



आईएफटीएम विश्वविद्यालय, मुरादाबाद, उत्तर प्रदेश  
**IFTM University, Moradabad, Uttar Pradesh**  
NAAC ACCREDITED

## SCHOOL OF SCIENCES

**Bachelor of Science (ZBC)**

THREE YEAR PROGRAMME

[W. E. F. ACADEMIC SESSION: 2020 - 21]

**IFTM UNIVERSITY**  
N.H.-24, Lodhipur Rajput, Delhi Road, Moradabad, Uttar Pradesh-244001  
[www.iftmuniversity.ac.in](http://www.iftmuniversity.ac.in)



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## SCHOOL OF SCIENCES

### Study & Evaluation Scheme of Bachelor of Science (ZBC) [Session 2020-21]

<b>Programme</b>	<b>: Bachelor of Science (ZBC)</b>
<b>Course Level</b>	<b>: UG Course</b>
<b>Duration</b>	<b>: Three Year (Six Semester) Full Time</b>
<b>Medium of Instruction</b>	<b>: English</b>
<b>Minimum Required Attendance</b>	<b>: 75%</b>
<b>Maximum Credits</b>	<b>: 180</b>

#### **Programme Outcomes (POs):**

#### **Students completing this course will be able to:**

- Understand different field of Zoology and its different subfields (animal diversity, principles of ecology, comparative anatomy and developmental biology of vertebrates, physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, applied Zoology, aquatic biology, immunology, reproductive biology, and insect, vectors and diseases, apiculture, aquarium fish keeping, medical diagnostics, and sericulture).
- Understand fundamental aspects of animal science relating to management of animals.
- Procedural knowledge that creates different types of professionals in the field of Zoology and related fields such as, apiculture, aquarium fish keeping, medical diagnostics, and sericulture, etc.
- Enhance the understanding about the diversity of animals, their classification, structure and growth.
- Identify various life forms of animals, their interaction with the environment and vice-versa.
- Understand the economic importance of animals and animal products.
- Think logically and organize tasks into a structured form.
- Analyze data using appropriate statistical methods.
- Prepare themselves for higher studies in the field of Zoology.

**Course Structure and Evaluation Scheme**  
**B. Sc. (ZBC) I Year**

S. No.	Subject Code	Subject Title	Periods			EVALUATION SCHEME				Total	Credit
						Internal Exam			External Exam		
			L	T	P	MSE	AS+AT	Total			
<b>Semester-I</b>											
1.	BBO-101	DIVERSITY OF MICROBES	3	1	0	10+10	5+5	30	70	100	4
2.	BBO-102	ALGAE AND BRYOPHYTES	3	1	0	10+10	5+5	30	70	100	4
3.	BBO-151	<b>BOTANY LAB-1</b>	-	-	4	-	-	30	70	100	2
4.	BZO-101	LOWER NON-CHORADATA	3	1	0	10+10	5+5	30	70	100	4
5.	BZO-102	HIGHER NON-CHORDATA	3	1	0	10+10	5+5	30	70	100	4
6.	BZO-151	<b>ZOOLOGY LAB-1</b>	-	-	4	-	-	30	70	100	2
7.	BCHE-101	INORGANIC CHEMISTRY	3	1	0	10+10	5+5	30	70	100	4
8.	BCHE-102	ORGANIC CHEMISTRY	3	1	0	10+10	5+5	30	70	100	4
9.	BCHE-151	<b>CHEMISTRY LAB-1</b>	-	-	4	-	-	30	70	100	2
10.	AECC*	<b>ENVIRONMENTAL STUDIES</b>	3	0	0	10+10	5+5	30	70	100*	3*
		<b>Total</b>	<b>21</b>	<b>6</b>	<b>12</b>	-	-	-	-	<b>900</b>	<b>30</b>
<b>Semester-II</b>											
1.	BBO-201	PTERIDOPHYTES, GYMNOSPERM AND PALAEOBOTANY	3	1	0	10+10	5+5	30	70	100	4
2.	BBO-202	SYSTEMATICS OF FLOWERING PLANTS AND ECONOMIC BOTANY	3	1	0	10+10	5+5	30	70	100	4
3.	BBO-251	<b>BOTANY LAB-2</b>	-	-	4	-	-	30	70	100	2
4.	BZO-201	CELL AND MOLECULAR BIOLOGY	3	1	0	10+10	5+5	30	70	100	4
5.	BZO-202	GENETICS	3	1	0	10+10	5+5	30	70	100	4
6.	BZO-251	<b>ZOOLOGY LAB-2</b>	-	-	4	-	-	30	70	100	2
7.	BCHE-201	PHYSICAL CHEMISTRY	3	1	0	10+10	5+5	30	70	100	4
8.	BCHE-202	BASICS OF ANALYTICAL CHEMISTRY	3	1	0	10+10	5+5	30	70	100	4
9.	BCHE-251	<b>CHEMISTRY LAB-2</b>	-	-	4	-	-	30	70	100	2
		<b>Total</b>	<b>18</b>	<b>6</b>	<b>12</b>	-	-	-	-	<b>900</b>	<b>30</b>

\*This is an audit course which is mandatory for UG courses.

**Course Structure and Evaluation Scheme**  
**B. Sc. (ZBC) II Year**

S. No.	Subject Code	Subject Title	Periods			EVALUATION SCHEME				Total	Credit
			L	T	P	Internal Exam			External Exam		
						MSE	AS+AT	Total			
<b>Semester-III</b>											
1.	BBO-301	SEXUAL REPRODUCTION IN FLOWERING PLANTS	3	1	0	10+10	5+5	30	70	100	4
2.	BBO-302	PLANT ANATOMY	3	1	0	10+10	5+5	30	70	100	4
3.	BBO-351	<b>BOTANYLAB-3</b>	-	-	4	-	-	30	70	100	2
4.	BZO-301	CHORDATA	3	1	0	10+10	5+5	30	70	100	4
5.	BZO-302	DEVELOPMENTAL BIOLOGY	3	1	0	10+10	5+5	30	70	100	4
6.	BZO-351	<b>ZOOLOGY LAB-3</b>	-	-	4	-	-	30	70	100	2
7.	BCHE-301	INORGANIC CHEMISTRY	3	1	0	10+10	5+5	30	70	100	4
8.	BCHE-302	ORGANIC CHEMISTRY	3	1	0	10+10	5+5	30	70	100	4
9.	BCHE-351	<b>CHEMISTRY LAB-3</b>	-	-	4	-	-	30	70	100	2
		<b>Total</b>	<b>18</b>	<b>6</b>	<b>12</b>	-	-	-	-	<b>900</b>	<b>30</b>
<b>Semester-IV</b>											
1.	BBO-401	CELL AND MOLECULAR BIOLOGY	3	1	0	10+10	5+5	30	70	100	4
2.	BBO-402	GENETICS, PLANT BREEDING AND BIOSTATISTICS	3	1	0	10+10	5+5	30	70	100	4
3.	BBO-451	<b>BOTANY LAB-4</b>	-	-	4	-	-	30	70	100	2
4.	BZO-401	PHYSIOLOGY AND BIOCHEMISTRY	3	1	0	10+10	5+5	30	70	100	4
5.	BZO-402	ANIMAL DISTRIBUTION & EVOLUTION	3	1	0	10+10	5+5	30	70	100	4
6.	BZO-451	<b>ZOOLOGY LAB-4</b>	-	-	4	-	-	30	70	100	2
7.	BCHE-401	PHYSICAL CHEMISTRY	3	1	0	10+10	5+5	30	70	100	4
8.	BCHE-402	ENVIROMENTAL CHEMISTRY	3	1	0	10+10	5+5	30	70	100	4
9.	BCHE-451	<b>CHEMISTRY LAB-4</b>	-	-	4	-	-	30	70	100	2
10.	<b>UDM*</b>	<b>DISASTER MANAGEMENT</b>	3	0	0	10+10	5+5	30	70	100*	3*
		<b>Total</b>	<b>21</b>	<b>6</b>	<b>12</b>	-	-	-	-	<b>900</b>	<b>30</b>

**\*This is an audit course which is mandatory for UG courses.**

**Course Structure and Evaluation Scheme**  
**B. Sc. (ZBC) III Year**

S. No.	Subject Code	Subject Title	Periods			EVALUATION SCHEME				Total	Credit
			L	T	P	Internal Exam			External Exam		
						MSE	AS+AT	Total			
<b>Semester-V</b>											
1.	BBO-501	PLANT PHYSIOLOGY	3	1	0	10+10	5+5	30	70	100	4
2.	BBO-502	PLANT BIOCHEMISTRY	3	1	0	10+10	5+5	30	70	100	4
3.	BBO-551	<b>BOTANY LAB-5</b>	-	-	4	-	-	30	70	100	2
4.	BZO-501	ECOLOGY & TOXICOLOGY	3	1	0	10+10	5+5	30	70	100	4
5.	BZO-502	ANIMAL BEHAVIOUR & BIostatISTICS	3	1	0	10+10	5+5	30	70	100	4
6.	BZO-551	<b>ZOOLOGY LAB-5</b>	-	-	4	-	-	30	70	100	2
7.	BCHE-501	INORGANIC CHEMISTRY	3	1	0	10+10	5+5	30	70	100	4
8.	BCHE-502	ORGANIC CHEMISTRY	3	1	0	10+10	5+5	30	70	100	4
9.	BCHE-551	<b>CHEMISTRY LAB-5</b>	-	-	4	-	-	30	70	100	2
		<b>Total</b>	<b>18</b>	<b>6</b>	<b>12</b>	-	-	-	-	<b>900</b>	<b>30</b>
<b>Semester-VI</b>											
1.	BBO-601	FUNDAMENTALS OF BIOTECHNOLOGY	3	1	0	10+10	5+5	30	70	100	4
2.	BBO-602	PLANT ECOLOGY	3	1	0	10+10	5+5	30	70	100	4
3.	BBO-651	<b>BOTANY LAB-6</b>	-	-	4	-	-	30	70	100	2
4.	BZO-601	BIOTECHNOLOGY, IMMUNOLOGY, BIOLOGICAL TOOLS AND TECHNIQUES	3	1	0	10+10	5+5	30	70	100	4
5.	BZO-602	APPLIED AND ECONOMIC ZOOLOGY	3	1	0	10+10	5+5	30	70	100	4
6.	BZO-651	<b>ZOOLOGY LAB-6</b>	-	-	4	-	-	30	70	100	2
7.	BCHE-601	PHYSICAL CHEMISTRY	3	1	0	10+10	5+5	30	70	100	4
8.	BCHE-602	POLYMER CHEMISTRY	3	1	0	10+10	5+5	30	70	100	4
9.	BCHE-651	<b>CHEMISTRY LAB-6</b>	-	-	4	-	-	30	70	100	2
		<b>Total</b>	<b>18</b>	<b>6</b>	<b>12</b>	-	-	-	-	<b>900</b>	<b>30</b>

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-I Year (I Semester)**  
**BZO-101: Lower Non-Chordata (Protozoa to Helminthes)**

**Objective:** The objective of this course is to expose the students to various animal groups of lower non-chordates through their general classification and by the type study of various animals. This course will also enhance the knowledge of the students about economic importance of protozoans.

**Unit-I:** General Outline Classification (up to Classes) of Protozoa, Porifera, Cnidaria, Platyhelminthes and Nematelminthes) **(08 Sessions)**

**Unit-II:** Habit, Habitat, Morphology, Physiology, Reproduction & Development of the *Euglena*, *Monocystis*, *Paramecium* & Protozoan & Diseases **(10 Sessions)**

**Unit-III:** Habit, Habitat, Morphology, Physiology, Reproduction & Life history of *Sycon*. **(08 Sessions)**

**Unit-IV:** Habit, Habitat, Morphology, Physiology, Reproduction & Life history of the *Obelia*, *Aurelia* & Salient features of Ctenophora **(08 Sessions)**

**Unit V:** Brief account of the *Fasciola*, *Taenia* & *Ancylostom* **(06 Sessions)**

**Course Outcomes:**

After completing this course, the students will be able to:

- Develop understanding on the diversity of life with regard to lower non-chordates.
- Group animals on the basis of their morphological characteristics/structures.
- Understand about the causative agents and pathogenesis for important diseases like malaria, leishmaniasis, trypanosomiasis, schistosomiasis, filariasis etc.

**Suggested Readings:**

1. Ruppert, E.E. and R.D. Barnes. Invertebrate Zoology. Saunders.
2. Invertebrate Zoology, E.L Jordon and P.S.Verma, S.Chand Publication
3. A textbook of Invertebrates, R.L.Kotpal, Rastogi publication, Meerut
4. Invertebrate Zoology series (Protozoa to Echinodermata) by R.L. Kotpal – (Rastogi Publications, Meerut).

**Online Resources:**

- [www.kopykitab.com](http://www.kopykitab.com)
- [www.pdfdrive.com/zoology-books.html](http://www.pdfdrive.com/zoology-books.html)
- [www.digitalbookindex.org](http://www.digitalbookindex.org)
- [www.kalyanipublication.co.in](http://www.kalyanipublication.co.in)
- [www1.biologie.uni-hamburg.de](http://www1.biologie.uni-hamburg.de)
- [www.topfreebooks.org](http://www.topfreebooks.org) ›
- [www.pdf.com](http://www.pdf.com)
- [en.wikipedia.org](http://en.wikipedia.org)
- [onlinecourses.nptel.ac.in](http://onlinecourses.nptel.ac.in)
- [www.yourarticlelibrary.com](http://www.yourarticlelibrary.com)
- [www.freebookcentre.net](http://www.freebookcentre.net)

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-I Year (I Semester)**

**BZO-102: Higher Non-Chordata (Annelida to Echinodermata)**

**Objective:** The objective of this course is to expose the students to various animal groups of higher non-chordates through their general classification and by the type study of various animals. It will help the student to understand the features and systematic organization of higher non-chordates based on their structural and functional affinities.

**Unit I:** General outline Classification (up to Classes) Of Annelida, Arthropoda, Mollusca and Echinodermata. **(10 Sessions)**

**Unit II:** Habit, Habitat, Morphology, Physiology, Reproduction & Life history of *Nereis*. **(08 Sessions)**

**Unit III:** Habit, Habitat, Morphology, Physiology, Reproduction & Life history of *Palaemon*. **(08 Sessions)**

**Unit IV:** Habit, Habitat, Morphology, Physiology, Reproduction & Life history of *Pila*. **(08 Sessions)**

**Unit V:** Habit, Habitat, Morphology, Physiology, Reproduction & Life history of *Pentaceros*. (Excluding Development) **(06 Sessions)**

**Course Outcomes:**

After completing this course, the students will be able to:

- Develop understanding on the diversity of life with regard to higher non-chordates.
- Group animals on the basis of their morphological characteristics/structures.
- Learn about the importance of systematics, taxonomy and structural organization of animals.
- Understand evolutionary history and relationships of different non-chordates through functional and structural affinities.

**Suggested Readings:**

1. Ruppert, E.E. and R.D. Barnes. Invertebrate Zoology. Saunders.
2. Invertebrate Zoology, E.L Jordon and P.S.Verma, S.Chand Publication
3. A textbook of Invertebrates, R.L.Kotpal, Rastogi publication, Meerut
4. Invertebrate Zoology series (Protozoa to Echinodermata) by R.L. Kotpal – (Rastogi Publications, Meerut).

**Online Resources:**

- [www.pdfdrive.com/zoology-books.html](http://www.pdfdrive.com/zoology-books.html)
- [www.digitalbookindex.org](http://www.digitalbookindex.org)
- [www.kalyanipublication.co.in](http://www.kalyanipublication.co.in)
- [www1.biologie.uni-hamburg.de](http://www1.biologie.uni-hamburg.de)
- [www.freebookcentre.net](http://www.freebookcentre.net)
- <https://www.easybiologyclass.com>

**Note:** Latest editions of all the suggested readings must be used.

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-I Year (I Semester)**  
**BZO-151: Zoology Lab-1**

**Objective:** The main Goal of this course is to share the knowledge to the students about the experiments. The students will get a better understanding of the concept studied by them in theory course and correlate with experimental observations.

**List of Experiments:**

**(20 Sessions)**

1. (a) Protozoa: Prepared slides of *Amoebasps. Euglena, Monocystis, Plasmodium, Paramecium* – demonstration of ciliary movement. Examination of *Arcella* and *Vorticella, Polystomella, Gregarina, Trypanosoma* and *Noctiluca*. Examination of *Opalina, Balantidium* and *Nyctotherus*

(b) Porifera: Sycon- morphology, T.S. and L.S. spicules. Gemmule, Spicules and sponging fibers, *Euplectella, Spongilla* and *Euspongia, Hyalonema, Leucosolenia*

(c) Coelenterata: *Hydra* specimen, T.S. and L.S. of *Hydra, Obelia*: colony and medusa, *Aurelia*- morphology, tentaculocyte and life history stages. *Physalia, Corallium, Fungia, Madrepora, Pennatula, Metridium*

(d) Platyhelminthes: *Fasciola*-specimen, T.S. and Larval Forms. *Taenia*-Scolex, proglottids and T.S. of mature proglottid. *Planaria, Polystomum, Paramphistomum, Schistosoma* and *Ancylostoma*

Nematehelminthes: *Ascaris*- Morphology, dissected specimen of male and female, T.S. of male and female. *Enterobius* and *Ancylostoma*

2. (a) Annelida: *Nereis*- morphology, dissected specimen, parapodium, T.S., *Pheretima*- morphology, dissection, ovary and septal nephridia, T.S. through various regions. *Heteronereis, Arenicola, Aphrodite, Dero, Branchellion, Bonellia* (female)

(b) Arthropoda: *Palaemon*- morphology, examination of appendages, dissection, Ovary and septal nephridia, glycerine preparation of hastate plate and statocyst. *Periplanata*- Morphology of male and female, circulation of blood in the wings of cockroach, glycerine preparation of mouthparts, salivary glands and trachea. Permanent preparation of salivary gland, Malpighian tubules, ovaries and testis. Anopheles and Culex- Male and female mouthparts, wings, life history. *Musca*- External characters and glycerine preparation of proboscis. *Daphnia, Cyclops, Balanus, Eupagurus* (hermit crab), *Sacculina, Nauplius* and *Zoea* larva, *Lepisma* (silver fish), *Schistocerca, Odontotermes* (white ant), *Cimex* (bed bug), *Pediculus* (louse), *Papilio* (butterfly), *Bombyx, Apis, Xenopsylla* or *Ctenocephalus* (dog flea), *Julus* (millipede), *Scolopendra* (centipede), *Lycosa* (wolf-spider), *Lxodes* (tick), *Limulus* (King crab)

(c) Mollusca: *Lamellidens*- morphology, permanent preparation of gill lamella, T.S. of middle region of body, *Glochidium* larva, *Pila*- morphology, dissection, permanent preparation of gill lamella and osphridium. *Chiton, Teredo, Turbinella, Doris, Aplysia, Dentalium, Nautilus, Sepia* and *Pinctada vulgaris* (pearl oyster)

(d) Echinodermata: *Pentaceros* (morphology, dissected specimen, Pedicellaria, T.S. arm) *Echinus* (sea urchin), *Ophiothrix, Holothuria* and *Antedon*

3. To prepare a permanent mount of mouth parts of insects, Radula & gill of *Pila*.

4. To study the nervous system of *Pila* & *Prawn*.

**Course Outcomes:**

After completing this course, students will be able to:

- Study of animals which will improve their observation skills, data collection skills, critical thinking and analytical skills of students.
- Furthermore, museology will give them a comprehensive idea of structural features of non-chordates and the basis of classification.
- Gain knowledge on fixation, dehydration, hand sectioning, microtome sectioning.

**Suggested Readings:**

1. Practical Zoology Invertebrate by S.S. Lal
2. Practical Zoology Invertebrate by P.S.Verma, S.Chand Publication

**Online Resources:**

- <https://oer.galileo.usg.edu>
- <http://www.biologycorner.com>

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-I Year (II Semester)**  
**BZO-201: Cell Biology & Molecular Biology**

**Objective:** To help the students to learn and develop an understanding of a cell as a basic unit of life. This course is designed to enable them to understand the functions of cellular organelles and how a cell carries out and regulates cellular functions. The course provides a detailed insight into basic concepts of cellular structure and function. It also gives an account of the complex regulatory mechanisms that control cell function.

**Unit I:** Structure of Virus, Bacteria & Animal cell, Structure & Function of cell organelles with special emphasis on Plasma membrane & Cell membrane, Mitochondria, Golgi bodies, Microbodies, Ribosome & Endoplasmic reticulum **(10 Sessions)**

**Unit II:** Structure & Types of DNA, DNA as a genetic material, DNA replication- semiconservative model, Meselson & Stahl experiment, Process of replication-Origin of replication, Concept of replication, directionality of replication **(10 Sessions)**

**Unit III:** Structure of RNA, Types of RNA, RNA as a genetic material, Difference between DNA & RNA **(06 Sessions)**

**Unit IV:** Structure of Nucleus & Nucleolus, Structure of chromosomes **(08 Sessions)**

**Unit V:** Cell division-Mitosis & Meiosis & their significance, Parthenogenesis **(06 Sessions)**

**Course Outcomes:**

After completing this course, the students will be able to

- Understand fundamental principles of cell biology.
- Explain structure and functions of cell organelles involved in diverse cellular processes.
- Understand the functioning of nucleus and extra nuclear organelles and understand the intricate cellular mechanisms involved.

**Suggested Readings:**

1. Gupta, P.K. 1999. A text book of Cell and Molecular Biology. Rastogi Publications, Meerut, India.
2. Lodish, H., Berk, A., Zipursky, S.L., Matsudaria, P., Baltimore, D. and Darnell, J. 2000.
3. Molecular, Cell Biology, W.H. Freeman and Co., New York., USA.  
Cytogenetics by P.K. Gupta – (Rastogi Publications, 2008).
4. Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetics. John Wiley and Sons, Inc. USA.
5. P.S. Verma and V.K. Agarwal. Molecular Biology. S. Chand & Co., New Delhi.

**Online Resources**

- <https://swayam.gov.in/course/150-cell-biology>
- <https://swayam.gov.in/courses/5173-biochemistry-and-cell-biology>
- <https://www.jove.com/science-education-library/9/cell-biology>
- <https://swayam.gov.in/courses/4922-genetics-and-genomics>

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-I Year (II Semester)**  
**BZO202: Genetics**

**Objective:** The course is designed to revise basic concepts of Genetics and then move onto advanced concepts. Some key aspects include the mechanism of inheritance, gene structure and function, sex chromosomal and autosomal anomalies, aspects of human genetics, etc. will be covered. A strong emphasis will be laid on the modern tools and techniques used in genetics.

**Unit I:** An overview of genetics, Mendel's principles of heredity on chromosomal basis, Crossing over, hybrid cross, Test cross, back cross, incomplete dominance, Multiple alleles, Blood group inheritance, interaction of genes. **(10 Sessions)**

**Unit II:** The role of DNA in heredity, Sex determination, Prenatal detection of genetic diseases (amniocentesis), Linkage & Sex linked characters. **(08 Sessions)**

**Unit III:** Genetic diseases and abnormalities, Chromosomal aberrations. **(06 Sessions)**

**Unit IV:** Genetic code-Characteristics of genetic code, Regulation of Protein synthesis in Prokaryotes, Lac Operon, Trp Operon Model. **(06 Sessions)**

**Unit V:** Wobble hypothesis of Protein Synthesis (**Transcription mechanism**-initiation, elongation and termination of transcription. **Translation**- activation of amino acid, transfer of activated amino acids to t-RNA, Initiation, elongation and termination of Polypeptide chain, Inhibitors of protein Synthesis) **(10 Sessions)**

**Course Outcomes:**

After successfully completing this course, the students will be able to

- Understand how DNA encodes genetic information and the function of mRNA and tRNA
- Gain knowledge of the basic principles of inheritance.
- Apply the principles of Mendelian inheritance.
- Understand the cause and effect of alterations in chromosome number and structure.

**Suggested Readings:**

1. Gupta, P.K. 1999. A text book of Cell and Molecular Biology. Rastogi Publications, Meerut, India
2. Russel, P.J. 1998. Genetics, The Benjamin/Cummings Publishing Co. Inc., USA
3. Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetics. John Wiley and Sons, Inc. USA.
4. P.S. Verma and V.K. Agarwal. Molecular Biology. S. Chand & Co., New Delhi.

**Online Resources**

- [www.kalyanipublication.co.in](http://www.kalyanipublication.co.in)
- <https://www.easybiologyclass.com>
- <https://swayam.gov.in/courses/4922-genetics-and-genomics>
- <https://www.coursera.org/learn/genetics-evolution>

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-I Year (II Semester)**  
**BZO-251:Zoology Lab-2**

**Objective:** The main Goal of this course is to share the knowledge to the students about the experiments. It is designed to enable the students to understand the functions of cellular organelles and how a cell carries out and regulates cellular functions. The students will get a better understanding of the concept studied by them in theory course and correlate with experimental observations.

**List of Experiments:**

**(20 Sessions)**

1. Cell division: Prepared slides of stages of mitosis and meiosis
2. To study the ultrastructure of prokaryotic cell & eukaryotic cell.
3. To prepare a temporary squash of onion root tip for the study of mitosis.
4. To isolate the DNA by phenol extraction method.
5. To isolate Plasmid DNA by minipreps method.
6. Problems based on genetics

**Course Outcomes:**

Completing this course, students will be able to:

- Understand fundamental principles of cell biology.
- Explain structure and functions of cell organelles involved in diverse cellular processes.
- Study of animals which will improve their observation skills, data collection skills, critical thinking and analytical skills of students.
- Gain knowledge on fixation, dehydration for the permanent preparation of slide.

**Suggested Readings:**

1. Practical Zoology Invertebrate by S.S. Lal
2. Practical Zoology Invertebrate by P.S.Verma, S.Chand Publication

**Website Sources:**

- <https://oer.galileo.usg.edu>
- <http://www.biologycorner.com>
- <https://sjce.ac.in/wp-content/uploads/2018/04/Cell-Biology-Genetics-Laboratory-Manual-17-18.pdf>

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-II Year (III Semester)**  
**BZO-301: Chordata**

**Objective:** The course is designed with an aim to provide scope and historical background of chordates. It will impart knowledge regarding basic concepts of origin of chordates and make the students understand the characteristics and classification of animals with notochord.

**Unit I:** Classification of Protochordates up to order, and detailed study of *Balanoglossus*, *Herdmania* & *Amphioxus*. **(06 Sessions)**

**Unit II:** Classification of Fishes up to order and detailed study of Lung Fishes. **(08 Sessions)**

**Unit III:** Classification of Amphibia & Reptilia up to order, Neoteny, Poisonous & Non-poisonous snakes and Biting mechanism **(10 Sessions)**

**Unit IV:** Classification of Aves up to order, Perching Mechanism, *Archaeopteryx* **(08 Sessions)**

**Unit V:** Classification of Mammals up to order, Aquatic mammals, Dentition in mammals **(08 Sessions)**

**Course outcomes:**

Upon completion of the course, students will be able to:

- Understand different classes of chordates, level of organization and evolutionary relationship between different subphyla and classes, within and outside the phylum.
- Study about diversity in animals making students understand about their distinguishing features.
- Appreciate similarities and differences in life functions among various groups of animals in Phylum Chordata.

**Suggested Readings**

1. Modern Textbook of Zoology: Vertebrates by R.L. Kotpal – Rastogi Publications, Meerut, 3rd edition, 2008.
2. A Text Book of Zoology Vol.II by Parkar and Hasswel – (MacMillan).
3. A Text Book of Zoology Vol.II by R.D.Vidyarthi– (S. Chand & Co., Delhi).
4. The life of vertebrates, Young, J.Z.

**Online Resources:** •

- <https://opentextbc.ca/biology2eopenstax/chapter/chordates/>
- [www.pdf.com](http://www.pdf.com)
- [en.wikipedia.org](http://en.wikipedia.org)
- [www.yourarticlelibrary.com](http://www.yourarticlelibrary.com)

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-II Year (III Semester)**  
**BZO-302: Developmental Biology**

**Objective:** The main aim of the paper on Developmental Biology is to provide the undergraduate students an in-depth knowledge on the embryonic and post embryonic developmental processes. An important aspect of developmental biology is its implication in medicine which is also dealt with in this course.

**Unit I:** Aims and scope of Developmental Biology, cell theory, mosaic and regulative development, Gametogenesis, Fertilization **(06 Sessions)**

**Unit II:** Structure & Types of gametes, Pattern of Cleavage. **(06 Sessions)**

**Unit III:** Process of Blastulation and Gastrulation, Fate map, Development & Metamorphosis in Frog **(10 Sessions)**

**Unit-IV:** Development of chick up to formation of primitive streak, Extra embryonic membranes of Chick. **(10 Sessions)**

**Unit V:** Placentation in mammals, types of Placenta and Placental diseases **(08 Sessions)**

**Course Outcomes:**

Upon completion of the course, students will be able to:

- Understand the events that lead to formation of a multicellular organism from a single fertilized egg, the zygote.
- Acquire basic knowledge of the cellular processes of development and the molecular mechanisms underlying these.
- Describe the general patterns and sequential developmental stages during embryogenesis; and understand how the developmental processes lead to establishment of body plan of multicellular organisms.

**Suggested Readings:**

1. Developmental Biology, Gilbert, (8<sup>th</sup> Ed,2006) Sinaurer Associates Inc. Massachusetts,USA
2. An Introduction to embryology, B. Balinsky,W. B. Saunders Company Philadelphia & London.
3. Foundation of Embryology, Patten, McGraw-Hill,New Delhi.
4. Developmental Biology, Dr. Veer Bala Rastogi, KedarNath Ram Nath publication, Meerut.
5. Developmental Biology, Sastry&Shukal, Rastogi Publications Meerut.
6. Elements of Developmental Biology, P.C.Jain, Vishal Publication,Jalandhar & Delhi

**Online Resources:**

- [https://en.wikipedia.org/wiki/Developmental\\_biology#:~:text=Developmental](https://en.wikipedia.org/wiki/Developmental_biology#:~:text=Developmental)
- <https://microbenotes.com/category/developmental-biology/>
- <https://www.hhmi.org/biointeractive/human-embryonic-development>
- <https://www.khanacademy.org/science/biology/developmental-biology>
- <https://ocw.mit.edu/courses/biology/7-22-development-biology-fall-2005/index.htm>
- [https://embryology.med.unsw.edu.au/embryology/index.php/Main\\_Page](https://embryology.med.unsw.edu.au/embryology/index.php/Main_Page)

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-II Year (III Semester)**  
**BZO-351:Zoology Lab-3**

**Objective:** Appreciate similarities and differences in life functions among various groups of animals in Phylum Chordata. · Comprehend the circulatory, nervous and skeletal system of chordates. The main Goal of this course is to share the knowledge to the students about the experiments.

**List of Experiments:**

**(20 Sessions)**

1. **PROTOCHORDATES:** *Herdmania*: external characters, dissection, permanent preparation of branchial wall, preparation of spicules, neural gland, nerve ganglion and dorsal tubercle. *Branchiostoma*(Amphioxus): general feature, permanent preparation of pharyngeal wall, oral hood and Velum slides, T.S. through various parts.
2. **CYCLOSTOMES:***Petromyzon*: External characters
3. **PISCES:** *Scoliodon* 1. External character, preparation of placoid scales, myotomes, endoskeleton 2. Axial skeleton: skull, visceral skeleton, vertebral column 3. Appendicular skeleton: pectoral and pelvic girdles, median fins 4. Dissections, digestive system, vascular system, heart, ventral aorta, afferent and efferent gills, urinogenital system, cranial nerves, internal ear, eye muscles, permanent preparation of Ampullae of Lorenzini , section through body and embryo. *Pristis*, *Astrape* (electric ray), *Chimera*, slide showing development of placoid scales. *Labeorohita*: general morphology and dissected specimen. Museum specimen: *Acipenser*, *Lepidosteus*, *Hippocampus*, *Antennarius*, *Anguilla*, permanent slides of different scales.
4. **AMPHIBIA:** *Rana tigrina*: development through models, Urodela: *Necturus*, *Ambystoma* and *Axolotl* larva. Anura: *Bufo*, *Rhacophorus*, *Alytes*, *Gymnophiona*; *Ichthyophis*.
5. **REPTILIA:** *Varanus*: External character and skeleton-Axial and appendicular. Lacertilia: *varanus*, *Heloderma*, *Hemidactylus*, *chamaeleon*, *Draco*. Ophidia: *Naja*, *Vipera*, *Typhlops*, *Python*. *Chelonia*: Dermal Armature, Crocodilia: *Alligator*, *Pteranodon*, *Tyranosaurus* and *Ichthyosaurus*.
6. **AVES:** (i) Archaeornithes: *Archaeopteryx* (cast)(ii) Neornithes: (a) Palaeognathae: *Struthio* (ostrich); (b) Neognathae: *Gallus* (fowl), *Anser*(duck), *Crovis* (crow), *Pesticula*(parrot) and *Pavo*(peacock) Perching mechanism: Model, Skulls and Beaks of birds, Feet of birds: Models
7. **MAMMAL:** *Ornithorhynchus*(Platypus), *Macropus*(Kangaroo), *Dasyopus*(Armadillo), *Manis*(Scaly ant eater), *Platanista*(Ganges dolphin) (d) Perissodactyla: *Equus caballus*(horse), *Equus vulgaris*(ass), *Equus zebra*(Zebra), *Rhinoceros unicornis*(Rhinoceros) (e) Artityla: *Camelus dromedaries* (Arabian camel), *Giraffacamelopardalis*(giraffe) *Box*(ox), *Ovis*(Sheep), *Capra*(Goat), *Cervus*(Deer), *Sus*(Dog).(f) Proboscidae: *Elephas indicus*(elephant)(g) Carnivora: *Felis domesticus*(cat), *Panthera leo*(Lion), *Acinoyxtigris*(Cheetah), *Canis familiaris* (Dog), *Ursus* (Bear), *Hyaena*(hyaena), *Phoca*(Seal), (h) Rodentia: *Mus* (Domestic rat), *Hystrix*(porcupine) (i) Lagomorpha: *Lepus* and *Oryctolagus*(hare and rabbit)(j) Insectivora: *Erinaceus*(hedgehog), *Crociodura*(chhachhundar), (k) Chiroptera: *Pteropus*(Flying fox)(l) Primates: *Macaca*(rhesus monkey), *Hylobates*(gibbon), *Simia*(Orangutan), *Anthropopithecus*(Chimpanzee), *Gorilla*, *Homo sapiens*(man).
8. **SKELETON:**(a) **Scoliodon:** Axial skeleton: Skull, Visceral skeleton, vertebral column Appendicular skeleton: Pectoral and Pelvic girdles, median fin  
(b) **Varanus:** (i) External characters  
(ii) Skeleton: Axial Skeleton: Skull, Vertebral column, Ribs and sternum Appendicular Skeleton: Pectoral girdle and Forelimb, Pelvic girdle and Hind limb  
(c) **Columba livia (Pigeon):** (i) External characters, Structure of feathers, Varieties of feathers. Development of feathers-Prepared slides  
(d) **Skeleton of Fowl:** Axial Skeleton: Skull, Vertebral column, Ribs and Sternum Appendicular Skeleton: Pectoral girdle and Forelimb, Pelvic girdle and Hind limb.  
(e) **Skeleton of Rabbit:** Axial Skeleton: Skull, Vertebral column, Ribs and Sternum

Appendicular Skeleton: Pectoral girdle and Forelimb, Pelvic girdle and Hind limb

**9. Study of permanent slides-**V.S. skin of Bird, Filoplume of bird, V.S. Skin of Mammal

**Permanent stained preparation:** Fish scales – Placoid, cycloid, ctenoid

Frog- Striated muscle

**10.** To study the nervous system of *Scoliodon*

**11. EMBRYOLOGY:**

(a) Fish: Embryo with yolk sac Placenta

(b) Frog: Development of frog from models, Permanent Slides of Frog:T.S. Blastula, T.S. Gastrula

(c) Bird: Slides of chick embryo: W.M. of 18,24,28,30, 36, 42, 55, 72 hrs.

**Course outcomes:**

Upon completion of the course, students will be able to:

- Understand different classes of chordates, level of organization and evolutionary relationship between different subphyla and classes, within and outside the phylum.
- Study about diversity in animals making students understand about their distinguishing features.
- Understand about the evolutionary development of various animals.

**Suggested Readings:**

1. A manual of practical zoology: biodiversity, cell biology, genetics & developmental biology part 1 (M.M. Trigunayat).

**Online Resources**

- <https://ocw.mit.edu/courses/biology/7-22-developmental-biology-fall-2005/index.htm>
- [https://embryology.med.unsw.edu.au/embryology/index.php/Main\\_Page](https://embryology.med.unsw.edu.au/embryology/index.php/Main_Page)
- Anatomyof shark: Shark dissection and anatomy(video)- [www.neosci.com](http://www.neosci.com)
- Anatomyof Frog: ProDissector (CD)- [www.prodissector.com](http://www.prodissector.com)

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-II Year (IV Semester)**  
**BZO-401: Physiology and**  
**Biochemistry**

**Objective:**

Physiology is the study of life, specifically, how cells, tissues and organ function. This course deals with various physiological functions in mammals. It also gives an account of the metabolic/biochemical pathways and the probable impact of environment on them. Besides satisfying a natural curiosity about how our body systems function, it gives us knowledge about the functions of all the parts and systems of the body.

**Unit I: Nutrition, Digestion, and Circulation:** Physiology of Digestion, assimilation and role of liver in digestion Physical characteristics of blood cells and plasma; Coagulation, blood groups. Functional anatomy of heart, cardiac cycle, electrocardiogram (ECG), Integration of cardiovascular function, Respiration, Blood and Circulation. **(10 Sessions)**

**Unit II:Respiration, Muscle Contraction, Thermoregulation:** Breathing and gas exchange, gas transport, Hb and O<sub>2</sub>, dissociation, chloride shift, Types of muscles, physical properties and ultrastructural organization of skeletal muscle fibres, muscle contraction. Modes of heat transfer, survival of poikilotherms in cold and hot environment, Mechanism of thermoregulation in homeotherms and Muscle contraction **(10 Sessions)**

**Unit III:Excretion and Osmoregulation:**Organs of excretion, nephron structure, and urine formation, control of excretion (role of ADH rennin and counter current mechanism) and excretion of nitrogenous wastes. Mechanisms of osmoregulation in fresh water and marine organisms. **(08 Sessions)**

**Unit IV:Nervous Integration and Endocrine system:** Structure of neuron, ionic basis of resting and action potentials, nerve impulse and its transmission, synapse and synaptic transmission, Reflex action. Physiology of Endocrine system. **(08 Sessions)**

**Unit V:** General chemistry and classification of Carbohydrates, Lipids and Proteins, Enzymes, carbohydrate, fat and protein metabolism, BMR. **(06 Sessions)**

**Course outcome:**

After completion of the course the students will be able to:

- Understand the physiology at cellular and system levels.
- Understand the mechanism and regulation of breathing, oxygen consumption and determination of respiratory quotient.
- Understand how mammalian body gets nutrition from different biomolecules.
- Understand the process of digestion and excretion.
- Understand the organization of nervous system and process of nerve conduction.
- Understand the process of vision and hearing.
- Understand the process of muscle contraction.

**Suggested Readings**

- Animal Physiology by K.A. Goyal and K.V. Sastry – (Rastogi Publications, 2008).

- Animal Physiology by Arora M.P. (1989) – Himalaya Publishing House.
- Textbook of Medical Physiology by Guyton A.C. & Hall J.E. (1996) – (W.B. Saunders & Co.).
- General and Comparative Physiology by Hoar W.S. (1983) – (Prentice Hall Publication).

**Online Resources:**

- Mammalian Physiology– [www.biopac.com](http://www.biopac.com)
- <http://abacus.bates.edu/acad/depts/biobook/AnimPhyl.pdf>

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-II Year (IV Semester)**  
**BZO-402: Animal Distribution and Evolution**

**Objective:** The course provides information about the patterns and processes of evolution above the species level. Besides elaborating the process of speciation, it also categorically differentiates between the three methods of phylogenetic analysis *viz.*, evolutionary systematics, phenetics and cladistics. This will also provide the knowledge of Mimicry and adaptive radiation to the student

**Unit I:** Origin of life, Historical account of evolution, Evidences of evolution. **(06 Sessions)**

**Unit II:** Theories of Evolution (including Neo-Lamarckism, Darwin-Wallace theory of natural selection, Neo-Darwinism, Modern Synthetic theory). **(08 Sessions)**

**Unit III:** Mutation theory of De Vries, Variation, Isolation, Role of isolation in evolution. **(08 Sessions)**

**Unit IV:** Mimicry, Adaptations, Macroevolution (adaptive Radiation), Evolution of man. **(08 Sessions)**

**Unit V:** Binomial nomenclature, Zoogeographical realms, Geological distribution of Animals. **(08 Sessions)**

### **Course outcomes**

After completing the course, the students will be able to:

- Realize that very similar mechanisms are used in very diverse organisms; and development is controlled through molecular changes resulting in variation in the expression and function of gene networks.
- Examine the evolutionary history of the taxon based on developmental affinities.

### **Suggested Readings:**

1. Evolutionary Biology, Dr. Veer Bala Rastogi, Kedar Nath Ram Nath Meerut.
2. Evolutionary Biology by B.S. Tomar & S.P. Singh – (Rastogi Publications, 2008).
3. The origin of life by K. John – (Reinhold Publishing Corpn).
4. The evolution of Man by G.W. Lasker – (Holt, Rinehart & Winston).

### **Online Resources**

- <https://www.coursera.org/learn/genetics-evolution>
- CEC Gurukul ([www.cec.nic.in](http://www.cec.nic.in))
- <https://www.youtube.com/user/cecedusat/featured>.
- National Institute of Science Communication and Information Resources (NISCAIR) (<http://www.niscair.res.in/>) and National Science Digital Library (NSDL) ([www.nsdli.niscair.res.in](http://www.nsdli.niscair.res.in)).

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-II Year (IV Semester)**  
**BZO-451: Zoology Lab – 4**

**Objective:**

To make the study relevant, interesting, encouraging to the students to join the industry or to prepare them for higher studies including research. The new and updated syllabus is based on a basic and applied approach to ensure that students develop problem solving skills, laboratory skills, chemistry communication skills, team skills as well as ethics.

**List of Experiments:**

**(20 Sessions)**

**1. Histological slides of Mammal:**

T.S.salivary gland, T.S.stomach, T.S.intestine, T.S.pancreas, T.S.liver and T.S.lung, T.S.kidney, pituitary, thyroid, adrenal, T.S.Testis & Ovary

**2. HISTOLOGY:** Preparation of epithelia, squamous, ciliated and stratified. Muscular: Striped and unstriped. Connective: Areolar, tendon of frog, adipose tissue from insect and frog, cartilage, bone Blood: Preparation of blood film.

**3. PHYSIOLOGY:**

(a) Experiment to test action of Salivary Amylase.

(b) Experiment to test the presence of Glucose in given sample of Urine.

(c) To prepare haemin crystals

(d) .To estimate the Hb% in the given blood sample.

(e) To study the effect of osmolarity of salt solution and haemolytic agents on red blood corpuscles.

(f) Separation of amino acid from given sample by Chromatography technique.

**Course Outcomes:**

After completion of the course, students will be able to

- Demonstrate foundation knowledge in biochemistry; synthesis of proteins, lipids, nucleic acids, and carbohydrates; and their role in metabolic pathways along with their regulation.
- Know about classical laboratory techniques, use modern instrumentation, design and conduct scientific experiments, and analyze the resulting data.
- Be knowledgeable in proper procedures and regulations in handling and disposal of chemicals.

**Suggested Readings:**

1. A manual of practical zoology: biodiversity, cell biology, genetics & developmental biology part 1 (M.M. Trigunayat).

**Online Resources:**

- <https://oer.galileo.usg.edu>
- <http://www.biologycorner.com>

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-III Year (V Semester)**  
**BZO-501: Ecology and Toxicology**

**Objective:** The primary aim of the syllabus is to sensitize the students about the paramount role and importance of nature. The study of ecology imparts us the knowledge about the judicious use of existing ecological resources for sustainable development. Ecology is the only branch of science which briefs us on the ways and means of living with nature for mutual benefit.

**Unit –I:** Ecosystem: Definition and types, pond ecosystem, Food chain, food web and ecological pyramids, Energy flow in an ecosystem, Single channel, Y – shape and Universal model.

**(08 Sessions)**

**Unit-II:** Population, Community, Ecological niche, Ecological Succession. Adaptation: Aquatic, Terrestrial, Aerial and Arboreal.

**(10 Sessions)**

**Unit III:** Concepts, sources, types (air, water, soil, noise and radiation) Effect and control of environmental pollutions, Adaptation: Aquatic, Terrestrial, Aerial and Arboreal

**(08 Sessions)**

**Unit IV:** Exposure of toxicants (Routes of exposure and duration and frequency of exposure) Dose response relationships, Categories of toxic effects.

**(08 Sessions)**

**Unit V:** Toxic effect of heavy metals (lead, cadmium and mercury) – Bioaccumulation and biomagnification.

**(06 Sessions)**

**Course Outcomes:**

After completing this course, the students will be able to:

- Know the evolutionary and functional basis of animal ecology.
- Demonstrate an understanding of key concepts in ecology with emphasis on historical perspective, role of physical factors and concept of limiting factors.
- Comprehend the population characteristics, dynamics, growth models and interactions.
- Understand the community characteristics, ecosystem development and climax theories.

**Suggested Readings:**

1. Odum, E.P. 1983: Basic Ecology, Saunders, Philadelphia.
2. Sharma, P.D. (2010) Ecology and Environment, (8th Ed.) Rastogi Publications, Meerut.
3. Singh, J.S., Singh, S.P. and Gupta, S. (2006) Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi

**Online Resources**

- Swayam (MHRD) Portal
- [https://en.wikipedia.org/wiki/Population\\_ecology](https://en.wikipedia.org/wiki/Population_ecology)
- [https://www.tutorialspoint.com/environmental\\_studies/environmental\\_studies\\_ecological\\_pyramid.html](https://www.tutorialspoint.com/environmental_studies/environmental_studies_ecological_pyramid.html)

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-III Year (V Semester)**  
**BZO-502: Animal Behavior and Biostatistics**

**Objective:** The course is aimed at introducing the application of bioinformatics and statistics in biology. It provides foundation on statistical methods to enable students to compute and interpret basic statistical parameters.

**Unit- I:** Introduction to Ethology - definition, historical out line, patterns of behaviour, objectives of behaviour ,Orientation primary and secondary orientation; kinesis – orthokinesis, klinokinesis; taxis – different kinds of taxis; sun-compass orientation.

**(08 Sessions)**

**Unit-II:** Fixed action pattern: mechanism, deprivation experiment, controversies. FAP- characteristics and evolutionary features. Learning and instincts: conditioning, habituation, sensitization and reasoning, Motivation: models of motivation, measuring motivation. Communication- chemical (pheromones) Hormones and pheromones influencing behaviour of animals.

**(10 Sessions)**

**Unit-III:** Biological Rhythms - Ultradian, Tidal/ Lunar, Circadian and Circannual rhythms; Migration in Fishes and Birds.

**(08 Sessions)**

**Unit-IV:** Sampling, Measures of central tendency (mean, median and mode)

**(06 Sessions)**

**Unit-V:** Dispersion (variance, standard deviation and standard error); Correlation and Regression.

**(06 Sessions)**

**Course Outcomes:**

After successfully completing this course, the students will be able to:

- Learn a wide range of theoretical and practical techniques used to study animal behavior.
- Develop skills, concepts and experience to understand all aspects of animal behaviour.
- Understand and evaluate information about animal behavior and ecology encountered in our daily lives.
- Understand and be able to objectively evaluate the role of behavior in the protection and conservation of animals in the wild.

**Suggested Readings:**

1. Animal Behaviour, David McFarland, Pitman Publishing Limited, London.
2. Animal Behaviour, John Alcock, Sinauer Associates Inc., USA
3. An Introduction to Animal Behaviour, A. Manning and M.S. Dawkins, Cambridge University Press, U.K.
4. Animal Behavior, Reena Mathur, Rastogi Publications, Meerut.
5. Principles of Biostatistics, Pagano M., Gauvreau, K, (2000), Duxbury Press, USA

**Online Resources:**

- <https://oer.galileo.usg.edu>
- <http://www.biologycorner.com>

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-III Year (V Semester)**  
**BZO-551: Zoology Lab –5**

**Objective:**

To make the study relevant, interesting, encouraging to the students to join the industry or to prepare them for higher studies including research. The new and updated syllabus is based on a basic and applied approach to ensure that students develop problem solving skills, laboratory skills, chemistry communication skills, team skills as well as ethics.

**List of Experiments:**

**(20 Sessions)**

1. To study Pyramid of numbers.
2. To study Pyramid of biomass.
3. To study Pyramid of energy.
4. To study and comment upon the adaptive and structural modifications in animals due to ecological conditions.
5. To determine the biomass of the given area.
6. To study the community by quadrat method by determining frequency, density and abundance of different species present in the community.
7. To study the pond ecosystems, its biotic components.
8. To study the soil profile.
9. To estimate pH of water sample by pH meter.
10. To study the geotaxis behaviour of earthworm.
11. To demonstrate the phenomenon of phototaxis in housefly.
12. Exercise based on Biostatistics

**Course Outcomes:**

After successfully completing this course, the students will be able to:

- Know about the types of ecosystems, food chains, food webs, energy models, and ecological efficiencies.
- Engage in field-based research activities to understand well the theoretical aspects taught besides learning techniques for gathering data in the field.
- Analyze a biological problem, derive testable hypotheses and then design experiments and put the tests into practice.
- Solve the environmental problems involving interaction of humans and natural systems at local or global level.
- Inculcate scientific quantitative skills, evaluate experimental design and read graphs.

**Suggested Readings:**

1. Practical Ecology-by K. S. Rao
2. Practical Methods in Ecology- by Peter A. Henderson

**Online Resources**

- Swayam (MHRD) Portal
- [https://www.tutorialspoint.com/environmental\\_studies/environmental\\_studies\\_ecological\\_pyramid.html](https://www.tutorialspoint.com/environmental_studies/environmental_studies_ecological_pyramid.html)

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**

**Bachelor of Science Programme**

**B. Sc. (ZBC)-III Year (VI Semester)**

**BZO-601: Biotechnology, Immunology, Biological Tools and Techniques**

**Objective:** This course is designed to enable understanding the molecular and cellular basis of the development and function of the immune system and identification of its biological, clinical and therapeutic implications. The diverse techniques from microscopy to spectroscopy, calorimetry, chromatography, ELISA, tissue culture, cloning etc. are included to make the student well versed with these protocols and methods.

**Unit I:** Genetic Engineering (concept and technology) and its applications in agriculture and medical areas and energy production. Biotechnology of food processing, pharmaceuticals (eg: use of microbes in insulin production) and fermentation. **(10 Sessions)**

**Unit II:** Concept of Immunology, types of immunity, Antigen and Antibodies, Types of Immunoglobulins and their applications. **(10 Sessions)**

**Unit III:** Vaccine, Vaccines of different diseases and immunological reactions and their types. **(06 Sessions)**

**Unit IV:** Principle and uses of instruments: pH Meter, Calorimeter, Microtome, Spectrophotometer and Centrifuge, ELISA **(08 Sessions)**

**Unit V:** Microscopy (light, transmission and Scanning electron microscopy) Chromatography and Electrophoresis. **(08 Sessions)**

**Course Outcomes:**

After completion of the course the students will be able to:

- Describe the basic mechanisms, distinctions and functional interplay of innate and adaptive immunity
- Relate to errors occurring during development leading to congenital disorders and human diseases.
- Understand the purpose of the technique, its proper use and possible modifications.
- Learn the accuracy of technique.
- Learn the maintenance laboratory equipments/ tools, safety hazards and precautions.

**Suggested Readings:**

1. Instant notes in Immunology, (P. M. Lydyard, A. Whelam & M.W. Franger) , Publishers: BIOS Scientific
2. Kuby Immunology, Richard, Thomas, Barbara, Janis, (5th Ed., 2003), W. H. Freeman and company, New York, USA
3. Gene Cloning, T. A. Brown
4. Biotechnology, B.D. Singh, Kalyani Publication
5. Biotechnology, R. C. Dubey, S. Chand Publication, New Delhi

**Online Resources**

- <https://sice.ac.in/wp-content/uploads/2018/04/Cell-Biology-Genetics-Laboratory-Manual-17-18.pdf>
- <https://oer.galileo.usg.edu>
- <http://www.biologycorner.com>

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-III Year (VI Semester)**  
**BZO-602: Applied and Economic Zoology**

**Objective:** The course is unique in highlighting the commercial and industrial significance/value of animals. It discusses the techniques/methods of rearing of animals for commercial usage and the prerequisites for their successful maintenance and sustenance.

**Unit-I:** Structure, Life cycle, Pathogenecity including diseases, Symptoms and control of following Parasites of domestic and humans, *Trypanosoma*, *Giardia*, *Plasmodium*, *Echinococcus*, *Schistosoma*, and *Wuchereria bancrofti*. **(08 Sessions)**

**Unit-II:** A detail study of the Life cycle and control of the Following: Gundhi Bug (Rice weevil), *Pyrrilla* (Sugar cane leafhopper), Grasshoppers, Cotton bollworms, Aphids, Red flour Beetle, Rodents, Termites and Mosquitoes and their control. **(08 Sessions)**

**Unit-III:** Brief account of Aquaculture and Pisciculture, Polutry & Livestock (Cattle & Buffaloes) **(06 Sessions)**

**Unit-IV:** A brief account of Sericulture, Apiculture and Lac culture and their economic importance. **(06 Sessions)**

**Unit-V:** A detailed account of endangered Species, Important Sanctuaries & National Parks of India. Different Projects launched for the preservation of animal species; in-situ and ex-situ conservation of wild life, Wild life Organizations, Wild Life in India. **(08 Sessions)**

**Course Outcomes:**

After successfully completing this course, the students will be able to:

- Understand the culture techniques of prawn, pearl and fish.
- Understand silkworms rearing and their products.
- Understand the Bee keeping equipment's and apiary management.
- Understand dairy animal's management, the breeds and diseases of goats and learn the testing of egg and milk quality.
- Learn various concepts of lac cultivation.

**Suggested Readings:**

1. Applied and economic Zoology ,Dr.Veer Bala Rastogi, Kedar Nath Ram Nath
2. A Hand Book of Sericulture by Iyonemura & M. N. RamaRao.
3. Bee keeping by J. E. Eckert and F. R. Shaw.
4. Economic Zoology by G.S. Shukla & V.B. Upadhya

**Online resources**

- [www.digitalbookindex.org](http://www.digitalbookindex.org)
- [www1.biologie.uni-hamburg.de](http://www1.biologie.uni-hamburg.de)
- [www.topfreebooks.org](http://www.topfreebooks.org) ›
- [www.pdf.com](http://www.pdf.com)

**Note: Latest editions of all the suggested readings must be used**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-III Year (VI Semester)**  
**BZO-651: Zoology Lab –6**

**Objective:**

To make the study relevant, interesting, encouraging to the students to join the industry or to prepare them for higher studies including research. The new and updated syllabus is based on a basic and applied approach to ensure that students develop problem solving skills, laboratory skills, chemistry communication skills, team skills as well as ethics.

**List of Experiments:**

**(20 Sessions)**

1. Study of histological slides of organs of immune system – Thymus, Lymph nodes and Spleen
2. Determination of blood groups (ABO and Rh) in humans.
3. Antigen – Antibody interaction by double diffusion method (Ouchterlony)
4. Introduction to basic laboratory instruments and equipments- Autoclave, Centrifuge and pH meter, Micropipettes, Digital balance, Electrophoresis apparatus.
5. Study of prepared slides/specimen of *Entamoeba*, *Giardia*, *Leshmania*, *Trypanosoma*, *Plasmodium*, *Fasciola*, *Taenia*, *Polystoma*, *Paraamphi-stomum*, *Schistosoma*, *Echinococcus*, *Entrobilus*, *Ascaris* and *Ancylostoma*.
6. Larval stages of Helminthes and Arthropods.
7. Permanent mount of wings, mouthparts and developmental stages of Mosquito and Collection and identification of pests.
8. Life history of Silkworm, Honeybee and Lac insects.
9. Different types of important edible fishes of India.

**Course Outcomes:**

After successfully completing this course, the students will be able to:

- Study of animals which will improve their observation skills, data collection skills, critical thinking and analytical skills of students.
- Understand silkworms rearing and their products.
- Understand the Bee keeping equipment's and apiary management.
- Learn various concepts of lac cultivation.

**Suggested Readings:**

1. A manual of practical zoology: biodiversity, cell biology, genetics & developmental biology part 1 (M.M. Trigunayat).
2. Practical Zoology Invertebrate by S.S. Lal
3. Practical Zoology Invertebrate by P.S.Verma, S.Chand Publication

**Online Resources:**

- E-content on e-PG Pathshala portal of Government of India:  
<https://epgp.inflibnet.ac.in/Fundamentals>
- <https://www.asmscience.org/content/book>

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-I Year (I Semester)**

**BBO-101: DIVERSITY OF MICROBES**

**Objective:** The objective of this course is to expose the students to bacterial structure, types, mode of nutrition in bacteria, reproduction, economic importance of cyanobacteria and bacteria. This course will also enhance the knowledge of the students about viruses, viroids, Fungi and their economic importance.

**Unit-I** **(08 Sessions)**

Structure of bacterial cell, flagellation and mode of nutrition in bacteria.

Reproduction in bacteria: asexual (binary fission and endospore formation) and sexual (genetic recombination).

**Unit-II** **(06 Sessions)**

Role of bacteria and cyanobacteria in agriculture.

Microorganisms and the production of alcoholic beverages, antibiotics and single cell protein.

**Unit-III** **(08 Sessions)**

Viruses: General characters of viruses, classification of viruses based on host, symptoms of virus infection in plants; transmission of plant viruses; viroids. Economic importance of viruses.

**Unit-IV** **(10 Sessions)**

General characters of Fungi, classification of Fungi (as per Alexopoulos and Mims, 1979).

Systematic position, occurrence, structure of mycelium, asexual reproduction, sexual reproduction and graphic life cycle of following fungal types:

- a. Phycomycetes: *Albugo*.
- b. Ascomycetes: *Aspergillus*
- c. Basidiomycetes: *Puccinia and Agaricus*
- d. Deuteromycetes: *Alternaria and Cercospora*

**Unit-V** **(08 Sessions)**

A general account of Lichens with economic importance.

**Course Outcomes:**

**Students completing this course will be able to:**

- Understand the diversity of micro-organisms such as viruses, bacteria, fungi lichens, their classification, structure and growth.
- Increase the understanding the economic values of bacteria, fungi, mycorrhizae, lichens and develop theoretical & technical skills about them.

**Suggested Readings:**

1. Bodke S.S. and N.M. Dhekle (2007): Diversity of Microbes and Cryptogams, Mansi prakashan, Nanded
2. Vashishta B.R. (1990) Botany for Degree Students Part-II Fungi, S. Chand & Co. New Delhi.
3. Alexopoulos C.J. & C.W. Mims (1979): Introductory Mycology Wiley Eastern Ltd., New Delhi

4. Smith G.M. (1971): Cryptogamic Botany Vol-I. Algae and Fungi, Tata McGraw Hill Publishing Co. New Delhi.
5. Dubey H.C. (1990): An Introduction to Fungi Vikas Publishing House, New Delhi.
6. Sharma P.D. (1995): The Fungi. Rastogi & Co., Meerut.
7. Sharma O.P. (1992): A Text Book of Thallophytes, Tata McGraw Hill Publishing Co. New Delhi.
8. Mehrotra R.S. and K.R. Aneja (1990): Introduction to Mycology Wiley Eastern Ltd. New Delhi.
9. Pandey S.N., P.S. Trivedi and S.P. Mishra: A Text Book of Botany Vol-I & II Vikas Publishing House, New Delhi.
10. Pandey B.P. (2000) College Botany Vol-I (Algae, Fungi, Bryophytes) S. Chand & Co. New Delhi.
11. Clinton A (1958) Introduction to Bacteria McMillan, New York.
12. Dubey H.C. (1982) Text Book of Fungi, Bacteria and Viruses, Vikas Publishing House, New Delhi.

**Website Sources:**

- [www.kopykitab.com](http://www.kopykitab.com)
- [www.pdfdrive.com/botany-books.html](http://www.pdfdrive.com/botany-books.html)
- [www.digitalbookindex.org](http://www.digitalbookindex.org)
- [cqej.altopianoblu.it](http://cqej.altopianoblu.it) › botany-notes-pdf
- [www.kalyanipublication.co.in](http://www.kalyanipublication.co.in)
- [www1.biologie.uni-hamburg.de](http://www1.biologie.uni-hamburg.de)
- [www.topfreebooks.org](http://www.topfreebooks.org) ›
- [www.pdf.com](http://www.pdf.com)
- [en.wikipedia.org](http://en.wikipedia.org)
- [onlineecourses.nptel.ac.in](http://onlineecourses.nptel.ac.in)
- [www.yourarticlelibrary.com](http://www.yourarticlelibrary.com)
- [www.freebookcentre.net](http://www.freebookcentre.net)

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**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-I Year (I Semester)**

**BBO-102: ALGAE AND BRYOPHYTES**

**Objective:** The course aims to have the understanding of classification, diversity, vegetative growth, reproduction methods algae and Bryophytes, their affinities, evolution of bryophytes and economic as well as ecological importance of both groups of plants.

**Unit-I** **(08 Sessions)**

General account of algae and their classification (based on F. E. Fritsch 1935)

Range of thallus in algae.

Flagellation, Pigmentation and Reproduction in algae.

**Unit-II** **(08 Sessions)**

Structure, reproduction and graphic life cycle with alternation of generation of the following algal types:

- Chlorophyceae – *Chlamydomonas, Volvox, Vaucheria, Chara*
- Phaeophyceae – *Ectocarpus*
- Rhodophyceae – *Polysiphonia*.

Economic importance of algae.

**Unit-III** **(08 Sessions)**

Bryophytes: general characters, classification (as given by Rothmaler),

Reproduction and affinities.

**Unit-IV** **(08 Sessions)**

Systematic position, occurrence, thallus structure (external and internal), vegetative reproduction, asexual reproduction, sexual reproduction and graphic life cycle with alternation of generation of the following types (Developmental stages not required):

- Hepaticopsida – *Riccia, Marchantia*
- Anthocerotopsida – *Anthoceros*
- Bryopsida – *Funaria*

**Unit-V** **(08 Sessions)**

Evolution of sporophyte in Bryophytes.

Economic importance of Bryophytes.

**Course Outcomes:**

**Students completing this course will able to:**

- Learn about the structure, pigmentation, food reserves and methods of reproduction of Algae.
- Understand the diversity of algae, and evolution of bryophytes.
- Have the knowledge of economic and ecological significance of both plant groups.
- It will help to understand the comparison between algae and bryophytes.

**Suggested Readings:**

1. Ganguly and Kar. College Botany Vo. II. Calcutta

2. Khan, M.1983: Fundamentals of Phycology. Bishen Singh Mahendra Pal Singh, Dehradun
3. Parihar, N.S. The Biology and Morphology of Bryophytes, Central Book Depo. Allahabad.
4. Puri, P. 1980. Bryophytes. Atma Ram & Sons, Delhi.
5. Sharma, O.P. A Text Book of Bryophyta.
6. Singh, V., Pandey, P.C. and Jain, D.K. A text book of botany
7. Vashishta, B.R. Text Book of Algae. New Delhi
8. Parihar, N.S. 1996: Biology & Morphology of Pteridophytes. Central Book Depot, Allahabad.
9. Smith G.M. (1971): Cryptogamic Botany Vol-I. Algae and Fungi Tata McGraw Hill Publishing Co. New Delhi.
10. Smith G.M. (1971): Cryptogamic Botany Vol-II Bryophytes and Pteridophytes Tata McGraw Hill Publishing Co. New Delhi.
11. Vashishta B.R. (1990): Botany for Degree Students Part-I Algae, S. Chand & Co. New Delhi.
12. Vashishta B.R. (1990): Botany for Degree Students Part-III Bryophyta S. Chand & Co. New Delhi.
13. Fritsch F.E.(1945): The Structure and Reproduction of Algae Vol- I & II. Cambridge University Press.
14. Chapman V.J. and D.J. Chapman (1962): The Algae, English Language Book Society McMillan, London.

**Website Sources:**

- [www.pdfdrive.com/botany-books.html](http://www.pdfdrive.com/botany-books.html)
- [www.digitalbookindex.org](http://www.digitalbookindex.org)
- [cqej.altopianoblu.it › botany-notes-pdf](http://cqej.altopianoblu.it/botany-notes-pdf)
- [www.kalyanipublication.co.in](http://www.kalyanipublication.co.in)
- [www1.biologie.uni-hamburg.de](http://www1.biologie.uni-hamburg.de)
- [www.freebookcentre.net](http://www.freebookcentre.net)
- <https://www.easybiologyclass.com>

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-I Year (I Semester)**

**BBO-151: BOTANY LAB-1**

**Objective:** The main goal of this course is to share the knowledge to the students about the experiments. The students will get a better understanding of the concept studied by them in theory course and correlate with experimental observations.

**List of Experiments:**

**(24 Sessions)**

1. To stain and study bacteria
2. **Fungi:** Study of thallus structures of different fungi through preparation of whole mounts and sections: *Albugo, Puccinia, Agaricus, Alternaria and Cercospora*
3. **Algae:** Study of thallus structures of different groups of algae:
  - Chlorophyceae – *Chlamydomonas, Volvox, Vaucheria, Chara*
  - Phaeophyceae – *Ectocarpus*
  - Rhodophyceae – *Polysiphonia*
4. **Bryophytes:** study of morphology and anatomy of thallus of different bryophytes with their suitable diagrams:
  - Hepaticopsida – *Riccia, Marchantia*
  - Anthocerotopsida – *Anthoceros*
  - Bryopsida – *Funari*

**Course Outcomes:**

Completing this course, students will be able to:

- Culture the different bacterial strains and isolate them from environmental conditions.
- Have the knowledge of Gram staining technique.
- Gain knowledge on fixation, dehydration, hand sectioning, microtome sectioning.
- Observe and identify the algae and fungi.

**Suggested Readings:**

1. Botany Practical Vol. I by B.P. Pandey
2. A text Book of Practical Botany 1 by Bendre and Kumar
3. Practical Botany II by O.P. Sharma

**Website Sources:**

- <https://oer.galileo.usg.edu>
- <http://www.biologycorner.com>

- **Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-I Year (II Semester)**

**BBO-201: PTERIDOPHYTES, GYMNOSPERM AND PALAEOBOTANY**

**Objective:** This course aims to familiarize the students with distribution, morphology and anatomy of pteridophytes and gymnosperms. The specific objectives of this course are to study heterospory, seed habits and stellar evolution in pteridophytes, economic importance of pteridophytes and gymnosperms, and general account of palaeobotany.

**Unit-I** (06 Sessions)  
General feature of Pteridophytes and their classification according to Sporne.  
Stelar systems in Pteridophytes.

**Unit-II** (10 Sessions)  
Systematic position, occurrence, anatomy and reproductive structures of following classes:

- Psilopsida: *Rhynia*
- Lycopsida: *Selaginella*
- Sphenopsida: *Equisetum*
- Pterosida: *Marsilea*

Heterospory and seed habit.

**Unit-III** (06 Sessions)  
General features of Gymnosperms and their classification( Sporne)  
Distribution of *Cycas* and *Pinus*

**Unit-IV** (08 Sessions)  
Morphology, anatomy and life cycle of *Cycas*, *Pinus* and *Taxus*  
Economic importance of gymnosperms.

**Unit-V** (08 Sessions)  
General account of Palaeobotany and geological time scale.  
Types of fossils and methods of fossilization

**Course Outcomes:**

Completing this course, the students will be able to:

- Describe the morphology and anatomy of the vascular cryptogams and gymnosperms.
- Enhance their knowledge about the economic and ecological importance of these plants.
- Study about the fossils, geological time scale etc.

**Suggested Readings**

1. Smith G.M. (1971) Cryptogamic Botany Vol-II Bryophytes and Pteridophytes Tata McGraw Hill Publishing Co. New Delhi.
2. Vashishta P.C. (1991) Botany for Degree Students Part-V Vascular Cryptogams (Pteridophyta) S. Chand & Co. New Delhi.

3. Sharma O.P. (1992) A Text Book of Pteridophytes McMillan (India) Ltd.
4. Pandey, S.N. A Text book of Pteridophyta
5. Parihar, N.S. 1996 Biology & Morphology of Pteridophytes. Central Book Depot, Allahabad
6. Vashishta, P.C. Text Book of Gymnosperm, S. Chand & Co. New Delhi.
7. Sharma, O.P. An Introduction to Gymnosperms, Pragati Prakashan, Meerut.
8. Singh, V., Pandey, P.C. and Jain, D.K. A text book of botany Rastogi Publication, Meerut.

**Website Sources:**

- [www.pdfdrive.com/botany-books.html](http://www.pdfdrive.com/botany-books.html)
- [www.digitalbookindex.org](http://www.digitalbookindex.org)
- [www1.biologie.uni-hamburg.de](http://www1.biologie.uni-hamburg.de)
- [www.topfreebooks.org](http://www.topfreebooks.org) ›
- [www.pdf.com](http://www.pdf.com)
- [en.wikipedia.org](http://en.wikipedia.org)
- [www.yourarticlelibrary.com](http://www.yourarticlelibrary.com)
- [www.freebookcentre.net](http://www.freebookcentre.net)

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-I Year (II Semester)**

**BBO-202: SYSTEMATICS OF FLOWERING PLANTS AND ECONOMIC BOTANY**

**Objective:** The objective of this course is to enhance the knowledge of the students about the flowering plants, their classification, nomenclature, herbarium and botanical gardens. The students will also learn about the botanical description, cultivation and economic importance of some food crops, oil yielding plants, fiber yielding plants, medicinal plants and timber yielding plants.

**Unit-I** **(08 Sessions)**

Binomial nomenclature, ICBN and its importance in modern plant taxonomy.  
Bentham and Hooker's system of classification; Principles, outline, merits and demerits.  
Herbarium & its techniques; important Herbaria and Botanic Gardens.

**Unit-II** **(10 Sessions)**

Systematic position, distinguishing characters and economic importance of the following families:

**Dicotyledons:**

**Polypetalae:** Ranunculaceae, Malvaceae, Brassicaceae, Fabaceae, Cucurbitaceae and Umbelliferae (Apiaceae).

**Gamopetalae:** Compositae (Asteraceae), Solanaceae, Apocynaceae, Asclepiadaceae and Labiatae (Lamiaceae).

**Unit-III** **(06 Sessions)**

**Monochlamydae:** Euphorbiaceae & Amaranthaceae  
**Monocotyledons:** Palmae (Arecaceae), Graminae (Poaceae).

**Unit-IV** **(10 Sessions)**

Economic importance with special reference to plants yielding:

**Food:** Cereals (Rice, Wheat & Maize); Millets (Pearl millet and Jowar); Potato, Sugarcane; Legumes (Soybean, Gram & Pea); Oil Yielding Plants (Mustard, Sunflower, Groundnut & Coconut).

**Common fiber yielding plants:** Cotton, Hemp, Sun-hemp, Flax, Jute, Coir and Ramie.

**Unit-V** **(08 Sessions)**

Medicinal Plants: Poppy, Serpgandha, Ashwagandha and Gheekwar.  
Timber yielding plants: Shisham, Sal, Teak and Babul.

**Course Outcomes:**

Students who successfully complete this course will be able to:

- What is the role of ICBN in plant taxonomy? what are different data sources in systematics?
- What are different methods of naming plants? What are different principles of nomenclature? Why name changes?
- What are artificial, natural and phylogenetic systems of classification?
- What are different methods of collecting and preserving plants? What is the importance of maintaining plants in botanic gardens?
- Comparison among different flowering plants groups.
- Learn the importance of plant of different plants.

### **Suggested Readings:**

1. Angiosperm Phylogeny Group (2003). An update of the Angiosperm Phylogeny Group classification for the orders and families of the flowering plants: APG II. *Botanical Journal of the Linnaean Society* 141: 399-436.
2. Crawford, D.J. (2003). *Plant Molecular Systematics*. Cambridge University Press, Cambridge, UK.
3. Cronquist, A. (1981). *An Integrated System of Classification of Flowering Plants*. Columbia University Press, New York.
4. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue, M.J. (2008). *Plant Systematics- A Phylogenetic Approach*. Sinauer Associates Inc, Massachusetts, USA.
5. Simpson, M.C. (2006). *Plant Systematics*. Elsevier, Amsterdam.
6. Stussy, T.F. 1990. *Plant Taxonomy*, Columbia University Press, USA.
7. *A text book of Angiosperm*, Singh, Pandey & Jain: Rastogi Publication, Meerut.
8. Kochhar, S.L. 2009 *Economic Botany in Tropic*. Macmillan and Co. New Delhi.
9. Wickens, G.E. 2004 *Economic Botany: Principles and Practices*, Springer. Kluwer Publishers, Dordrecht, The Netherlands.
10. *Economic Botany*, B. B. Pandey.
11. V.Verma. *Economic Botany*.
12. Saxena and Saxena, *Plant taxonomy*, Pragati Prakashan, Meerut.
13. Subramanyam and Sambamurti. *Morphology and Taxonomy of Plants*. Sri Sai Printography.

### **Website Sources:**

- <http://www.equisetites.de>
- <https://www.science.gov>
- [www.pdfdrive.com/botany-books.html](http://www.pdfdrive.com/botany-books.html)
- [www1.biologie.uni-hamburg.de](http://www1.biologie.uni-hamburg.de)
- [www.pdf.com](http://www.pdf.com)
- [en.wikipedia.org](http://en.wikipedia.org)
- [onlineecourses.nptel.ac.in](http://onlineecourses.nptel.ac.in)
- [www.yourarticlelibrary.com](http://www.yourarticlelibrary.com)
- [www.freebookcentre.net](http://www.freebookcentre.net)
- [www.nativeplants.org](http://www.nativeplants.org)

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-I Year (II Semester)**

**BBO-251: BOTANY LAB-2**

**Objectives:** The main Goal of this subject is to share the knowledge to the students about the experiments. The students will get a better understanding of the concept studied by them in theory course and correlate with experimental observations.

List of Experiments: **(24 Sessions)**

1. Study of following types with the help of specimens, photographs, section cutting and temporary slide preparations:

**Pteridophytes:** *Selaginella, Equisetum & Marsilea.*

**Gymnosperm:** *Cycas & Pinus .*

2. **Angiosperm:** Detailed description and identification of locally available wild plants of the families: Ranunculaceae, Brassicaceae, Rosaceae, Umbelliferae (Apiaceae), Compositae (Asteraceae), Solanaceae, Apocynaceae, Asclpiadaceae, Labiatae (Lamiaceae), Euphorbiaceae and Graminae (Poaceae).

3. Economic Botany: Identification and comment on the plant products as prescribed in theory course.

4. Submission of Herbarium collection of atleast 25 local wild plants.

**Course Outcomes:**

Completing this course, students will be able to:

- Gain knowledge on fixation, dehydration, hand sectioning, microtome sectioning.
- Observe and identify the Pteridophytes, Gymnosperms and Flowering Plants.
- Develop the skill of collection and preservation of plant specimens.
- Study the different food crops, plants fibers, medicinal plants and timber yielding plants.

**Suggested Reading:**

1. Practical Botany II by O.P Sharma
2. A text Book of Practical Botany2 by Bendre and Kumar
3. Modern Practical Botany Vol. III by B.P. Pandey

**Website Sources:**

- <https://oer.galileo.usg.edu>
- <http://www.biologycorner.com>

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-II Year (III Semester)**

**BBO-301: SEXUAL REPRODUCTION IN FLOWERING PLANTS**

**Objective:**

**This course aims to expose the students to the following topics:**

- Students should understand complete details about the structures, development of embryo at different stages including gametogenesis, fertilization, and implantation.
- Ability to correlate between the embryological structure and its significance.
- Introduce with seed and fruit development, apomixes, polyembryony and parthenocarpy.

**Unit-I** **(08 Sessions)**

Microsporangium (anther wall, sporogenous tissue), Microsporogenesis and development of male gametophyte.

**Unit-II** **(08 Sessions)**

Megasporangium (types of ovules, integuments, nucellus), Megasporogenesis and development of female gametophyte; types of embryo sac, structure of mature embryo sac.

**Unit-III** **(10 Sessions)**

Pollination (anther dehiscence and transfer of pollens), types of pollination, agencies of pollination. Fertilization and double fertilization.

**Unit-IV** **(06 Sessions)**

Endosperm and its types, xenia and metaxenia.  
Structure of dicot and monocot embryos.

**Unit-V** **(06 Sessions)**

Formation of seed and fruit.  
Apomixis; Polyembryony and Parthenocarpy.

**Course Outcomes:**

**Completing this course, students will be able to:**

- Understand the structure of male and female reproductive bodies in flowering plants.
- Familiarize to pollination processes.
- Learn about double fertilization and their significance
- Know about the structure and development of dicot and monocot embryos.
- Understand apomixes, polyembryony and parthenocarpy.

**Suggested Reading:**

1. Bhojwani, S. S. and Bhatnagar, S. P. 2000: the Embryology of Angiosperms, 4<sup>th</sup>, revised and enlarged edition. Vikas Publishing House, Delhi.
2. Maheshwari P. (1972) An Introduction to Embryology of Angiosperms Tata Mc Graw Hill Book Pub. Co. Ltd. New York.
3. B. P. Pandey: A text book of Angiosperms, S. Chand & Company, N. Delhi.
4. Singh, Pandey & Jain. Angiosperm, Rastogi Publication, Meerut.

**Website Sources:**

- [www.digitalbookindex.org](http://www.digitalbookindex.org)
- [www1.biologie.uni-hamburg.de](http://www1.biologie.uni-hamburg.de)
- [www.topfreebooks.org](http://www.topfreebooks.org) ›
- <https://sites.google.com/>
- [www.pdfdrive.com/botany-books.html](http://www.pdfdrive.com/botany-books.html)
- <https://gurukpo.com>
- <http://www.brainkart.com>

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-II Year (III Semester)**

**BBO-302: PLANT ANATOMY**

**Objective:** This course aims to study the cellular structures and their role in plant development, tissues system, Water and food conducting elements, secondary growth in plants. The other objective of this course is to create understanding of leaf abscission and healing of wounds.

**Unit-1** **(08 Sessions)**

Meristem and its classification based on position and origin.

Organization of root and shoot apices: Apical cell theory, Histogen theory & Tunica- carpus theory.

**Unit-II** **(08 Sessions)**

Tissues: Simple tissues (Parenchyma, Collenchyma & Sclerenchyma); Complex tissues (Xylem & Phloem) and Secretory Tissues.

**Unit-III** **(08 Sessions)**

Anatomy of stems with special reference to plants showing primary anomalies: *Nyctanthes*, *Bougainvillea*, *Amaranthus* & *Leptadenia*.

**Unit-IV** **(06 Sessions)**

Normal secondary growth in dicot stem and dicot root.

Leaf abscission and healing of wounds.

**Unit-V** **(08 Sessions)**

Anomalous secondary growth in dicot stem and monocot stem: *Bignonia*, *Salvadora*, *Boerhaavia* & *Dracaena*.

**Course Outcome:**

**Students who successfully complete this course will be able to:**

- Understand the meristems and role in plant development.
- Draw and explain the structures of various tissues in plants and their functions.
- Know how the secondary growth takes place in some dicot stem.
- Understand the process of abscission and healing of wounds

**Suggested Reading:**

1. Cutter, E. G. 1971: Plant Anatomy: Experiment and Interpretation. Part II. Organs. Edward Arnold, London.
2. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
4. Mauseth, J.D. 1988 Plant Anatomy. The Benjamin/Cummings Publisher, USA.

5. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
6. Sundara Rajan (1998) College Botany Vol-1 and Vol-2 Himalaya Publication House, Nagpur.
7. Dutta A.C. (1968) A Botany for Degree Students Oxford Press, London.
8. Tayal M.S. (1983) Plant Anatomy Rastogi Publication, Meerut.
9. Ganguli, Das, Dutta (1981) College Botany Vol-1 and Vol-2 New Cenral Book Agency, Kolkatta.
10. Pandey B.P. (1993) Plant Anatomy S. Chand & Co. Pvt. Ltd.
11. Singh V, Pande P.C. & D.K. Jain (1994) Anatomy of Seed Plants Rastogi Publication, Meerut.
12. P.C. Vashishtha. Plant Anatomy. S. Chand & Co.

**Website Sources:**

- [www.digitalbookindex.org](http://www.digitalbookindex.org)
- [www1.biologie.uni-hamburg.de](http://www1.biologie.uni-hamburg.de)
- [www.topfreebooks.org](http://www.topfreebooks.org) ›
- <https://sites.google.com/>
- [www.pdfdrive.com/botany-books.html](http://www.pdfdrive.com/botany-books.html)
- <https://gurukpo.com>
- <http://www.brainkart.com>

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-II Year (III Semester)**

**BBO-351: BOTANY LAB-3**

**Objectives:** The main Goal of this subject is to share the knowledge to the students about the experiments. The students will get a better understanding of the concept studied by them in theory course and correlate with experimental observations.

**List of Experiments:**

1. Embryology: **(12 Sessions)**
  - Study of pollinia in *Calotropis* flower.
  - Study of permanent slides – L. S. of ovule types,
  - T. S. of anther; Germinating pollen,
  - Embryosac Polygonum type.
  - T. S. of ovary showing placentations, Dicot and Monocot Embryos.
2. Plant Anatomy: Anatomy of following stems: *Nyctanthes*, *Bougainvillea*, *Amaranthus*, *Bignonia*, *Mirabilis*, *Salvadora*, *Leptadenia*, *Boerhaavia* & *Dracaena*. **(12 Sessions)**

**Course Outcomes:**

**Completing this course, students will be able to:**

- Dissect out the pollinia from *Calotropis procera* flower and explain the structure.
- Explain the T.S. of anther of *Datura*.
- Understand the types of placentation in different flower bud practically and physically.
- Gain knowledge on fixation, dehydration, hand sectioning, microtome sectioning of dicot and monocot stem.

**Suggested Reading:**

1. Practical Botany II by O.P Sharma
2. A text Book of Practical Botany2 by Bendre and Kumar
3. Modern Practical Botany Vol. III by B.P. Pandey

**Website Sources:**

- <https://oer.galileo.usg.edu>
- <http://www.biologycorner.com>

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-II Year (IV Semester)**

**BBO-401: CELL AND MOLECULAR BIOLOGY**

**Objective:** This course aims to introduce the students with prokaryotic and eukaryotic cell, ultra structures and function of cell organelles, morphology and chemistry of chromosomes, cell cycle, and nucleic acid as genetic material as well as replication of DNA.

**Unit-I** **(08 Sessions)**

Prokaryotic and eukaryotic cell; differences between plant cell and animal cell; ultrastructure of typical plant cell.

Ultrastructures and functions of cell organelles: Nucleus, chloroplast, mitochondria, golgi complex, endoplasmic reticulum and ribosomes.

**Unit-II** **(08 Sessions)**

Morphology and chemistry of chromosomes; Giant chromosomes-Polytene and Lampbrush Chromosomes.

Euchromatin and heterochromatin.

**Unit-III** **(06 Sessions)**

Cell cycle: mitosis; meiosis and their significance. Comparison of meiosis and mitosis.

**Unit-IV** **(10 Sessions)**

Nucleic acids as genetic material (Avery et al. and Hershey and Chase experiments; Fraenkel Conrat's expt. with TMV); Structure of nucleic acids; A, B, C & Z DNAs; genetic and non genetic RNAs.

Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semi conservative and semi discontinuous replication, RNA priming; various models of DNA replication; Enzymes involved in DNA replication.

**Unit-V** **(08 Sessions)**

Gene function: (a) Transcription; Genetic code and its properties  
(b) Translation and termination of protein synthesis.

Gene regulation: Lac-operon model.

**Course Outcomes:**

**On completion of the course, students will able to understand:**

- Difference between prokaryotic eukaryotic cell and ultra structure of plant cell.
- Structure and functions of cell organelles.
- The eukaryotic cell cycle and mitotic and meiotic cell division.
- Structure and chemistry of chromosomes, types of chromosomes.
- Nucleic acid as genetic material, types of DNA, DNA replication and enzymes involved in DNA replication.

**Suggested Reading:**

1. Atherly, A.G. Girton, J.R. and McDonald, J.F. 1999. The Science of Genetics, Saunders College Publishing, Fort Worth, USA.

2. Gupta, P.K. 1999. A text book of Cell and Molecular Biology. Rastogi Publications, Meerut, India.
3. Kleinsmith, L. J and Kish, V.M. 1995. Principles of Cell and Molecular Biology (2nd edition) Harper Collins College Publishers, New York, USA.
4. Lodish, H., Berk, A., Zipursky, S.L., Matsudaria, P., Baltimore, D. and Darnell, J. 2000. Molecular, Cell Biology, W.H. Freeman and Co., New York., USA.
5. Russel, P.J. 1998. Genetics, The Benjamin/Cummings Publishing Co. Inc., USA.
6. Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetics. John Wiley and Sons, Inc. USA.
7. P.S. Verma and V.K. Agarwal. Molecular Biology. S. Chand & Co., New Delhi.

**Website Sources:**

- [www.pdfdrive.com/botany-books.html](http://www.pdfdrive.com/botany-books.html)
- [www.pdf.com](http://www.pdf.com)
- [en.wikipedia.org](http://en.wikipedia.org)
- [onlineecourses.nptel.ac.in](http://onlineecourses.nptel.ac.in)
- [www.yourarticlelibrary.com](http://www.yourarticlelibrary.com)
- [www.freebookcentre.net](http://www.freebookcentre.net)
- <https://gurukpo.com>

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**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-II Year (IV Semester)**

**BBO-402: GENETICS, PLANT BREEDING AND BIOSTATISTICS**

**Objective:** The objective of this course is to gain the understanding of students about mendelian concept, interaction of genes, linkage and crossing over, chromosomal aberrations and mutations. This course also aims to understand the brief history of plant breeding and methods using plants breeding and role of statistics in plant breeding.

**Unit-I** **(08 Sessions)**

Mendelism: Concept of dominance; genotype-phenotype concept, Mendel laws, incomplete dominance, test cross-back cross.

Interaction of genes: epistasis, supplementary and complementary

Linkage and Crossing over.

Cytoplasmic inheritance.

**Unit-II** **(08 Sessions)**

Chromosomal aberrations (Deficiency; Duplication; Translocation ; Inversion) and numerical alterations in chromosomes (Aneuploidy and Euploidy with special reference to polyploids; autopolyploids & allopolyploids)

Mutation: spontaneous and induced mutation; methods of mutation and its significance in evolution.

**Unit-III** **(08 Sessions)**

Aims and objectives of plant breeding; brief history of plant breeding.

Methods of plant breeding:

1. Selection
2. Hybridization
3. Plant introduction and acclimatization
4. Mutation breeding

**Unit-IV** **(08 Sessions)**

Hybrid vigour (Heterosis) and its application.

Breeding for disease resistance

**Unit-V** **(08 Sessions)**

Classification of data, mean, median and mode. Standard deviation, standard error, variance, co-relation,  $X^2$  test and experimental designs.

**Course Outcomes:**

**On completion of the course, students will able to:**

- Explain the Mendelian inheritance, post mendelian inheritance and chromosomal aberration.
- Understand the science of plant breeding.
- Study the techniques of production of new superior crop varieties.

- Get the detail knowledge about modern strategies applied in Plant Breeding for crop improvement i.e. Mass selection, Pureline Selection and Clonal selection.
- Know about exploitation of heterosis, hybrid and variety development and their release through artificial hybridization.
- Understand various statistical methods of analysis.

### **Suggested Reading:**

1. Atherly, A.g. Girton, J.R. and McDonald, J.F. 1999. The Science of Genetics, Saunders College Publishing, Fort Worth, USA.
2. Gupta, P.K. 1999. A text book of Cell and Molecular Biology. Rastogi Publications, Meerut, India
3. Kleinsmith, L.J. and Kish, V.M. 1995. Principles of Cell and Molecular Biology (2<sup>nd</sup> edition). Harper Collins College Publishers, New York, USA.
4. Lodish, H., Berk, A., Zipursky, S.L., Matudaria, P., Baltimore, D. and Darnell, J. 2000.
5. Molecular, Cell Biology, W.H. Freeman and Co., New York, USA.
6. Russel, P.J. 1998. Genetics, The Benjamin/Cummings Publishing Co. Inc., USA.
7. Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetics. John Wiley and Sons, Inc. USA.
8. Satish Kumar & Parul Tyagi. Plant Breeding and Biotechnology. Pragati Prakashan . Meerut.
9. P. K. Gupta. Evolution and Plant Breeding. Rastogi Publication, Meerut
10. B. D. Singh. Plant Breeding, Kalyani publication.
11. P.K. Benargee.: Biostatistics
12. R. Rangaswamy. A text Book Of Agriculture Statistics
13. Radha Raman. Breeding of Horticulture Crops

### **Website Sources:**

- [www.pdfdrive.com/botany-books.html](http://www.pdfdrive.com/botany-books.html)
- [www.digitalbookindex.org](http://www.digitalbookindex.org)
- [www1.biologie.uni-hamburg.de](http://www1.biologie.uni-hamburg.de)
- [www.topfreebooks.org](http://www.topfreebooks.org) ›
- [www.pdf.com](http://www.pdf.com)
- [en.wikipedia.org](http://en.wikipedia.org)
- [www.yourarticlelibrary.com](http://www.yourarticlelibrary.com)
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**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-II Year (IV Semester)**

**BBO-451: BOTANY LAB-4**

**Objective:** The main Goal of this subject is to share the knowledge to the students about the experiments. The students will get a better understanding of the concept studied by them in theory course and correlate with experimental observations.

List of Experiments:

**(20 Sessions)**

1. Preparation of mitotic and meiotic spreads and analysis of various stages of cell division (*Phlox and Allium*).
2. Isolation and purification of nuclei and their staining with Feulgen stain or DAPI.
3. Isolation of mitochondria and their visualization with Janus green B and mitotracker.
4. Isolation of chloroplasts
5. Extraction of genomic DNA from plants by CTAB method.
6. Numerical problems related to gene interaction and modified dihybrid ratio.
7. Plant breeding: emasculation technique.

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

- Understand the various stages occurred in mitotic and meiotic cell divisions.
- Apply quantitative problem-solving skills to genetics problems and issues.
- Select and apply experimental procedures to solve genetic problems.
- Perform the emasculation technique in various crop plants.
- Isolate and identify the plant DNA, chloroplast, mitochondria and nucleus.

**Suggested Readings:**

1. A text Book of Practical Botany 2 by Bendre and Kumar
2. Practical Biotechnology by R.S.Gaud.

**Website Sources:**

- <https://oer.galileo.usg.edu>
- <http://www.biologycorner.com>

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-III Year (V Semester)**

**BBO-501: PLANT PHYSIOLOGY**

**Objective:** This course aims to familiarize the students with various physiological processes, water absorption, transpirations, ascent of sap, photosynthesis and respiration. The main objective of this course is to understand the growth hormones and their role in plant's physiology.

**Unit-I** **(08 Sessions)**

Water relation of plants: imbibitions, diffusion, osmosis, Plasmolysis, water potential, water absorption, loss of water and ascent of sap.

Mineral nutrition of plants: Physiological role and deficiency symptoms of micro and macronutrients.

**Unit-II** **(08 Sessions)**

Photosynthesis: structure of chloroplast, absorption of light, transfer of light energy, electron transport, photophosphorylation, C<sub>3</sub>, C<sub>4</sub>, CAM pathways of carbon fixation.

**Unit-III** **(08 Sessions)**

Transport of solutes: sugar translocation.

Respiration: aerobic and anaerobic, glycolysis. Krebs cycle, Electron Transport System (ETS), factors affecting respiration, respiratory quotient (RQ) and its measurement.

**Unit-IV** **(10 Sessions)**

Plant growth hormones: physiological role of auxins, gibberellins, cytokinins, abscisic acid and ethylene.

Plant movements: movements of locomotion -spontaneous and induced (Tactic) and movements of curvature-spontaneous and induced (Tropic & Nastic).

**Unit-V** **(08 Sessions)**

Physiology of flowering: photoperiodism and vernalization.

Seed dormancy and germination.

**Course Outcomes:**

**On completion of the course, students will be able to:**

- Understand the plants and plant cells in relation to water, the movement of sap and absorption of water in plant body.
- Know micro and macronutrients and their role in plant developments.
- Understand the process of photosynthesis in higher plants with particular emphasis on light and dark reactions, C<sub>3</sub> and C<sub>4</sub> pathways.
- Understand the respiration in higher plants with particular emphasis on aerobic and anaerobic respiration.
- Understand the plant movements, physiology of flowering, seed dormancy and germination.

**Suggested Reading:**

1. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
2. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4th edition, W.H. Freeman and Company, New York, USA.
3. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.

4. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4th edition, Sinauer Associates Inc .MA, USA.
5. Dennis, D.T., Layzell, D.B., Lefebvre, D.D. and Turpin, D.H. (1997) Plant Metabolism. Addison Wesley Longman.
6. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.
7. S.K. Verma, A text book of Plant Physiology, Biochemistry & Biotechnology, S. Chand & Company.
8. H.N. Srivastava, Plant Physiology, Pradeep Publication, Jhalandhar
9. S.N. Pandey & B.K. Sinha, Plant Physiology, Vikas Publication, Delhi
10. C.P. Malik. Plant PhysioloHy

**Website Sources:**

- [www.pdfdrive.com/botany-books.html](http://www.pdfdrive.com/botany-books.html)
- [www.digitalbookindex.org](http://www.digitalbookindex.org)
- [www1.biologie.uni-hamburg.de](http://www1.biologie.uni-hamburg.de)
- [www.topfreebooks.org](http://www.topfreebooks.org) ›
- [www.pdf.com](http://www.pdf.com)
- [en.wikipedia.org](http://en.wikipedia.org)
- [www.yourarticlelibrary.com](http://www.yourarticlelibrary.com)
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**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-III Year (V Semester)**

**BBO-502: PLANT BIOCHEMISTRY**

**Objective:** The main objective of this course to familiarize the students with enzymes, mechanism of enzymes, synthesis and biological role of ATP, Chemistry of Nucleic acid, general account of vitamins, biomolecules and their significance as well as nitrogen metabolism.

**Unit-I** **(08 Sessions)**

Enzymes: classification, nomenclature, mechanism of action (binding to substrate, lowering of activation energy), factors controlling enzyme activity, Coenzymes.

ATP, its synthesis and biological role.

**Unit-II** **(08 Sessions)**

Nucleic Acid: Introduction, Nitrogenous Bases, Chemistry of structure of Bases, Pentose sugar, Phosphoric acid; Nucleoside; Nucleotide; Structure of DNA; Mechanism of DNA replication in eukaryotes.

Vitamins: General account of water and fat soluble vitamins.

**Unit-III** **(06 Sessions)**

Carbohydrates: Introduction, classification of carbohydrates, chemistry of monosaccharide; some important reactions of monosaccharides; Reducing and non-reducing sugar; significances of carbohydrates.

**Unit-IV** **(08 Sessions)**

Proteins: Introduction; classification of protein; structure of protein-primary, secondary and tertiary; denaturation and renaturation of protein.

The Lipids: Introduction; Classification of lipids/fatty acids; properties of fatty acid and fats; waxes; Derived lipids (Steroids); importance of lipids.

**Unit-V** **(06 Sessions)**

Nitrogen metabolism: N<sub>2</sub> fixation (Symbiotic and Asymbiotic); assimilation into Amino-acids.

**Course Outcomes:**

**On completion of the course, students will be able to:**

- Understand the structure and general features of enzymes, concept of enzyme activity and enzyme inhibition.
- Have the knowledge of DNA chemical constituents, and its replication.
- Understand the structure of biomolecules like carbohydrates, proteins, lipids and vitamins.
- Understand nitrogen metabolism in plants.

**Suggested Readings:**

1. Davies P J. (2004) Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.

2. Jordan BR. (2006) The Molecular Biology and Biotechnology of Flowering, 2nd Edition, CAB International, Oxfordshire, U.K.
3. Lodish H, Berk A, Kaiser CA and Krieger M. (2008) Molecular Cell Biology, 6th Edition, W.H. Freeman and Company, New York, USA.
4. Lehninger (2004). Principles of Biochemistry, 4th Edition, Freeman and Company, New York, USA.
5. Taiz L and Zeiger E. (2006) Plant Physiology, 4th Edition, Sinauer Associates Inc. Publishers, Massachusetts, USA.
6. Jain, J. L. A text book of Biochemistry, S. Chand Publication, New Delhi.
7. Voet and Voet. Biochemistry. John Willey and Sons, Delhi.

**Website Sources:**

- [www.pdfdrive.com/botany-books.html](http://www.pdfdrive.com/botany-books.html)
- [www.digitalbookindex.org](http://www.digitalbookindex.org)
- [www1.biologie.uni-hamburg.de](http://www1.biologie.uni-hamburg.de)
- [www.topfreebooks.org](http://www.topfreebooks.org) ›
- [www.pdf.com](http://www.pdf.com)
- [en.wikipedia.org](http://en.wikipedia.org)
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**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-III Year (V Semester)**

**BBO-551: BOTANY LAB-5**

**Objective:** The main objective of this subject is to share the knowledge to the students about the experiments. The students will get a better understanding of the concept studied by them in theory course and correlate with experimental observations.

List of Experiments:

**Plant Physiology:** (08 Sessions)

- i. Demonstration of Endosmosis, Exosmosis, Plasmolysis and Imbibition.
- ii. Measurement of transpiration, photosynthetic rate and R. Q. of different respiratory substrates.
- iii. Effect of temperature & light on the germination of seeds.

**Biochemistry:** (08 Sessions)

- i. Colour tests, microtests for carbohydrates, proteins and lipids.
- ii. Paper chromatography of chlorophyll pigments and amino-acids.
- iii. The study of Azolla and Rhizobium as biofertilizers.

**Course outcomes:**

**After completing this course, the students will be able to:**

- Understand how water is absorbed by the plants through the osmosis and what is Plasmolysis and imbibitions?
- Find out the transpiration rate, respiration quotient of different respiratory substrates, photosynthesis rate under different conditions.
- Know how do light and temperature effect the germination of seeds?
- Observe the carbohydrates, protein and lipids in plant products.
- Identify and explain the type of chlorophyll and amino acid present.

**Suggested Reading:**

1. Practical Agronomy by R. B. Tiwari
2. A text Book of Practical Botany2 by Bendre and Kumar

**Website Sources:**

- [www.pdfdrive.com/botany-books.html](http://www.pdfdrive.com/botany-books.html)
- [www.digitalbookindex.org](http://www.digitalbookindex.org)
- [en.wikipedia.org](http://en.wikipedia.org)
- [www.yourarticlelibrary.com](http://www.yourarticlelibrary.com)

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**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-III Year (V Semester)**

**BBO-601: FUNDAMENTALS OF BIOTECHNOLOGY**

**Objective:** This course aims to introduce to the students with basics concepts of biotechnology and its role in agriculture, medical field, functional foods and nutraceuticals.

**Unit – I** **(08 Sessions)**  
Introduction, Recombinant DNA technology: Restriction enzymes and cleavage; Agarose Gel Electrophoresis; Cloning vectors.

**Unit – II** **(08 Sessions)**  
Isolation of cellular DNA; Methods to obtain passenger DNA through genomic library, polymerase chain reaction; Ligation of passenger DNA into a vector.

**Unit – III** **(06Sessions)**  
Transfer of recombinant DNA into bacterial cell (host); downstream processing.

**Unit – IV** **(08 Sessions)**  
Application of Biotechnology in agriculture; Pest resistant crops Bt crops, RNAi mediated crops; functional food and nutraceuticals.

**Unit – V** **(08 Sessions)**  
Herbicide resistant transgenic plants; transgenic microbes; medical applications; production of enzymes, vitamins and antibiotics.

**Course Outcomes:**

**Students, who successfully complete this course will be able to:**

- Describe bio-catalysis, pathway engineering, bioprocess control and downstream processing.
- Demonstrate their ability to reason both inductively and deductively with experimental information and data.
- Explain the theory and practice of recombinant DNA technology.
- Select and apply experimental procedures to the spectrum of fields making use of biotechnology.

**Suggested Readings:**

1. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.
2. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
3. Chrispeel, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones and Barlett Publishers.
4. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
5. Smith, R. 2000 Plant Tissue Culture: Techniques and Experiments, 2nd edition, Academic.
6. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
7. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rd edition. Benjamin Co.

8. Raven, P.H., Johnson, G.B., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
9. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
10. Sambrook & Russel. Molecular Cloning: A Laboratory manual. (3rd edition)
11. B. D. Singh. Biotechnology. Kalyani Publications.
12. H. D. Kumar, Molecular Biology and Biotechnology, Vikas Publication, Delhi.
13. S. K. Verma. Plant Physiology, biochemistry & biotechnology. S. Chand & Co., New Delhi.
14. K. G. Ramawat. Plant Biotechnology, S. Chand & Co., New Delhi.

**Website Sources:**

- [www.pdfdrive.com/botany-books.html](http://www.pdfdrive.com/botany-books.html)
- [www.digitalbookindex.org](http://www.digitalbookindex.org)
- [www1.biologie.uni-hamburg.de](http://www1.biologie.uni-hamburg.de)
- [www.topfreebooks.org](http://www.topfreebooks.org) ›
- [www.pdf.com](http://www.pdf.com)
- [en.wikipedia.org](http://en.wikipedia.org)
- [www.yourarticlelibrary.com](http://www.yourarticlelibrary.com)
- [www.freebookcentre.net](http://www.freebookcentre.net)
- [onlineecourses.nptel.ac.in](http://onlineecourses.nptel.ac.in)

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-III Year (VI Semester)**

**BBO-602: PLANT ECOLOGY**

**Objective:** This course aims to familiarize the students with environment and its factors and to know the interrelationship between organisms in populations and communities and to aware the students regarding environmental issues and problems at local, national and international levels. The main theme of the study of plant ecology is to know the structure and functions of ecosystems,

**Unit-I** **(10 Sessions)**

Introduction to Ecology: Definition; scope and importance; levels of organization.

Environment: Introduction; environmental factors- climatic (water, light, temperature), edaphic (soil profile, physico-chemical properties), topographic and biotic factors (species interaction).

**Unit-II** **(08 Sessions)**

Ecosystem: Structure (components) and functions (trophic levels, food chains, food webs, ecological pyramids and energy flow)

Biogeochemical cycles: carbon and nitrogen; Phosphorus cycle.

**Unit-III** **(08 Sessions)**

Plant adaptations: Xerophytes, Hydrophytes, Halophytes, mangrove vegetation and Epiphytes.

Ecological succession: Xerosere and Hydrosere, climax concept.

Ecological nich; genecology with reference to ecads and ecotypes

**Unit-IV** **(06 Sessions)**

Phytogeography: Phytogeographical regions of India; vegetation types of India (forests).

**Unit-V** **(08 Sessions)**

Environmental pollution: Sources, types and control of air and water pollution Global change: Greenhouse effect and greenhouse gases; impact of global warming.

**Course Outcomes:**

**On completion this course, students will be able to:**

- Explain the ecological interconnectedness of life on earth by tracing energy and nutrient flow through the environment.
- Understand the effects of the physical features of the environment on the structure of populations, communities, and ecosystems.
- Describe the plant succession and plant adaptations.
- Understand the environmental pollution and its effects.

**Suggested readings:**

1. Odum, E.P. 1983: Basic Ecology, Saunders, Philadelphia.
2. Kormondy, E.J. 1996: Concepts of Ecology, Prantice-Hall of India Pvt. Ltd., New Delhi.
3. New Delhi.
4. Mackenzie, A. et al. 1999: Instant Notes in Ecology, Viva Books Pvt. Ltd., New Delhi.
5. Delhi.

6. Joseph, B., Environmental studies, Tata Mc Graw Hill.
7. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2nd edition) Cambridge University Press.
8. Sinha, S. 2010. Handbook on Wildlife Law Enforcement in India. TRAFFIC, India.
9. Singh, J.S., Singh, S.P. and Gupta, S. (2006) Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi
10. Wilkinson, D.M. (2007). Fundamental Processes in Ecology. An Earth System Approach. Oxford.
11. Daubenmier, R.F. (1970). Plants and Environment: A text book of Plant Autoecology, Wiley Eastern Private Limited
12. Daubenmier, R.F. (1970), Plant Communities, Wiley Eastern Private Limited.
13. Odum, E. (2008) Ecology. Oxford and IBH Publisher.
14. Sharma, P.D. (2010) Ecology and Environment, (8th Ed.) Rastogi Publications, Meerut.
15. Shukla and Chandel; Ecology and Soil Science, S. Chand Publication,

**Website Sources:**

- [www.pdfdrive.com/botany-books.html](http://www.pdfdrive.com/botany-books.html)
- [www.digitalbookindex.org](http://www.digitalbookindex.org)
- [www1.biologie.uni-hamburg.de](http://www1.biologie.uni-hamburg.de)
- [www.topfreebooks.org](http://www.topfreebooks.org) ›
- [www.pdf.com](http://www.pdf.com)
- [en.wikipedia.org](http://en.wikipedia.org)
- [www.yourarticlelibrary.com](http://www.yourarticlelibrary.com)
- [www.freebookcentre.net](http://www.freebookcentre.net)
- [onlineecourses.nptel.ac.in](http://onlineecourses.nptel.ac.in)

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science Programme**  
**B. Sc. (ZBC)-III Year (VI Semester)**

**BBO-651: BOTANY LAB-6**

**Objective:** The main objective of this subject is to share the knowledge to the students about the experiments. The students will get a better understanding of the concept studied by them in theory course and correlate with experimental observations.

**List of Experiments:**

**Biotechnology:**

**(04 Sessions)**

- a. Plasmid DNA isolation: Miniprep
- b. Agrose gel electrophoresis of isolated plasmid.

**Ecology:**

**(12 Sessions)**

- c. Study of vegetation by Quadrat method; study of parameters such as – Density, abundance, Frequency and Relative Frequency.
- d. Study of morphology and anatomy of hydrophytes, Xerophytes and Halophytes.
- e. Study of polluted water and saline water on seed germination and seedling growth of a given crop.
- f. Identification of Soil texture - clay, sand, loamy.
- g. Measurement of pH of soil using pH meter.
- h. Study of water holding capacity of different soils.
- i. Study of qualitative presence of CO<sub>3</sub>, NO<sub>3</sub>, SO<sub>4</sub> & Cl in soil.

**Suggested Readings:**

1. A text Book of Practical Botany<sup>2</sup> by Bendre and Kumar
2. Modern Practical Botany Vol. III by B.P. Pandey
3. Practical Biotechnology by R.S.Gaud

**Website Sources:**

- [www.pdfdrive.com/botany-books.html](http://www.pdfdrive.com/botany-books.html)
- [www.digitalbookindex.org](http://www.digitalbookindex.org)
- [www.topfreebooks.org](http://www.topfreebooks.org) ›
- [www.pdf.com](http://www.pdf.com)
- [en.wikipedia.org](http://en.wikipedia.org)
- [onlineecourses.nptel.ac.in](http://onlineecourses.nptel.ac.in)

**Note: Latest editions of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science (ZBC) Programme**  
**B.Sc (ZBC) I Year (I Semester)**

**BCHE-101: INORGANIC CHEMISTRY**

**Objectives:** This course will equip students with the necessary knowledge to understand chemistry at the most fundamental level to understand the periodic properties of different elements, different principles for filling electrons in different energy levels and to draw energy diagrams, and how to calculate bond order.

**Unit-I**

**(08 Sessions)**

**Periodic Properties:**

Atomic and ionic radii, ionization energy, electron affinity and electro negativity - definition, methods of determination or evaluation, trends in periodic table and applications in predicting and explaining the chemical behaviour.

**Unit – II**

**(08 Sessions )**

**Chemical Bonding:**

Covalent Bond – Valence bond theory and its limitations, directional characteristics of covalent bond, MO theory, homonuclear and heteronuclear (CO and NO ) diatomic molecules , multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electro – negativity difference .

**Unit-III**

**(10 Sessions )**

**s-Block Elements:**

Comparative study, diagonal relationship, salient features of hydrides, solvation and complexation tendencies including their function in biosystems , an introduction to alkyls and aryls .

**Unit -IV**

**(10 Sessions )**

**p – Block Elements:**

Comparative study of group 13 – 17 elements , compounds like hydrides, oxides, oxyacids and halides of group 13–16, hydrides of boron– diborane and higher boranes, fullerenes, carbides, silicates, interhalogens.

Chemistry of Noble Gasses: Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds.

**Course Outcomes:**

Students completing this course will able to:

- ❖ Gain an understanding of the bonding fundamentals for both ionic and covalent compounds, including electronegativities, bond distances and bond energies using MO diagrams and thermodynamic data
- ❖ Predicting geometries of simple molecules
- ❖ The fundamentals of the chemistry of the main group elements, and important real world applications of many of these species

**Suggested Readings:**

1. Inorganic Chemistry by J.E.Huheey

2. Basic Inorganic Chemistry by Cotton and Wilkinson
3. Organic Chemistry by Morrison and Boyd
4. Concise Inorganic Chemistry by J.D.Lee

**Website Sources:**

- ❖ <https://www.internetchemistry.com/>
- ❖ <http://www.chemguide.co.uk/>
- ❖ <https://freebookcentre.net/>
- ❖ Chemical Elements.com

**Note: Latest edition of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science (ZBC) Programme**  
**B.Sc (ZBC) I Year (I Semester)**  
**BCHE-102: ORGANIC CHEMISTRY**

**Objectives:** The main objective of this course is to make the students knowledgeable about the fundamentals of carbon chemistry, to understand the consequences (reactivity, properties) of the three-dimensionality of molecules, so that they may be able to interpret patterns of reactivity on the basis of mechanistic reasoning,

**Unit – I**

**(08 Sessions)**

Mechanism of Organic Reactions:

Homolytic and heterolytic bond fission, Types of reagents – electrophiles and nucleophiles, Types of organic reactions.

Reactive intermediates – Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples), charge transfer complexes, resonances, hyperconjugation, inductive and electromeric effects.

**Unit – II**

**(10 Sessions )**

Stereochemistry of Organic Compounds:

Concept of isomerism, types of isomerism: Optical isomerism – elements of symmetry, molecular chirality, enantiomers, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomer and racemization. Relative and absolute configuration, sequence rules, R & S systems of nomenclature.

Geometric isomerism – determination of configuration of geometric isomers, E & Z system of nomenclature.

**Unit – III**

**(08 Sessions)**

Cycloalkanes: Nomenclature, Baeyer's strain theory and its limitations, Ring strain in small rings (cyclopropane and cyclobutane), theory of strain less rings. Preparation and properties of cycloalkane.

**Unit – IV**

**(08 Sessions)**

Arenes and Aromaticity: Huckel's rule, aromatic ions. , Nomenclature of benzene derivatives, the aryl group, aromatic nucleus and side chain, Aromatic electrophilic substitution –Mechanism of nitration, halogenation, sulphonation and Friedel – Crafts reaction. Orientation and ortho/para ratio, side chain reactions of benzene derivatives, Birch reduction: Methods of preparation and chemical reactions of alkyl benzenes and naphthalene and anthracene.

**Course Outcomes:**

Students completing this course will be able to:

- ❖ Interpret the concept of aromaticity and the main properties of aromatic compounds.
- ❖ Associate polarization of a bond with electronegativity.

- ❖ Understand nucleophile and electrophile groups and their properties.
- ❖ Associate different bond types of carbon and its hybrid orbitals.
- ❖ Express the differences between valence bond and molecular orbital approaches.
- ❖ Derive mechanism of a reaction.
- ❖ Interpret the reactions and properties of cyclo alkanes, arenes, halogen compounds.

**Suggested readings:**

1. A Textbook of Qualitative Inorganic Analysis By A.I. Vogel
2. A Text Book Of Organic Chemistry By I L Finar Vol I
3. M.S Singh, Advanced Organic Chemistry/Reactions And Mechanism: Pearson Education Pvt.Ltd.
4. S.M. Mukerjee And S.P., Singh Reaction Mechanism In Organic Chemistry Macmillan India Ltd.

**Web sources:**

- ❖ <https://www.masterorganicchemistry.com/>
- ❖ <https://www.organic-chemistry.org/>

**Note: Latest edition of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science (ZBC) Programme**  
**B.Sc (ZBC) I Year (I Semester)**

**BCHE-151: CHEMISTRY PRACTICAL**

**Objectives:** The objective of this course is to give knowledge to the students about the chemical experiments, properly carry out the experiments, and appropriately record and analyze the results. Students will be able to use standard laboratory equipment, modern instrumentation, and classical techniques to carry out experiments. Students will know and follow the proper procedures and regulations for safe handling and use of chemicals. Students will be able to successfully pursue their career objectives in advanced education in professional and/or graduate schools, in a scientific career in government or industry, in a teaching career in the school systems, or in a related career following graduation.

**INORGANIC CHEMISTRY PRACTICALS**

**(10 Sessions)**

1. Qualitative inorganic analysis: Analysis of mixture salt containing two anions and two cations (From two different groups) from the following:  
Anions: Carbonate, sulphate, chloride, bromide, acetate, nitrate, borate, phosphate.  
Cations: Lead, copper, iron, aluminum, zinc, manganese, calcium, strontium, barium, potassium and ammonium.
2. Semi micro Analysis – cation analysis, separation and identification of ions from Group I, II, III, IV, V and VI.
3. Find the strength in grams per litre of the given solution of sodium hydroxide with the help of standard oxalic acid solution.
4. Determine the total alkalinity in ppm in the given sample of water using standard sulphuric acid solution.
5. Determination of Fe (II) using  $\text{KMnO}_4$  with oxalic acid as primary standard.

**ORGANIC CHEMISTRY PRACTICALS**

**(10 Sessions)**

- 1) Determination of melting point:  
Naphthalene  $80 - 82^\circ$ , Benzoic acid  $121.5 - 122^\circ$       m - Dinitrobenzene  $90^\circ$   
Urea  $132.5 - 133^\circ$ , Succinic acid  $184.5 - 185^\circ$       P – Dichlorobenzene  $52^\circ$
- 2) Crystallization:
  - i- Phthalic acid from hot water (using fluted filter paper and steam less funnel)
  - ii- Naphthalene from ethanol
  - iii- Benzoic acid from water
- 3) Decolorisation and crystallization using charcoal:
  - i- Decolorisation of brown sugar (Sucrose) with animal charcoal using gravity filtration.
  - ii- Crystallization and decolorisation of impure naphthalene (100g of naphthalene mixed with 0.3 gm of Congo Red using 1 g decolorizing carbon) from ethanol.
- 4) Detection of extra element (n and halogens) and functional groups in the given organic compound
- 5) Qualitative analysis of phenols, carboxylic acids, carbonyl compounds (aliphatic and aromatic), carbohydrates, amines, Acetamide amides) organic compounds.

### **Course outcomes:**

Students completing this course will be able to:

- ❖ Demonstrate mastery of basic organic chemistry laboratory techniques, including Distillation, recrystallization, melting point determination, liquid-liquid extraction, gravity and liquid filtration, and chromatography.
- ❖ Students will demonstrate the ability to safely and effectively perform synthetic organic reactions, using proper glassware set-up, handling of hazardous chemicals, and following the prescribed experimental procedures.
- ❖ Students will demonstrate safe laboratory practices through the use of appropriate personal protective equipment and appropriate handling of all chemicals, including proper disposal of waste.
- ❖ Students will critically assess the progress and success of their experiments, and be able to adjust experimental procedures when necessary.

### **Suggested Readings:**

1. Practical Chemistry - Giri, Bajpai And Pandey, S. Chand & Co. Ltd., New Delhi.
2. Laboratory Manual In Organic Chemistry, R.K. Bansal, Willey Eastern.
3. Experimental Organic Chemistry, Vol. I And II, P.R. Singh, D.S. Gupta And K.S. Bajpai, Tata Mc- graw Hill.
4. Instrumental Methods of Chemical Analysis G.W. Ewing Mc Graw Hill.
5. Experiments In General Chemistry, N.R. Rado And U.C. Agarwal, Eastern Press.

### **Web Sources:**

- ❖ <https://www.acs.org/content/acs/en/education/students/highschool/chemistryclubs/activities/simulations.html>
- ❖ <http://www.chem.ox.ac.uk/vrchemistry/>

**Note: Latest edition of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science (ZBC) Programme**  
**B.Sc (ZBC) I Year (II Semester)**  
**BCHE-201-PHYSICAL CHEMISTRY**

**Objectives:** The main objectives of this course are to learn errors and data analysis methods. To understand the fundamental theory and laboratory techniques in physical chemistry. Also to calculate gaseous state numerical problem analysis. and to know about colloids and their practical application.

**Unit – I**

**(10 Sessions)**

**Mathematical Concepts and Computers:**

Mathematical Concepts: Logarithmic relations, curve sketching, linear graphs and calculation of slopes, differentiation of functions like  $Kx$ ,  $X^n$ ,  $\sin x$ ,  $\log x$  maxima and minima, differentiation and reciprocity relations. Integration of some useful/relevant functions

Computers: General introduction to computers, different components of a computer, hardware and software, input – output devices, binary numbers and arithmetic.

**Unit – II**

**(10 Sessions)**

**Gaseous State:**

Postulates of kinetic theory of gases, deviation from ideal behavior, Vander Waals equation, relationship between critical constants and Vander Waals constants, law of corresponding states, reduced equation of state.

Molecular velocities: Root mean square, average and most probable velocities, collision number, mean free path and collision diameter, Liquefaction of gases.

**Liquid State:**

Intermolecular forces, structure of liquids (a qualitative description).

Liquid crystals: classification & application of liquid crystals

Solid State: space lattice, unit cell. Laws of crystallography, X – Ray diffraction by crystals, Derivation of Bragg's equation.

**Unit – III**

**(08 Sessions)**

**Colloids: Definition and classification**

Sols: kinetic, optical and electrical properties, coagulation, stability of colloids, Hardy – Schulze law, gold number.

Emulsions: types of emulsions, preparation, Emulsifiers.

Gels: preparation and properties.

Applications of colloids.

**Unit – IV**

**(08 Sessions)**

**Chemical kinetics:**

Rate of a reaction, factors influencing the rate of a reaction.

Reactions: Zero order, first order, second order, half life and mean life. Determination of the order of reaction - integration method, Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Collision theory and transition state theory.

**Course outcomes:**

Students completing this course will be able to:

- ❖ Describe the ideal and real gases.
- ❖ By interpreting the real gases, the student will be able to solve the problems.
- ❖ Uses the Van Der Waals gas equation.
- ❖ Uses the real gas and Van Der Waals isotherms.
- ❖ Describes the critical state, adapts critical state equation to the problems.

**Suggested readings:**

1. Spectroscopy by William Kemp
2. Spectroscopy by Pavia
3. Organic Spectroscopy by J. R. Dyer
4. Modern Electrochemistry by J.O. M. Bockris and A.K.N.Reddy
5. Advanced Physical Chemistry by Atkins
6. Introduction to Electrochemistry by S. Glasstone
7. Elementary organic spectroscopy by Y.R. Sharma
8. Spectroscopy by P.S.Kalsi

**Web Sources:**

- ❖ <https://www.edx.org/learn/physical-chemistry>
- ❖ <https://www.learnchem.net/>

**Note: Latest edition of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science (ZBC) Programme**  
**B.Sc (ZBC) I Year (II Semester)**

**BCHE-202: BASICS OF ANALYTICAL CHEMISTRY**

**Objectives:** The main objectives of this course are to learn Intermediate theory and laboratory techniques in analytical and physical chemistry. To know about the advanced data analysis methods and goodness-of-fit criteria. Fourier transforms spectroscopic methods and instrumentation. Students will know the applications of Electrochemistry and Liquid chromatography.

**Unit -I**

**(10 Sessions)**

Data Analysis –

Concept of significant figures—its importance, accuracy, methods of expressing accuracy, error analysis, types of errors, minimizing errors, precision-mean, median, mean deviation, standard deviation and confidence limit.

Chemical and single pan balance , precautions in using balance, sources of error in weighing, correction for buoyancy, temperature effects, calibration of weights.

**Unit -II**

**(10 Sessions)**

Calibration of glassware and volumetric analysis

Calibration of pipette, volumetric flask , Burette. Measurements in analytical chemistry, S.I units-Fundamental units (Mass, amount of substances, distance, time, temperature, current) and Derived. Units(Area, Volume ,density, velocity, force, pressure, energy, heat, work, power, charge, potential, resistance, frequency) (S.I Units and Symbol only)

Preparation of standard solution, indicators, acid base titration, complex metric titration

**Unit -III**

**(08 Sessions)**

Chromatographic Techniques-

Types of chromatography, principle , column chromatography-principle, types of adsorbents, preparation of the column, elution, recovery of substances and applications.

TLC-principles, choice of adsorbent and solvent, preparation of chromatoplates. Rf values.

Factors affecting the Rf values .Significance of Rf values.

Paper Chromatography-principle, solvent used development of chromatogram, ascending, descending and radial paper chromatography.

**Unit -IV**

**(08 Sessions)**

Gravimetric Analysis –

Principle-theories of precipitation-solubility product and precipitation-factors affecting solubility. Conditions of precipitation, co- precipitation and post precipitation. Reduction of errors. Precipitation from homogeneous solution-washing and drying of precipitate.

Choice of the precipitant-Specific and Selective precipitants-Anthranilic acid , Cupferon, Dimethyl glyoxime, Ethylenediamine .

**Course Outcomes:**

Students completing this course will able to:

- ❖ Explain the theoretical principles and important applications of classical analytical methods within titration (acid/base titration, complexometric titration, redox titration).
- ❖ Various techniques within gravimetric and coulometric methods.
- ❖ Theoretical principles of selected instrumental methods within electro analytical and spectrometric/spectrophotometric methods
- ❖ Main components in such analytical instruments. Like various separation techniques in chromatography, and typical applications of chromatographic techniques.
- ❖ Assess and suggest a suitable analytical method for a specific purpose, and evaluate sensitivity, important sources of interferences and errors, and also suggest alternative analytical methods for quality assurance.

**Suggested readings:**

1. Analytical Chemistry by Skoog and Miller
2. A textbook of qualitative inorganic analysis by A.I. Vogel
3. Nanochemistry by Geoffrey Ozin and Andre Arsenault
4. Stereochemistry by D. Nasipuri
5. Organic Chemistry by Clayden.
5. J.H. Kenedy, Analytical Chemistry:

**Web Sources:**

- ❖ <https://edu.rsc.org/teacher-pd/in-person/analytical-chemistry/classroom-resources>.

**Note: Latest edition of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science (ZBC) Programme**  
**B.Sc (ZBC) I Year (II Semester)**  
**BCHE-251: CHEMISTRY PRACTICAL**

**Objectives:** Students will understand the scientific reasoning, quantitative analysis laboratory practice and safety. They will know the basic analytical and technical skills to work effectively in the various fields of chemistry. The ability to perform accurate quantitative measurements with an understanding of the theory and use of contemporary chemical instrumentation, interpret experimental results, perform calculations on these results and draw reasonable, accurate conclusions.

**PHYSICAL CHEMISTRY**

**(10 Sessions)**

1. Determination of relative surface tension of the given organic compound.
2. Determination of relative viscosity of the given organic compound.
3. Determination of order of reaction.
4. Determination of number of molecules of water of crystallization (n) in the given sample of Mohr's salt.
5. Determination of percentage purity of an impure sample of  $\text{kmno}_4$ .

**ANALYTICAL CHEMISTRY**

**(10 Sessions)**

1. Determination of  $r_f$  value by using paper chromatography.
2. Determination of common food adulteration in various food sample (desi ghee, mustard oil, turmeric powder, chili powder).
3. Determination of oxalate ion content in the guava fruit.
4. Determination of quantity of casein present in different samples of milk.
5. Determination of dosage of bleaching powder required for disinfection of different samples of water taken from different sources.

**Course Outcomes:**

Students completing this course will able to:

- ❖ To understand the principles defining analytical chemistry from the point of view of the "problem solving" approach.
- ❖ Furthermore, he will acquire knowledge about the chemical equilibria in solution ,carrying out simple qualitative tests and of defining the optimal conditions for a reaction to proceed.
- ❖ volumetric and gravimetric quantitative determinations; standard analysis procedures, understanding and development of a SOP
- ❖ Statistical treatment of the data and significance tests for the final evaluation of analytical data; potentiometry and its applications.

**Suggested Readings:**

1. D.A. Skoog, Principles of Instrumental Analysis: Sundars College Publicing.
2. Modern Methods of Chemical Analysis: R.L. Pecsok: John Willey New York
3. Experiments in Physical Chemistry - J.C. Ghose, Bharti Bhawan.

### **Web Sources**

- ❖ <https://www.labster.com/chemistry-virtual-labs/>
- ❖ <https://digitalllearning.ucf.edu/ilab/remote-labs/college-of-sciences-remote-lab-resources/>

**Note: Latest edition of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science (ZBC) Programme**  
**B.Sc (ZBC) II Year (III Semester)**  
**BCHE-301: INORGANIC CHEMISTRY**

**Objectives:** This course will equip students with the necessary knowledge to understand chemistry at the most fundamental level. Understand the Characteristic properties of d-block elements. To understand Coordination Compounds, Werner's coordination theory and its experimental verification. Learning of Lanthanides and Actinides their properties and applications

**Unit – I**

**(09 Sessions)**

Elements of First Transition Series

Characteristic properties of d-block elements. Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and study of their complexes with respect to relative stability of their oxidation states, coordination number and geometry.

**Unit – II**

**(09 Sessions)**

Coordination Compounds

Werner's coordination theory and its experimental verification, effective atomic number (E.A.N.) concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes.

**Unit – III**

**(09 Sessions)**

Lanthanides and Actinides

Electronic configuration, oxidation states, ionic radii and magnetic properties, lanthanide and actinide contraction, complex formation .

**Unit – IV**

**(09 Sessions)**

Oxidation and Reduction:

Oxidation Number, Oxidising agents, Reducing agents, Electrode potential, electrochemical series and its applications,

Acids and Bases:

Arrhenius , Bronsted-Lowry, Lewis , Lux-Flood concept , Usanovitch and solvent system concepts of acids and bases.

Non-aqueous Solvents:

Physical properties of a solvent, types of solvents and their general characteristics, Reactions in non-aqueous solvents with reference to liquid NH<sub>3</sub> and Liquid SO<sub>2</sub>.

**Course outcomes:**

Students completing this course will able to:

- ❖ Gain an understanding of Elements of First Transition Series elements.
- ❖ Coordination compounds and their applications.
- ❖ Predicting stereo chemistry and geometries of coordination compounds.
- ❖ Electrode potential, electrochemical series and its applications.

**Suggested readings:**

1. Inorganic Chemistry by J.E.Huheey
2. Basic Inorganic Chemistry by Cotton and Wilkinson
3. Organic Chemistry by Morrison and Boyd
4. Concise Inorganic Chemistry by J.D.Lee

**Website Sources:**

- ❖ <https://www.internetchemistry.com/>
- ❖ <http://www.chemguide.co.uk/>
- ❖ <https://freebookcentre.net/>

**Note: Latest edition of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science (ZBC) Programme**  
**B.Sc (ZBC) II Year ( III Semester )**  
**BCHE-302: ORGANIC CHEMISTRY**

**Objectives:** This course will give an introduction to modern spectroscopic techniques including time-resolved laser methods. Students will learn theory and application to, ultraviolet and visible spectroscopy, infrared spectroscopy, Raman, fluorescence, nuclear magnetic resonance spectroscopy, time-resolved spectra including lifetime measurements, etc. Comprehension and industrial applications of alcohols, phenols and ethers and synthesis of many carboxylic acids and their industrial production will be learned by students.

**Unit – I**

**(09 Sessions)**

Electromagnetic Spectrum: Absorption Spectra-

Brief idea about Ultraviolet (UV) absorption spectroscopy –Beer-Lambert's law ; molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome, Bathochromic, hypsochromic, hyperchromic and hypochromic shifts.

Infrared (I.R.) absorption spectroscopy – molecular vibrations, Hooke's law, selection rules, intensity and position of I.R. bands, fingerprint region, characteristic absorptions of various functional groups and interpretation of I.R. spectra of simple organic compounds.

**Unit – II**

**(09 Sessions)**

Phenols:

Nomenclature, structure and bonding, preparation of phenols, physical properties and acidic character, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols: electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Friedel Craft reaction, Fries rearrangement, Kolbe Schmitt reaction, oxidation and reduction of phenol, brief idea about dihydric phenols.

**Unit – III**

**(09 Sessions)**

Aldehydes and Ketones:

Nomenclature and structure of the carbonyl group , synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of ketones from nitrile and from carboxylic acids, Mechanism of nucleophilic additions to carbonyl group with particular emphasis on Benzoin, Aldol, Perkin and Knoevenagel Condensations.

**Unit – IV**

**(09 Sessions)**

Carboxylic Acids:

Nomenclature, structure and bonding, acidity of carboxylic acids, effects of substituent on acid strength, Preparation of carboxylic acids, Reactions of carboxylic acids , Synthesis of acid chlorides, esters and amides, Reduction of carboxylic acids , Hydroxy acids: lactic , Tartaric and Citric Acids.

Carboxylic Acid Derivatives: Preparation of carboxylic acid derivatives, chemical reactions. Mechanisms Of Esterification And Hydrolysis(Acidic And Basic).

**Course Outcomes:**

Students completing this course will be able to:

- ❖ understand how to use their understanding of organic mechanisms to predict the outcome of reactions
- ❖ How to design syntheses of organic molecules.
- ❖ How to determine the structure of organic molecules using IR and NMR spectroscopic techniques
- ❖ Students will demonstrate an advanced level of knowledge in organic spectroscopy.

**Suggested readings:**

1. Inorganic Chemistry by J.E.Huheey
2. Basic Inorganic Chemistry by Cotton and Wilkinson
3. Organic Chemistry by Morrison and Boyd
4. Concise Inorganic Chemistry by J.D.Lee

**Web Sources:**

- ❖ <https://www.masterorganicchemistry.com/>
- ❖ <https://www.organic-chemistry.org/>

**Note: Latest edition of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science (ZBC) Programme**  
**B.Sc (ZBC) II Year (III Semester )**

**BCHE-351: CHEMISTRY PRACTICAL**

**Objectives:** Students will be able to understand the objective of their chemical experiments, properly carry out the experiments, and appropriately record and analyze the results. Students will be able to use standard laboratory equipment, modern instrumentation, and classical techniques to carry out experiments. Students will know and follow the proper procedures and regulations for safe handling and use of chemicals. Students will be able to communicate the concepts and results of their laboratory experiments through effective writing and oral communication skills.

**A) Inorganic Chemistry:**

**(10 Sessions)**

- 1) Determination of alkali content – an acid tablet using HCl.
- 2) Estimation of hardness of water by EDTA.
- 3) Estimation of ferrous and ferric ions by dichromate method.
- 4) Estimation of copper using sodium thiosulphate solution.
- 5) Inorganic preparations:
  - a) Preparation of chrome alum.
  - b) Preparation of potash alum.
  - c) Preparation of chrome red.

**B) Organic Chemistry:**

**(10 Sessions)**

- 1) Determination of  $R_f$  values and identification of organic compounds using paper chromatography.
- 2) Separation of green leaf pigments (spinach leaves may be used).
- 3) Separation of a mixture of phenylalanine and glycine, Alanine and aspartic acid, Leucine and glutamic acid, using Spray reagent –ninhydrin.
- 4) Separation of monosaccharide – a mixture of D- galactose and D-fructose using n-butanol: acetone: water (4:5:1), spray reagent – aniline hydrogen phthalate.
- 5) Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.

**Course outcomes:**

Students completing this course will be able to:

- ❖ Demonstrate mastery of basic organic chemistry laboratory techniques, including identification of organic compounds using paper chromatography.
- ❖ Students will demonstrate the ability Separation of a mixture of amino acids by paper chromatography.
- ❖ Students will understand the estimation of hardness of water.
- ❖ Students will critically assess the progress and success of their experiments, and be able to adjust experimental procedures when necessary.

**Suggested Readings:**

1. Practical Chemistry - Giri, Bajpai and Pandey, S. Chand & Co. Ltd., New Delhi.
2. Laboratory Manual In Organic Chemistry, R.K. Bansal, Willey Eastern.
3. Experimental Organic Chemistry, Vol. I and II, P.R. Singh, D.S. Gupta And K.S. Bajpai, Tata Mc Graw Hill.
4. Method of Chemical Analysis G.W. Ewing Mc Graw Hill.
5. Experiments In General Chemistry, N.R. Rado And U.C. Agarwal, Eastern Press.

**Web Sources:**

- ❖ <https://www.acs.org/content/acs/en/education/students/highschool/chemistryclubs/activities/simulations.html>
- ❖ <http://www.chem.ox.ac.uk/vrchemistry/>

**Note: Latest edition of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science (ZBC) Programme**  
**B.Sc (ZBC) II Year( IV Semester)**  
**BCHE-401: PHYSICAL CHEMISTRY**

**Objectives:** To learn electrochemistry and Conductance in electrolyte. Fundamental theory of thermodynamics and variables used to calculate gaseous state numerical problem related to thermodynamics and electrochemistry. To know the Statement and meaning of the terms- phase equilibrium system of two component system-(Pb-Ag system).

**Unit – I**

**(10 Sessions)**

Thermodynamics – I

*First Law of Thermodynamics:*

Statement, definition of internal energy and enthalpy, Heat capacity, heat capacities at constant volume and pressure and their relationship, Joule's law – Joule-Thomson coefficient and inversion temperature. Calculation of  $w$ ,  $q$ ,  $dU$  &  $dH$  for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process. Kirchhoff's equation.

**Unit – II**

**(10 Sessions)**

Thermodynamics – II

*Second Law of Thermodynamics:*

Need for the law, different statements of the law, Carnot's cycle and its efficiency, Carnot's theorem. Thermodynamic scale of temperature.

*Concept of entropy:*

Entropy as a state function, entropy as a function of  $V$  &  $T$ , entropy as a function of  $P$  &  $T$ , entropy change in physical change, Clausius Clapeyron equation, entropy as a criteria of spontaneity and equilibrium.

*Gibbs and Helmholtz functions:*

Gibbs function ( $G$ ) and *Helmholtz* function ( $A$ ) as thermodynamic quantities,  $A$  &  $G$  as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of  $G$  and  $A$  with  $P$ ,  $V$  and  $T$ .

**Unit – III**

**(08 Sessions)**

(Electrochemistry)

Conductance in electrolyte solutions, variation of molar equivalent and specific conductance with dilution. Migration of ions and Kohlrausch's law, weak and strong electrolytes, Ostwald's dilution law, Transport number, and its determination by Hittorf's method. Applications of conductivity measurements. Nernst theory and equation, derivation of cell E.M.F. and single electrode potential, standard hydrogen electrode, standard electrode potential, sign conventions, Electrolytic and Galvanic cells.

## Unit – IV

(08 Sessions)

(Phase Equilibrium)

Statement and meaning of the terms-phase, component and degree of freedom, phase equilibrium system of one component system-(water, and Sulphur) phase equilibrium system of two component system-(Pb-Ag system), desilverisation of lead (Pattinson's Process)

### Course Outcomes:

Students completing this course will be able to:

- ❖ Know how to make solutions of various molar concentrations.
- ❖ Understand the calculation of internal energy and enthalpy, Heat capacity, heat capacities.

### Suggested Readings:

1. Text Book of Physical Chemistry by S Glasstone
2. Advanced Physical Chemistry by Gurudeep Raj
3. Modern Electrochemistry J.O.M. Bockris And A.K .M. Reddy: Plenum Press New York.
4. Physical Chemistry: Atkins, Oxford University Press, New York.
5. Physical Chemistry, I.N.Livine: Tata Mc Graw Hill Publication New Delhi.

### Web sources:

- ❖ <https://www.acs.org/content/acs/en/education/students/highschool/chemistryclubs/activities/simulations.html>
- ❖ <http://www.chem.ox.ac.uk/vrchemistry/>

**Note: Latest edition of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science (ZBC) Programme**  
**B.Sc (ZBC) II Year (IV Semester)**  
**BCHE-402: ENVIRONMENTAL CHEMISTRY**

**Objectives:** This course provides an overview of the concepts and applications used to predict and explain chemical concentrations found in different parts of indoor and outdoor environments. The course main objectives is to answer the connection between chemical uses and mishaps, and damage to human health or to ecologies. This course introduces concepts that form a basis for rationalizing or predicting environmental behavior of pollutant chemicals.

**Unit – I**

**(09 Sessions)**

Components of Environment (a brief introduction), air and water pollutants and their classification, air and water quality standards, soil chemistry: inorganic and organic chemistry of soil, macro and micro nutrients of soil.

**Unit – II**

**(09 Sessions)**

Methods of control of air and water pollution:

Adsorption of gaseous pollutants, electrostatic precipitation of air pollutants, cyclonic separation of air pollutants, aeration of water, waste water treatment, softening of water .

**Unit – III**

**(09 Sessions)**

Sampling and analysis of air and water pollutants:

Methods of sampling gaseous, liquid and solid pollutants, analysis of NO<sub>2</sub>, SO<sub>2</sub>, H<sub>2</sub>S And CO, analysis of toxic heavy metals(Cd, Cr, As, Pd, Cu, Hg)

Analysis of total cationic and anionic burdens of water.

Analytical techniques for pesticide residue analysis.

**Unit – IV**

**(09 Sessions)**

Environmental Toxicology:

Bio-degradability, Bio-Oxidation, Bio-reduction, Bio-hydrolysis, Biochemical effects of arsenic, cadmium, lead, mercury, designing a green synthesis, designing safer chemicals.

**Course Outcomes:**

Students completing this course will able to:

- ❖ Demonstrate knowledge of chemical and biochemical principles of fundamental environmental processes in air, water, and soil.
- ❖ Recognize different types of toxic substances & responses and analyze toxicological information.
- ❖ Apply basic chemical concepts to analyze chemical processes involved in different environmental problems
- ❖ Describe water purification and waste treatment processes and the practical chemistry involved.
- ❖ Describe causes and effects of environmental pollution by energy industry and discuss some mitigation strategies. 6. Explain energy crisis and different aspects of sustainability.

**Suggestive Readings:**

1. Fundamentals of ecology by M.C.Dash

2. A Text book of Environmental chemistry by W. Moore and F.A. Moore
3. Environmental Chemistry by Samir k. Banerji

**Web Sources:**

- ❖ <https://nptel.ac.in/courses/104/103/104103020/>
- ❖ <https://www.openlearning.com/courses/introduction-to-environmental-chemistry/>
- ❖ <https://environmentalchemistry.com/>

**Note: Latest edition of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science (ZBC) Programme**  
**B.Sc (ZBC) II Year( IV Semester)**  
**BCHE-451: CHEMISTRY PRACTICAL**

**Objectives:** To give ability to perform accurate quantitative measurements with an understanding of the theory and use of contemporary chemical instrumentation, interpret experimental results, perform calculations on these results and draw reasonable, accurate conclusions to the students. They will understand the scientific reasoning and quantitative analysis, laboratory practice and safety. Students will learn the basic analytical and technical skills to work al and technical skills to work effectively in the various fields of chemistry like physical and environmental chemistry.

**Physical Chemistry:**

**(10 Sessions)**

1. Determination of the transition temperature of the given substance by thermometric method (e.g.  $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$  /  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  /  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ )
2. Determination of the solubility of benzoic acid at different temperatures and to determine  $\Delta H$  of the dissolution process.
3. Determination of the enthalpy of neutralization of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionization of the weak acid/weak base.
4. Acid-base titration by pH meter.
5. Determination of the equivalent conductance of given electrolyte solution at room temperature using conductivity meter.

**Environmental Chemistry:**

**(10 Sessions)**

1. Determination of the percentage of available chlorine in the given sample of bleaching powder.
2. Determination of total dissolved solids in water / effluent sample.
3. Determination of Biological Oxygen Demand (BOD) of the given water sample.
4. Determination of Chemical Oxygen Demand (COD) of the given water sample using  $\text{K}_2\text{Cr}_2\text{O}_7$  solution.
5. Determination of the conductivity of the soil sample.

**Course outcomes:**

Students completing this course will able to:

- ❖ Understand the principles defining physical chemistry and environmental chemistry from the point of view of the "problem solving" approach.
- ❖ Furthermore, he will acquired knowledge about total dissolved solids in water, Chemical Oxygen Demand (COD) of the given water sample carrying out simple qualitative tests and of defining the optimal conditions for a reaction to proceed.

**Suggestive Readings:**

1. Experimental physical chemistry by Frederick A. Bettelheim
2. Experimental physical chemistry by G. Peter Matthews
3. Experimental physical chemistry by Farrington Daniels
4. Experimental physical chemistry by Halpern and McBane
5. Experiments in Physical Chemistry by Shoemaker, Garland and Nible

### **Web Sources**

- ❖ <https://www.labster.com/chemistry-virtual-labs/>
- ❖ <https://digitallearning.ucf.edu/ilab/remote-labs/college-of-sciences-remote-lab-resources/>

**Note: Latest edition of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science (ZBC) Programme**  
**B.Sc (ZBC) III Year (V Semester)**  
**BCHE-501 -INORGANIC CHEMISTRY**

**Objectives:** This course deals with the production, chemistry and properties of the transition metals, lanthanides and actinides. Specifically, the class introduces electron configurations for the elements and oxidation state trends for each group. Including bonding and isomerism in coordination compounds, crystal field theory, and electronic properties of ligands. Also Cover metal bonding in clusters, the HSAB concept, chelate effect, and complex stability.

**Unit – I**

**(09 Sessions)**

Transition Metal Complexes:

Limitations of valence bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, factors affecting the crystal-field parameters.

stability of metal complexes and factors affecting the stability, stability constants of complexes and their determination.

**Unit – II**

**(09 Sessions)**

Magnetic Properties of Transition Metal Complexes:

Types of magnetic behavior, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes.

**Unit – III**

**(09 Sessions)**

Metal carbonyls, Silicones and Phosphazenes

Metal carbonyls: 18 electron rule, preparation, structure and nature of bonding in the mononuclear carbonyls. Silicones and phosphazenes as examples of inorganic polymers.

**Unit – IV**

**(09 Sessions)**

Hard and Soft Acids and Bases (HSAB)

Classification of acids and bases as hard and soft, Pearson's HSAB concept, acid-base strength and hardness and softness, Symbiosis, theoretical basis of hardness and softness, electro negativity and hardness and softness.

**Course Outcomes:**

Students completing this course will be able to:

- ❖ To know the relative stability about coordination complexes.
- ❖ A brief knowledge about hardness and softness of Lewis acids and bases
- ❖ Nature of bonding in carbonyl, silicones and phosphazenes.
- ❖ Useful applications about magnetic properties of transition metal complexes.

**Suggested Readings:**

1. Inorganic Chemistry by J.E. Huheey
2. Basic Inorganic Chemistry by Cotton and Wilkinson
3. Concise Inorganic Chemistry by J.D. Lee

4. The Organometallic Chemistry Of Transition Metals: John Willey

**Web Sources:**

1. [www.chem.tamu.edu](http://www.chem.tamu.edu)
2. [www.academia.edu](http://www.academia.edu)
3. [www.amu.ac.in](http://www.amu.ac.in)
4. [www.chem.tamu](http://www.chem.tamu)

**Note: Latest edition of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science (ZBC) Programme**  
**B.Sc (ZBC) III Year ( V Semester )**  
**BCHE-502: ORGANIC CHEMISTRY**

**Objective:** To Predict and explain patterns in shape, structure of organic compounds. To give idea about Synthesis and reactivity for carbohydrates . To provide explanation of the chemistry of amino acids and proteins To understand the concepts of organic chemical structure and bonding and stability found in fats and oils.

**Unit – I**

**(09 Sessions)**

**Spectroscopy**

Nuclear magnetic resonance (NMR) spectroscopy, Proton magnetic resonance (<sup>1</sup>H- NMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of <sup>1</sup>H NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1, 1, 2-tribromoethane, ethyl acetate, toluene and acetophenone, Problems pertaining to the structures elucidation of simple organic compounds using UV, IR and <sup>1</sup>H NMR spectroscopic, techniques.

**Unit – II**

**(09 Sessions)**

**Carbohydrates**

Classification and nomenclature, Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Conversion of glucose into mannose, Formation of glycosides, Determination of ring size of monosaccharides, Structures of ribose and deoxyribose, An introduction to disaccharides (maltose, sucrose and lactose)

**Unit – III**

**(09 Sessions)**

**Amino Acids, Peptides and Proteins:**

Classification, structure and stereochemistry of amino acids, Acid-base behavior isoelectric point and electrophoresis, Preparation and reactions of α-amino acids, classification and structure of proteins, selective hydrolysis of peptides, Protein denaturation/renaturation.

**Unit – IV**

**(09 Sessions)**

**Fats, Oils and Detergents**

Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, hydrogenation of unsaturated oils, Saponification value, iodine value, acid value, Soaps, synthetic detergents.

**Course Outcomes:**

Students completing this course will able to:

- ❖ Confirm the structure of carbohydrates.
- ❖ Student can understand the synthesis and properties of amino acids and proteins
- ❖ To predict the synthesis and properties of detergents and soaps.
- ❖ Explore the knowledge about effects of fats and oils

**Suggested Readings:**

- ❖ Biochemistry : L. Steyer, Freeman And Co.; New York
- ❖ Organic Synthesis: M.B. Smith: Mc Graw Hill, New York
- ❖ Advanced Organic Chemistry Reaction, Mechanism And Structure, M.B. Smith And J. March: John Willey And Sons, New York.

**Web Sources:**

1. [www.structbio.ptt.edu>notes>nmr\\_ref\\_notes-2011](http://www.structbio.ptt.edu>notes>nmr_ref_notes-2011)
2. [www.academia.edu>CHE\\_320\\_organic\\_spectroscopy](http://www.academia.edu>CHE_320_organic_spectroscopy)
3. [www.chtf.stuba.sk>files>Carbohydrates\\_Boudreaux](http://www.chtf.stuba.sk>files>Carbohydrates_Boudreaux)
4. <https://nptel.ac.in/content/storage2/courses/104103071/pdf/mod11.pdf>

**Note: Latest edition of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science (ZBC) Programme**  
**B.Sc (ZBC) III Year (V Semester)**  
**BCHE-551- CHEMISTRY PRACTICAL**

**Objectives:**

- ❖ Chemistry lab includes basic laboratory operation, separation and purification of organic compounds.
- ❖ To identify simple precipitation and crystallization, sublimation, solid-liquid and liquid-liquid extraction.
- ❖ To learn laboratory exercises in simple distillation, fractional distillation, melting point determination, re crystallization, and rudimentary organic synthesis and analysis.

**(10 Sessions)**

**Inorganic Chemistry**

1. Estimation of Copper by gravimetric method.
2. Estimation of Nickel by gravimetric method.
3. Estimation of Copper and Zinc in a mixed solution of both by gravimetric method.
4. Preparation of Ni-DMG complex,  $[\text{Ni}(\text{DMG})_2]$
5. Preparation of copper tetra ammine complex.  $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4$ .

**(10 Sessions)**

**Organic Chemistry:**

1. Determination of saponification value of an oil or fat.
2. Determination of Iodine value of an oil or fat.
3. Isolation of lactose from milk and its quantitative analysis.
4. Estimation of amino acid using ninhydrin by spectrophotometric method.
5. Preparation of methyl orange / methyl red / iodoform / m-dinitrobenzene / fluorescein/ Malachite green/ drug.

**Course outcomes:**

Students completing this course will able to:

- ❖ Understands the gravimetric analysis.
- ❖ Understand the synthetic process of organic compounds.
- ❖ Learn the synthesis of drugs and dyes.

**Suggested readings:**

1. A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
2. A.I. Vogel: Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
3. A.I. Vogel: Textbook of Practical Organic Chemistry, Prentice Hall, 5th Edn.
4. F. G. Mann & B. C. Saunders: Practical Organic Chemistry, Orient Longman (1960).M university

**Web Sources**

- ❖ <http://www.freebookcentre.net/Chemistry/InOrganic-Chemistry-Books.html>
- ❖ <http://www.freebookcentre.net/Chemistry/InOrganic-Chemistry-Books.html>
- ❖ <http://onlinelabs.in/chemistry>

**Note: Latest edition of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science (ZBC) Programme**  
**B.Sc (ZBC) III Year (VI Semester)**  
**BCHE-601: PHYSICAL CHEMISTRY**

**Objectives:** To develop basic and advance concepts regarding the Physical Properties and Molecular Structure. To derive the expressions for Schrödinger wave equation and its importance. To study the concept, Interaction of radiation with matter and Laws of photochemistry.

**Unit – I**

**(09 Sessions)**

**Physical Properties and Molecular Structure:**

Optical activity, polarization – ( Clausius – Mossotti equation), orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment-temperature method and refractivity method, dipole moment and structure of molecules, magnetic properties paramagnetism, diamagnetism and ferromagnetism.

**Unit – II**

**(09 Sessions)**

**Quantum Mechanics:**

Schrödinger wave equation and its importance, postulates of quantum mechanics, particle in a one dimensional box., calculation of energy levels from wave functions, Hybrid orbitals – sp, sp<sup>3</sup>, sp<sup>2</sup>, calculation of coefficients of A.O's used in sp and sp<sup>2</sup> hybrid orbitals and interpretation of geometry.

**Unit – III**

**(09 Sessions )**

**Spectroscopy:**

Introduction: electromagnetic radiation, regions of the spectrum.

Rotational *Spectrum-*

Diatomic Molecules:

energy levels of a rigid rotor (semi-classical principles), selection rules, determination of bond length, qualitative description of non-rigid rotor, isotope effect.

Infrared Spectrum: Energy levels of simple harmonic oscillator, selection rules, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, , idea of vibrational frequencies of different functional groups.

**Unit – IV**

**(09 Sessions)**

**Photochemistry:**

Interaction of radiation with matter, Laws of photochemistry: Grothus – Drapper law, Stark – Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non- radiative processes (internal conversion, intersystem crossing), quantum yield.

**Course outcomes:**

Students completing this course will able to:

- ❖ Derive mathematical expressions for different energy levels from wave functions.

- ❖ Explain the electromagnetic radiation, regions of the spectrum.
- ❖ Explain the concept of Jablonski diagram depicting various processes occurring in the excited.
- ❖ Apply the concepts of dipole moment and structure of molecules.

**Suggested Readings:**

1. Text Book Of Physical Chemistry By S Glasstone
2. Advanced Physical Chemistry By Gurudeep Raj
3. Modern Electrochemistry J.O.M. Bockris And A.K .M. Reddy: Plenum Press New York.
4. Physical Chemistry: Atkins, Oxford University Press, New York.
5. Physical Chemistry, I.N.Livine: Tata Mc Graw Hill Publication New Delhi.

**Web Sources:**

- ❖ <http://www.freebookcentre.net/Chemistry/Chemistry-Books-Online.html>
- ❖ <https://guides.lib.umich.edu/c.php?g=282900&p=1885122>

**Note: Latest edition of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science (ZBC) Programme**  
**B.Sc (ZBC) III Year ( VI Semester)**  
**BCHE-602: -POLYMER CHEMISTRY**

**Objectives:** To Know about polymeric materials and their classification and to learn about different mechanisms of polymerization along with polymerization techniques To determine chain length of polymers based on their kinetic mechanism To learn about different methods of finding out average molecular weight of polymers and transition temperature ( $T_g$ ) and crystalline melting point ( $T_m$ ) Determination of  $T_g$  and  $T_m$

**Unit – I**

**(09 Sessions)**

Introduction and nomenclature:

Characteristic, Classification, Nomenclature of Polymer, Functionality, Physical Properties of Polymer, Mechanism of Polymerization (Addition Polymerization)

**Unit-II**

**(09 Sessions)**

Molecular Weight Determination:

Molecular weight, Determination of molecular weight of polymers by osmotic pressure and viscosity method and its practical significance, Viscometry, Chemical and geometrical structure of Polymers

**Unit-III**

**(09 Sessions)**

Characterization:

Glass-transition temperature ( $T_g$ ) of Polymer, Factors that affect the value of  $T_g$ ,  $T_g$  and molecular weight ,melting point ,Importance of  $T_g$ , Brief idea of crystallinity.

**Unit-IV**

**(09 Sessions)**

Processing of Polymers:

Processing of Polymers (Calendering, Die casting, Film casting, Moulding), High Performance Polymers (PPS, PES, PEEK, Polyamides), Classification and application of composites.

**Course Outcomes:**

Students completing this course will able to:

- ❖ Understand the importance of macromolecules/polymers in day to day life and apply their knowledge in sustainable development of mankind.
- ❖ Apply the learned fundamental instrumental techniques in the polymer characterization.
- ❖ Explain (1) step-growth and chain-growth polymerization, with respect to synthesis mechanisms and kinetics, (2) crystalline melting temperature and glass transition temperature, including the influence of kinetics, and (3) the flow properties of polymer melts and polymer solutions, with respect to both temperature and molecular weight.
- ❖ Demonstrate an ability to quickly acquire knowledge in new polymer related applications and to acquire new knowledge for the innovation and development of polymer materials and related processes.

**Suggested Readings:**

1. Text Book Of Polymer Science, F.W. Billmeyer, Willey Science New York.

- 2 .Principles Of Polymerization, J. Odien, John Willey, Singapore
- 3.Principles Of Polymer Science, P. Bahadur And N. V. Shashtri , Narosa Publishing House New Delhi.
4. Polymer Sciences, V.R. Gowarikar And J. Sridhar, Willey Eastern New Delhi.

**Web Sources**

- ❖ <https://guides.lib.umich.edu/c.php?g=282900&p=1885122>
- ❖ <http://www.freebookcentre.net/Chemistry/Chemistry-Books-Online.html>

**Note: Latest edition of all the suggested readings must be used.**

**IFTM University, Moradabad**  
**Bachelor of Science (ZBC) Programme**  
**B.Sc (ZBC) III Year (VI Semester)**  
**BCHE-651-CHEMISTRY PRACTICAL**

**Objectives:** To impart the knowledge of Scientific reasoning and quantitative analysis Laboratory practice and safety. The basic analytical and technical skills to work effectively in the various fields of physical and polymer chemistry. The ability to perform accurate quantitative measurements with an understanding of the theory and use of contemporary chemical instrumentation, interpret experimental results, perform calculations on these results and draw reasonable, accurate conclusions.

**Physical Chemistry:**

**(10 Sessions)**

- 1) Determination of rate constant of acid catalyzed hydrolysis of an ester.
- 2) Determination of order of hydrolysis of an ester by sodium hydroxide.
- 3) Studies on the kinetics of iodination of acetone.
- 4) Determine the partition coefficient of iodine between water and carbon tetrachloride.
- 5) Verify Beer – Lambert Law for  $\text{KMnO}_4$  /  $\text{K}_2\text{Cr}_2\text{O}_7$  and determining the concentration of the given solution of the substance from absorption measurement.

**Polymer Chemistry:**

**(10 Sessions )**

1. Preparation of a Thiokol Rubber.
2. Preparation of a Rubber Ball from Rubber Latex.
3. Preparation of casein glue from milk and testing of its activity.
4. Determine the viscosity of polymer solution of different concentrations.
5. Determine the number average/molecular weight average / viscosity average molecular weight of a polymer.

**Course outcomes:**

Students completing this course will able to:

- ❖ Understand the principles defining physical chemistry from the point of view of the "problem solving" approach.
- ❖ Furthermore, he will acquired knowledge about rate constant, Heat of reactions , partition coefficient and spectroscopic analysis of the given sample and carrying out simple qualitative tests and can defining the optimal conditions for a reaction to proceed.

**Suggested Readings:**

1. Experimental physical chemistry by Frederick A. Bettelheim
2. Experimental physical chemistry by G. Peter Matthews
3. Experimental physical chemistry by Farrington Daniels
4. Experimental physical chemistry by Halpern and McBane
5. Experiments in Physical Chemistry by Shoemaker, Garland and Nible

**Web Sources**

- ❖ <https://www.labster.com/chemistry-virtual-labs/>
- ❖ <https://digitallearning.ucf.edu/ilab/remote-labs/college-of-sciences-remote-lab-resources/>

**Note: Latest edition of all the suggested readings must be used.**