SRI SATHYA SAI INSTITUTE OF HIGHER LEARNING

(Deemed to be University)

Syllabus for

B.Sc. (Hons.) in Biosciences

Prasanthi Nilayam – 515 134
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1st June 2015 onwards

Sri Sathya Sai Institute of Higher Learning

(Deemed to be University)

Syllabus (Unit-wise) for Three Year

B.Sc. (Hons.) in Biosciences

(Effective from the Academic Year 2015-16 onwards)

Programme Objectives:

The Department of Biosciences at SSSIHL offers a three year Bachelor of Science (Honors) programme as part of the Five Year Integrated MSc. frame work. The undergraduate curriculum has a total of thirty four courses that imparts students with both theoretical and practical knowledge in Biological Sciences encompassing a wide range of fundamental concepts and their applications in day to day life. The courses equip the students to understand and appreciate the fascinating biological diversity starting from simple unicellular forms to complex multi-cellular forms; the underlying principle of unity in diversity; variety and complexity of life processes along with evolutionary novelties; and the enormous relevance of Biological Sciences in the life of Man.

Programme Specific Outcomes:

The first two years of the program comprises of eight theory and eight practical courses that deal with the form and structural organization and development of various organisms: Plants, Animals and Microbes. A course on Biostatistics introduces the students to the use of a variety of quantitative techniques that are necessary for empirical studies.

In the third year of the programme, students study ten theory and eight practical courses. Building on the foundation of comprehensive understanding of morphological and anatomical aspects gained earlier, the students in the third year learn about Structure - Functional relationships that exist among organisms and applications developed in the field of Biological Sciences for improving the quality of Man's life. Cell Biology, Molecular Biology and Biochemistry; Physiology, Immunology and Biotechnology; Ecology, Genetics and Evolution are the diverse subjects taught. Also, a course on Instrumentation acquaints the students with the principles and working of various sophisticated equipments routinely used in Biological Research.

Much emphasis is laid on getting the students abreast with the newly emerging areas of Biological Sciences. In order to enhance their understanding of the basic and applied concepts taught in theory courses, corresponding practical courses are drawn up to impart required hands-on training in laboratory techniques.

In addition to the courses on Biology, students are required to do four theory and four practical courses in Chemistry in the first two years of the undergraduate curriculum. To assist students in developing good communication skills, study of four General English courses and four Additional Language courses are made mandatory during the first two years. Keeping in tune with the Philosophy of the Institute: Holistic Personality Development of students and nurturing them to grow into good human beings, living in harmony with nature and society, a short course on Environment in the first semester; and similar short courses, one in each of the six semesters, on Comparative Religion and Spirituality are included in the curriculum.

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DEPARTMENT OF BIOSCIENCES

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 / ADDITIONAL ENGLISH)

PART-II: CORE SUBJECTS
(Offered in all the six semesters) – Title 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: The title of the papers and the syllabus contents of Part-I and Part-III are provided separately.

SCHEME OF INSTRUCTION AND EVALUATION

B.Sc. (HONOURS) in BIOSCIENCES

(Effective 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	IE1	T	100
	Another Language-I #	**4**	4	IE1	T	100
Semester II						
UGEN-201	General English-II #	**5**	5	IE1	T	100
	Another Language-II #	**4**	4	IE1	T	100
Semester III						
UGEN-301	General English-III #	**5**	5	IE1	T	100
	Another Language-III #	**4**	4	IE1	T	100
Semester IV						
UGEN-401	General English-IV #	**5**	5	IE1	T	100
	Another Language-IV #	**4**	4	IE1	T	100
	PART-I TOTAL	**36** credits	**36** hours			**800** marks

1st June 2015 onwards

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	IE1	T	100
UBIO-102	Animal Diversity-I (Invertebrata)	**3**	3	IE1	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	IE1	T	100
UBIO-202	Animal Diversity–II (Chordata)	**3**	3	IE1	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	IE1	T	100
UBIO-302	Developmental Biology (Embryology of Animals)	**4**	4	IE1	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	IE1	T	100
UBIO-402	Bacteriology and Virology	**4**	4	IE1	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	IE1	T	100
UBIO-502	Animal Physiology	**4**	4	IE1	T	100
UBIO-503	Cell Biology	**4**	4	IE1	T	100
UBIO-504	Ecology and Environmental Biology	**3**	3	IE1	T	100
UBIO-505	Instrumentation	**3**	3	IE1	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	IE1	T	100
UBIO-602	Biotechnology	**4**	4	IE1	T	100
UBIO-603	Introductory Molecular Biology	**4**	4	IE1	T	100
UBIO-604	Biological Chemistry	**3**	3	IE1	T	100
UBIO-605	Introductory Immunology	**3**	3	IE1	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	IE1	T	100
UCHM-102	Laboratory course in Qualitative Inorganic Analysis	**1**	3	I	P	50
		4 credits	**6** hours			**150** marks
Semester II						
UCHM-201	Inorganic, Organic and Physical Chemistry-I	**3**	3	IE1	T	100
UCHM-202	Laboratory Course in Inorganic, Organic and Physical Chemistry-I	**1**	3	I	P	50
		4 credits	**6** hours			**150** marks
Semester III						
UCHM-301	Inorganic, Organic and Physical Chemistry-II	**4**	4	IE1	T	100
UCHM-302	Laboratory course in Inorganic, Organic and Physical Chemistry-II	**1**	3	I	P	50
		5 credits	**7** hours			**150** marks
Semester IV						
UCHM-401	Inorganic, Organic and Physical Chemistry–III	**4**	4	IE1	T	100
UCHM-402	Laboratory course in Inorganic, Organic and Physical Chemistry-III	**1**	3	I	P	50
		5 credits	**7** hours			**150** marks
PART-II TOTAL (Chemistry)		**18** credits	**26** hours			**600** marks

* IDE: Interdepartmental elective

Indicator	Legend
IE1	CIE and ESE ; ESE single evaluation
IE2	CIE and ESE ; ESE double evaluation
I	Continuous Internal Evaluation **(CIE)** only Note: 'I' does not connote 'Internal Examiner'
E	End Semester Examination **(ESE)** only Note: 'E' does not connote 'External Examiner'
E1	ESE single evaluation
E2	ESE double evaluation

Indicator	Legend
T	Theory
P	Practical
V	Viva voce
PW	Project Work
D	Dissertation

Continuous Internal Evaluation (CIE) & End Semester Examination (ESE)

PS: Please refer to guidelines for 'Modes of Evaluation for various types of papers', and 'Viva voce nomenclature & scope and constitution of the Viva voce Boards'.

1st June 2015 onwards

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-I: Education for Transformation (Based on Life and Teachings of Bhagawan Baba)	**2**	2	I	T	50
UENT-101	Environment-I: Environmental Studies and Human Values	**2**	2	I	T	75
Semester II						
UAWR-200	Awareness Course-II: Unity of Religions	**2**	2	I	T	50
UENT-201	Environment-II: Environmental Studies and Human Values	**2**	2	I	T	75
Semester III						
UAWR-300	Awareness Course-III: Eternal Values for the Changing World	**2**	2	I	T	50
Semester IV						
UAWR-400	Awareness Course-IV: Study of Classics – I: Bhagawath Vahini	**2**	2	I	T	50
Semester V						
UAWR-500	Awareness Course-V: Study of Classics – II: The Ramakatha Rasavahini	**2**	2	I	T	50
Semester VI						
UAWR-600	Awareness Course-VI: Life and its Quest	**2**	2	I	T	50
	PART-III TOTAL	**16** credits	**16** hours			**450** marks

SUMMARY

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

PART-II: CORE SUBJECT (Honours in Biosciences)

UBIO-101 **(3 CREDITS)**

PLANT DIVERSITY - I
(Algae, Fungi and Bryophytes)

Course Objectives:
To study the basic introduction to Algae, Fungi and Bryophytes

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.

UBIO-102 **(3 CREDITS)**

ANIMAL DIVERSITY – I
(Invertebrata)

Course Objectives:
To study the basic introduction to Invertebrates

1. Protozoa: Distinguishing characters and classification upto 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 7th Ed.
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., New Delhi.

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UBIO-103 **(1 CREDIT)**

PRACTICAL COURSE ON PLANT DIVERSITY – I

(Algae, Fungi and Bryophytes)

Course Objectives:
To study the available representative forms of Algae, Fungi and Bryophytes

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*.

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UBIO-104 **(1 CREDIT)**

PRACTICAL COURSE ON ANIMAL DIVERSITY – I

(Invertebrata)

Course Objectives:

To study the available representative forms of 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.

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UBIO-201 **(3 CREDITS)**

PLANT DIVERSITY - II

(Pteridophytes, Gymnosperms and Morphology of Angiosperms)

Course Objectives:

To study the basic introduction to Pteridophytes, Gymnosperms and Morphology of Angiosperms

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 **2 hrs**

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.

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UBIO-202 **(3 CREDITS)**

ANIMAL DIVERSITY – II
(Chordata)

Course Objectives:
To study the basic introduction to Chordates

I. General morphological characters of Chordates:

1. Protochordata: Structural Organisation of sub-phyla *Hemichordata*, *Urochordata* and *Cephalochordata*. Classification upto class. **3hrs** Retrogressive Metamorphosis. **1hr**
2. Division Agnatha: Distinguishing features and classification up to class. **1hr**
3. Super- class Pisces: Distinguishing features; classification up to Class of Chondrichthyes and Osteichthyes. **2hrs** Migration, Airbladder, Extrabranchial-respiratory organs; economic importance of fishes; Pisciculture. **3hrs**.
4. Amphibia: Origin and evolution of land vertebrates. **2hrs** Distinguishing features and classification of Amphibia upto sub-class. Parental care. **2hrs**
5. Reptilia: Distinguishing features and classification upto sub-class. Poisonous snakes of India, identification of poisonous snakes; biting mechanism in poisonous snakes. **4hrs** Composition of snake venom; poly-anti venoms and prophylactic treatment. **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 up to orders with special emphasis on beaks and claws. Breeding habits. **3hrs**
7. Mammalia: Distinguishing features and classification of different groups of mammals. Classification of Eutheria upto 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 and spinal cord. **4hrs**.
12. Urinogenital System: Evolution of Urinogenital system; succession of 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.

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UBIO-203 **(1 CREDIT)**

PRACTICAL COURSE ON PLANT DIVERSITY - II

(Pteridophytes, Gymnosperms and Morphology of Angiosperms)

Course Objectives:
To study the available representative forms of Pteridophytes, Gymnosperms and Angiosperms

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.

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UBIO-204 **(1 CREDIT)**

PRACTICAL COURSE ON ANIMAL DIVERSITY – II

(Chordata)

Course Objectives:
To study the available preserved specimens of chordates

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*, *Viper russelli*, *Echis carinatus*, *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; brain and eye.
2. Rabbit: Study of the skeleton: Skull; vertebral column; sternum; rib skeleton; pectoral and pelvic girdles; limb skeleton.
3. A few interesting and informative videos on Chordates to be shown.

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UBIO 301 **(4 CREDITS)**

PLANT DIVERSITY - III
(Taxonomy, Anatomy and Embryology of Angiosperms)

Course Objectives:

To study the basic introduction to Taxonomy, Anatomy and Embryology of Angiosperms

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. Vikas Publishing 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.

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UBIO-302 **(4 CREDITS)**

DEVELOPMENTAL BIOLOGY
(Embryology of Animals)

Course Objectives: To study the basic introduction to Embryology of animals

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: *Caenorhabditis elegans* **1hr**, *Drosophila* **1hr**, 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 *Caenorhabditis elegans* **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. *In vitro* fertilization and test tube babies. **2hrs**
14. Synergistic inductions. **1hr**, Stem cells – A broad overview. **1hr**

Basic texts:

1. **Scott F. Gilbert,** (2003) Developmental Biology, 7th Ed., Sinauer Associates, Inc, Sunderlands, Massachusets.
2. **P.S. Verma and 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.

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UBIO-303 **(1 CREDIT)**

PRACTICAL COURSE ON PLANT DIVERSITY - III

(Taxonomy, Anatomy and Embryology of Angiosperms)

Course Objectives: To study the Taxonomy, Anatomy and Embryology of locally available representative forms

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* & *Zea mays*

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.

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UBIO-304 **(1 CREDIT)**

PRACTICAL COURSE ON DEVELOPMENTAL BIOLOGY

(Embryology of Animals)

Course Objectives: To understand the developmental stages of animals using permanent slides.

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. and 96hrs. 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*.

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UBIO-401 **(4 CREDITS)**

BIOSTATISTICS

Course Objectives: To study the quantitative methods for summarizing biological data.

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.

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UBIO-402 **(4 CREDITS)**

BACTERIOLOGY AND VIROLOGY

Course Objectives: To study the fundamentals of bacterial and viral diversity and their effects on human health.

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.

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UBIO-403 **(1 CREDIT)**

PRACTICAL COURSE ON BIOSTATISTICS

Course Objectives: To study the application of quantitative methods for summarizing and visual representation of biological data.

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.

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UBIO-404 **(1 CREDIT)**

PRACTICAL COURSE ON BACTERIOLOGY AND VIROLOGY

Course Objectives: To study practical aspects of isolation and culturing of bacteria in laboratory setup.

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).

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UBIO-501 **(4 CREDITS)**

PLANT PHYSIOLOGY

Course Objectives: To study the physiological processes in plants.

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 texts:

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.

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UBIO-502 **(4 CREDITS)**

ANIMAL PHYSIOLOGY

Course Objectives: To study the physiological processes in animals.

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 concept of "Second Messenger" and its role in hormone function. **2hrs**

Basic texts:

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

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UBIO-503 **(4 CREDITS)**

CELL BIOLOGY

Course Objectives: To study the fundamental aspects of cell structure and function.

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 organisation and functions of mitochondria; **2 hrs** biogenesis of Mitochondria. Bioenergetics **3hrs**

10. Plastids: Chloroplasts and other plastids; molecular organisation 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 organisation 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 signalling – Overview: Signalling 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.

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UBIO 504 **(3 CREDITS)**

ECOLOGY AND ENVIRONMENTAL BIOLOGY

Course Objectives: To study fundamental aspects of ecology and environment.

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. 3rd Ed., Students' Friends & Co.
2. **E.P. Odum,** (1971) Fundamentals of ecology, 3rd Ed., 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.

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UBIO-505 **(3 CREDITS)**

INSTRUMENTATION

Course Objectives: To study the fundamentals of analytical techniques in biological sciences.

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.

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UBIO-506 **(1 CREDIT)**

PRACTICAL COURSE ON PLANT PHYSIOLOGY

Course Objectives: To study practical methods in understanding plant physiology.

(Any ten experiments)

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.

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UBIO-507 **(1 CREDIT)**

PRACTICAL COURSE ON ANIMAL PHYSIOLOGY

Course Objectives: To study practical methods in understanding animal physiology.

(Any ten experiments)

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.

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UBIO-508 **(1 CREDIT)**

PRACTICAL COURSE ON CELL BIOLOGY

Course Objectives: To study basic methods to understand the cell structure and function.

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 *Rheo discolor* anthers smear.
10. Karyotype analysis
11. Microtomy

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UBIO-509 **(1 CREDIT)**

PRACTICAL COURSE ON 504 AND 505

Course Objectives: To study practical methods in ecology and environment. To study basic bio-analytical techniques.

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.

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UBIO-601 **(4 CREDITS)**

GENETICS AND EVOLUTION

Course Objectives: To study the fundamentals of genetics and evolution.

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 DeVries; 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., Mc Graw Hill Publishing.
2. **Veer Bala Rastogi,** (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.

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UBIO-602 **(4 CREDITS)**

BIOTECHNOLOGY

Course Objectives: To study the application of various organisms for human welfare.

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.

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UBIO-603 **(4 CREDITS)**

INTRODUCTORY MOLECULAR BIOLOGY

Course Objectives: To study the fundamental aspects of molecular biology.

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 for each 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 tRNA synthetase 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.

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UBIO-604 **(3 CREDITS)**

BIOLOGICAL CHEMISTRY

Course Objectives: To study the fundamental aspects of chemistry of biomolecules.

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 amino acids – 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.

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UBIO-605 **(3 CREDITS)**

INTRODUCTORY IMMUNOLOGY

Course Objectives: To study the fundamental aspects of human immune system.

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. **2hrs**

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. **2hrs** Epitopes-properties, Haptens and antigenicity, pattern recognition receptors. **2hrs**

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.

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UBIO-606 **(1 CREDIT)**

PRACTICAL COURSE ON BIOTECHNOLOGY

Course Objectives: To study practical methods in plant tissue 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.

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UBIO-607 **(1 CREDIT)**

PRACTICAL COURSE ON INTRODUCTORY MOLECULAR BIOLOGY

Course Objectives: To study basic methods in isolation and quantification of DNA and RNA

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. Quantitative estimation of RNA (Orcinol method).
9. Separation of DNA fragments by Agarose gel Electrophoresis.
10. Separation of proteins by SDS – PAGE Electrophoresis.

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UBIO-608 **(1 CREDIT)**

PRACTICAL COURSE ON BIOLOGICAL CHEMISTRY

Course Objectives: To study basic methods in isolation and quantification of micro and macro biomolecules.

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.

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UBIO-609 **(1 CREDIT)**

PRACTICAL COURSE ON GENETICS AND IMMUNOLOGY

Course Objectives:

- To understand the concepts of genetics and inheritance through problem solving.
- To study basic practical techniques in immunology.

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.

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