SRI SATHYA SAI INSTITUTE OF HIGHER LEARNING

(Deemed to be University)

SYLLABUS FOR

B.Sc. (Hons.) in BIOSCIENCES

(Effective from 2015-2016)

DEPARTMENT OF BIOSCIENCES

Unit-wise Syllabus for Three Year B.Sc. (Hons.) in Biosciences Programme

Introduction:

The Department of Biosciences offers a three-year program B. Sc. (Honors) in Biosciences as part of the Five-Year study leading to M. Sc. (Biosciences) program. The undergraduate curriculum has a total of thirty-four courses that impart both theoretical and practical knowledge in Biological Sciences spreading across a wide range of areas. The main goal of the program is acquainting the student with diversity of life, the various life processes which are fundamental to the functioning of living beings along with aspects that deal with interactions of a variety of organisms and the environments they inhabit.
In addition to the above, theory and practical courses in Chemistry (four each); General English (five) and Additional Language (four) are also taught during the first two years (four semesters) of the program

As part of an effort in promoting 'Holistic Personality Development', two short courses on Environment in the first year; and similar short courses, one in each of the six semesters on Comparative Religion and Spirituality are included in the curriculum.

Program Outcomes:

On successful completion of the program, the student would be
1. fully conversant with fundamental concepts taught in various courses.
2. able to apply concepts learnt for problem solving in respective disciplines like Mathematics, Physics, Chemistry, Biosciences and Economics.
3. able to perform experiments, record experimental data, analyse results and arrive at meaningful conclusions.
4. tuned to observing various scientific phenomena and appreciate their relevance in day-to-day life and offer innovative solutions to problems with an interdisciplinary approach.
5. able to effectively communicate the scientific knowledge gained - orally and in written form.
6. capable of working efficiently both as an individual or as a member of the team.
7. able to develop in to a multifaceted personality and conduct as a responsible, ethical and socially conscious citizen.
8. able to compete and secure admission to post-graduate or professional programs offered by reputed institutions anywhere in the country or abroad.

Program Specific Outcomes:

1. Courses on Plant Diversity and Animal Diversity along with Bacteriology and Virology, Developmental Biology provide an overview of the diversity of living organisms starting from simple unicellular forms to highly evolved multicellular forms. Students become aware of the underlying principle of unity of structure and function across living organisms even as evolution lead to immense diversity.

2. Courses on Cell Biology, Physiology, Biochemistry, Molecular Biology and Immunology bestow the student with a comprehensive understanding and appreciation of the vast variety and complexity of life processes at the level of molecules, cells, tissues, organs systems, including aspects of function and coordination.

3. The course on Biostatistics equips the student to evaluate various Biological data points quantitatively.

4. Courses on Ecology and Environmental Biology, Genetics and Evolution teach the student the intrinsic and inseparable connection between Man and the Environment.

5. The course on Biotechnology imparts knowledge about the applications that could be put to use in Industry, Public Health and Medicine.

6. Practical courses accompanying each of the theory courses impart hands on training to the student in handling biological specimens, qualitative and quantitative analyses etc.

7. The program covers almost all spheres of Biology. As such, a student completing this program can successfully enroll in to any higher degree (PG) course in the field of Biological Sciences / Life Sciences.

8. The knowledge acquired in this program prepares the student to face any National and International competitive examinations successfully or get gainful employment in the Industry.

Undergraduate Honours Programme structure consists of three parts:

PART-I: LANGUAGES**#**

(a) General English (four papers offered, one each in the first four semesters)

(b) Another Language (four papers offered, one each in the first four semesters – Any

one out of: HINDI / SANSKRIT / TELUGU / KANNADA / ADDITIONAL ENGLISH)

PART-II: CORE SUBJECTS

(Offered in all the six semesters) – Titles of the papers are given below in the Scheme of Instruction & Evaluation and the syllabus contents are enclosed.

Part-II consists of two-subject-combination during the first four semesters, which, each student has to study. Two Subject combinations that are offered in the Honours Programme are Biosciences/Chemistry). During the fifth and sixth semesters the students will choose one of the two subjects in the two-subject-combination as subject of exclusive study for Honours. (i.e., either BIOSCIENCES or CHEMISTRY).

PART-III: AWARENESS COURSE and ENVIRONMENTAL COURSE**##**

a) Awareness Courses – (UAWR) (six papers offered, one each, in all the six semesters)

b) Environmental Courses – (UENT) (two papers offered, one each, in the first two semesters)

NOTE: Title of the papers and the syllabus contents of Part-I and Part-III are provided separately.

SCHEME OF INSTRUCTION AND EVALUATION

(Effective from 2015-16 batch onwards)

PART-I: LANGUAGES

Paper Code	Title of the Paper	Credits	Hours	Mode of Evaluation	Theory / Practicals	Maximum Marks
Semester – I						
UGEN-101	General English-I #	**5**	5	IE	T	100
	Another Language-I #	**4**	4	IE	T	100
Semester – II						
UGEN-201	General English-II #	**5**	5	IE	T	100
	Another Language-II #	**4**	4	IE	T	100
Semester – III						
UGEN-301	General English-III #	**5**	5	IE	T	100
	Another Language-III #	**4**	4	IE	T	100
Semester – IV						
UGEN-401	General English-IV #	**5**	5	IE	T	100
	Another Language-IV #	**4**	4	IE	T	100
	PART-I TOTAL	**36** Credits	**36** Hours			**800** Marks

PART-II: CORE SUBJECT (Honours in Biosciences)

Paper Code	Title of the Paper	Credits	Hours	Mode of Evaluation	Theory / Practicals	Maximum Marks
Semester – I						
UBIO-101	Plant Diversity-I (Algae, Fungi and Bryophytes)	**3**	3	IE	T	100
UBIO-102	Animal Diversity-I (Invertebrata)	**3**	3	IE	T	100
UBIO-103	Practical Course on Plant Diversity-I	**1**	3	I	P	50
UBIO-104	Practical Course on Animal Diversity-I	**1**	3	I	P	50
	Total	**8** Credits	**12** Hours			**300** Marks
Semester – II						
UBIO-201	Plant Diversity–II (Pteridophytes, Gymnosperms and Morphology of Angiosperms)	**3**	3	IE	T	100
UBIO-202	Animal Diversity–II(Chordata)	**3**	3	IE	T	100
UBIO-203	Practical Course on Plant Diversity-II	**1**	3	I	P	50
UBIO-204	Practical Course on Animal Diversity-II	**1**	3	I	P	50
	Total	**8** Credits	**12** Hours			**300** Marks
Semester – III						
UBIO-301	Plant Diversity-III (Taxonomy, Anatomy and Embryology of Angiosperms)	**4**	4	IE	T	100
UBIO-302	Developmental Biology (Embryology of Animals)	**4**	4	IE	T	100
UBIO-303	Practical Course on Plant Diversity-III	**1**	3	I	P	50
UBIO-304	Practical Course on Developmental Biology	**1**	3	I	P	50
	Total	**10** Credits	**14** Hours			**300** Marks
Semester – IV						
UBIO-401	Biostatistics	**4**	4	IE	T	100
UBIO-402	Bacteriology and Virology	**4**	4	IE	T	100
UBIO-403	Practical Course on Biostatistics	**1**	3	I	P	50
UBIO-404	Practical Course on Bacteriology and Virology	**1**	3	I	P	50
	Total	**10** Credits	**14** Hours			**300** Marks

Paper Code	Title of the Paper	Credits	Hours	Mode of Evaluation	Theory / Practicals	Maximum Marks
Semester – V						
UBIO-501	Plant Physiology	**4**	4	IE	T	100
UBIO-502	Animal Physiology	**4**	4	IE	T	100
UBIO-503	Cell Biology	**4**	4	IE	T	100
UBIO-504	Ecology and Environmental Biology	**3**	3	IE	T	100
UBIO-505	Instrumentation	**3**	3	IE	T	100
UBIO-506	Practical Course on Plant Physiology	**1**	3	I	P	50
UBIO-507	Practical Course on Animal Physiology	**1**	3	I	P	50
UBIO-508	Practical Course on Cell Biology	**1**	3	I	P	50
UBIO-509	Practical Course on 504 and 505	**1**	3	I	P	50
	Total	**22** Credits	**30** Hours			**700** Marks
Semester – VI						
UBIO-601	Genetics and Evolution	**4**	4	IE	T	100
UBIO-602	Biotechnology	**4**	4	IE	T	100
UBIO-603	Introductory Molecular Biology	**4**	4	IE	T	100
UBIO-604	Biological Chemistry	**3**	3	IE	T	100
UBIO-605	Introductory Immunology	**3**	3	IE	T	100
UBIO-606	Practical Course on Biotechnology	**1**	3	I	P	50
UBIO-607	Practical Course on Introductory Molecular Biology	**1**	3	I	P	50
UBIO-608	Practical Course on Biological Chemistry	**1**	3	I	P	50
UBIO-609	Practical Course on Genetics and Introductory Immunology	**1**	3	I	P	50
	Total	**22** Credits	**30** Hours			**700** Marks
PART-II BIOSCIENCES GRAND TOTAL		**80** Credits	**112** Hours			**2600** Marks

PART-II: CORE SUBJECT (Chemistry)

Paper Code	Title of the Paper	Credits	Hours	Mode of Evaluation	Theory / Practicals	Maximum Marks
Semester –I						
UCHM-101	Theoretical Chemistry and Analytical Chemistry	**3**	3	IE	T	100
UCHM-102	Laboratory course in Qualitative Inorganic Analysis	**1**	3	I	P	50
	Total	**4**Credits	**6**Hours			**150**Marks
Semester –II						
UCHM-201	Inorganic, Organic and Physical Chemistry-I	**3**	3	IE	T	100
UCHM-202	Laboratory Course in Inorganic, Organic and Physical Chemistry-I	**1**	3	I	P	50
	Total	**4**Credits	**6**Hours			**150**Marks
Semester –III						
UCHM-301	Inorganic, Organic and Physical Chemistry-II	**4**	4	IE	T	100
UCHM-302	Laboratory course in Inorganic, Organic and Physical Chemistry-II	**1**	3	I	P	50
	Total	**5**Credits	**7**Hours			**150**Marks

Paper Code	Title of the Paper	Credits	Hours	Mode of Evaluation	Theory / Practicals	Maximum Marks
Semester –IV						
UCHM-401	Inorganic, Organic and Physical Chemistry–III	**4**	4	IE	T	100
UCHM-402	Laboratory course in Inorganic, Organic and Physical Chemistry-III	**1**	3	I	P	50
	Total	**5**Credits	**7**Hours			**150**Marks
PART-II CHEMISTRY GRAND TOTAL		**18**Credits	**26**Hours			**600**Marks

IE: Continuous Internal Evaluation (CIE) &End Semester Examination (ESE)
I:only CIE
E: only ESE
*** IDE:** Interdepartmental elective

PART-III: AWARENESS AND ENVIRONMENTAL COURSES

Paper Code	Title of the Paper	Credits	Hours	Mode of Evaluation	Theory / Practicals	Maximum Marks
Semester – I						
UAWR-100	Awareness Course-1 ##	**2**	2	I	T	50
UENT-101	Environment-I ##	**2**	2	I	T	75
Semester –II						
UAWR-200	Awareness Course-2 ##	**2**	2	I	T	50
UENT-201	Environment-II ##	**2**	2	I	T	75
Semester –III						
UAWR-300	Awareness Course-3 ##	**2**	2	I	T	50
Semester–IV						
UAWR-400	Awareness Course-4 ##	**2**	2	I	T	50
Semester –V						
UAWR-500	Awareness Course-5 ##	**2**	2	I	T	50
Semester –VI						
UAWR-600	Awareness Course-6 ##	**2**	2	I	T	50
PART-III TOTAL		**16** Credits	**16** Hours			**450** Marks

SUMMARY SHEET

	Credits	Hours	Maximum Marks
PART-I: LANGUAGES			
PART-I TOTAL	**36**	**36**	**800**
PART-II: CORE SUBJECTS			
PART-II TOTAL (Honours in Biosciences)	**80**	**112**	**2600**
PART-II TOTAL (Chemistry)	**18**	**26**	**600**
PART-III: AWARENESS AND ENVIRONMENTAL COURSES			
PART-III TOTAL (Awareness and Environment)	**16**	**16**	**450**
GRAND TOTAL [B.Sc. (Hons.) in Biosciences]	**150**	**190**	**4450**

PART-II: CORE SUBJECT (Honours in Biosciences)

UBIO-101 **(3 CREDITS)**

PLANT DIVERSITY - I

(Algae, Fungi and Bryophytes)

Course Objectives:

- Impart knowledge about the general characters and classification of thallophytes
- Compare their morphological, anatomical, reproductive and life cycle details
- Discuss the evolutionary trends shown by these simple groups of organisms

I. Algae:

1. Introduction to Algae – Classification by Fritsch and Modern views. **3hrs**
2. Habitat, Cellular and Thallus diversity of Algae with specific reference to Cyanophyta, Chlorophyta, Xanthophyta, Bacillariophyceae, Phaeophyta, Rhodophyta. **4hrs**
3. Types of Alternation of Generation and Reproduction in the following representative forms:
   Volvox **1hr**, *Cladophora* **1hr**, *Vaucheria* **2hr**, *Fucus* **2hrs**, *Polysiphonia.* **2hrs**
4. Economic and Scientific importance of Algae. **2hrs**

II. Fungi:

5. Introduction to Fungi - Classification by Alexopoulos and Ainsworth. **2hrs**
6. Thallus organisation, diversity and reproduction in the following representative forms:
   Phytophthora **3hrs**, *Penicillium* **2hrs**, *Puccinia* **3hrs**, *Agaricus* **3hrs**, *Cercospora.* **1hr**
7. Economic and Scientific importance of Fungi. **2hrs**

III. Bryophytes:

8. Introduction to Bryophytes – Modern classification. **2hrs**
9. Structural organisation of Gametophyte and Sporophyte in the following representative forms:
   Marchantia **3hrs**, *Anthoceros* **3hrs**, *Funaria.* **3hrs**
10. Origin of Bryophytes - Algal and Pteridophytean hypotheses. **1hr**
11. Evolution of Sporophyte in Bryophytes. **1hrs**
12. Economic and Scientific importance of Bryophytes. **2hrs**

Basic texts:

1. **B.R. Vashishta,** (2013) Botany for degree students, Part I: Algae. S. Chand and Co. Ltd., New Delhi.
2. **B.R. Vashishta,** (2014) Botany for degree students, Part II: Fungi. S. Chand and Co. Ltd., New Delhi.
3. **B.R. Vashishta,** (2014)Botany for degree students, Vol. III: Bryophyta. S. Chand and Co. Ltd., New Delhi.

Reference books:

1. **G.M. Smith,** (1984) Cryptogamic Botany, Vol I: Algae and Fungi, McGraw Hill Book Co.
2. **G.M. Smith,** (1984) Cryptogamic Botany, Vol II: Bryophytes and Pteridophytes, TMH Edition.

Course outcomes: The student gains knowledge about

- Geographical location, habitat and habit of key forms
- Cellular and anatomical organization of vegetative and reproductive parts
- Details of early and late developmental stages and life history
- Evolution of gametophyte and sporophyte
- Economic importance

UBIO-102 **(3 CREDITS)**

ANIMAL DIVERSITY - I

(Invertebrata)

Course objectives:

- To understand the basis of invertebrate classification
- Distribution, specific features, adaptations needed for existence of invertebrates

1. Protozoa: Distinguishing characters and classification up to classes. **2hrs** Parasitic protozoans; shelled protozoans. **3hr**
2. Porifera: Distinguishing characters and classification upto classes. **2hrs** Histology, skeleton and canal system in sponges. Regeneration. **3hrs**
3. Coelenterata: Distinguishing characters and classification upto classes. **2hrs**Polymorphism, corals and coral reefs. **3hrs**
4. Helminthes: Distinguishing characters and classification upto classes. **2hrs**Parasitic adaptations. Pathogenic Helminthes of man. **3hrs**
5. Annelida: Distinguishing characters and classification upto classes. **2hrs** Nephridia, coelom, metamerism. **2hrs** Vermiculture and Vermicompost. **2hrs**
6. Arthropoda: Distinguishing characters and classification upto classes. **2hrs** Social life in insects. Household pests, vectors and their control. **2hrs** Sericulture, lac culture. **2hrs**
7. A Brief study of the life history of Prawn: Morphology, musculature and locomotion. **3hrs** Digestive, respiratory, circulatory, nervous and reproductive systems. **3hrs** Developmental stages in the life history. **1hr**
8. Mollusca: Distinguishing characters and classification upto classes. **2hrs** Torsion in gastropoda. Shell and foot in Mollusca. Pearl culture. **3hrs**
9. Echinodermata: Distinguishing characters and classification upto classes. **2hrs**Water vascular system; Haemal system. **2hrs**

Basic texts:

1. **A.J. Marshall and W.D. Williams,** (1972) Text Book of Zoology, Vol. I, ELBS 7thEd.
2. **R.D. Barnes,** (1963) Invertebrate Zoology, CBS College Publishing Saunders College International Edition.
3. **E.L. Jordan and P.S.Verma,** (2001)Invertebrate Zoology, S. Chand and Co. Ltd., NewDelhi.

Course Outcomes: On completion of the course, the student will be able to

- Understand the classification of invertebrates and their diversity
- Know about the salient feature of phyla and their representative species
- Know about the economic importance of Invertebrates

- Learn about the life cycle of some of the parasites harmful to man
- Know the evolutionary trends among the invertebrate phyla

UBIO-103 **(1 CREDIT)**

PRACTICAL COURSE ON PLANT DIVERSITY – I

(Algae, Fungi and Bryophytes)

Course Objectives:

- Learn how to handle algal and fungal specimens
- Observe the specimens under a microscope and identify them
- Train in cutting sections and preparing temporary slides of bryophytes
- Develop drawing skills

Study of available representative forms of Algae, Fungi and Bryophytes:

I. Algae:

Microscopic study of the thallus and reproductive structures of *Scytonema, Volvox, Cladophora, Oedogonium, Coleocheate, Chara, Vaucheria, Ectocarpus, Fucus and Polysiphonia*.

II. Fungi:

Microscopic study of the mycelium and reproductive structures of *Phytophthora, Penicillium, Claviceps, Peziza, Puccinia, Agaricus and Cercospora.*

III. Bryophytes:

1. Study of morphology; and preparation of temporary slides of V.S of the thallus, antheridiophore and archegoniophore and capsule of *Marchantia*.
2. Study of morphology and preparation of temporary slides of V.S of the thallus and T.S capsule of *Anthoceros*.
3. Study of morphology and preparation of temporary slides of whole mounts of leaf, antheridial and archegonial heads and T.S of capsule of *Funaria*
4. Observation of permanent slides of the thallus of *Porella* and *Sphagnum*.

Course Outcomes: The student gains hands on experience and skill to

- Handle the plant and fungal specimens
- Observe the specimens under a microscope and identify them
- Cut sections and prepare temporary slides of plants
- Develop drawing skills

UBIO-104 **(1 CREDIT)**

PRACTICAL COURSE ON ANIMAL DIVERSITY – I

(Invertebrata)

Course objectives:

- Observation of permanent slides
- Study of preserved specimens to understand the morphology, life-cycle stages of common invertebrates

I. **Protozoa:** Study of available permanent slides of *Amoeba, Plasmodium, Monocystis,*

Euglena, Vorticella, Paramoecium, Trypanosoma and Leishmania
(at least SIX) - Culturing of *Euglena and Paramecium*.

II. **Porifera:** Study of available preserved specimens of *Euplectella*, *Hyalonema*, *Spongilla*, *Euspongia.* Observation of gemmule and spicules.

III. **Coelenterata:** Study of the salient features of available preserved specimens of *Hydra, Obelia, Halistemma, Physalia, Porpita, Velella, Tubipora, Alcyonium, Gorgonia, Pennatula, Metridium, Aurelia* and *Obelia* medeusa (at least NINE).

IV. **Helminthes:** Study of the morphological Features of Planaria and Liver fluke; Tape worm: Scolex in front view, proglottid and onchosphere stage; Ascaris: Male and Female; *Ancylostoma.*

V. **Annelida:** Earth worm – study of external features. Study of salient features of following preserved specimens: *Terebella, Aphrodite, Chaetopterus, Arenicola, Sabella, Serpula, Neries*and*Heteroneris* (at least SIX); Leech – study of external features.

VI. **Arthropoda:** Prawn – study of external features.

VII. **Mollusca:** Fresh water mussel and snail – study of external characters.

A few interesting and informative videos on Invertebrates to be shown.

Course Outcomes: On completion of the course, the student will be able to

- Describe the structural details of various species among invertebrates
- Understand the different adaptive condition of the invertebrates in which they live
- Know about the primary and secondary hosts of parasites during the course of their life cycle
- Relate their Taxonomic position

UBIO-201 **(3 CREDITS)**

PLANT DIVERSITY - II

(Pteridophytes, Gymnosperms and Morphology of Angiosperms)

Course Objectives:

- Impart knowledge about the general characters and classification of vascular plants producing spores and naked seeds respectively
- Compare their morphological, anatomical, reproductive and life cycle details
- Discuss the evolutionary trends shown by non-angiosperm vascular plants
- Morphology and Modifications of plant parts of Angiosperm plants

I. Pteridophytes:

1. Introduction to Pteridophytes – Modern classification **2hrs**

2. A general comparison between Bryophytes and Pteridophytes **1hr**

3. Structural organisation of Sporophyte and Gametophyte of the following representative forms:
Psilotum **3hrs**, *Selaginella* (origin of heterospory and seed habit) **4hrs**, *Marselia* **3hrs**.

4. Evolution of stele in Pteridophytes **2hrs**

II. Gymnosperms:

5. Introduction to Gymnosperm – Classification by Sporne. **2hrs**

6. Study of morphology, anatomy, structure and organisation of the

microsporophyll and megasporophyll, Sporangium, ovule, fertilization and embrogeny of the following: *Cycas* **4hrs**, *Pinus* **4hrs**, *Gnetum.* **4hrs**

7. Evolutionary relationship between Gymnosperms, Pteridophytes and Angiosperms. **2hrs**

III. Morphology of Angiosperms:

8. Root: Types and modification of root. **2hrs**

9. Stem: Aerial and underground modifications of stem. **3hrs**

10. Leaf: Types of leaves, phyllotaxy, venation and modification of leaf. **2hrs**

11. Flower: A detailed study of flower parts – Calyx and Corolla (including Aestivation) **3hrs** Androecium and Gynoecium. **3hrs**

12. Inflorescence: Types of inflorescence - Racemose, Cymose and Special types of inflorescence.**2hrs**

13. Fruits: Simple, Aggregate and Multiple fruits with suitable examples. **2hrs**

Basic texts:

1. **P.C. Vashishta,** (2014) Botany for degree students, Vol. IV: Pteridophyta. S. Chand and Co. Ltd., New Delhi.
2. **P.C. Vashishta,** (2006) Botany for degree students, Vol. V: Gymnosperms. S. Chand and Co. Ltd., New Delhi.
3. **V. Venkateswarlu,** (1974) External Morphology of Angiosperms, S. Chand & Co, New Delhi

Reference books:

1. **G.M. Smith,** (1984) Cryptogamic Botany, Vol II: Bryophytes and Pteridophytes, TMH Edition.
2. **H.C. Bold,** (1973) Morphology of Plants. Harper and Row Publishers, New York.
3. **S.P. Bhatnagar and Alok Moitra,** (1997) Gymnosperms. New Age Intl. Pvt Ltd.

Course outcomes: The student gains knowledge about

- Geographical location, habitat and habit of vascular plants bearing spores and naked seeds respectively
- Cellular, morphological and anatomical features of vegetative and reproductive parts, including developmental stages and life history details
- Evolutionary aspects and Economic importance of non-angiosperm plants
- Details of Morphology and Modifications of parts of Angiosperm plants

UBIO-202 **(3 CREDITS)**

ANIMAL DIVERSITY - II

(Chordata)

Course objectives:

- To understand the basis of vertebrate classification
- Distribution, specific features, adaptations needed for survival of vertebrates

I. General morphological characters of Chordates:

1. Protochordata: Structural Organisation of sub-phyla *Hemichordata*, *Urochordata* and *Cephalochordata*. Classification up to class.**3hrs** Retrogressive Metamorphosis. **1hr**

2. Division Agnatha: Distinguishing features and classification up to class. **1hr**
3. Super- class Pisces: Distinguishing features; classification upto Class of Chondrichthyesand Osteichthyes. **2hrs** Migration, Airbladder, Extrabranchial-respiratory organs; economic importance offishes; Pisciculture. **3hrs**.
4. Amphibia: Origin and evolution of land vertebrates. **2hrs** Distinguishing features and classification of Amphibiaupto sub-class. Parental care. **2hrs**
5. Reptilia: Distinguishing features and classification upto sub-class. Poisonous snakes of India, identification of poisonous snakes; biting mechanism inpoisonous snakes. **4hrs** Composition of snake venom; poly-anti venoms and prophylactictreatment. **2hrs**
6. Aves: Origin of birds; principles of bird flight. **2hrs** Flight adaptations in birds; general aspects of migration of birds. **2hrs** Distinguishing features and classification of Neognathae upto orders with special emphasis on beaks and claws. Breeding habits.**3hrs**
7. Mammalia: Distinguishing features and classification of different groups of mammals. Classification of Eutheriaupto sub-class and infra class. **2hrs** A brief account of reasoning and learning in mammals. **2hrs**

II. Comparative anatomy of different systems in Chordates

(*Ex: Scoliodon, Rana, Uromatrix, Columbia* and*Oryctolagus*)

8. Digestive System: Comparative account of the alimentary canal **3hrs**
9. Circulatory System: General plan of circulation among aquatic and land living chordates. Comparative anatomy of hearts and circulatory System. **4hrs**.
10. Respiratory System: Comparative account of respiratory organs and types of breathing - cutaneous, lamellar, pulmonary. **3hrs**
11. Nervous System: Comparative anatomy and evolution of brain andspinal cord. **4hrs**.
12. Urinogenital System: Evolution of Urinogenital system; successionof kidney. **3hrs**

Basic texts:

1. **T.J. Parker and W.A.Haswell,** (1921)Text Book of Zoology - Vertebrates Vol. II, ELBS.
2. **R. Pearson and John N. Ball,** (1981) Lecture notes on Vertebrate Zoology, Blackwell Scientific Co., Oxford.
3. **E.L. Jordan and P.S.Verma,** (2009) Chordate Zoology, S. Chand and Co. Ltd., New Delhi.

Course outcomes: On completion of the course, the student will be able to

- Understand the classification of vertebrates and their diversity
- Know about the salient features of each phyla and their representative species
- Know about the evolution of the Mammals from their apelike ancestors
- Understand the role of vertebrates in eco-system
- Understanding of the anatomical and functional details of physiological systems
- Understand the evolution of physiological systems among vertebrates

UBIO-203 **(1 CREDIT)**

PRACTICAL COURSE ON PLANT DIVERSITY - II

(Pteridophytes, Gymnosperms and Morphology of Angiosperms)

Course Objectives:

- Study of morphology of non-angiosperm vascular plants
- Train in cutting sections, prepare temporary slides and observe anatomical features
- Study the morphological features and modifications of Angiosperm plants

I. Pteridophytes:

1. Study of morphology and preparation of temporary slides of T.S of the aerial part of *Psilotum*.
2. Study of morphological & reproductive features and preparation of temporary slides of T.S of aerial part of *Lycopodium* and *Selaginella.*
3. Study of morphological & reproductive features and preparation of temporary slides of T.S of rhizome of *Equisetum*.
4. Study of morphological & reproductive features and preparation of temporary slides of T.S of rhizome and petiole of *Marselia.*

II. Gymnosperms:

A. Preparation of double-stained temporary slides of cross section of the following:

1. Cycas : Rachis, leaflet, stem, coralloid root
2. Pinus : Needle; stem, root
3. Gnetum: Leaf, stem, root

B. Observation of male & female cones of *Cycas*, *Pinus* and *Gnetum*.

III. Morphology of Angiosperms:

1. Study of the morphology of modifications of root, stem and leaf (locally available plants)
2. Study of types of inflorescence: Racemose and Cymose types
3. Study of types of fruits: Fleshy and Dry fruits.

Course Outcomes: The student gets first-hand experience to

- Handle non-angiosperm vascular plants and study their morphology
- Cut sections, prepare temporary slides and observe the anatomical features
- Study the morphological features and modifications of Angiosperm plants
- Develop drawing skills

UBIO-204 **(1 CREDIT)**

PRACTICAL COURSE ON ANIMAL DIVERSITY – II

(Chordata)

Course objectives:

- Observation of permanent slides and preserved specimens to understand morphology, anatomy of major vertebrates

I. **Protochordates:** Study of the distinguishing features of preserved specimens of *Amphioxus*, *Ascidia* and *Balanoglossus*.

II. Pisces

1. Study of the distinguishing features of the following preserved specimens: *Zygaena*, *Trygon*, *Chimaera, Acipenser, Amia, Clarias, Anabas, Ophiocephalus, Exocoetus, Echeneis, Sygnathus, Hippocampus, Proteopterus, Lepidosiren*and *Neoceratodus* (any NINE).
2. Scoliodon: Study of morphological features.

III. Amphibia

1. Study of the distinguishing features of the preserved specimens of *Rana, Bufo, Hyla*and*Rhacophorus.*
2. Frog (*Rana*): Study of morphological features. Frog skeleton: Skull; vertebral column; Urostyle; pectoral and pelvic girdles and limb skeleton.

IV. Reptilia

1. Study of the distinguishing features of the preserved specimens of the following:*Chameleon*, *Draco*, *Mabuiya*, *Varanus*, *Viperrusselli*, *Echiscarinatus*, *Bungarus*, *Naja*, *Python*, *Typhlops*, Turtle and Tortoise (any NINE). *Uromastix* or *Calotes*: Study of morphological features.

V. Aves

1. Study of the salient features of *Columbia livia*; beaks; claws;feathers.
2. Skeleton of fowl: Skull; vertebral column; synsacrum; pygostyle; sternum; keel; pectoral and pelvic girdles; wing and leg skeleton.

VI. Mammalia

1. Study of mammalian organs: lung; heart; kidney; brainand eye.
2. Rabbit: Study of the skeleton: Skull; vertebral column; sternum; rib skeleton; pectoral and pelvic girdles; limb skeleton.

A few interesting and informative videos on Chordates to be shown.

Course outcomes: On completion of the course, the student will be able to

- Describe the structural details of various species among vertebrates
- Identification of morphological uniqueness of the species and their life cycle
- Taxonomically position the species based on morphologically identification
- Understand their adaptive features

UBIO 301 **(4 CREDITS)**

PLANT DIVERSITY-III

(Taxonomy, Anatomy and Embryology of Angiosperms)

Course Objectives:

- Impart the knowledge about identification and classification of the plant into different groups based on its morphological features
- Discuss the economic importance of plants in our everyday lives
- Elucidate on Simple and Complex tissues of the plant
- Enumerate on the structural organization of the plant- structure of stem, root and leaf
- Understand the process of plant development

I. Taxonomy:

1. Introduction: Principles of classification, A brief account of Artificial, Natural, and Phylogenetic systems of the plant classification. **2hrs**

2. Binomial nomenclature and ICBN. **2hrs**

3. Systems of Classification: Bentham & Hooker, **2hrs** Engler & Prantl. **2hrs**

4. A study of the following families with respect to their position in Bentham and Hooker's system:

Magnoliaceae(**1hr**), *Brassicaceae*(**2hrs**), *Malvaceae*(**1hr**), *Leguminosae* (**3hrs**), *Cucurbitaceae* (**2hrs**), *Asteraceae*(**2hrs**), *Asclepiadaceae* (**2hrs**), *Solanaceae* (**1hr**), *Acanthaceae* (**1 hr**), *Lamiaceae* (**1hr),** Euphorbiaceae(**2hrs**), *Orchidaceae* (**2hrs**) *Musaceae* (**1hr**), *Arecaceae* (**1 hr**), *Poaceae* (**2hrs**).

II. Anatomy of Angiosperms:

5. Meristematic tissues – Types. Theories concerning organisation of shoot apex and root apex.**3hrs**

6. Simple tissues - Parenchyma, Collenchyma, Sclerenchyma **3hrs -** Complex tissues - Xylem and Phloem. **3hrs**.

7. Structure of primary stem, root and leaf of Monocot and Dicot plants**2hrs -** Root -shoot transition – An over view. **1hr**

8. Secondary growth in stem and root of Dicot plants **1hr** - Anomalous secondary growth in *Boerhaavia* and *Dracaena.* **2hrs**

III. Embryology of Angiosperms:

9. The anther: Structure of the anther; microsporangium, microsporogenesis and development of male gametophyte. **3hrs**

10. The ovule: Types of ovules; structure of ovule **1hr**Megasporogenesis, types of female gametophyte development - monosporic, bisporic & tetrasporic. **3hrs**

11. Fertilization: Growth of pollen tube, entry of pollen tube in ovule, syngamy and triple fusion. **3hrs**

12. Embryogeny: Embryo development in monocot and dicot plants (with only one specific example for each). **3hrs** Polyembryony and Agamospermy- A brief overview **1hr**

13. Endosperm development: Types - Nuclear, Cellular and Helobial (with only three specific examples for each type); rumination. **3hrs**

Basic texts:

1. **S.N. Pandey and A. Chadha**, (2005) Plant Anatomy and Embryology. VikasPublishing House.
2. **S.S. Bhojwani and S.P. Bhatnagar**, (1981) The Embryology of Angiosperms Vikas Publishing House Pvt Ltd., New Delhi.
3. **N.S. Subramayam,** (1997)Modern Plant Taxonomy, Vikas Publishing House.
4. **B.P. Pandey,** (2007) Taxonomy of Angiosperms, S. Chand and Co. Ltd., New Delhi.
5. **G.H.M.Lawrence,** (2012) Taxonomy of vascular plants, Oxford and IBH Publishers.

Course Outcomes: The student gains knowledge about

- Identification and classification of the plant into different groups based on its morphological features
- The economic importance of plants in our everyday lives
- Simple and Complex Tissues
- The structural organization of the plant- structure of stem, root and leaf
- The process of plant development

UBIO-302 **(4 CREDITS)**

DEVELOPMENTAL BIOLOGY

(Embryology of Animals)

Course objectives:

- The course deals with mechanisms of gamete formation & embryo formation
- The study of the embryo development in model organisms like Drosophila, Zebra fish, rabbit

1. Introduction: The questions of Developmental Biology. **2hrs**
2. Spermatogenesis: Structure of testis; A detailed study of spermatogenesis and formation of a spermatozoon. **4hrs**
3. Oogenesis: Structure of ovary; vitellogenesis; role of follicle/nurse cells in oogenesis; egg maturation; egg membranes; polarity of eggs. **4hrs**
4. Types of egg membranes; Addition of accessory layers around the fertilized ovum of chick. **2hrs**
5. Fertilisation: Mechanism of fertilization - encounter of spermatozoa and ova, approach of the spermatozoon to the egg, chemotaxis, fertilizin-antifertilizin interaction; capacitation. **2hrs** Acrosome reaction and penetration, activation of ovum, migration of pronuclei and amphimixis. **4hrs**
6. Cleavage: Types of animal eggs. **1hr**. General patterns of embryonic cleavage. **2hrs** Cleavage patterns in: *Caenorhabditiselegans***1hr**, Drosophila **1 hr**, Sea urchin **1hr**, Zebra fish **1hr**, Frog **1hr**, Chick **1hr** and Rabbit **1hr**. Fate maps of sea urchin and frog. **3hrs**
7. Gastrulation: Types of cell movements. **1hr**, Gastrulation in *Caenorhabditiselegans* **1hr** Drosophila **1hr**, Sea urchin **1hr**, Zebra fish **2hrs**, Frog **2hrs**, Chick **2hrs** and Rabbit **2hrs**.
8. Neurulation in frog **2hrs**; Metamorphosis in frog. **2hrs**
9. Extra embryonic membranes in chick and their functions. **3hrs**; Characteristic features of chick embryos at 24 hrs, 48 hrs, 72hrs and 96 hrs of incubation. **2hrs**
10. Placentation in mammals: Types of placenta and their physiological roles. **3hrs**
11. Regulation of embryo development in Sea urchin: Experiments of Hans Driesch, Sven Horstadius, Eric Davidson. **3hrs**
12. Regulation during amphibian development: Hans Spemann experiment; Spemann and Mangold experiment. **2hrs**.
13. *Invitro* fertilization and test tube babies. **2hrs**
14. Synergistic inductions. **1hr**, Stem cells. **1hr** – A broad overview.

Basic books:

1. **Scott F. Gilbert,** (2003) Developmental Biology, 7th Ed., Sinauer Associates, Inc, Sunderlands, Massachusets.
2. **P.S.Vermaand V.K. Agarwal**, (2009) Chordate Embryology. S. Chand and Co. Ltd., New Delhi.

Reference books:

1. **Maurice Sussman,** (2011) Animal Growth and Development, Foundations of Modern Biology series, Prentice-Hall of India Ltd.
2. **Scot F. Gilbert and Anne M.Raunio,** (1997) Embryology: Constructing the organism, Sinauer Associates, Inc.

Course outcomes: On completion of the course, the student will be able to

- Comprehend distinctive gamete formation among different animal species
- Obtain a broad understanding of embryo developmental processes
- Distinguish, embryological stages during the developmental of the embryo
- Understand development of advanced techniques used in embryo transfer over the year
- Differentiate, the developmental stages of chick embryo

UBIO-303 **(1 CREDIT)**

PRACTICAL COURSE ON PLANT DIVERSITY – III

Course Objectives:

- Providing practical skills to identify and classify the plant into different groups based on its morphological features and Imparting skills in the preparation of herbarium
- Providing the ability to identify botanical names of the economically important products from the plants
- Impart training in slide preparation techniques required for study of plant tissues
- Learn about the structure of embryo, endosperms and types of ovules

I. Taxonomy:

1. Study of locally available plants belonging to the families studied in the theory course
2. Identification of the systematic position of plant up to family level (Plants from a minimum of 15 families to be studied).
3. Identification of economic importance of the plant part with Botanical name and family of the following:
   - Cereals: Rice, Wheat, Corn, Maize
   - Pulses: Red gram, Green gram, Black gram
   - Vegetables: Tomato, Potato, Brinjal, Bottle gourd, Radish, Onion
   - Spices: Cardamom, Mustard, Coriander, Cumin, Garlic, Chilly
   - Fruits: Mango, Coconut, Orange, Banana, Lemon, Apple, Custard Apple
4. Collection of plant material and preparation of Herbarium (A minimum of 40 specimens to be submitted along with the field note book).

II. Anatomy of Angiosperms:

A. Preparation of double-stained temporary slides of cross section of the following:

1. Dicot stem – *Luffa* & *Helianthus*
2. Dicot root – *Cicer* & *Tinospora*
3. Monocot stem – *Canna* & *Zea mays*
4. Monocot root – *Canna* & *Zea mays*
5. Abnormal secondary growth - *Boerhaavia* (Hog weed), *Nyctanthus*, *Mirabilis*, *Amaranthus* & *Bougainvillea*.
6. Leaves –*Mangifera* & *Zeamays*

B. Study of vascular tissues through permanent slides/maceration of plant stem.

III. Embryology of Angiosperms:

1. Study of the embryo of *Crotalaria* or *Cyamopsis* and endosperm of *Cucumis* through permanent slides.
2. Study of orthotropous, anatropous, campylotropous and amphitropous ovules through permanent slides.

Course Outcome: On completion of this course, the student gains

- Practical skills to identify and classify the plant into different groups based on its morphological features
- Skills in the preparation of herbarium
- The ability to identify botanical names of the economically important products from the plants
- Practical skills in slide preparation techniques required for study of plant tissues
- Insights about structure of embryo, endosperms and types of ovules

UBIO-304 **(1 CREDIT)**

PRACTICAL COURSE ON DEVELOPMENTAL BIOLOGY

Course objectives:

- To observe various embryo stages in some of the available live specimens e.g. Drosphila, *Lymnea* handling techniques
- Incubation & observation of chick embryo development at different stages

1. Study of reproductive structures of the following through permanent slides: Cross section of Testis and ovary of frog, chick and rabbit.
2. Observation of permanent slides and identification of the following developmental stages: Study of early and late cleavage stages of the fertilized egg; V.S of blastula, gastrula and yolk plug stages in frog.
3. Field trip a local pond – observation of different stages of young larvae of frog (No collection); studying the development till froglet stage through embedded specimen or chart.
4. Study of life cycles of a few insects showing complete and incomplete metamorphosis respectively through preserved specimens.
5. Study of a few available invertebrate larvae through Permanent slides.
6. Chick Embryology: Study of permanent slides of developmental stages of chick at 18hrs., 21hrs., 24hrs., 33hrs., 48hrs., 56hrs., 72hrs., 84hrs. and96hrs. Study of cross section and sagittal section of embryos.
7. Study of developmental stages of *Drosophila*. (Can be collected on banana peel or by rearing of *Drosophila* flies in culture tubes on synthetic medium (duration of the experiment: 2 –3 weeks).

OR

Study of developmental stages of Zebra fish or *Caenorhabditis elegans*.

Course outcomes: On completion of the course, the student will be able

- Identify the developmental stages in various animals
- Understand the Life cycle of some important organisms
- Culture and maintain *Drosophila* (fruit flies)
- Identify common *Drosophila* species

UBIO-401 **(4 CREDITS)**

BIOSTATISTICS

Course Objectives:

- Introduce the students to the field of statistics, and its application in biological research.
- Discuss the various stages involved in a statistical investigation and provide an overview of a statistical investigation.
- Elaborate on formulation of hypothesis, testing them, and offer an overview of the different statistical tools available for processing the data.
- Understand the various ways of representing the data for analysis, interpretation and drawing conclusions.
- Provide clarity to the students on the appropriate statistical tool to address a problem at hand.

1. Introduction: Definition of statistics; statistical data; statistical methods; functions & limitations of statistics; scope of statistics; biostatistics. **3hrs**

2. Statistical Data: Collection (primary and secondary); classification (Geographical, chronological, qualitative and quantitative) **3hrs** - Tabulation (parts of table, format of a table, types of tables); presentation – diagrams (one, two and three dimensional; pie chart) and graphs (histogram, frequency polygon, smoothed curve &ogives). **3hrs**

3. Population and sample: Sampling techniques; methods of sampling; characteristics of a sample; sample size; sampling errors. **3hrs**

4. Measures of Central Tendency: Mean; median; mode; geometric mean; Harmonic mean – Definitions; problems; merits & demerits. **3hrs**

5. Measures of dispersion: Absolute & relative measures; Range; quartile deviation; mean deviation; **3hrs** - Standard deviation; Lorenz curve - Definitions; problems; merits & demerits; skewness absolute and relative measures and Kurtosis. **3hrs**

6. Theory of probability: Introduction; definitions of different terms; approaches – classical, empirical and subjective; axiomatic; **3hrs** - Probability function; theorems on probabilities of events; Problem solving. **3hrs**

7. Probability distribution: Binomial; Poisson; normal – Definitions; characteristics; constants; **3hrs** - Problem solving. **3hrs**

8. Statistical inference: Hypothesis testing; procedure of testing hypothesis; estimation; **3hrs** - Test of significance for small samples; parametric tests; non parametric tests. **3hrs**

9. Student's t-test: Student's t-distribution; t-statistics; t-table; **3hrs** - Application – test the mean of random sample, unpaired test, paired test and test the significance of an observed correlation coefficient. **3hrs**

10. Analysis of Variance: One-way classification; assumptions; technique; ANOVA table. **3hrs**

11. Chi-square Analysis: X^2defined; conditions for applying X^2 test; one tail analysis; **3hrs** - Uses – test of independence; test of goodness of fit; test of homogeneity. **3hrs**

12. Correlation Analysis: Positive &negative; simple, partial & multiple; linear and curvilinear correlation; **3hrs** Karl Pearson coefficient of correlation. **2hrs**

13. Regression Analysis: Simple linear regression; regression lines and regression equations; **2hrs** Regression coefficients; fitting a straight line by Least squares method. **3hrs**

Basic texts:

1. **S.C. Gupta and V.K. Kapoor,** Elements of mathematical statistics, Sultan Chand & Sons Publishers, Delhi.
2. **S.Gupta,** (2014) Statistical Methods, Sultan Chand & Sons Educational Publishers; Delhi.
3. **Marcello Pagano & Kimberlee Gauvreau,** (2000) Principles of Biostatistics, 2nd Ed., Duxbury Thomson Learning.
4. **I.A. Khan and Khanum A. Ukaai,** Fundamentals of Biostatistics, Ukaaz Publications, Hyderabad.

Course Outcomes: On completion of this course, the student will be able to

- Have an overall understanding of the application of statistics in everyday life and in biological research.
- Collect, tabulate, present, analysis the data using various statistical tools.
- Formulate hypothesis, test it and validate it.
- Interpret the results of statistical analysis and draw meaningful conclusions and communicate them scientifically.
- Ascertain the suitable statistical tool for a given problem at hand.

UBIO-402 **(4 CREDITS)**

BACTERIOLOGY AND VIROLOGY

Course Objectives

- Discuss the structure and physiology of bacteria like cell wall structure, growth kinetics and microbial nutrition
- Understand the interaction between the host and the pathogen.
- Elaborate on how bacteria and viruses cause disease in the host
- Provide an overview on the general characters of viruses, its classification and replication strategies
- Discuss the role of virus in causing cancer
- Learn about horizontal gene transfer in bacteria

1. Microbial world- General Introduction. **2hrs**

I. Bacteriology:

2. Bacterial taxonomy: A brief overview. **3hrs**
3. Bacterial structure and function: bacterial cell structure; bacterial cell wall; cell wall synthesis**4hrs** - Bacterial movement and chemotaxis. **2hrs**
4. Bacterial Growth: bacterial cell division, the growth curve, measurement of microbial growth **3hrs -** Microbial Nutrition: Nutritional requirements in bacteria and nutritional categories, culture media, types of media **3hrs**
5. Microbial Growth Control: Physical antimicrobial control: heat, filtration and radiation **2hrs** - Chemical methods of microbial control: chemical antimicrobial agents for external use, Antimicrobial agents *in vivo.* **2hrs**
6. Host-Pathogen Interactions: Entry and colonisation in human hosts; bacterial toxins; host defence mechanism **4hrs**
7. Bacterial diseases:A brief account of Diphtheria, Pertussis, Tuberculosis, Cholera, Anthrax, tetanus, Bubonic plague, Gonorrhoea, Syphilis, Leprosy. **4hrs**

II. Virology:

8. Viral taxonomy: A brief over view**. 3hrs**
9. Viral structure: viral symmetry, viral proteins; viral nucleic acid **3hrs**
10. Viral culture: Cultivation of viruses; viral assay **3hrs** viral replication: General features, virus attachment and penetration, replication strategies of virus as per Baltimore classification, assembly, maturation and release of virions **4hrs**
11. Spread of Viruses: Infection, virus and immune system; virus vaccines **3hrs**
12. Oncogenic viruses: Types of oncogenic DNA and RNA viruses. Concepts of oncogenes, proto oncogenes and tumour suppressor genes **3hrs**
13. Sub-viral particles: An overview of Viroids and Prions **2hrs**
14. Viral diseases: A brief account of Influenza; Herpes Simplex; Chicken Pox; Measles; Rubella; Mumps; Dengue fever; Hepatitis: - A, B, C, and delta; Rabies; Polio. **4hrs**
15. Retro-viral disease: HIV; immunological response; diagnosis; transmission; Spectrum of HIV illness; treatment. **4hrs**

III. Microbial Recombination:

16. Plasmids: Structure and types of plasmids. **2hrs**
17. An overview of recombination, conjugation, transformation, transduction and transposition **4hrs**

Basic texts:

1. **N.J. Dimmock, A.J. Easton, and K.N. Leppard,** (2009) Introduction to modern virology, 6th Ed., Blackwell Publishing Co.
2. **L.M. Prescott, J.P. Harley and D.A. Klein,** (2001) Microbiology, WCB McGraw-Hill publishers.
3. **Michael T. Madigan, John M. Martinko, Kelly Bender, Daniel P. Buckley, David A. Stahl, Daniel H. Buckley and Thomas Brock,** (2014) Brock Biology of Microorganisms, 14th Ed., Benjamin-Cummings Publishing Company.

Course Outcome: On completion of this course, student will gain knowledge about

- The structure and physiology of bacteria like cell wall structure, growth kinetics and microbial nutrition
- The interaction of host and the pathogen and how bacteria and viruses cause disease in the host
- General characters of viruses, its classification and replication strategies
- Role of virus in causing cancer
- General mechanism about the Horizontal gene transfers in bacteria

UBIO-403 **(1 CREDIT)**

PRACTICAL COURSE ON BIOSTATISTICS

Course Objectives:

- Demonstrate the steps involved in a statistical investigation.
- Train the students formulate hypothesis and test them.
- Provide the students with a hands-on learning of Microsoft Word, PowerPoint and Excel.
- Enable students to employ various statistical tools to analyse the data, interpret it and draw conclusions.

1. Processing of raw data into a Frequency Table.
2. Diagrammatic and Graphic representation of Biological Data.
3. Computation of Mean, Mode, Median, Geometric and Harmonic mean, Standard deviation, Mean deviation, Variance and Coefficient of Variance.
4. Computation of Coefficient of correlation.
5. Regression analysis: Curve fitting by the method of Least squares.
6. Students "t" test: Unpaired test.
7. X^2 test (Chi square test).
8. Test for probability
9. Analysis of Variance: One-way classification.
10. Computer utilization in Biostatistics.

Course Outcomes: On completion of this course, the student will be able to

- Efficiently use Microsoft Word, and format word documents and make them look appropriate and professional.
- Tabulate the data efficiently using Microsoft Excel and create diagrammatic or graphical representation of the data.
- Prepare quality presentations using Microsoft PowerPoint.
- Perform various statistical analysis of the data, by hand and by employing statistical software.
- Perform various statistical analysis of the data, by hand and by employing statistical software.

UBIO-404 (1 CREDIT)

PRACTICAL COURSE ON BACTERIOLOGY AND VIROLOGY

Course Objectives

- Hands on training of the general equipment's used in microbiology laboratory
- Providing practical skills in aseptic techniques, staining techniques
- Learn isolation and maintaining of pure cultures of bacteria
- Learn quantification of bacteria
- Imparting practical as well as analytical skills to perform microbial growth kinetics experiments

1. Getting acquainted with of the following laboratory equipment: Compound microscope, autoclave, hot air oven, laminar flow chamber, colony counter, incubator, and a pH meter.
2. Preparation of bacterial medium. Preparation of plates and slants.
3. Isolation of pure cultures of bacteria by streaking method
4. Growing of bacterial colonies following dilution plate method and Estimation of CFU count by spread plate method.
5. Staining methods: 1. Simple staining 2. Negative staining 3. Gram's staining 4. Capsule staining 5. Spore staining. Acid fast staining-observing permanent slides.
6. Preparation of different types of solid media for growth of microorganism: 1) Synthetic media 2) Complex Media-Nutrient Agar 3) Selective and differential media: McConkey agar, EMB agar, Mannitol Salt Agar.
7. Isolation of bacteria and fungi from different soils and water.

8. Analysis of water for potability and determination of MPN.
9. Study of growth in Bacteria: Construction of growth curve using turbidimetric method and calculation of specific growth rate and generation time.
10. Study of effect of temperature, pH and different carbon sources on growth of bacteria.
11. Demonstration of effect of antibiotics on bacterial growth by Kirby-Bauer method
12. Isolation of bacillus from soil, Staphylococcus from milk, Rhizobium from root nodules of legumes, phosphate solubilizers from soil, antibiotic producing bacteria from soil, microbes (bacteria and fungi) from rhizosphere and rhizoplane. (ANY TWO isolations can be taken up).

Course Outcome: On completion of this course, students gain practical skills in

- Handling the general equipment's used in microbiology laboratory
- Aseptic techniques and staining techniques
- Isolation and maintaining of pure cultures of bacteria
- Quantification of bacteria
- Performing microbial growth kinetics experiments

UBIO-501 **(4 CREDITS)**

PLANT PHYSIOLOGY

Course Objectives:

- Highlight the various aspects of Plant Physiology such as photosynthesis, transpiration, translocation, respiration and hormones.
- Understand the role of mineral nutrition and learn about the manifestation of deficiency symptoms.
- Appreciate the Photoperiodism and biological clocks of plants.
- Learn how plants cope up with ecological (biotic and abiotic) stresses.

1. Water and plant cell: - The structure and properties of water; water transport processes-osmosis; diffusion; imbibition; **3hrs** - Water potential and water status of plant. **2hrs**

2. Water uptake – water in the soil; bulk flow; water absorption by roots (apoplast, transmembrane and symplast pathways) **3hrs** - Root pressure; water transport through xylem (The Cohesion - Adhesion theory; xylem transport of water in trees faces physical challenges); water movement from the leaf to the atmosphere. **2hrs**

3. Loss of water from plants: Transpiration; types of transpiration; structure of stomata; specialized features cell walls of guard cells. **3hrs** - Factors affecting rate of transpiration; anti-transpirants; guttation; exudation. **2hrs**

4. Mineral nutrition: Chemical composition of plants; essential elements; criteria for essentiality **3hrs** - Special techniques used in nutritional studies – hydroponics, nutrient film and aeroponic growth system; their role in plants; diagnosis of mineral deficiencies in plants. **3hrs**

5. Solute transport – Passive and active transport; ions transport across a membrane barrier; membrane transport processes. **3hrs** - Membrane transport proteins; ion transport in roots. **2hrs**

6. Photosynthesis - Radiant energy; photosynthetic pigments, photophysological reactions; emerson effect; pigment systems; **2hrs** - Light harvesting complexes; photoprotective mechanisms; mechanisms of electron transport; **3hrs** - CO_2 fixation - C_3, C_4 and CAM pathways; photosynthetic features of C_3, C_4 and CAM plants. **3hrs**
7. Phloem translocation – Pathways of translocation; patterns of translocation; translocated materials (sucrose, amino acids, hormones, and some inorganic ions). **3hrs** - Rate of movement; mechanism of translocation -the pressure flow model. **2hrs**
8. Respiration - Types of respiration; respiratory substrates; respiratory quotient; glycolysis; citric acid cycle; plant mitochondrial electron transport and ATP synthesis; **3hrs** - Alternate oxidase; Oxidative Pentose Phosphate pathway; photorespiratory pathway. **2hrs**
9. Nitrogen metabolism - Nitrate and ammonium assimilation; nitrogen fixation; nitrogen cycle. **4hrs**
10. Plant hormones –Physiological effects and mechanisms of action of Auxins, Gibberellins, Cytokinins, **3hrs** - Ethylene, ABA. **2hrs**
11. Sensory photobiology – Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins**3hrs** - Stomatal movement; photoperiodism and biological clocks. **3hrs**
12. Stress physiology – Responses of plants to biotic (pathogen and insects) **2hrs** - and abiotic (water, temperature and salt) stresses. **3hrs**

Basic text books:

1. **Lincoln Taiz and Eduardo Zeiger,** (2002) Plant Physiology, 3rd Ed., Sinauer Associates Publishing.
2. **Devlin and Witham,** (1986) Plant Physiology, Litton Educational Publishing, Inc., New York.
3. **R.K.Sinha,** (2014) Modern Plant Physiology, Narosa Publishing House, New Delhi.

Course Outcomes: On completion of this course, the student will be able to

- Comprehend the various aspects involved in the physiology of the plants.
- Appreciate the role of macronutrients as well as micronutrients and identify their deficiency symptoms.
- Get an overview of the economically viable means to cultivate plants under controlled conditions.
- Understand the various roles light plays in the life of a plant, such as Photoperiodism, stomatal movements.
- Explain how plants interact and respond to the various internal and external stimuli.

UBIO-502 **(4 CREDITS)**

ANIMAL PHYSIOLOGY

Course Objectives:

- Highlight the importance of structure-function relationship in animals
- Explain the evolutionary advancements seen various functional systems
- Enumerate basic mechanisms of physiological processes taking place in the body

- Describe coordination of action between various systems

1. Nutrition and digestion: Types of nutrition encountered in animal kingdom. Principles of coordination of secretions in the alimentary canal. Regions of the digestive tract: Mouth, buccal cavity, oesophagus, stomach, duodenum, ileum, small intestine, large intestine; movements of the alimentary canal and elimination of faeces.**3hrs** Enzymes of the Alimentary canal: General properties; how enzymes work; factors controlling the rates of enzyme reaction. **3hrs** Biochemistry of digestion and assimilation of carbohydrates, proteins and lipids. **3hrs**.
2. Respiration: Respiratory system in mammals; ventilation; lung capacities; gas exchange; nervous coordination of respiration. **3hrs** - A comparative account of respiratory apparatus and pigments. **1hr** - Transport of respiratory gases in mammals - Nature of haemoglobin and Myoglobin; transport of oxygen; oxygen equilibrium curves. **3hrs** - Transport of carbon dioxide. **1hr**.
3. Skin and temperature control: Structure of mammalian skin. Modification of skin in non-mammalian vertebrates. **2hrs** - Classification of animals on the basis of their ability to regulate body temperatures. **1hr** - Thermal neutral zone. Hypothalamus - a thermostatic organ. **2hrs** - Adaptations of animals living in extremely cold and very warm environments; Torpor; Hibernation; Aestivation. **3hrs**
4. Blood circulation: Types of hearts in animals; double circulation of mammals; chambers of the mammalian heart; cardiac muscle and its properties. **3hrs** - The origin and conduction of the heartbeat, mechanical events during heartbeat, heart output and its regulations. **2hrs** - Pressures encountered within the circulatory system. **1hr** - Exchange between capillaries, tissues and the lymph. **1hr** - Blood: Cellular components of the blood; Haemostasis: mechanism of blood coagulation (XIII factors). **2hrs**.
5. Muscle and body movement: Types of muscles. **1hr** - Detailed structure of skeletal muscle; ultra-structure of muscle proteins and their inter relationship; Sarcomere and t-tubule system. **3hrs** - Physiology of muscle contraction - sliding filament theory. Role of Ca^{2+} and ATP in muscle contraction **2hrs**.
6. Excretion: Types of kidneys; detailed structure of mammalian kidney. **2hrs**. - Nephron and the mechanism of urine formation; counter current multiplier System and its role in urine concentration. **3hrs** - Acid- base regulation; role of the kidney in the maintenance of pH.**1hr -** Nitrogenous excretory substances in the urine of mammals: Urea – Krebs'Ornithine cycle; Ammonia; Creatinine. **2hrs**
7. Nervous Integration: Brain and spinal cord; functional organization of CNS. Structure of neuron. **2hrs** - Physiology of nerve conduction - Donnan's equilibrium; Ion gating; action potential; all or none principle; generation of impulse. **2hrs** - Propagation of impulse; its direction and magnitude; synapse and neurotransmitters. **2hrs**. - Learning and memory: The limbic system. Process of learning; Types of memory – short and long term memory. Defective memory (types of amnesia). **3hrs**
8. Endocrine System: Nature of hormones; how they differ from enzymes. **1hr** - A brief study of the role of hormones of the pituitary, thyroid, parathyroid supra renal and pancreatic glands; disorders caused due to their hypo and hyper secretions. **3hrs** - Feedback control of hormone production. **1hr** - Mechanisms of action of lipid soluble and water soluble hormones; the

conceptof “Second Messenger” and its role in hormone function. **2hrs**

Basic texts:

1. **D. Randall, Warren W. Burggren, K. French, R. Eckert,** (2002) Animal Physiology, IllustratedEd., W H Freeman & Co.
2. **William S. Hoar,** (2008) General and Comparative Physiology, 3rdEd., Phi Learning Pvt. Ltd.
3. **Arthur J. Vander, James H. Sherman, Dorothy S. Luciano,** (2000) Human Physiology, 8thEd., McGraw Hill.
4. **Knut Schmidt-Nielsen,** (1997) Animal Physiology, 4thEd., Cambridge University Press.

Course Outcomes: The student gains knowledge about

- Details of the functioning of the various organ systems
- Interrelationships and interdependence between various systems
- Coordination and feedback control of secretions and their consequent functions
- Effect of environment on the functioning of the body

UBIO-503 **(4 CREDITS)**

CELL BIOLOGY

Course Objectives

- Understand the structural organization of cell
- Discuss the structure and functions of organelles in the cell
- Learn about organization of chromosome
- Describe the process of cell cycle and cell division
- Provide an overview of the process of cell growth, cell aging and cell signaling

1. Introduction: Historical background; properties of cell; basic physical and chemical concepts. **2hrs**
2. The cell: General organization of: Prokaryotic cell and Eukaryotic cell **2hrs**
3. Cell wall: Structure of Cell Wall; Chemical properties; Ultrastructure of cell wall, function and origin. **3hrs -** Study of bacterial cell wall (Prokaryotic) and Pollen wall (Eukaryotic) **2hrs**
4. Cell membrane and permeability: Molecular organization of cell membrane. **3hrs** A brief account of molecular models of cell membrane; cell permeability. **3 hrs**
5. Cytoskeleton and cell motility: Microtubules; microfilaments; intermediate filaments **3hrs** Cilia; flagella; centrioles. Cell motility. **3hrs**
6. Endoplasmic reticulum and protein segregation: General morphology, ultra-structure of endoplasmic reticulum. Biogenesis and functions of the ER; **3hrs**Microsomes – biochemical studies. **2hrs**
7. Golgi complex and cell secretion: Morphology and cytochemistry of the golgi complex; Functions of the golgi complex. **3hrs**
8. Lysosomes and peroxisomes: Major characteristics of lysosomes; functions of lysosomes; Polymorphism, Functions of Lysosomes, Lysosomes and Diseases **3hrs** Peroxisomes - morphology and functions. **2hrs**
9. Mitochondria: Morphology of mitochondria; molecular organization and functions of mitochondria; **2 hrs** biogenesis of Mitochondria. Bioenergetics **3hrs**

10. Plastids: Chloroplasts and other plastids; molecular organization of thylakoids; biogenesis of chloroplasts**. 3hrs**
11. Interphase nucleus: Occurrence and Position; Ultra structure of nucleus; nuclear envelope. **3hrs** Chromosomes: nomenclature; karyotype and giant chromosomes**. 3hrs** - Chromatin: heterochromatin; euchromatin**2 hrs**
12. Cell cycle and cell division: Phases of cell cycle; their significance. **2hrs -** Cell division – Mitosis: molecular organization and function of the mitotic apparatus; **3hrs -** Meiosis and its significance **3hrs**
13. Cell growth and aging: Growth in unicellular and Multicellular forms, sub cellular changes due to aging, causes of aging. **3hrs**
14. Cell signaling – Overview: Signaling molecules and their receptors; Functions of cell surface receptors. **3hrs**

Basic texts:

1. **E.D.P. De Robertis and E.M.F. De Robertis,** (2010) Cell and Molecular Biology, 8th Ed., Lippincott Williams &Wilkins.
2. **D.E. Sadava,** (1993) Cell Biology: Organelle structure and function. Jones and Bartlett Publishers – Boston.
3. **G. Karp,** (2009) Cell and Molecular Biology, 6th Ed., John Wiley & Sons Inc., New York.
4. **P.S. Verma and V.K. Agarwal,** (1999) Cytology, S. Chand and Co. Ltd., New Delhi.

Course Outcomes: On completion of this course, student gains knowledge about the

- Structural organization of prokaryotic and eukaryotic cell
- Structure and functions of organelles in the cell
- General organization of chromosome
- Process of cell cycle and cell division
- Process of cell growth, cell aging and cell signaling

UBIO- 504 **(3 CREDITS)**

ECOLOGY AND ENVIRONMENTAL BIOLOGY

Course Objectives:

- Highlight the importance of environment, biodiversity and their conservation
- Explain the process of soil formation, erosion control and soil conservation
- Study of different types of land and water ecosystems; their flora and fauna.
- Discuss the concept of productivity and flow of energy through the ecosystem.
- Study of ecosystem following individualistic and community approaches
- Create awareness about various environmental issues, pollution in particular

1. Introduction: Basic principles and concepts of Ecology and Environment – **1hr**
2. Ecosystem: Definition and components of Ecosystem; homoeostasis; food chain and food web; Ecological pyramids – **2hrs**
3. Types of Ecosystem: Pond, marine, grass land and forest –**3hrs**
4. Production Ecology: Energy flow through trophic levels – Box and pipe model - **2hrs**. Concept of productivity; primary and secondary productivity – **2hrs**

5. Biogeochemical cycles: Gaseous- Carbon and nitrogen. Sedimentary - Phosphorus – **3hrs**
6. Ecological factors and Adaptations: Climatic and Edaphic factors; Adaptive features exhibited by hydrophytes and xerophytes – **4hrs** - Adaptations in flying, arboreal, deep sea and desert animals – **2hrs**
7. Soil: Formation and transportation; weathering; texture and structure of soil; soil profile – **3hrs**. Soil organisms and organic matter; soil erosion – **2hrs**
8. Autecology: Population characteristics and dynamics; survivorship curves – r and K selection plants; ecotype differentiation – **3hrs** - Population growth curves and population structure – **2hrs** - Biotic interactions between species: positive and negative – **1hr**
9. Synecology: Methods of studying a community; qualitative characteristics – Raunkiaers' life forms – **2hrs**. Quantitative characteristics – Quadrates, ecotone; similar index; species diversity – **3hrs**. Concept of habitat and niche – **1hr** - Ecological succession: Definition; Primary and secondary succession; stages of succession; climax terminologies – **2hrs**
10. Biodiversity: Definition; Types of biodiversity; biological hotspots; rare, threatened and endangered species; importance and conservation of biodiversity – **3hrs**
11. Environmental pollution: An over view of the causes, effects and measures of control of pollution: Air **2hrs**; Water **2hrs**; Land **2hrs** and Noise **1hr**.

Basic texts:

1. **R.S. Ambasht and N.K. Ambasht,** (1996) A Text of Plant Ecology. 3rdEd., Students' Friends & Co.
2. **E.P.Odum,** (1971) Fundamentals of ecology, 3rdEd., W B Saunders Co.

Reference books:

1. **T.M. Smith and R.L. Smith,** (2006) Elements of Ecology. Pearson Edu. Inc.
2. **E.J.Kormondy,** (1996) Concepts of Ecology. Prentice Hall(I) Ltd.

Course Outcomes: The student gains knowledge about

- Geography, structure and organization of different ecosystems
- Production process and the flow of energy in the ecosystem
- Soil structure and texture, physio-chemical properties, soil organisms etc.
- Adaptations shown by plants and animals living under special environments
- Qualitative and quantitative study of populations and communities
- Biodiversity – its importance and strategies to protect and conserve them
- Understand and appreciate the causes, effects and methods to control of pollution

UBIO-505 **(3 CREDITS)**

INSTRUMENTATION

Course Objectives:

- Learn about the wide spectrum of instruments available for Biological research.
- Elucidate the working principles of the instruments used in biological laboratories.
- Explain the processes involved in the electrophoretic separation of nucleic acids and proteins.

- Expound the various chromatographic techniques employed for purification of biological analytes.
- Enumerate the methodology that is suitable for the biological research problem at hand, and understand the merits and demerits of the various approaches.

1. Microscopy**:** Principles and working of light microscopes; compound microscope; **2hrs** polarizing microscope; phase contrast microscope, Fluorescence microscope. **4hrs**
2. Microtome**:** Fixing of samples, embedding and section cutting, Slide preparation.**3hrs**
3. Chromatographic Techniques**:** General principles and applications of paper chromatography, thin layer chromatography, Ion-exchange chromatography. **4hrs** High-Performance Liquid Chromatography (HPLC), Affinity chromatography. **3hrs**
4. Electrophoretic Techniques**:** General principles, factors effecting electro forces; Agarose gel electrophoresis of DNA and RNA. **1hr** Pulsed-field gel electrophoresis, gradient gel electrophoresis – pH, temperature **3hrs Separation** of proteins by SDS-PAGE. **2hrs**
5. Spectroscopic Techniques**:** Principles, instrumentation and application of Colorimeter, UV and Visible spectrometers. **4hrs**
6. pH meter and Buffers: Principles and applications of pH meter, factors affecting pH reading. **1hr** Electrodes (ion-selective, rank oxygen, reference). **3hrs** Solution preparation - Calculations for Molarity, Normality, Electrophoresis buffers, loading dyes, serial dilution of solutions. **4hrs**
7. Centrifugation Techniques: Principles of sedimentation, centrifuges and their uses; Design and care of rotors. **3hrs** Types of centrifuges – bench top, clinical, cooling, ultracentrifuge. **4hrs** Types of centrifugal separations – differential, density gradient. **2hrs**
8. Safety cabinets: Principle and functioning of Laminar Air Flow, bio-safety cabin, and fume-hood. **3hrs**
9. Principles and uses: autoclave, distillation unit. **2 hrs**

Basic texts:

1. **Keith Wilson and John Walker,** (2002) Practical Biochemistry, Principles and Techniques, 5th Ed., Cambridge University Press.
2. **R.F. Boyer,** (1993) Modern Experimental Biochemistry, 2nd Ed., Benjamin Publishing Co., New York.

Reference Books:

1. **Prakash S. Bisen and Anjana Sharma**, (2012) Introduction to Instrumentation in Life Sciences, CRC Press, Taylor and Francis Group of Publishers, London.

Course Outcomes: On completion of this course, the student will be able to

- Gain insight into the wide spectrum of instruments used in biological research.
- Understand the working principles of various instruments used in biological laboratories.
- Gain clarity about the electrophoretic separation of nucleic acids and proteins.
- Appreciate the role of chromatographic techniques for purification of biological samples.
- Ascertain the appropriate methodology to approach a given problem at hand.

UBIO-506 **(1 CREDIT)**

PRACTICAL COURSE ON PLANT PHYSIOLOGY

(Any ten experiments)

Course Objectives:

- Appreciate the plant cells as an osmotic system.
- Learn ways to determine and measure various aspects of plant physiology.
- Learn to estimate the pigment contents in a plant tissue.
- Learn to identify the mineral deficiency symptoms in plants.
- Learn to identify the various types of stomatal distribution in plants and to calculate the stomatal index.
- Ascertain the appropriate methodology to approach a given problem at hand.

1. Cell as an osmotic system.
2. Determination of water potential of plant tissue by falling drop and tissue weight method.
3. Estimation of total chlorophyll and carotenoids.
4. Estimation of anthocyanins.
5. Separation of chloroplast pigments by paper chromatography.
6. Determine the stomatal index of a given leaf sample.
7. Kinds of stomata – anomocytic, paracytic, anisocytic, diacytic, graminaceous.
8. Determination of absorption spectrum of chlorophyll. Fluorescence of chlorophyll.
9. Identification of C3 and C4 plants growing wild in the campus.
10. Diurnal acid cycle in succulent plants.
11. Mineral deficiency – Chlorosis, necrosis. Identify the mineral deficiencies in the campus grown plants.
12. Estimation of catalase activity in seeds.
13. Determination of liberation of heat during respiration.
14. Measurement of transpiration by cobalt chloride method.

Course Outcomes: On completion of this course, the student will be able to

- Estimate the various pigments in a plant tissue.
- Identify the various mineral deficiency symptoms in plants.
- Determine the stomatal index of a plant leaf, and discern the distribution of stomata in monocots and dicots.
- Ascertain the process of transpiration in plants.

UBIO-507 **(1 CREDIT)**

PRACTICAL COURSE ON ANIMAL PHYSIOLOGY

(Any ten experiments)

Course Objectives:

- Provide training in how to hand laboratory equipment
- Imparting the skill for preparing blood smears slides
- Demonstrate, the preparation of reagents and buffers

- Acquaint students with procedures for qualitative and quantitative analysis of various substances

1. Qualitative analysis of food stuffs for carbohydrates, proteins, lipids.
2. Determination of the amount of carbon dioxide released by man during respiration before and after exercise.
3. Preparation of hematin crystals from human blood and demonstration of the effect of isotonic, hypotonic and hypertonic solutions on R B Cs.
4. Total count of R B Cs in human blood using Haemocytometer.
5. Total count of W B Cs in human blood using Haemocytometer.
6. Quantitative analysis of human urine for normal and abnormal constituents.
7. Estimation of Haemoglobin content in human blood and determination of blood groups of man based on antigen and antibody reaction.
8. Estimation of amount of protein in liver tissue by Lowry's method.
9. Uptake of dissolved oxygen from water by fish.
10. Demonstration of the digestive action of enzymes Pepsin and Trypsin on egg proteins.
11. Separation of amino acids from a mixture by thin layer chromatography. Determination of systolic, diastolic and mean arterial pressure.

Course Outcomes: The student gains hands on experience of

- Handling laboratory equipment
- Learning how to prepare the blood smears slides
- Preparing reagents and buffers
- Making qualitative and quantitative estimation of various substances

UBIO-508 **(1 CREDIT)**

PRACTICAL COURSE ON CELL BIOLOGY

Course Objectives:

- Provide training in microscopic and various staining techniques
- Learns to differentiate the cells of various living organisms
- Learn the stages of mitosis and meiosis
- Learn types of chromosomes and karyotype analysis
- Hands on training on microtomy

1. Cell Structure under light microscope
2. Various cell shapes – permanent slides of nerve cell, squamous epithelial cell, plant cell, *Desmidium*, Diatom, *Ceratium* etc. Acellular forms – *Vaucheria*
3. Drawing figures of stages of mitosis by viewing permanent slides of mitosis
4. Drawing figures of stages of meiosis by viewing permanent slides of meiosis
5. Principles of fixation and staining, different types of stain – Orcein, Carmine, Feulgen and Acrydine (Fluorescent)
6. Chromosomes – Metacentric, sub-metacentric, acentric, telocentric – permanent slides
7. Types of chromosomes - Polytene chromosome and Giant chromosomes – permanent Slides
8. Study of mitosis in onion root tip squash. Calculate the mitotic index.
9. Study of meiosis in Allium, or *Rheodiscolor* anthers smear.

10. Karyotype analysis
11. Microtomy

Course Outcomes: On completion of this course, student gain

- Practical skills in microscopic techniques and staining techniques
- The ability to differentiate the cells of various living organism
- Understanding of the stages of mitosis and meiosis
- Skill to identify types of chromosomes and karyotype analysis
- Hands on training on microtomy

UBIO-509 **(1 CREDIT)**

PRACTICAL COURSE ON 504 AND 505

Course Objectives:

- Learn about handling, care and usage of instruments available in Biological laboratories.
- Learn to estimate the concentration of nucleic acids, proteins, and the density of bacterial cultures using spectroscopic techniques.
- Learn the methodology of electrophoretic separation of nucleic acids and proteins.
- Learn to estimate important physical and chemical properties of soil and water from different ecological niches.
- Conduct field studies to demonstrate the plant species diversity on the campus.

I. **Ecology and Environmental Biology**:

1. Estimation of salinity in water samples collected from different sources.
2. Estimation of total alkalinity in water samples collected from different sources.
3. Determine the hardness of water under different conditions.
4. Colorimetric estimation of phosphates in pond water and sewage water samples.
5. Analysis of a few physical and chemical properties of soil from a garden and a playground.
6. Quantification of the primary productivity of a pond.
7. Field studies
   - Determination of the minimum size of a quadrate by species-area curve method.
   - Determination of minimum number of quadrates for the study of a community.
   - Quantitative analysis of a local community: frequency, density, abundance.

II. Instrumentation:

A. General awareness of handling, care and usage of equipment including microscope objectives / eye pieces, centrifuge rotors, micropipettes, cuvettes, etc.

B. Discussing principles and depicting the layout of the instrument through appropriate line diagrams to explain the functioning / mechanism of the following instruments:

1. ELISA
2. Chromatography (paper, TLC, affinity, ion exchange)
3. Microscopy (Light, Phase contrast, Fluorescent)
4. Spectrophotometer (UV-VIS)

5. Bomb Calorimeter
6. Gel documentation for the detection of DNA and RNA
7. Electrophoresis (Agarose and SDS-PAGE)

C. Laboratory safety (lecture/video series)

1. Lab rules and safety, reading and understanding Material Safety Data Sheets (MSDS), Safe laboratory practices, Biosafety, disposal of chemical, biological and radioactive waste.
2. Fire extinguisher types and uses, Information on First Aid procedures.

Course Outcomes: On completion of this course, the student will be able to

- Handle various instruments in the biology laboratory and be familiar with laboratory safety procedures.
- Perform UV and Visible spectroscopic measurements of biomolecules and bacterial cultures.
- Acquire hands-on skills in performing electrophoresis of nucleic acids and proteins.
- Analyze a few physical and chemical parameters of soil and water from different ecological niches.
- Perform field studies and estimate the minimum size of the quadrate by species-area curve method.

UBIO-601 **(4 CREDITS)**

GENETICS AND EVOLUTION

Course objectives:

- The course covers important topics in genetics Mendelian ratios, maternal inheritance, mutations etc.
- Genetic diversity among various life forms and their evolution through the ages
- Understanding, the works of evolutionary biologists like Lamarck, Darwin etc

I. Genetics:

1. Introduction**:** Mendel's experiments, first law, second law. Test cross and back cross, reciprocal cross. **3hrs**

2. Mendelian inheritance in man – pedigree - autosomal dominant, recessive and x-linked conditions.**4hrs**

3. Chromosome and heredity: Cytological evidences, chromosomal determination of sex – Walter Sutton's concepts - Morgan's experiment. **3hrs** Morgan's cross – Bridge's – experiment - non disjunction as proof of chromosomal basis of heredity. **3hrs**

4. Extension of Mendelian inheritance: Incomplete dominance, Co-dominance, Lethal allele. **2 hrs** Modified Dihybrid Ratio: (Alteration of 9:3:3:1): Inheritance of following ratios – (1)3:6:3:1:2:1; (2) 9:3:4; (3) 12:3:1; (4) 9:7; (5)15:1; (6) 9:6:1; (7) 13:3. **4hrs** Penetrance and expressivity **1hr**

5. Multiple alleles: Blood groups in human (ABO and Rh); coat colour in mammals; self-sterility alleles in plants. **2hrs**

6. Quantitative genetics: Polygenic inheritance - wheat kernel, human height and intelligence, QTL mapping. **2hrs**

7. Linkage: Experiments with Drosophila, Sturtevant map, two-factor cross - three factor cross – interference – co-incidence of coefficient - ordered and unordered tetrad analysis. Linkage mapping. **4hrs**

8. Non-Mendelian inheritance: Organelle heredity – Mitchondrial and chloroplast DNA inheritance. **1hr**Maternal inheritance – Shell coiling in snail (*Limnea*),

Kappa particles; criteria for extra-chromosomal inheritance. **2hrs**

9. Mutations: Point mutation – types; mutagen types - mechanism of action**3hrs** Structural and numerical variations of chromosomes - applications of polyploidy. **2hrs**

II. Evolution:

10. Origin life: Biochemical origin of life. **3hrs**. Diversity of life: Categorization of living things in to five kingdoms (Whittaker's classification). **2hrs**
11. Evolutionary thought**:** Theory of special creation - Greek theories; pre-modern theories; modern theories. **2hrs**
12. Lamarckism: Inheritance of acquired characters; criticism of Lamarckism; Neo-lamarckism. **2hrs**
13. Charles Darwin and Darwinism: Origin of species; criticism of Darwinism; theory of pangenesis, Neo-Darwinism. Weismann's theory of germplasm. **2hrs**
14. Mutation theory of De Vries; biogenetic law; Von Bear's principles; **2hrs**
15. Isolation: Mechanisms of isolation. **3hrs**
16. Basic pattern of evolution: Sequential and divergent evolutions; micro, macro, mega and quantum evolution; co-evolution. **2hrs**
17. Origin of species: Factors causing genetic divergence in the species population. Types of speciation. **3hrs**
18. Hardy Weinberg Law: Calculation - testing in human population **3hrs** Isolation **2hrs.** Genetic drift – founder effect and bottle neck effect. **2hrs**

Basic texts:

1. **Robert J. Brooker,** (2014) Genetics: Analysis and principles, 4th Ed., McGraw Hill Publishing.
2. **Veer BalaRastogi,** (2006) Organic Evolution, Kedarnath Ramnath Publishers, Meerut.
3. **E.J Gardner, M.J. Simmons and D.P Snusta,** (2010) Principles of Genetics, 8th Ed., John Wiley & Sons.
4. **P.S Verma and V.K Agarwal,** (2002) Genetics, S. Chand and Co. Ltd., New Delhi.

Reference books:

1. **Tamarin,** (2001) Principles of Genetics, 7th Ed., The McGraw−Hill Company.
2. **Klug, Cummings, Spencer and Palladino,** (2011) Concepts of Genetics, 10th Ed., Pearson publishing.
3. **Brian K. Hall,** (2014) Strickberger's Evolution, 5th Ed., Jones and Bartlett India.
4. **V. Venugopal Rao and Pratibha Nallari,** (2006) Population Genetics, Kalyani Publishers.

Course Outcomes: On completion of the course, the student will be able to

- Comprehend the basis of Mendelian genetics, non-Mendelian genetics,
- Appreciate the role of mutation in evolution
- Understand about the Gene Mapping
- Outline different theories of evolution
- Differentiate and understand the concepts in speciation, population genetics

UBIO-602 **(4 CREDITS)**

BIOTECHNOLOGY

Course Objectives:

- Highlight the interdisciplinary nature of biotechnology, and its application in the field of Agriculture, Medicines, Vaccines, Disease Diagnosis, Bio fertilizers.
- Understand the evolution of the modern biotechnology, the progresses and the advancements in the 20th and 21st century.
- Enumerate the general principles used in plant biotechnology and animal biotechnology, and various approaches employed in genetic manipulation of plants and animals.
- Provide an overview of the various sterilization techniques required for plants and animal cell culture.
- Discuss the basics of recombinant DNA technology, and elaborate methodologies involved in DNA sequencing.

1. Introduction to Biotechnology – Historical development; Interdisciplinary nature; biotechnological processes; main areas of application; product safety. **3hrs**
2. Plant tissue culture techniques- Historical aspects; uses of plant cell culture; totipotency; culture types and their establishment. **3hrs**
3. Core Techniques – Aseptic techniques; media design; culture environment; **3hrs** - Plant growth regulators; differentiation; plant regeneration. **2hrs**
4. Micro propagation - Elite plants; stages of micro propagation; **3hrs** Advantages over conventional propagation; disadvantages; economic considerations. **2hrs**
5. Secondary plant metabolites – Diversity & importance; production *in vitro*; relationship between cell differentiation & secondary metabolite formation; screening cell lines; **3hrs** Techniques – organ culture; suspension culture; immobilized cell cultures; hairy root cultures. **2hrs**
6. Haploids cultures – haploid cells (pollen & ovule); pre-treatment of donor plants; selection of anthers; anther pre-treatment; anther and pollen cultures; *in vitro* androgenesis; haploid regeneration; **3hrs** Factors affecting haploid production; inducing homozygosity; significance and uses. **2hrs**
7. Protoplast culture - Preparation; plasmolyticum; isolation methods; purification; quantification; viability; culturing methods. **3hrs** Somatic hybridization - methods of protoplast fusion, sorting of fusion products; regeneration. **2hrs**
8. Gene manipulation in plants: Direct DNA uptake - shot-gun method; Mediated uptake - *Agrobacterium* mediated gene transfer; natural transfer process; structure of Ti-plasmid; leaf disk transformation method. **3hrs**
9. Basic principles of Animal cell culture: Primary culture - cell line- cell strain- finite vs continuous cell line; Cell culture systems – adherent & suspension cultures; Cultural environment: **3hrs** Media – components; basal media, reduced-serum media, serum-free media; Physiochemical – pH, CO_2, temperature; Morphology of cells – fibroblastic, epithelial, lymphoblast; cryopreservation; uses of animal cell culture. **3hrs**
10. Recombinant DNA technology - Restriction endonucleases; types; specificity; cleavage pattern (blunt & sticky – 3' overhang and 5' overhang; compatible ends; ligase enzymes. **3hrs** - Cloning vectors – Types; plasmid - pBR322 and pUC 18/19. **2hrs**.
11. DNA sequencing: Chemical method; chain termination method. **3hrs**
12. Applications of gene transfer technology in agriculture – Transgenic plants, herbicide resistance, virus resistance, **3hrs** - Polymer production and edible vaccine. **2hrs**
13. Applications of Biotechnology in medicine **2hrs**, disease diagnosis **2hrs** and gene therapy. **2hrs**

14. Role of microbes in Biotechnology: Biogas **2hrs** and biofertilizers **2hrs**

Basic texts:

1. *In vitro* cultivation of plant cells from Biotol series; published by Butterwoth Heinemann Ltd.
2. **John E. Smith,** (2004) Biotechnology, 4th Ed., Cambridge University Press.
3. **Bernard R. Glick, Jack J. Pasternak**, (2009) Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Ed., Asm Press.
4. **R.C. Dubey,** (2006) A Text Book of Biotechnology, S. Chand and Co. Ltd., New Delhi.

Course Outcomes: On completion of this course, the student will be able to

- Appreciate the interdisciplinary nature of biotechnology, and its wide variety of applications.
- Grasp the evolution of modern biotechnology in comparison to the traditional methodologies.
- Understand the general principles employed in genetic manipulation of plants and animals.
- Get an overview of the various sterilization procedures employed in biological laboratories.
- Grasp the basics of gene cloning and sequencing.

UBIO-603 **(4 CREDITS)**

INTRODUCTORY MOLECULAR BIOLOGY

Course Objectives:

- Discuss the structure and organization of Nucleic acids
- Explain the basic principles of Replication, Transcription and Translation
- Highlight the necessity and importance of RNA processing in Eukaryotes
- Introduce the concept of Gene Regulation; and how is occurs in different organisms

1. Chemistry of the gene: Chemical structure of purines, pyrimidines and nucleic acids; molar ratio of nucleotides – Chargaff's rule. **3hrs** - Biosynthesis of purines and pyramidines – A brief account. **2hrs**- DNA: Watson and Crick's model; Alternate forms of DNA; special base sequences; denaturation and renaturation of DNA; **3hrs**RNA: Types of RNA – a brief account of their structure and organization; secondary structure in RNA.**3hrs**

2. Genome organization in Eukaryotes and Prokaryotes: A brief over view of the organization of DNA in Prokaryotic (*E. coli*) and Eukaryotic (human) Chromosome(s) **3hrs**

3. DNA Replication: Prokaryotic and Eukaryotic DNA polymerases - their properties and mechanisms of action. **4hrs**. - Semi conservative replication model for DNA synthesis; discontinuous replication model for DNA synthesis in Prokaryotes (Bacteria) and Eukaryotes; leading and lagging strands; Okazaki fragments.**4hrs** DNA replication in viruses - Rolling circle replication model only.**2hrs**

4. Transcription: Concept – Comparison between replication and transcription Genetic code; properties of genetic code; Wobble hypothesis. Central dogma of Molecular biology. **4hrs** - RNA polymerase in prokaryotes – its

properties; organization of promoter; mechanism of transcription **4hrs** - RNA polymerases in Eukaryotes – their properties; organization of promoters foreach of the three types of polymerases. **2hrs** - Detailed mechanism of transcription involving RNA Pol II only. **3hrs**

5. RNA Processing: Processing in Prokaryotes and Eukaryotes- a comparison. mRNA processing – primary transcript; addition of caps and tails (poly A); splicing of Introns; lariat formation; spliceosome. Ribozymes. **3hrs**
6. Protein Synthesis: Translation; genetic code and its universality; second genetic code – interaction between amino acyl tRNAsynthetase and tRNA; Codon and anticodon recognition. **3hrs** - Ribosomes - Physical and chemical structure; types of ribosomes. **2hrs** - Mechanism of translation in Prokaryotes and Eukaryotes – A detailed study of initiation, elongation and termination; half-life of mRNAs; polysomes. **4Hrs**- Protein folding: Levels of structural organization of proteins; tertiary structure – turns; loops; domains; motifs. Chaperones and Chaperonins. **3hrs**
7. Regulation of gene expression in Prokaryotes: Operon concept; Transcriptional control - Positive and negative control systems in *Lac* Operon, Trp operon. Translational and post translational control in *Lac* Operon (one example for each). **4hrs**
8. Regulation of gene expression in Eukaryotes: General aspects; Reversible and irreversible types of regulation. **2hrs** - Regulation at transcriptional level – Determination of cell type, differentiation and development of specific types of cells, action of hormones in regulation; Regulation at post-transcriptional level (One example for each) **4hrs**
9. An overview of**:** Polymerase chain reaction and DNA finger printing. **2hrs**

Basic texts:

1. **J.D. Watson,** (1987) Molecular biology of the gene 4th Ed., Benjamin and Cummings.
2. **D. Freifelder,** (2008) Molecular Biology, 2nd Ed., Narosa book distributors Pvt. Ltd., New Delhi.
3. **A.L. Lehninger,** (1999) Principles of Biochemistry.

Course Outcomes: Upon completion of the course the student would be

- Conversant with historical milestones during the evolution of molecular biology as a key branch of biology
- Able to have a clear picture of the constituents and their chemical structures making up the nucleic acids
- Understand the role and functioning of various classes of enzymes like polymerases, ligases etc
- Outline of the mechanisms of replication, transcription, processing and translation
- Know the structure and organization of proteins - role of chaperons and chaperonins
- Various events take place during regulation of gene expression in prokaryotes and eukaryotes

UBIO-604 **(3 CREDITS)**

BIOLOGICAL CHEMISTRY

Course Objectives:

- Discuss the structure and functions of major macromolecules like proteins, carbohydrates, lipids and nucleic acids
- Explain the properties of enzyme, its mechanism of action and regulation
- To provide an overview on the role of vitamins and oxidation of fatty acids
- Understand the laws of thermodynamics, concepts of entropy, enthalpy and free energy changes and their application to biological systems
- Elucidate on the importance of secondary metabolites

1. Carbohydrates: Classification of carbohydrates-some examples of monosaccharide, disaccharides and polysaccharides- storage of starch and glycogen; polymers; Stereo isomers. **3hrs -** Glycoproteins: Structure and function; proteoglycans and bacterial cell wall – penicillin inhibits cell wall biosynthesis. **1hr**
2. Amino acids and proteins: Structure, characteristics and classification of amino acids. **2hrs** Classification of protein based on composition, solubility, shape and function; physical and chemical properties; Peptide bond, bonds responsible for protein structure; primary, secondary, tertiary and quaternary structure of protein. **3hrs** Synthetic synthesis of polypeptide. **2hrs** Biosynthesis of aminoacids –Methionine, Histidine, Tryptophan only **4hrs**
3. Lipids: Classification – fatty acids, triacylglycerols, glycerolphospholipids, spingolipids, cholesterol and their composition. **3hrs**
4. Enzymes: Biological catalysts; Classification and nomenclature, substrate specificity – stereospecificity and geometric specificity. Isozymes, physical basis for isozymes. **3hrs** Kinetics- factors affecting enzyme activity –pH, Temperature, substrate concentration; inhibitors – competitive, non-competitive and uncompetitive. **4hrs** Regulation of enzyme activity – enzyme availability; control of enzyme activity-feedback inhibition, allosteric changes; Prosthetic groups and coenzymes. **3 hrs**
5. Vitamins: Definition; classification; role of vitamins**. 3hrs**
6. Laws of thermodynamics and their relevance to organisms; oxidation and reduction levels of reactants; intermediate and terminal acceptors of electrons; redox potentials and electrochemical gradients**. 3hrs** High energy compounds;principles of chemiosmotic synthesis of ATP. **3hrs**
7. Nucleic acids: structure of nucleosides and nucleotides; DNA and RNA**. 2hrs** Physical properties: Melting point; hypo-& hyper chromacity, optical rotation, viscosity; studies of Nucleic acids. **3hrs**
8. Transformation of chemical energy; oxidation of fatty acids and organic acids (Pyruvic acid and Lactic acid). **3hrs**
9. Secondary products of metabolism: Occurrence, properties and functions of porphyrins, anthocyanins, phenolics and alkaloids. **3hrs**

Basic texts:

1. **B.D. Haines, N.M. Hooper and J.D. Houghton,** (1998) Instant notes in Biochemistry. Viva Books Pvt. Ltd., New Delhi.
2. **G.L. Zubay, W.W. Parson and D.E. Vance,** (1995) Principles of Biochemistry, Wmc. Brown Communications, Inc., Dubuque.
3. **A. L.Lehninger,** (1985) Biochemistry, Macmillan Publishers.
4. **U. Satyanarayana,** (2013) Biochemistry, Books & Allied Pvt. Ltd., Kolkata.

Course Outcome: On completion of this course, the student gains knowledge about the

- Structure and functions of major macromolecules- proteins, carbohydrates, lipids and nucleic acids
- Oroperties of enzyme, its mechanism of action and regulation
- Role of vitamins, oxidation of fatty acids
- Laws of thermodynamics, concepts of entropy, enthalpy and free energy changes and their application to biological systems
- Importance of secondary metabolites

UBIO-605 **(3 CREDITS)**

INTRODUCTORY IMMUNOLOGY

Course Objectives:

- Introduce the principal concepts of Immunity and types of Immunity
- Outline Hematopoiesis and the types of blood cells involved in immunity
- Explain constituents and the working of Humoral and Cell Mediated Immunity
- Discuss importance of vaccines, types of vaccines and principles of their production
- Enumerate principles underlying working of instruments commonly used in the study of Immunology

I. Introduction:

1. Historical perspective: Early studies-humoral and cellular components of the immune system, early theories – antigen-antibody interaction. **1hr**

II. Immune system:

2. Innate Immunity-Skin, mucosal, physiological, phagocytes, inflammation. **1hr**

3. Adaptive immunity- B-lymphocytes, T-lymphocytes, Antigen –presenting cells, humoral immunity, antigen recognition, mechanism that generate diversity in antigen, **3hrs** major histocompatibility molecules recognise antigen, antigen presentation by MHC, clonal expansion of lymphocytes, efficiency of immune response. **3hrs** Collaborative effective of innate and adaptive immunity, Comparative immunity, immunity dysfunction and its consequences. **2hr**

III. Cells and organs of immune system:

4. Hematopoiesis. **2hrs** Cells of immune system- lymphoid cells; mononuclear phagocytes, granulocytic cells. **3hrs** Organs of the immune system- primary lymphoid organs, secondary lymphoid organs, Cutaneous associated lymphoid tissue, systemic function of immune system. **3hrs**

IV. Antigens:

5. Factors and immunogenecity, nature of immunogen, biological system. **2 hrs** Epitopes - properties, Haptens and antigenicity, pattern recognition receptors. **2 hrs**

V. Structure and functions of antibodies:

6. Basic structure of antibodies. **1hr** Fine structure of antibody- multiple domains; diversity in the variable region – complementarity-determining regions (CDRs), antigen binding, conformational change. **3hrs**

7. Constant region domains; Antibody mediated effector functions. **2hrs** Classes of antibodies and their activities: IgG, IgA, IgM, IgE and IgD. **2hrs** Antigenic determinants of Imunoglobulins. **1hr** Antibody production: Principle of antibody production, polyclonal antibody, monoclonal antibody; clinical importance. **3hrs**

VI. Immune system and Health:

8. Vaccines – Active and Passive immunization; whole organism as vaccine;

macromolecules as vaccine, recombinant vector vaccine; DNA Vaccine. **3hrs**

9. Immunodeficiency- Primary – lymphoid (eg: SCID), myeloid (eg: Neutrophil count reduction) **2hrs**
10. Secondary – AIDS – transmission, retrovirus HIV-1, its replication cycle. **2hrs**
11. Autoimmunity – organ specific (eg: insulin-dependent diabetes mellitus). **2hrs**

VII. Applications of Antigen-antibody interactions:

12. Principles- cross reactivity, precipitation, agglutination. **2hrs** Radio immunoassay (RIA), Enzyme-Linked Immunosorbent Assay (ELISA), Western Blotting, Immunoprecipitation, Immunofluorescence, Flowcytometry and Fluorescence. **3hrs**

Basic Texts:

1. **Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt,** (2011) Roitt's Essential Immunology, 12th Ed., Wiley-Blackwell, John Wiley and sons, New York.

Course Outcomes: The student gains knowledge about

- How the body's immune system functions
- Development of different types of blood cells
- Overall understanding of Humoral and Cell mediated Immunity
- Causes and mechanisms of Autoimmunity and Immunodeficiency
- Mechanism of action of a vaccine and types of vaccines.
- Techniques and Instruments used in Immunology

UBIO-606 **(1 CREDIT)**

PRACTICAL COURSE ON BIOTECHNOLOGY

Course Objectives:

- Explain the basic laboratory layout for plants and animal cell cultures
- Elaborate on the preparation of various stock solutions, reagents required in biological experiments, and for plant tissue culture
- Gaining a hands-on training on the various sterilization techniques required for plant and animal cell culture
- Learn the methodologies involved in the initiation and establishment of callus culture, and suspension culture

1. Basic laboratory layout for plant biotechnology and equipment.
2. Study of sterilization techniques.
3. Preparation of stock solutions of various components of basal medium (MS)
4. Preparation of hormone additions to basal medium
5. Preparation of media with various growth hormone combinations.
6. Percentage germination of in vitro seedlings of green gram on ½ strength MS medium.
7. Shoot culture/nodal culture of a given plant.
8. Study the morphogenetic response with respect to polarity of explants (hypocotyl & epicotyl).
9. Study the morphogenetic response with respect to growth regulators and explant types.
10. Initiation and establishment of callus culture.

11. Initiation of cell suspension culture.
12. Monitoring the growth of suspension culture
13. Measurement of cell viability
14. Basic laboratory layout for animal cell culture and equipment.

Course Outcomes: On completion of this course, the student will be able to:

- Understand the basic laboratory layout for plants and animal cell cultures.
- Prepare various stock solutions and plant tissue culture media.
- Perform various sterilization techniques required in plant and animal cell culture.
- Perform the initiation and establishment of callus culture, and suspension culture.

UBIO-607 **(1 CREDIT)**

PRACTICAL COURSE ON INTRODUCTORY MOLECULAR BIOLOGY

Course Objectives:

- Facilitate understanding of the concepts of Replications, Transcription and Translation through drawing suitable sequence of diagrams
- Impart training in handling sensitive analytical equipment.
- Estimate proteins and nucleic acids from biological samples
- Electrophoretically separate Proteins and fragments of DNA

1. Drawing figures of structures of Nucleotides, Sugars, DNA - B DNA, Z DNA and triple stranded DNA; mRNA (primary and secondary structures tRNA (Clover leaf model).
2. Drawing diagrams showing the sequence of DNA replication (Semi-conservative) and Transcription in Prokaryotes.
3. Drawing diagrams of the structure of ribosomes and sequence of steps in protein synthesis in Prokaryotes.
4. Recording the spectrum for DNA and proteins. Determination of the melting point of DNA from various sources using a UV - Vis Spectrophotometer.
5. Extraction of DNA from onion using a kitchen blender.
6. Extraction of RNA from commercially available yeast powder.
7. Quantitative estimation of DNA (Diphenylamine method).
8. uantitative estimation of RNA (Orcinol method).
9. Separation of DNA fragments by Agarose Gel Electrophoresis.
10. Separation of proteins by SDS – PAGE Electrophoresis.

Course Outcomes: The student

- Gains clarity in understanding concepts about Replications, Transcription and Translation
- Acquires experience of handling sensitive analytical equipment and learn to estimate proteins and nucleic acids for samples
- Learns the art of separating of fragments of Proteins and fragments of DNA

UBIO-608 **(1 CREDIT)**

PRACTICAL COURSE ON BIOLOGICAL CHEMISTRY

Course Objectives:

- Provide practical and analytical skills required to quantify major biomolecules in the sample
- Hands on training on extraction, quantification and analysis of various biomolecules
- Develop skills in identification of types of amino acids in a sample
- Learn estimation of enzyme activity
- Develop capability to quantify enzymes and determine its kinetic parameters

1. Estimation of reducing sugars by 2, 4 –di nitro salicylic acid method.
2. Estimation of total soluble sugars by anthrone method
3. Estimation of amino acid by ninhydrin method
4. Extraction and estimation of proline from plant tissues
5. Extraction and estimation of ascorbic acid from plant / animal tissue
6. Estimation of nucleic acids in plant tissue
7. Estimation of lipase activity in germinating castor seed
8. Extraction purification and quantification of beta amylase from sweet potato
9. Immobilization of beta amylase enzyme from sweet potato and assay of its activity
10. Estimation of peroxidase in plant tissues.

Course Outcomes: On completion of this course, student gain
- Practical and analytical skills required to quantify major biomolecules in the sample
- Practical skills on extraction, quantification and analysis of various biomolecules
- Skills in identification of types of amino acids in a sample
- Skills in estimation of enzyme activity
- The ability to quantify enzymes and determine its kinetic parameters

UBIO-609 **(1 CREDIT)**

PRACTICAL COURSE ON GENETICS AND IMMUNOLOGY

Course objectives:
- The course covers various ratios derived from mendelian, non-mendelian approaches
- Theory and practice of important immunological methods

I. Genetics:

Problem solving on the following topics.

1. Finding the F2 ratios for monohybrid cross- test cross, back-cross – in dominant-recessive condition, incomplete dominant, co-dominance. Use of Punnet-square and branch/ pork method.
2. Drawing pedigree, predict the recessive, dominant, autosomal and sex-linked inheritance from pedigree.
3. Finding the ratios for dihybrid cross, reciprocal cross for sex-linked characters; Gene interactions of different characters with different nature of interaction, Use of Punnet-square and branch fork method.
4. Predicting the genotypic condition of parents from (i) crosses involving multiple allele; (ii) maternal inheriting characters. Probability calculations for blood group inheritance.
5. Determining the distance between the genes in two-point cross, three-point cross, calculating the number of double cross over, interference, coincidence of co-efficient. Determine the expected progeny in different phenotypes, if the linkage distance is known.

6. Microbial gene mapping by interrupted mating.
7. Geological time scale – Preparation of chart and learning about eras, periods and epoch; Major events in the evolutionary time scale.

II. Immunology:

1. Affinity purification of Serum antibodies
2. Ouchterlony Double diffusion
3. Trypan blue exclusion test for cell viability
4. Purification of IgG by size exclusion chromatography.

Course Outcomes: On completion of the course, the student will be able

- To solve numerous genetic problems involving several crosses
- Solve problems related to population genetics
- Appreciate major events in evolutionary time scale
- Understand the genetics associated with production of hybrids

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