</li> <li>6. The concepts of GMP, GLP, QA and QC and its significance</li> </ol> |   |                                |
| <b>Unit 1: Dairy Technology</b>   |   |                                |
| Milk: Normal flora, changes in raw milk, Enumeration, Factors affecting bacteriological quality, Dairy technology, Preservation methods, Pasteurization, Starter Cultures, Fermented products -Production process and spoilage of Cheese: Swiss and Cheddar, Butter, Yogurt and Buttermilk.   |   |                                |
| <b>Unit 2: Down-stream Processing (DSP)</b>   |   |                                |
| Introduction of DSP; Foam separation; Types of Precipitation; Filtration, Centrifugation; Chromatography in DSP; Cell disruption- physical and chemical methods, Solvent recovery, Membrane processes, Drying, Crystallization and Whole broth processing.  |   |                                |
| <b>Unit 3: Fermentation Process</b>   |   |                                |
| Introduction to Inoculum development, Bacterial and fungal inoculum development with one example each, scale up, scale down; Production of: Streptomycin, Protease, Mushroom, Glutamic acid, Lysine, Ethanol production, Semi-synthetic Penicillin, Biotransformation   |   |                                |
| <b>Unit 4: QA-QC and GLP</b>  |   |                                |
| Concept of GLP and GMP, Guidelines to GLP, Requirements of GMP implementation, Documentation of GMP practices, Regulatory certification of GMP, Quality Control (QC): Concept of QC, Requirements for implementing QC, Concept of QA; Requirements for implementing QA, ISO, Preparation of SOPs, Validation of methods, Calibration records, Audit and audit reports   |   |                                |

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| <b>Paper III</b>   | : | <b>Basic Pharmacology and Toxicology</b> |
| <b>Paper Code</b>  | : | <b>UGBT603</b>                           |
| <p><b>Learning Outcome:</b> Students will be able to understand –</p> <ol style="list-style-type: none"> <li>1. Mechanism of drug action, drug receptors and biological responses.</li> <li>2. Concept of drug antagonism, potency and intrinsic activity.</li> <li>3. Various factors affecting the rate of drug absorption.</li> <li>4. Influence of various factors during drug distribution.</li> <li>5. Concept of drug metabolism and excretion.</li> <li>6. The concepts of basic and regulatory toxicology.</li> </ol>   |   |  |
| <b>Unit 1: General Principles of Pharmacology</b>  |   |  |
| Mechanism of drug action, drug receptors and biological responses, second-messenger systems, the chemistry of drug–receptor binding, dose–response relationship, therapeutic index, ED, LD, Potency and Intrinsic Activity, drug antagonism.   |   |  |
| <b>Unit 2: Drug Absorption and Distribution</b>  |   |  |
| Absorption of drugs from the alimentary tract, factors affecting rate of gastrointestinal absorption, absorption of drugs from lungs, skin, absorption of drugs after parenteral administration, factors influencing drug distribution, binding of drugs to plasma protein, Physiological barriers to drug distribution.   |   |  |
| <b>Unit 3: Metabolism and Excretion of drugs</b>   |   |  |
| Biotransformation: Synthetic and Non-synthetic, Inhibition of drug metabolism, Microsomal enzyme induction, Consequences and possible uses, first pass metabolism<br>Excretion of drugs, Urine, Feces, Exhaled air, Saliva, Sweat and Milk, Renal excretion  |   |  |
| <b>Unit 4: Basic Toxicology and Regulatory Toxicology</b>  |   |  |
| Background Definitions, Causation: degrees of certainty Classification, Causes Allergy in response to drugs, Effects of prolonged administration, Chronic organ toxicity, Adverse effects on reproduction, Poisons: Deliberate and accidental self-poisoning, Principles of treatment, Poison-specific measures, General measures, Specific poisonings: cyanide, methanol, ethylene glycol, hydrocarbons, volatile solvents, heavy metals, herbicides and pesticides, biological substances, Overdose of medicinal drugs is dealt with under individual agents, Incapacitating agents: Drugs used for torture, Non-medical use of drugs. |   |  |

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| <b>Paper IV</b>  | : | <b>Environmental Biotechnology</b> |
| <b>Paper Code</b>  | : | <b>UGBT604</b>                     |
| <p><b>Learning Outcome:</b> Students will be able to understand –</p> <ol style="list-style-type: none"> <li>1. Different sources of pollution and its environmental effects.</li> <li>2. Difference between conventional and alternative energy resources and their sources.</li> <li>3. Technologies and procedures used to harness energy from various non- conventional energy resources.</li> <li>4. Biological (aerobic and anaerobic) methods to treat effluent and wastewater.</li> <li>5. Biological agents and sensors used to detect pollutants in environment.</li> <li>6. Concept of bioremediation.</li> </ol> |   |                                    |
| <p><b>Unit 1: Environmental Pollution and its Effects</b></p>  |   |                                    |
| <p>Sources of Pollution, Air Pollution: Types, Sources, Classification of Air Pollutants, Air Pollution Monitoring and Control, Water Pollution: Causes, Types and Classification, Eutrophication, Assessment of Water Quality, Pollutant Monitoring and Control, Soil and Solid Waste Pollution: Characteristics of Wastes, Impacts of Solid Waste on Health, Occupational Hazards and Control, Soil Erosion: Concept, Causes and Effects, Green house effect, Global Warming, Ozone Depletion, Kyoto Protocol, UV Radiation, Acid Rain.</p>  |   |                                    |
| <p><b>Unit 2: Renewable Resources</b></p>  |   |                                    |
| <p>Energy sources renewable – Solar energy, Wind power, Geothermal energy and Hydropower, Biomass energy, Biogas technology- Biogas plant &amp; types, Bio-digester, Biogas- composition, production and factors affecting production, uses; Bio-fuels – Ethanol production, Microbial hydrogen production Biodiesel, Petro-crops</p>  |   |                                    |
| <p><b>Unit 3: Effluent &amp; Wastewater Treatment</b></p>  |   |                                    |
| <p>Biological processes for industrial effluent treatment, aerobic biological treatment- activated sludge process, CASP, advanced activated sludge processes (any two) Biological filters, RBC, FBR, Anaerobic biological treatment- Contact digesters, Packed bed reactors, Anaerobic baffled digesters, UASB, Solid waste treatment, Pollution indicators &amp; Biosensors</p>   |   |                                    |
| <p><b>Unit 4: Bioremediation</b></p>   |   |                                    |
| <p>Concept of Bioremediation, Biodegradation of xenobiotics- Persistent compounds, Chemical properties influencing biodegradability, Microorganisms in Biodegradation, Use of immobilized enzymes or microbial cells for treatment, Heavy metal pollution – Sources, microbial systems for heavy metal accumulation, Techniques used for heavy metal removal, Bioaugmentation and Biostimulation, Biosorption by bacteria, Fungi and algae, Factors affecting Biosorption, limitations of Biosorption</p>  |   |                                    |

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| <b>Paper V</b>   | : | <b>Agri-Biotechnology</b> |
| <b>Paper Code</b>  | : | <b>UGBTAC605</b>          |
| <p><b>Learning Outcome:</b> Students will be able to understand –</p> <ol style="list-style-type: none"> <li>1. The concept of precision agriculture and agriculture systems</li> <li>2. The concept of greenhouse technology and its function</li> <li>3. Plant stress biology in relation to biotic and abiotic factors</li> <li>4. Concept of genetic markers in plant breeding.</li> <li>5. Plant DNA barcoding and recent advances.</li> <li>6. Monoculture, Co culture inoculant and Polymicrobial inoculant formulations.</li> </ol>  |   |                           |
| <b>Unit 1: Precision Agriculture and Agriculture Systems</b>   |   |                           |
| Introduction to Agriculture and Agriculture systems, Green house Technology- Types of green house, importance, functions and features of green house, Design criteria and calculation, Construction material, covering material and its characteristics, growing media, green house irrigation system, nutrient management, Greenhouse heating, cooling and shedding and ventilation system, Computer controlled environment, Phytotrons, fertigation and roof system, Precision Cultivation- tools, sensors for information acquisition   |   |                           |
| <b>Unit 2: Plant Stress Biology</b>  |   |                           |
| Abiotic Stress –Physiological and molecular responses of plants to water stress, salinity stress, temperature stress – heat and cold, Photo-oxidative stress, stress perception and stress signaling pathways, Ionic and osmotic homeostasis, reactive oxygen species scavenging, Biotic stress - plant interaction with bacterial, viral and fungal pathogens, plant responses to pathogen– biochemical and molecular basis of host-plant resistance, toxins of fungi and bacteria, systemic and induced resistance –pathogen derived resistance, signaling   |   |                           |
| <b>Unit 3: Molecular Markers in Plant Breeding</b>   |   |                           |
| Genetic markers in plant breeding- Classical markers, DNA markers (RFLP, RAPD, AFLP, SSR, SNP, Application of Molecular Markers to Plant Breeding [quantitative trait locus (QTL) mapping], Plant DNA Barcoding- Barcoding Markers (matK, rbcL, ITS, tmHpsbA), steps, recent advances, Benefits, Limitations   |   |                           |
| <b>Unit 4: Biofertilizers and Biopesticides</b>  |   |                           |
| Biofertilizer, Nitrogen-fixing Rhizobacteria - Symbiotic Nitrogen Fixers, Nonsymbiotic Nitrogen Fixers, Plant Growth Promoting Microorganisms – Phosphate Solubilizing Microbes (PSM), Phytohormones and Cytokinins, Induced Systemic Resistance, Plant Growth Promotion by Fungi - Mycorrhizae, Arbuscular, Mycorrhizae, Ectomycorrhizae, Microbial Inoculants - Inocula, Carriers, and Applications, Monoculture and Co-culture Inoculant Formulations Biocontrol, Polymicrobial Inoculant Formulations, Biopesticides – types, <i>Bacillus thuringiensis</i> , insect viruses and entomopathogenic fungi (characteristics, physiology, mechanism of action and application) |   |                           |

## T.Y.B.Sc. Biotechnology

### Semester IV Practicals

#### UGBT601 Biochemistry

|    |   |
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| 1. | Determination of blood glucose levels for detection of diabetes mellitus. |
| 2. | Determination of serum cholesterol (total, HDL and LDL ratio)             |
| 3. | Estimation vitamin C by DCPIP method from food samples.                   |

#### UGBT602 Industrial Microbiology

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| 1. | Estimation of Milk protein-Pynes method      |
| 2. | Microbial analysis of Milk by MBRT and RRT   |
| 3. | Phosphatase test in Milk                     |
| 4. | DMC of milk sample                           |
| 5. | Isolation of Normal flora from Milk and curd |

#### UGBT603 Basic Pharmacology and Toxicology

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| 1. | LD <sub>50</sub> , ED <sub>50</sub> evaluation using suitable models |
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#### UGBT604 Environmental Biotechnology

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| 1. | Study the effect of heavy metals on the growth of bacteria.   |
| 2. | Determination of Total Solids from an effluent sample.  |
| 3. | Study of physico-chemical (pH, color, turbidity, BOD, COD) parameters of any one industrial effluent sample |
| 4. | Estimation of chromium from Effluents (Demonstration)   |
| 5. | Visit to ETP/ CETP  |

#### UGBT605 Agri-Biotechnology

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| 1. | RAPD analysis demonstration experiment  |
| 2. | Isolation of Rhizobium  |
| 3. | Isolation of Azotobacter  |
| 4. | Isolation of Phosphate solubilising bacteria  |
| 5. | Study of effect of abiotic stress on plants.  |
| 6. | Rapid screening tests for abiotic stress tolerance (Drought, PEG, Mannitol & salinity NaCl) |
| 7. | Estimation of antioxidants and antioxidant enzymes – Ascorbate & Proline                    |
| 8. | Visit to green house facility and submission of field visit report.                         |



## References

### **Title of Paper: UGBT601 Biochemistry**

1. Lehninger, principles of biochemistry, 4th edition (2005), David Nelson and Michael Cox *W.H. Freeman and Company*, New York.
2. Biochemistry , 4th edition (2010), Voet and Voet, John Wiley and sons, USA
3. Harper's Illustrated Biochemistry, 27th edition, RK Murray, DK Granner, PA Mayes and VW Rodwell, McGraw Hills publication.
4. Biochemistry, 4nd edition (2017), Satyanarayana and Chakrapani, Books & Allied (P) Ltd
5. Nutrition Science, 6th edition (2017), Srilakshmi, new age international publishers

### **Title of Paper: UGBT602 Industrial Microbiology**

1. Applied Dairy Microbiology Elmer H Marth and James L Steele MerceL Dekker Inc New York, 2nd edition
2. Microbial Technology Peppler. H.J and Perlman. D 2nd Academic Press Practicals
3. Industrial Microbiology Prescott and Dunn CBS publishers
4. Dairy technology by Yadav and Grower
5. Fermentation technology by Stanbury and Whittkar
6. Pharmaceutical Microbiology by Russel and Hugo

### **Title of Paper: UGBT603 Basic Pharmacology and Toxicology**

1. Textbook of Medical Physiology Guyton, A.C and Hall 11th edition J.E Saunders
2. Modern Pharmacology with clinical Applications Craig. C.R, Stitzel. R.E, 5th edition
3. Clinical Pharmacology Bennet. P.N, Brown. M.J, Sharma.P, 11th edition Elsevier
4. Biochemistry Metzler, D.E Elsevier

### **Title of Paper: UGBT604 Environmental Biotechnology**

1. Environmental Biotechnology Allan Scragg Oxford University press
2. Environmental Biotechnology (Basic concepts and applications) Indu Shekar Thakur IK International
3. Environmental Biotechnology (Industrial pollution management) S.D. Jogdand Himalaya Publishing House

### **Title of Paper: UGBTAC605 Agri-Biotechnology**

1. M. Ajmal Ali, G. Gyulai, F. Al-Hemaid -Plant DNA Barcoding and Phylogenetics, LAP Academic Publishing ( 2015)
2. P. Parvatha Reddy (auth.)-Sustainable Crop Protection under Protected Cultivation-Springer Singapore (2016)
3. S.B. Anderson (ed.), Plant Breeding from Laboratories to Fields, InTech,2013
4. Henry Leung, Subhas Chandra Mukhopadhyay (eds.) - Intelligent Environmental Sensing (2015, Springer International Publishing)
5. Travis R. Glare, Maria E. Moran-Diez - Microbial-Based Biopesticides\_ Methods and Protocols (2016, Humana Press)
6. Altieri, Miguel A. Farrell, John G-Agroecology- The Science Of Sustainable Agriculture, Second Edition-CRC Press (2018)
7. Arie Altman, Paul Michael Hasegawa-Plant Biotechnology and Agriculture\_ Prospects for the 21st Century-Academic Press (2011)

## Board of Studies in the Subject of Biotechnology

### Evaluation Methods

**Semester End Examination: 60 Marks**

**Continuous Internal Evaluation: 40 Marks**

| Sr.no | Class | Semester | Paper I                           | Paper II                                 | Paper III                  | Paper IV                  | Paper V                                 |
|-------|-------|----------|-----------------------------------|--|----------------------------|---------------------------|---|
| 1     | TYBSC | V        | Test- 20 Marks                    | Test- 20 Marks                           | Test- 20 Marks             | Test- 20 Marks            | Test- 20 Marks                          |
|       |       |          | Written Project- 10 Marks         | Written Project- 10 Marks                | Written Project- 10 Marks  | Written Project- 10 Marks | Written Project- 10 Marks               |
|       |       |          | MCQ's- 10 Marks                   | SOP preparation- 10 Marks                | Poster making- 10 Marks    | OBT- 10 Marks             | IPR infringement case studies- 10 Marks |
|       |       | VI       | Test- 20 Marks                    | Test- 20 Marks                           | Test- 20 Marks             | Test- 20 Marks            | Test- 20 Marks                          |
|       |       |          | Written Project- 10 Marks         | Written Project- 10 Marks                | Written Project- 10 Marks  | Written Project- 10 Marks | Written Project- 10 Marks               |
|       |       |          | Flowchart and pathways - 10 Marks | Product preparation flowcharts- 10 Marks | MSDS preparation- 10 Marks | MCQ's- 10 Marks           | OBT- 10 Marks                           |