KOLHAN UNIVERSITY, CHAIBASA

Proposed Syllabus for FYUGP, NEP-2020
B.Sc. (Hons.) Zoology
(Effective from Academic Year 2022-23 onwards)

Draft Prepared by:

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DEPARTMENT OF ZOOLOGY, K.U. FYUGP 2022 ONWARDS

Credit distribution for the course:

Semester	Course Code	Course Name/ Paper	Credits (Theory + Practical)
I	MDC-1/2/3	Human Physiology	3 + 0
	MN-1A	Food, Nutrition & Health	3 + 1
	MJ-1	Diversity of Life- Protists to Echinoderms	3 + 1
II	MN-2A	Sericulture	3 + 1
	MJ-2	Diversity of Chordates	3 + 1
	MJ-3	Comparative Anatomy of Vertebrates	3 + 1
III	MN-1B	Apiculture	3 + 1
	MJ-4	Principles of Ecology	3 + 1
	MJ-5	Cell Biology and Histology	3 + 1
IV	MN-2B	Pisciculture	3 + 1
	MJ-6	Animal Physiology - I	3 + 1
	MJ-7	Fundamentals of Biochemistry	3 + 1
	MJ-8	Evolutionary Biology	3 + 1
V	MN-1C	Wildlife Conservation & Management	3 + 1
	MJ-9	Animal Physiology - II	3 + 1
	MJ-10	Metabolism	3 + 1
	MJ-11	Developmental Biology	3 + 1
	IAP	Internship/ Apprenticeship/ Field Work/ Dissertation/ Project	4 + 0
VI	MN-2C	Medical Diagnostics	3 + 1
	MJ-12	Genetics	3 + 1
	MJ-13	Molecular Biology	3 + 1
	MJ-14	Microbiology	3 + 1
	MJ-15	Immunology	3 + 1

VII	MN-1D	Genetic Counselling	3 + 1
	MJ-16	Biotechnology	3 + 1
	MJ-17	Biostatistics and Bioinformatics	3 + 1
	MJ-18	Animal Behaviour and Chronobiology	3 + 1
	MJ-19	Endocrinology	3 + 1
VIII	MN-2D	Aquarium Fish Keeping	3 + 1
	MJ-20	Tools and Techniques	3 + 1
	RC or AMJ-1 AMJ-2 AMJ-3	Research Internship/Field Work/Dissertation or Entomology (Disciplinary/Interdisciplinary Major) Fish and Fisheries (Disciplinary/Interdisciplinary Major) Practical (based on AMJ -1 & AMJ – 2) (Disciplinary/Interdisciplinary Major)	12 or 4 4 4
		Total Credits	**160**

INSTRUCTION TO QUESTION SETTER

SEMESTER INTERNAL EXAMINATION (SIE)

There will be only one Semester Internal Examination in Major, Minor and Research Courses, which will be organized at college/ institution level. However, only one End semester evaluation in other courses will be done either at College/ Institution or University level depending upon the nature of course in the curriculum.

(SIE 10 + 5 = 15 marks):

There will be two group of questions. Question No.1 will be very short answer type in Group A consisting of five questions of 1 mark each. Group B will contain descriptive type two questions of five marks each, out of which any one to answer.

The Semester Internal Examination shall have two components:

(a) One Semester Internal Assessment Test (SIA) of 10 Marks
(b) Class Attendance Score (CAS) of 5 marks.

Conversion of Attendance into score may be as follows:

Attendance Up to 45%, 1 mark;
45<Attendance <55, 2 marks;
55< Attendance 65, 3 marks;
65<Attendance<75, 4 marks;
75<Attendance, 5 marks.

END SEMESTER UNIVERSITY EXAMINATION (ESE)

ESE (60 marks) **Time : 3 Hours**

- There will be two groups of questions.
- Group A is compulsory which will contain 3 Questions.
- Question number 1 will be very short answer type consisting of five Questions of 1 mark each.
- Question number 2 and 3 will be short answer type of 5 marks.
- Group B will contain the descriptive type 5 questions of 15 marks out of which any 3 are to be answered.
- Numbers in right indicate full marks of the question.

Multi-Disciplinary Course (MDC)
Human Physiology

Theory (Credits 3):

UNIT I: Digestion and Excretion **8 hrs**

Food intake and breakdown with the help of different enzymes; Liver disorders; Mechanism of excretion and urine formation.

UNIT II: Nerve and Muscle **8 hrs**

Structure and type of neurons and brief introduction of neuroglia; Brain centers including grey and white matter; Structure of muscles. Mechanism of muscle contraction.

UNIT III: Respiration **7 hrs**

Respiration and breathing; Muscles involved in breathing; Exchange and transportation of gases.

UNIT IV: Circulation **6 hrs**

Structure of heart. Blood cells and blood vessels. Cardiac cycle. ECG.

UNIT V: Reproduction **8 hrs**

Types of Reproduction. Spermatogenesis and oogenesis. Fertilization and Foetal Development.

UNIT VI: Endocrine glands and hormones **8 hrs**

Structure and function of endocrine glands *viz*., pituitary, thyroid, pancreas and adrenal.

Recommended Readings:

- Tortora, G.J. and Derrickson, B.H. (2009) Principles of Anatomy and Physiology (12th edition) John Wiley and Sons, Inc.
- Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander's Human Physiology (9th edition) McGraw Hill.
- Guyton, A.C. and Hall, J.E. (2011) Textbook of Medical Physiology (12th edition) Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
- Marieb, E. (1998) Human Anatomy and Physiology (4th edition) Addison-Wesley.
- Kesar, S. and Vashisht, N. (2007) Experimental Physiology, Heritage Publishers.

Minor Paper 1A (MN 1A): Food, Nutrition & Health

Credits: Theory:03
Practical: 01
Total: 04

Theory (03 Credits):

UNIT I: Basic concept of food and nutrition **11 hrs**

Food components: Major and supplementary components; Concept of a balanced diet, nutrient needs and dietary pattern for various groups- adults, pregnant and nursing mothers, infants, school children, adolescents and elderly.

UNIT II: Nutritional Biochemistry **11 hrs**

Carbohydrates, Lipids, Proteins: their dietary source and role; Vitamins: their dietary source and importance; Minerals: their biological functions. Dietary Fibres: definition, their dietary source and nutritional importance. Elementary idea of Probiotics, Prebiotics, Organic Food.

UNIT III: Health **12 hrs**

Definition and concept of health, Major nutritional Deficiency diseases- (kwashiorkor and marasmus), Deficiency disorders, their causes, symptoms, treatment, prevention and government programmes, if any. Life style related diseases- hypertension, diabetes mellitus, obesity- their causes and prevention through dietary and lifestyle modifications.

UNIT IV: Food hygiene **11 hrs**

Food and Water borne infections; Bacterial infection: Cholera, typhoid fever, dysentery; Viral infection: Hepatitis, Poliomyelitis; Protozoan infection: amoebiasis, giardiasis; Parasitic infection: taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention.

Recommended Readings:

- Shashi Goyal & Pooja Gupta. Food, Nutrition and Health (ISBN: 9788121940924)
- Linda Tapsell. Food, Nutrition and Health. I Edition, Oxford (ISBN: 978-0195518344)
- Gibney MJ et al. (eds) (2009) Introduction to Human Nutrition. Wiley-Blackwell A John Wiley & Sons Ltd, Nutritional Society.
- Mann J and Truswell SA, Essentials of Human Nutrition, Oxford University Press
- Yuan Kun Lee and Seppo Salminen: Handbook of Probiotics and Prebiotics, second ed., John Viley & Sons, Inc.
- James Robinson, Deborah J McCornick, Concepts in Health and Wellness, Delmar Cenage Learning, 1st ed

- Jeremy Hawker, Norman Begg, Iain Blair, Ralf Reintjes, Julius Weinberg, Communicable Disease Control Handbook, 2nd ed
- Clive de W Blackburn, Food Spoilage Microorganisms, Woodhead Publishing Limited, cambridge
- Avantina Sharma. Principles of Therapeutic Nutrition and Dietetics.. CBS Publishers and Distributors Pvt. Ltd.
- Elia M et al. (eds) Clinical Nutrition. Wiley-Blackwell A John Wiley & Sons Ltd.

Practical (01 Credits): 30 hours

1. To detect adulteration in a) Ghee/Butter b) Sugars c) Tea leaves and d) Turmeric.
2. Ascorbic acid estimation in food by titrimetry.
3. Study of the stored grain pests from slides/photographs (*Sitophilus oryzae, Trogoderma granarium, Callosobruchus chinensis*and *Tribolium castaneum*): their identification, habitat and food sources, damage caused and control. Preparation of temporary mounts of the above stored grain pests.
4. Report on visit to food testing lab /or any agency of food standards.
5. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Practical Examination: (25 Marks)

1. Adulteration Expt. (8 Marks)
2. Estimation Expt./Spotting (7 Marks)
3. Visit Report (4 Marks)
4. Practical record (3 Marks)
5. Viva-voce (3 Marks)

Semester I

Major Paper 1 (MJ 1) : Diversity of Life- Protists to Echinoderms

Credits: Theory: 03
Practical: 01
Total: 04

Theory (03 Credits): **45 hours**

UNIT I: Introduction to Animalia **2 hours**

General Characteristics of Kingdom Animalia and Basis of Classification

UNIT II: Protista **4 hours**

Protista: General characteristics and Classification up to classes; Locomotion and Reproduction in Protista

UNIT III: Porifera **4 hours**

Porifera: Introduction to Parazoa; General characteristics and Classification up to classes; Canal system in sponges

UNIT IV: Cnidaria **5 hours**

Evolution of Metazoa, Cnidaria: General characteristics and Classification up to classes; Polymorphism in Cnidaria.

UNIT V: Ctenophora **3 hours**

Ctenophora: General characteristics and evolutionary significance

UNIT VI: Helminthes **5 hours**

Platyhelminthes and Nemathelminthes: General characteristics and Classification up to classes; Parasitic adaptations in helminthes.

UNIT VII: Annelida **4 hours**

Annelida: General characteristics and Classification up to classes; Role of Nephridia in excretion among Annelids.

UNIT VIII: Arthropoda **6 hours**

Arthropoda: General characteristics and Classification up to classes, Vision and Respiration in Arthropoda

UNIT IX: Onychophora **2 hours**

Onychophora: General characteristics and Evolutionary significance.

UNIT X: Mollusca **5 hours**

Mollusca: General characteristics and Classification up to classes; Torsion and detorsion in Gastropoda.

UNIT XI: Echinodermata **5 hours**

Echinodermata: General characteristics and Classification up to classes; Water-vascular system in Echinoderms.

Recommended Readings:

- Barnes, R.D. (2006) Invertebrate Zoology. VII Edition, Cengage Learning, India.
- Barnes, R. S. K.; Calow, P.; Olive, P. J. W.; Golding, D. W.; Spicer, J. I. (2002) The Invertebrates: a Synthesis, Blackwell Publishing.
- Pechenik, J. A. (2015) Biology of the Invertebrates. VII Edition, McGraw-Hill Education
- Hickman, C.; Roberts, L.S.; Keen, S.L.; Larson, A. and Eisenhour, D. (2018) Animal Diversity, McGraw-Hill.
- Holland, P. (2011) The Animal Kingdom: A Very Short Introduction, Oxford University Press.
- Barrington, E.J.W. (2012) Invertebrate Structure and Functions. II Edition, EWP Publishers.
- Ruppert, E.E., Fox, R.S., Barnes, R. D. (2003) Invertebrate Zoology: A Functional Evolutionary Approach. VII Edition, Cengage Learning, India.

Practical (01 Credit): **30 hours**

1. Study of following permanent slides/ specimens: *Amoeba, Paramecium*, *Sycon, Obelia, Physalia, Taenia solium*, Male and female *Ascaris lumbricoides*, *Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Limulus, Palamnaeus, Scolopendra, Julus, Periplaneta, Chiton, Dentalium, Pila, Unio, Octopus, Pentaceros, Echinus, Cucumaria.*
2. Study of Digestive and Nervous system of Earthworm.
3. Mounting of septal nephridia.
4. Submission of project report on study of animals in nature during a survey of a National Park/ Biodiversity parks/ Zoological Museum.
5. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Practical Examination: **(25 Marks)**

1. Spotting (8 Marks)
2. Dissection and mounting (4+3 Marks)
3. Visit Report (4 Marks)
4. Practical record (3 Marks)
5. Viva-voce (3 Marks)

MN- 2A: Sericulture

Credits: **Theory:03**

Practical: 01

Total: 04

Theory (03 Credits): **45 hours**

UNIT I: Introduction to Sericulture **5 hours**

Sericulture: Definition, history and present status; Silk route; Types of silkworms, Distribution and races; Exotic and indigenous; Mulberry sericulture; Non-mulberry Sericulture, Eri, Muga, Tassar.

UNIT II: Biology of Silkworm **5 hours**

Life cycle of *Bombyx mori*; Structure of silk gland and secretion of silk; Composition and properties of silk.

UNIT III: Rearing of Silkworms **15 hours**

Selection of mulberry variety and establishment of mulberry garden, Rearing house and rearing appliances, Disinfectants: Formalin, bleaching powder, RKO Silkworm rearing technology: Early age and Late age rearing, Types of mountages, Harvesting and storage of cocoons, Postharvest technology- Silk reeling, Dyeing and weaving, Ahimsa silk

UNIT IV: Pests and Diseases **15 hours**

Pests of silkworm: Uzi fly, dermestid beetles and vertebrates; Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial; Control and prevention of pests and diseases

UNIT V: Silk Industry and Its Importance **5 hours**

Silk usage and application in Textile and non-textile industry, Sericulture industry in India

Recommended Readings:

- Manual on Sericulture (1976); Food and Agriculture Organisation, Rome.
- Ullal, S.R. and Narasimhanna M.N. (1987) Handbook of Practical Sericulture; 3rd Edition, CSB, Bangalore.
- Yonemura, M. and Rama Rao, N. (1951) A Handbook of Sericulture. I. Rearing of silk-worms. Government Branch Press, Mysore.
- Ananthanarayanan, S. K. (2008) Silkworm Rearing. Daya Publishing House
- Aruga, H. (1994). Principles of Sericulture. CRC Press.
- Sathe, T. V. and Jadhav, A. (2002) Sericulture and Pest Management. Daya Publishing House.
- Yup-Lian, L. (1991) Silkworm Diseases. Food and Agricultural Organization.

Practical (01 Credits): **30 hours**

1. Study of the life cycle of different species of silk moths - *Bombyx mori*, *Philosamia ricini*, *Antherea paphia*/*Antherea mylitta*, *Antherea assama* and silk secreted by them.
2. Study of the sexual dimorphism in caterpillar, pupae and adults of *Bombyx mori*.
3. Study of the structure of silk gland of silk worms.
4. Study of rearing house and different appliances used in rearing of silk worms.
5. Analysis of silk fibre quality- Visual examination, thickness, purity.
6. Study of silkworm diseases and their control- Pebrine, Flacherie, Grasserie, Muscardine.
7. Submission of a report on visit to a 'Sericulture Institute'/'Various Sericulture Centres in India'.
8. Group discussion or Seminar presentation from any topic from the paper

Pattern of Examination: **(25 Marks)**

1. Life cycle of any silkworm (4 Marks)
2. Analysis of silk fibre quality (3 Marks)
3. Spotting (8 Marks)
    a. Sexual dimorphism (2 Marks)
    b. Silk gland (2 Marks)
    c. Appliance used in Silk rearing (2 Marks)
    d. Silkworm disease (2 Marks)
4. Visit Report (4 Marks)
5. Practical record (3 Marks)
6. Viva-voce (3 Marks)

Semester II

Major Paper 2 (MJ 2) : Diversity of Chordates

Theory (03 Credits): 45 hours

UNIT I: Introduction to Chordates **2 hours**
General characteristics and outline classification of Chordates.

UNIT II: Protochordata **6 hours**
Specific characteristics of Hemichordata, Urochordata and Cephalochordata; Retrogressive metamorphosis in Urochordata

UNIT III: Origin of Chordates **2 hours**
Dipleurula concept and the Echinoderm theory of origin of chordates

UNIT IV: Agnatha **2 hours**
Specific characteristics of Agnatha and classification up to Class

UNIT V: Pisces **6 hours**
Specific characteristics of Pisces*, Classification up to class, Migration and Osmoregulation in Fish
*Comparative account or difference between classes should be discussed and emphasis also will be given to lateral line system.

UNIT VI: Amphibia **6 hours**
Origin of Tetrapoda, Amphibia: Specific characteristics and classification up to order; Introduction to Parental care in Amphibians

UNIT VII: Reptilia **6 hours**
Reptilia: Specific characteristics and classification up to order; Poison apparatus, feeding and biting mechanism in snakes

UNIT VIII: Aves **6 hours**
Aves: Specific characteristics and classification up to order; Flight adaptations and migration in birds

UNIT IX: Mammals **6 hours**
Mammals: Specific characters and classification up to order, Adaptive radiation with reference to locomotory appendages

UNIT X: Zoogeography **3 hours**

Zoogeographical realms, Distribution of vertebrates in different realms

Recommended Readings:

- Young, J. Z. (2004) The Life of Vertebrates. III Edition. Oxford university press.
- Hickman, C.; Roberts, L.S.; Keen, S.L.; Larson, A. and Eisenhour, D. (2018) Animal Diversity, McGraw-Hill.
- Holland, P. (2011) The Animal Kingdom: A Very Short Introduction, Oxford University Press.
- Darlington P.J. (1966). The Geographical Distribution of Animals, R.E. Krieger Pub. Co.

Major Paper 3 (MJ 3) : Comparative Anatomy of Vertebrates

Theory (03 Credits): (45 hours)

UNIT I: Integumentary System **5 hours**
Structure and derivatives of integument, functions of skin.

UNIT II: Skeletal System **12 hours**
Outline of axial and appendicular skeleton (tetrapod): basic plan of bones of skull, girdles and limbs. Classification of vertebrae, structure of a typical vertebra (basic layout), Jaw suspensorium, Visceral arches.

UNIT III: Digestive System **4 hours**
Alimentary canal and associated glands, dentition.

UNIT IV: Respiratory System **4 hours**
Skin, gills, lungs and air sacs; Accessory respiratory organs.

UNIT V: Circulatory System **6 hours**
General plan of circulation, Evolution of heart and aortic arches.

UNIT VI: Urinogenital System **6 hours**
Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri.

UNIT VII: Nervous System **5 hours**
Comparative account CNS, PNS, ANS with special emphasis on brain (from formation to partitioning); Cranial nerves in mammals.

UNIT VIII: Sense Organs **3 hours**
Classification of receptors (organ of special senses); Brief account of visual and auditory receptors in man.

Recommended Readings:

- Kardong, K.V. (2005). Vertebrate's Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
- Leiem C.F., Bermis W.E, Walker, W.F, Grande, L. (2001). Functional anatomy of the vertebrates, An evolutionary perspective. III Edition, Brookes/Cole, Cengage Learning.

- C.K Weichert and W. Presch (1970). Elements of Chordate Anatomy, IV Edition, McGraw- Hill.
- Pough.H. (2018). Vertebrate Life.X Edition. Pearson International.

MJ 2 (Practical) (02Credits): (60 hours)

(Based on theory papers MJ2 and MJ3)

1. Study of following specimens: *Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Myxine, Scoliodon, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis, Salamandra, Bufo, Hyla, Chelone, Chamaeleon, Draco, Vipera, Naja, Crocodylus*, Any three common birds from different orders, *Bat, Loris.*
2. Key for identification of poisonous and non-poisonous snakes on the basis of tail, scales, fangs, nature of venom and other morphological features.
3. Types of beaks and claws in birds.
4. Study of placoid, cycloid and ctenoid scales of fish through temporary mounts/permanent slides/photographs.
5. Study of different types of feathers of birds through demonstrations/photographs.
6. Comparative Osteology: Disarticulated skeleton of Frog, *Varanus*, Fowl, Rabbit (Limb bones, Girdles).
7. Study of carapace and plastron of turtle/tortoise through specimen/ model/photographs.
8. Submission of project report on study of animals in nature during a survey of a National Park/ Biodiversity parks/ Zoological Museum.
9. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Examination: **50 Marks**

1. Spotting
    a. (6 specimens × 2 marks) (12 Marks)
    b. Osteology- at least one from each class (8 Marks)
2. Key for Identification of poisonous and non-poisonous snakes. (3 Marks)
3. Types of beaks and claws in birds (3 Marks)
4. Scales (1) and Feathers (1) Identification (5 Marks)
5. Carapace/Plastron Identification (4 Marks)
6. Visit Report (5 Marks)
7. Practical record (5 Marks)
8. Viva-voce (5 Marks)

MN- 1B: Apiculture

Credits: **Theory:03**
Practical: 01
Total: 04

Theory (03 Credits): **45 hours**

UNIT I: Biology of Bees **10 hrs**

History, Classification and biology of Honey Bees, different species of honey bees- *Apis dorsata, Apis cerana indica, Apis florea, Apis mellifera*, *Melipona* sp. Social Organization of bee colony, behavioural patterns (Bee dance, swarming).

UNIT II: Rearing of Bees **15 hrs**

Artificial bee rearing (Apiary), Beehives- Newton and Langstroth; Bee Pasturage; Selection of bee species for Apiculture- *Apis cerana indica, Apis mellifera*; Bee keeping equipment, Methods of extraction of Honey (Indigenous and Modern) and processing; Apiary management- Honey flow period and Lean period.

UNIT III: Diseases and Enemies **6 hrs**

Bee diseases, control and preventive measures; Enemies of bees and their control.

UNIT IV: Bee Economy **7 hrs**

Products of Apiculture Industry (Honey, Bees Wax, Propolis, Royal jelly, Pollen etc.) and their uses; Modern methods in employing artificial beehives for cross pollination in horticultural gardens.

UNIT V: Entrepreneurship in Apiculture **7 hrs**

Bee Keeping Industries- Recent efforts, Employment opportunities, Economics in small scale and large-scale beekeeping, Scope for women entrepreneurs in beekeeping sector.

Recommended Readings:

- Singh S. (1962) Beekeeping in India, Indian Council of Agricultural Research, New Delhi.
- Mishra, R. C. (1995) Honeybees and their Management in India. Indian Council of Agricultural Research, New Delhi.
- Prost, P. J. (1962) Apiculture. Oxford and IBH, New Delhi.
- Rahman, A. (2017) Beekeeping in India. Indian Council of Agricultural Research, New Delhi.
- Gupta, J. K. (2016) Apiculture, Indian Council of Agricultural Research, New Delhi.

Practical (01 Credit): **30 hours**

1. Study of the life cycle of honey bee from specimen/ photographs - Egg, larva, pupa, adult (queen, drone, worker).

2. Study of natural bee hive and identification of queen cells, drone cells and brood.
3. Study of morphological structures of honey bee through permanent slides/photographs: mouth parts, antenna, wings, legs (antenna cleaner, mid leg, pollen basket), sting apparatus.
4. Study of artificial hive (Langstroth/Newton), its various parts and beekeeping equipment.
5. Visit to an apiary/honey processing unit/Institute and submission of a report.
    a. Study of bee pasturage
    b. Visit to fields/gardens/orchards for studying the bee activity (role in pollination and nectar collection).
    c. Making of herbarium of nectar and pollen yielding flowering plants
6. Submission of a few products obtained from apiculture industry.
7. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Practical Examination: **(25 Marks)**

1. Life cycle of honey bee (3 Marks)
2. Spotting (4 spotting × 3 marks = 12 Marks)
    a. Mouth part/ antenna/ wing/ leg
    b. Sting apparatus
    c. Any type of artificial hive/ bee product
    d. Any beekeeping equipment
3. Visit Report (4 Marks)
4. Practical record (3 Marks)
5. Viva-voce (3 Marks)

Semester III

Major Paper 4 (MJ 4) : Principles of Ecology

Credits: **Theory:03**
Practical: 01
Total: 04

Theory (03 Credits): **45 hours**

UNIT I: Introduction to Ecology **3 hrs**

History and Scope of ecology, Autecology and synecology, Laws of limiting factors, Study of physical factors: Temperature and Light.

UNIT II: Population **18 hrs**

Unitary and Modular populations; Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion; Exponential and logistic growth, equation and patterns, *r* and *k* strategies, Population regulation; Density-dependent and independent factors; Population interactions; Gause's Principle with laboratory and field examples; Lotka-Volterra equation for competition and predation.

UNIT III: Community **8 hrs**

Community characteristics: species richness, dominance, diversity, abundance, Guilds, Ecotone and edge effect; Ecological succession with examples and types; Theories pertaining to climax community.

UNIT IV: Ecosystem **12 hrs**

Types of ecosystems with detailed study of any one: Forest Ecosystem, Pond or Lake ecosystem, Mangrove and Coral reef ecosystem. Vertical stratification in Forest and Aquatic ecosystem, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies, Nutrient and biogeochemical cycle with one example of Nitrogen cycle.

UNIT V: Applied Ecology **4 hrs**

Ecology in wildlife conservation and management, Biodiversity types, Importance & threats, Protected areas: National Parks, Bioreserves and Sanctuaries, Global climate change and its mitigation.

Recommended Readings:

- Odum, E.P. (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole

- Smith, R. L. (2000). Ecology and field biology. Harper and Row publisher
- Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
- Ricklefs, R.E. (2000). Ecology. V Edition. Chiron Press.

Practical (01 Credit): (30 hours)

1. Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community.
2. Study of an aquatic ecosystem: phytoplankton and zooplankton, measurement of area, temperature, turbidity/penetration of light, determination of pH, and dissolved oxygen content (Winkler's method), chemical oxygen demand and free CO2, alkalinity.
3. Report on a visit to National Park/Biodiversity Park/Wildlife sanctuary.
4. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Practical Examination: 25 Marks

1. Spotting (2 spotting × 2.5 marks = 5 Marks)
    a. Any one phytoplankton
    b. Any one zooplankton
2. Determination of population density and calculation of diversity index or Determination of pH and dissolved oxygen content in given water sample. (10 Marks)
3. Visit Report (3 Marks)
4. Practical record (3 Marks)
5. Viva-voce (4 Marks)

Major Paper 5 (MJ 5) : Cell Biology and Histology

Credits: **Theory: 03**
Practical: 01
Total: 04

Theory (03 Credits): **(45 hours)**

UNIT I: Overview of Cells **2 hrs**
Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions

UNIT II: Plasma Membrane **5 hrs**
Various models of plasma membrane structures, Transport across membranes: active and passive transport, facilitated transport; Cell-cell junctions, structures and functions: Tight junctions, adherens junctions, gap junctions

UNIT III: Endomembrane System **12 hrs**
Structure and Functions: Endoplasmic Reticulum, Signal hypothesis, Vesicular transport from ER to Golgi apparatus; Protein sorting and transport from Golgi apparatus; Golgi apparatus, Vesicular transport: Coated Vesicles; Lysosomes; Peroxisomes.

UNIT IV: Mitochondria **6 hrs**
Structure, Semi-autonomous nature, Endo-symbiotic hypothesis; Respiratory chain, Chemiosmotic hypothesis and ATP Synthase.

UNIT V: Cytoskeleton **4 hrs**
Structure and Functions: Microtubules, Microfilaments and Intermediate filaments.

UNIT VI: Nucleus, Cell Division and Cell Signalling **8 hrs**
Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Transport of molecules across nuclear membrane, Nucleolus, Mitosis, Meiosis, Cell cycle and its regulation, Basics of Cell Signalling, Apoptosis.

UNIT VII: Histology **8 hrs**
Introduction to tissues. Epithelial tissue: types, structure and characteristics. surface modifications. Basement membrane: structure and characteristics. Connective tissue cells. Blood: structure and functions. Structure and function of loose, dense and adipose tissue. Structure of Cartilage and bone. Muscular tissue: ultrastructure of smooth, skeletal and cardiac muscles. Structure and classification of neurons. Types of supporting (glial) cells and their function. Membranes of the brain and spinal cord.

Recommended Readings:

- Cooper, G.M., Hausman, R.E. (2009) The Cell: A Molecular Approach. V Edition, ASM Press and Sinauer Associates.
- Becker, Kleinsmith, and Hardin (2009) The World of the Cell,VIII Edition, Benjamin Cummings Publishing, San Francisco.
- Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments,VI Edition, John Wiley & Sons Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2009) The Cell and Molecular Biology, Lippincott Williams & Wilkins, Philadelphia.
- Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Robert Keith and Watson James. (2008). Molecular Biology of the Cell, V Edition, Garland publishing Inc., New York and London.

Practical (01 Credit): (30 hours)

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis.
2. Study of various stages of meiosis.
3. Preparation of temporary stained mount to show the presence of Barr body in human female blood cells/ cheek cells.
4. Study of types of tissue through permanent slides: epithelial, connective, muscular, nervous.
5. Study of histology of tissues by preparing permanent stained slides through microtomy.
6. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Practical Examination: 25 Marks

1. Spotting (3 spotting × 2 marks = 6 Marks)
    a. Permanent slide of any one mitosis or meiosis stage
    b. Permanent slide of any two types of mammalian tissue
2. Preparation of temporary stained squash of onion root tip or Barr body in human female blood cells/ cheek cells (10 Marks)
3. Practical record (4 Marks)
4. Viva-voce (5 Marks)

Semester IV

Minor Paper: 2B Pisciculture

Credit: Theory: 03
Practical: 01
Total: 04

UNIT I	**Objective of fish culture:** Qualities of cultivable species of fishes.	(5 hrs)
UNIT II	**Types of cultivable fishes:** Qualities of major carps, Breeding habits of cultivable fishes with special reference to major carps	(5 hrs)
UNIT III	**Fish culture programming**	(5 hrs)
UNIT IV	**Factors in fish culture:** Physical factors, Chemical factors, biological factors	(5 hrs)
UNIT V	**Induced breeding by hypophysation**	(5 hrs)
UNIT VI	**Fishing methods in India:** Fishing crafts and gear	(5 hrs)
UNIT VII	**Entrepreneurship Development through value addition of fish and fishery products** a) Stakeholder's determination b) Product development c) Marketing and marketing mix d) Market competition e) Consumer satisfaction f) Economic aspects for entrepreneurship development	(15 hrs)

Recommended Reading

- Arumugam N., **Aquaculture and Fisheries**, Saras Publication
- Khanna S.S., Singh H.R., **A Textbook of Fish Biology and Fisheries**
- Rath R.K., **Freshwater Aquaculture**, 3rd Revised and Enlarged Edition
- Bhosale M.M., Mugale R.R., Dutta G.K., **Basic Principles and Practices in Aquaculture**

Practical (01 Credit) – 30 hours

1. **Taxonomic Description** up to species of important freshwater, local, and marine fishes.
2. **Physical, Biochemical, and Microbiological Methods** to examine freshness of fish.
3. **Methods of Transportation of Seeds**
4. **Modern Crafts and Gears**
5. **Adaptation / Plankton** Collection and identification of aquatic plants, weeds, and planktons.
6. **Report on Visit to Aquaculture Centre**

Pattern of Examination:

1. Taxonomic Description – 8 marks
2. Spotting – 7 marks
3. Visit Report – 4 marks
4. Practical Record – 8 marks
5. Viva-voce – 3 marks

Semester IV

Major Paper 6 (MJ 6) : Animal Physiology – I

Credits: Theory: 03
Practical: 01
Total: 04

Theory (03 Credits): 45 hours

UNIT I: Tissues **4 hrs**

Structure, location, classification, embryonic origin and functions of Epithelial tissue, Connective tissue, Muscular tissue and Nervous tissue.

UNIT II: Bone and Cartilage **2 hrs**

Histology of different types of bones and cartilages.

UNIT III: Nervous System **8 hrs**

Structure of neuron, Resting membrane potential, Origin of action potential and its propagation across the myelinated and non-myelinated nerve fibers; Types of synapse, Synaptic transmission, Neuromuscular junction; Physiology of hearing and vision.

UNIT IV: Muscle **10 hrs**

Histology of different types of muscle; Ultrastructure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, Summation and tetanus.

UNIT V: Reproductive System **6 hrs**

Histology of testis and ovary; Functioning of male and female reproductive system.

UNIT VI: Endocrine System **15 hrs**

Histology of endocrine glands- pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; Hormones secreted by them and their physiological action; Classification of hormones; Regulation of their secretion; Mode of hormone action- Signal transduction pathways for steroidal and non-steroidal hormones.

Recommended Readings:

- Tortora, G.J. and Grabowski, S. (2006). Principles of Anatomy & Physiology. XI edition. John Wiley & Sons.

- Vander, A., Sherman, J., and Luciano, D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, Mc Graw Hills.
- Ganong, W.F. (2019) Review of Medical Physiology. 26th Edition, Mc Graw-Hill.
- Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourtm Asia PTE Ltd/W.B. Saunders Company.
- Marieb, E.N. (1998) Human Anatomy and Physiology. IV Edition, Addison Wesley Longman Inc.

Practical (01 credit): 30 hours

1. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)
2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres, Nerve cells
3. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid
4. Demonstration of technique of microtomy to have hands-on experience and learning of the technique.
5. Submission of a Project report on methods of contraception in male and female.
6. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Practical Examination: 25 Marks

1. Preparation of temporary mount: Squamous epithelium or Striated muscle fibres or Nerve cells (3 marks)
2. Spotting (4 spotting × 3 marks = 12 Marks)
   a. Permanent slide of mammalian skin or cartilage or bone or spinal cord or nerve cell
   b. Permanent slide of any mammalian endocrine gland
   c. Permanent slide of mammalian Testis or Ovary
   d. Principle of microtomy
3. Project Report on methods of contraception in male or female (4 Marks)
4. Practical record (3 Marks)
5. Viva-voce (3 Marks)

Major Paper 7 (MJ 7) : Fundamentals of Biochemistry

Credits: Theory: 03
Practical: 01
Total: 04

Theory (03 Credits): 45 hours

UNIT I: Carbohydrates 6 hrs

Structure and Biological importance of Carbohydrates with emphasis on aldose, ketose, chiral centre, polarized light and Fischer nomenclature, Cyclization reaction of glucose, anomers, pyranose, furanose, glycosidic linkage; Reducing and non-reducing sugars: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates.

UNIT II: Lipids 5 hrs

Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids.

UNIT III: Proteins 12 hrs

Amino acids: Structure, Classification and General properties of α-amino acids; Physiological importance of essential and non-essential α-amino acids; Proteins: Bonds stabilizing protein structure; Levels of organization in protein motifs, folds and domains; Denaturation; Introduction to simple and conjugate proteins. Immunoglobulins: Basic Structure.

UNIT IV: Nucleic Acids 10 hrs

Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids; Cot Curves: Base pairing, Denaturation and Renaturation of DNA; Types of DNA and RNA, Complementarity of DNA, Hypo-Hyperchromicity of DNA.

UNIT V: Enzymes 12 hrs

Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Michaelis-Menten equation, Concept of K_m and V_{max}, Lineweaver- Burk plot; Multi-substrate reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme reaction.

Recommended Readings:

- Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry. V Edition, W.H. Freeman and Co., New York.

- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry. VI Edition, W.H. Freeman and Co., New York.
- Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry. XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
- Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry. II Edition, BIOS Scientific Publishers Ltd., U.K.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene. VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.

Practical (01 credit): 30 hours

1. To understand the preparation and roles of two important biological buffer systems: phosphate and bicarbonate; Preparation of buffers and determination of pH
2. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
3. Quantitative Tests: Determination of Ascorbic acid – DCPIP method or Estimation of Calcium–Titrimetric method.
4. Paper chromatography of amino acids.
5. Action of salivary amylase under optimum conditions.
6. Effect of pH, temperature and inhibitors on the action of salivary amylase.
7. Demonstration of proteins separation by SDS-PAGE.
8. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Practical Examination: 25 Marks

1. Preparation and role of any biological buffer system: (4 marks)
2. Qualitative test of functional group in carbohydrate or protein or lipid (3 marks)
3. Determination of Ascorbic acid – DCPIP method or Estimation of Calcium–Titrimetric method. (3 marks)
4. Paper chromatography of amino acids. (3 marks)
5. Effect of pH, temperature and inhibitors on the action of salivary amylase. (3 marks)
6. Principle of protein separation by SDS-PAGE (3 marks)
7. Practical record (3 Marks)
8. Viva-voce (3 Marks)

Major Paper 8 (MJ 8): Evolutionary Biology

Credits: Theory:03
Practical: 01
Total: 04

Theory (03 Credits): 45 hours

UNIT I: Life's Beginning **5 hrs**

Chemogeny, RNA World, Biogeny, Origin of photosynthesis, Endo-symbiotic theory.

UNIT II: Historical Review of Evolutionary Concepts **2 hrs**

Lamarckism, Darwinism, Neo-Darwinism.

UNIT III: Evidences of Evolution **10 hrs**

Palaeontological: Fossils (formation, types and dating); Geological time scale; Study of horse phylogeny; Molecular: neutral theory of molecular evolution, Molecular clock, Example of globin gene family, rRNA/cyt c; Phylogenetic trees: types, interpretation and applications.

UNIT IV: Raw Material for Evolution **4 hrs**

Variations: Heritable variations and their role in evolution.

UNIT V: Forces of Evolution: Qualitative Studies **5 hrs**

Natural selection, Types of selection, kin selection, adaptive resemblances, sexual selection. frequency dependent selection.

UNIT VI: Forces of Evolution: Quantitative Studies **5 hrs**

Hardy-Weinberg Equilibrium: statement, assumptions, derivation of the equation; Derivation of equations for change in allelic frequencies in a population by evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, selection coefficient), genetic drift (founder's effect, bottleneck phenomenon), migration and mutation (genetic load).

UNIT VII: Product of Evolution **7 hrs**

Speciation: Micro-evolutionary changes (inter-population variations, clines, Ring species, races), Species concept, Isolating mechanisms, Modes of speciation, Adaptive radiation/macroevolution, Phyletic gradualism and punctuated equilibrium.

UNIT VIII: Loss of Biodiversity **2 hrs**

Mass extinctions (events, causes and effects), Detailed explanation of K-T extinction.

UNIT IX: Origin of Evolution of Man **5 hrs**

Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from Dryopithecus leading to Homo sapiens, molecular evidences in human evolution.

Recommended Readings:

- Ridley, M. (2004). Evolution. III Edition, Blackwell publishing.
- Hall, B.K. and Hallgrimson, B. (2013). Evolution. V Edition, Jones and Barlett Publishers.
- Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
- Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition, Wiley- Blackwell.
- Campbell, N.A. and Reece J.B. (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.

Practical (01 Credit): 30 hours

1. Study of fossils from models/pictures.
2. Study of homology and analogy from suitable specimens/pictures.
3. Construction of cladograms based on morphological characters.
4. Construction of phylogenetic tree with the help of bioinformatics tools (Clustal X, Phylip, MLK) and its interpretation.
5. Study and verification of Hardy-Weinberg Law by chi square analysis.
6. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Practical Examination: **25 Marks**

1. Spotting (6 spots × 1.5 Marks = 9 Marks)
2. Construction of cladograms or phylogenetic tree. (6 Marks)
3. Hardy-Weinberg Law by chi square analysis (4 Marks)
4. Practical record (3 Marks)
5. Viva-voce (3 Marks)

SEMESTER-V

MN 1C: Wildlife Conservation and Management

Course Learning objective:

1. The course is an introduction to wildlife management and gives an account of the tools used by wildlife managers.
2. Topics covered are to equip students with adequate knowledge of various biodiversity monitoring methodologies conservation and management issues of vertebrate pests and over abundant species.

Course Learning outcome:

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

1. To know about wildlife and preparation of an inventory of the wildlife of own area.
2. To study the causes of its depletion.
3. To know the distinction between wildlife sanctuary, national park and biosphere reserve.
4. Concept of homes range territory of big cats. Concept of pug-mark, difference of pug-marks between male and female big cats, remote sensing and geographic information system.
5. To know the reasons of entry of wild animals (elephant and leopard) in human dwellings.
6. Strategies of conservation of wildlife fauna and flora.

Course Content:

Credits: **Theory: 03**
Practical: 01
Total: 04

Theory (03 Credits): **45 hours**

Unit I: Introduction of Wildlife **5 hours**

Values of wildlife; Conservation ethics; Importance of conservation; Causes of depletion; Concept of threatened, endangered and vulnerable species; Red Data Book.

Unit II: Evaluation and Management of Wildlife **10 hours**

Habitat analysis: Physical parameters (topography, geology, soil and water) and Biological parameters (food, cover, forage, browse and cover estimation); Standard evaluation procedures (remote sensing and GIS).

Unit III: Management of habitats **10 hours**

Setting back succession: Grazing logging; Mechanical treatment; Preservation of general genetic diversity, Restoration of degraded habitats.

Unit IV: Population Estimation **5 hours**

Population density, Natality, Birth rate, Mortality, Fertility schedules and sex ratio computation.

Unit V: Management Planning of Wildlife in Protected Areas **10 hours**

Priority fixation for in-situ and ex-situ conservation; Estimation of carrying capacity, Human-wildlife conflict; Eco tourism/ wildlife tourism in forests; Climax communities: characteristics and theories

Unit VI: Protected Areas **5 hours**

National Park and sanctuaries, Biosphere Reserve, Conservation and community reserve, Important features of protected areas in India.

Recommended Readings:

- Saha, G.K. and Mazumdar, S. (2017). Wildlife Biology: An Indian Perspective. PHI learning Pvt. Ltd. ISBN: 8120353137, 978-812035313
- Sinclair, A.R.E., Fryxell, J.M. and Caughley, G. (2006). Wildlife Ecology, Conservation and Management. Wiley-Blackwell, Oxford, UK.
- Singh, S.K. (2005). Text Book of Wildlife Management. IBDC, Lucknow.
- Hudson, P.J., Rizzoli, A., Grenfell, B.T. Heestrbeek, H. and Dobson, A.P. (2002). The Ecology of Wildlife Diseases. Oxford University Press, Oxford.
- Banerjee, K. (2002). Biodiversity Conservation in Managed and Protected Areas. Agrobios, India.
- Sharma, B.D. (1999). Indian Wildlife Resources Ecologyand Development. Daya Publishing House, Delhi.
- Primack, R.B. (1998). Essentials of Conservation Biology. Sinauer Associates, Inc. Sunderland, MA.
- Hossetti, B. B. (1997). Concepts in Wildlife Management. Daya Publishing House, Delhi.

Practical (01 Credit): **30 hours**

1. Identification of mammalian fauna, avian fauna, herpato fauna through direct and indirect evidences seen on a field trip to a wildlife conservation site.
2. Demonstration of basic equipment needed in wildlife studies: use, care and maintenance (Campass, Binoculars, Spotting scope, Range finders, Global Positioning system, Various types of cameras and lenses).
3. Identification of big cats: Lion, Tiger, Panther, Cheetah, Leopard and Jaguar.
4. A report based on a visit to National Park/ Wildlife Sanctuary/ Biodiversity park or any other wildlife conservation site.
5. Group discussion or seminar presentation from any topic from the paper.

Pattern of Practical Examination **(25 Marks)**

1. Spotting (5 spot ×3 marks = 15 marks)

   a. Mammalian/Avian/Herpato fauna (any 2)

   b. Equipment in wildlife studies (any 2)

   c. Big cats identification (any 1)

2. Visit Report (4 marks)
3. Practical Record (3 marks)
4. Viva-voce (3 marks)

MJ-9: Animal Physiology- II

Course Learning Objective:

Physiology is the study of life, specifically, how cells, tissues and organ function. It is a core and fundamental scientific discipline that defines the health and well-being of living organisms. Besides satisfying a natural curiosity about how our body systems function, it gives us knowledge about the functions of all the parts and systems of the body. It is also of central importance in medicine and health sciences. The course has been designed to apply the theoretical concept to the laboratory exercises for acquiring skills. The fundamental or coherent understanding of the subject will be extended to related disciplinary areas/subjects through understanding of normal body functions, enabling effective treatment of abnormal or diseased states. The students will be equipped with skill-based knowledge to help them undertake further studies in physiology and related areas as well as in multidisciplinary subjects.

Course Learning Outcome:

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

- Have a clear knowledge of basic fundamentals and understanding of advanced concepts so as to develop a strong foundation that will help them to acquire skills and knowledge to pursue advanced degree courses.
- Comprehend and analyse problem-based questions on physiological aspects.
- Recognize and explain how all physiological systems work in coordination to maintain homeostasis in the body; and use of feedback loops to control the same.

Learn an integrative approach to understand the interactions of various organ systems resulting in the complex overall functioning of the body

Course Content:

Credits: **Theory: 03**
Practical :01
Total :04

Theory (03 credits) 45 hours

Unit I: Physiology of digestion **10 hours**

Structural organization, functions of gastrointestinal tract in mammals and associated glands, Mechanical and chemical digestion of food. Absorptions of Carbohydrates, lipids, amino acids, water, minerals and vitamins, Hormones involved in the physiology of digestion.

Unit II: Physiology of respiration **10 hours**

Structural organization of mammalian respiratory system; Histology of respiratory tract, Mechanism of respiration, Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and Carbon dioxide in blood and the factors influencing it; Bohr's effect and Haldane's effect, Control of respiration.

Unit III: Physiology of circulation **10 hours**

Structure of mammalian heart, Origin and conduction of cardiac impulses, Cardiac cycle, Cardiac output and its regulation, Frank-Starling law of the heart, Nervous and chemical regulation of heart rate, Electrocardiogram, Blood pressure and its regulation.

Unit IV: Physiology of excretion **9 hours**

Structure of kidney in mammals and its functional unit, Mechanism of urine formation, Regulation of water balance, Regulation of acid -base balance.

Recommended Books:

• Tortora, G.J.& Grabowski, S (2006) Principles of Anatomy & Physiology, XI edition. John Wiley & Sons

• Vander A, Sherman J, and Luciano D (2014). Vander's Human Physiology: The mechanism of Body Function. XIII Edition, Mc Graw Hills.

• Ganong W.F. (2019). Review of Medical Physiology 26th ed Mc Graw-Hill,

• Guyton, A.C & Hall, J.E. (2006).Textbook of Medical Physiology, XI Edition. Hercourt Asia PTE Ltd/W.B. Saunders Company

• Marieb E.N. (1998). Human Anatomy and Physiology, 4th Ed, Addison Wesley Longman, Inc.

Practical (01 credit) 30 hours

1. Enumeration of red blood cells and white blood cells using haemocytometer.
2. Estimation of haemoglobin using Sahli's haemoglobinometer.
3. Preparation of haemin and Haemochromogen crystals.
4. Recording of blood pressure using sphygmomanometer (normal and stressed condition).
5. Group discussion of seminar presentation from any topic from the paper.

Pattern of Practical examinations (25 marks)

1. Enumeration of RBC /WBC using hemocytometer (7 marks)
2. Estimation of hemoglobin using Sahil's hemoglobinometer (7 marks)
3. Preparation of haemin/haemochromogen crystals (5 marks)
4. Practical Record (3 marks)
5. Viva-voce (3 marks)

MJ-10: Metabolism

Course Learning Objective:

The program is designed to enable a student acquire sound knowledge of biochemistry and its practicable applicability. Effort has been made to make the study relevant, interesting and encouraging to the students to join the industry or to prepare them for higher studies including research. The current course syllabus is based on a basic and applied approach to ensure that the students will be equipped with skill-based knowledge to help them undertake further studies in metabolism, metabolic disorders and related areas as well as in multidisciplinary subjects.

Course Learning Outcome:

Upon completion of the course, students will be able to

- Gain knowledge and skill in the interactions and interdependence of physiological and biomolecules
- Understand essentials of the metabolic pathways along with their regulation.
- Know the principles, instrumentation and applications of bioanalytical techniques.
- Get exposure to various processes used in industries.
- Become aware about classical laboratory techniques, use modern instrumentation,
- design and conduct scientific experiments and analyze the resulting data.
- Be knowledgeable in proper procedures and regulations in handling and disposal of chemicals,

Course Content:

Credits: Theory:03
Practical: 01
Total: 04

Theory (03 credits) 45 hrs

Unit I: Carbohydrate metabolism 20 hours

Glycolysis, Kreb's cycle, Electron transport chain and ATP synthesis, Oxidative phosphorylation, Pentose phosphate pathway, gluconeogenesis, glycogenesis glycogenolysis.

Unit II: Lipid metabolism 10 hours

Beta-oxidation & Omega oxidation of saturated fatty acids, Biosynthesis of Palmitic acid.

Unit III: Protein metabolism 10 hours

Catabolism of amino acids, Transamination, Deamination, Urea cycle

Unit IV: Metabolic Disorders 5 hours

Diabetes mellitus, Obesity, fatty liver disease, Gout.

Recommended Books:

• Cox, M.M and Nelson, D.L. (2008). Lehninger Principles of Biochemistry. V Edition, W.H. Freeman and Co., New York.

• Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry. VI Edition, W.H. Freeman and Co., New York.

• Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry. XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.

• Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, IIEdition, BIOS Scientific Publishers Ltd., U.K.

Practical (01 credit): 30 hours

1. Estimation of total protein in given solution by Lowry's method.
2. Study of biological oxidation (SDH) goat liver.
3.To study enzymatic activity of trypsin and lipase.
4.Group discussion or seminar presentation from any topic from the paper.

Pattern of Practical Examination (25 marks)

1.Estimation of total protein and given solution by Lowry's method	(10 marks)
2.Study of enzymatic activity of Trypsin/lipase/ SDH	(9 marks)
3. Practical record	(3 marks)
4.Viva-voce	(3 marks)

MJ 11: Developmental Biology

Course learning objective

A Developmental Biology course aims to provide a comprehensive understanding of how organisms develop from a single cell into complex, functional entities, encompassing topics like embryogenesis, cell signaling and morphogenesis with an emphasis on the molecular and genetic mechanism involved.

Course learning outcomes

After successfully completing the course, the student will be able to

1. Develope critical understanding how a single-celled fertilized egg becomes an embryo and then a fully formed adult by going through the important processes of cell division, cell differentiation and morphogenesis.
2. Understand how developmental processes and gene functions within a particular tissue or organism can provide insight into functions of other tissues and organisms.
3. Realize that very similar mechanism are used in very diverse organisms and development is controlled through molecular changes resulting in variation in the expression and function of gene networks.

Course Content

Credit: **Theory :03**
Practical :01
Total: 04

Theory 03 Credits 45 hours

Unit I: Introduction of developmental Biology 10 hours

Historical perspective and basic concepts, Phases of development, cell-cell interaction, pattern formation, differentiation and growth, differential gene expression, cytoplasmic determination and asymmetric cell division

Unit II: Early and late embryonic Development 20 hours

Gametogenesis; Spermatogenesis, Oogenesis, Types of eggs, Egg membranes, Fertilization: Factors and events, Blocks to polyspermy. Cleavage: Planes and patterns of cleavage; Types of blastula, Fate maps (including techniques), Early development of amphibian embryo up to gastrulation, Fate of Germ layers, Formation of neural tube; Embryonic induction and

organizers, Extra-embryonic membranes in birds, Implantation of embryo in humans, Placenta: Structure, types and functions of placenta.

Unit III: Post Embryonic Development and its implications **15 hours**

Metamorphosis in amphibia and insects with hormonal regulations, Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example); Ageing, Teratogenesis; *in vitro* fertilization, Stem cell, Amniocentesis.

Practical (1 credit) **30 hours**

1. Study of whole mounts and sections of developmental stages of frog embryo through permanent slides.
2. Study of whole mount of developmental stages of chick embryo through permanent slides.
3. Study of different types of placenta using photomicrographs /slides.
4. Project report on visit to Poultry farm/ IVF.
5. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Practical Examination (25 marks)

1.Spotting	(5 spots × 3 marks = 15 marks)
(a) Developmental stages of frog embryo	(any 2)
(b) Developmental stages of chick embryo	(any 2)
(c) Types of placenta	(any 1)
2. Visit Report	(4 marks)
3. Practical Record	(3 marks)
4. Viva-voce	(3 marks)

IAP- Internship/Apprenticeship/Project Course

Credits: 4
Marks: 100

Course Description:

This IAP course aims at providing students with the opportunity to procure practical experience in a professional setting related to their field of study. The students will go in for various tasks such as research, writing, project management, and more, under the guidance of experienced professionals. The program focuses on bridging the gap between academic learning and real-world application, helping students to explore potential career paths. The program will help students in developing essential skills for their careers while also providing them opportunities to actively engage in an on-site experiential learning.

In this Internship/Apprenticeship/Project course the students will have the option to undergo Apprenticeship or Internship training of 8-week or 2-month duration. The students who do not opt either for Internship or Apprenticeship training will be required to carry out a Field Project based on a topic to be assigned by the concerned department.

Learning Objectives:

- Apply academic knowledge and skills to the real-world tasks and projects in a professional environment.
- Enhance professional skills in research, writing, communication, and project management.
- Gain insight into potential career paths and industries relevant to the student's field of study.
- Strengthen critical thinking and problem-solving skills through engagement with practical challenges and assignments.

Learning Outcomes:

At the end of the Internship/Apprenticeship/Project course, students will be able to:

- Demonstrate the ability to apply academic theories and skills to practical tasks and projects.
- Exhibit proficiency in professional communication, including writing reports, emails, and presenting ideas effectively.
- Manage and complete projects efficiently, demonstrating strong organizational and time-management skills.
- Conduct thorough and efficient research using appropriate methods and sources.
- Build and maintain a network of professional contacts that can support career development.

The Internship/Apprenticeship avenues may include the following:

- Local industry, business organisations, health areas and research laboratories.
- Local governments such as Panchayats, Municipalities and other such bodies, offices of Parliamentarians other elected representatives, government and non-government social service organisations.
- Media organisations, publication houses, academic institutions, literary and cultural organisations, artists and craft persons.

The students should undertake their Apprenticeship or Internship training preferably in their related discipline in order to enhance their learning.

On successful completion of Internship/Apprenticeship the students will be required to:

- Produce a certificate of having undergone an Internship/Apprenticeship training of 8-week or two-month duration.
- Submit a report of about 40 to 50 pages based on their Internship/Apprenticeship training.

Alternatively, the students who do not opt either for Internship or Apprenticeship training will be required to carry out a Field Project on a topic to be assigned by the concerned department.

The students will prepare their Project/Dissertation of about 40 to 50 pages on their assigned topics under the supervision of a faculty..

Examination and Evaluation: The students opting for Internship/ Apprenticeship training will prepare a Project Report based on their I/A training and submit the same to the department along with a proper certificate of their I/A training of 8-week or 2-month duration,

The students opting to write a project or dissertation on the topic assigned by the concerned department will submit a Dissertation Project of about 40-50 pages.

The Project Reports/Dissertations submitted by the students will be examined by an external examiner who will also conduct a viva voce examination of the students to assess their understanding of the Dissertation/ Project Report prepared by them.

Internship/Project Report or Project/Dissertation	75 marks
Viva-voce	25 marks
Total	100 marks

SEMESTER-VI

MN 2C: Medical Diagnostics

Course learning objective

The course is designed to explain the concept of diagnosis including the use of medical history, physical examination, laboratory test and imaging studies; familiarize with common diagnosis test and procedure. Learn about diagnostic imaging modalities such as X-ray, CT, MRI and ultrasound.

Course learning outcomes

Students will be able to analyze patient data, identify patterns and formulate differential diagnosis and to take a thorough medical history, perform a physical examination and communicate effectively with patient and healthcare teams.

Course Content:

Credits: Theory: 03
Practical: 01
Total: 04

Theory (03 Credits):

Unit I: Introduction, Medical Diagnostics of body fluids and Noninfectious diseases 25 hours

Introduction to medical diagnostics, Blood composition, Blood bank, Transfusion of blood, RBC, WBC and platelets count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R.), Packed Cell Volume (P.C.V.), Analysis of urine, sputum, faces and semen (sperm count), Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary),Diagnosis and detection of types of tumors(Benign/Malignant) and metastasis, FNAC.

Unit II: Medical Diagnostics of infectious diseases 10 hours

Methods to diagnose and isolate infectious agents of diseases like Tuberculosis, Hepatitis and AIDS

Unit III: Diagnostic medical imaging 10 hours

Principle of medical imaging techniques like X-Ray of Bone fracture, PET, MRI and CT scan

Recommended Readings:

- Park , K. (2007) Preventive and Social Medicine ,B.B Publishers •Godkar P.B. and Godker D.P.(2005) Textbook of Medical Laboratory Technology,lll Edition,Bhalani Publishing House.
- Prakash, G.(2012),Lab Manual on Blood Analysis and Medical Diagnostics,S.Chand and Co. Ltd.
- Robbins and Cortan, Pathologic Basis of Diseases, Vlll Edition, Saunders Sounders

Practical (01 credit) 30 hours

1. ABO blood group typing .
2. Estimation of haemoglobin content using Sahil's hemoglobinometer .
3. Total leukocytes count from blood .
4. Measurement of blood pressure under normal and stress condition.
5. Estimation of blood glucose/ cholesterol by kit
6. Determination of bleeding time /clotting time.
7. Interpretation of ECG .
8. Medical Imaging techniques : X-Ray of bone fracture, MRI ,CT scan
9. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Practical Examination (25 marks)

1. Blood group typing /Hb estimation (5 marks)
2. TLC count from blood /bleeding time and clotting time (6 marks)
3. Spotting (3 marks × 2 =6 marks)
   (a) ECG graph /Machine
   (b)X-ray/MRI (CT Sean)
4. Practical Record (4 Marks)
5. Viva-voce (4 marks)

MJ 12: Genetics

Course learning objective:

The Genetics course aims to provide knowledge to the students about various principles of genetics. The course allows the students to learn about various phenomena in genetics. It aims at making students familiar with the process of sex determination and extrachromosomal inheritance. It also aims at imparting knowledge to the students about mutation.

Course learning outcome:

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

- understand the principles of inheritance and its extensions
- learn about how genes interact with each other to produce phenotypes
- comprehend sex linked, sex limited and sex influenced characters
- know about Linkage and Crossing over
- understand about sex determination in drosophila and man
- learn about extrachromosomal inheritance
- comprehendabout gene and chromosomal mutation
- know about the Transposable genetic elements

Course Content

Credits : Theory: 03
Practical :01
Total : 04

Theory (03 Credits) **45 hours**

Unit I: Mendelian Genetics and its extension **25 hours**

Principles of inheritance, Intergenic and intragenic inheritance (Incomplete dominance and co-dominance, Multiples alleles, Lethal alleles, penetrance and expressivity, Epistasis, Pleiotropy), Sex-linked, sex-influenced and sex-limited characters inheritance. Concept of gene; Linkage and crossing over, Cytological basis of crossing over, Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses, linkage map, Polygenic Inheritance.

Unit II: Sex Determination and Extra- chromosomal Inheritance 10 hours

Basis of sex determination: Genetic and environmental, Sex determination in Drosophila and Man, Mechanism of dosage compensation. Comparison of nuclear and extra nuclear inheritance, Organelle inheritance and Maternal effect.

Unit III: Mutation & Transposable genetic elements 10 hours

Type of gene mutations, Mutagens: Physical and Chemical, Molecular basis of spontaneous and induced mutation, Chromosomal aberrations; Variations in number and structure. Transposons in bacteria, P element in *Drosophila*, Transposons in humans, Transposons as mutagens.

Recommended Readings :

- Primrose ,S.B .,and Twyman ,R.M (2006).Principles of Gene Manipulation and Genomics .Vll Edition, Bglackwell publishing (Oxford, UK) ISBN 13 :978-1- 4051 - 3544-3 .
- Watson J.D., Myers,R.M. ,Caudy, A and Witkowski, J.K. (2007) Recombinant DNA-Genes and Genomes-A Short Course. III Edition ,Freeman and Co.,N.Y., USA .
- Clark D.P. and Pazdernik,N.J. (2012) Biotechnology. Academic Press, ISBN 978- 0 - 12 -385063- 8

Practical (01 credit)

1. Simulation exercise using beads or seeds to study the Mendel's laws and gene interactions.
2. Verification of Mendelian ratios using Chi-square analysis/ test.
3. Pedigree analysis.
4. Linkage maps based on data from *Drosophila* crosses.
5. Study of human karyotype (normal and abnormal).
6. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Practical Examination (25 Marks)

1. Stimulation exercises or beads for study of Mendel's laws of gene interactions/verification of Mendelian ratio using Chi-square analysis test second Pedigree analysis/ test. (8 marks)
2. Pedigree Analysis/ Karyotype study. (5 marks)
3. Linkage maps based on data from Drosophila crosses. (6 marks)
4. Practical Record (3 marks)
5. Viva -voce (3 marks)

MJ 13: Molecular Biology

Course Learning Objective:

The course aims to provide students with an introduction of the underlying molecular mechanisms of various biological processes in cells. The study primarily involves learning about structure and synthesis of DNA and RNA, synthesis of proteins, regulation of gene expression, DNA damage and repair mechanisms. The course aims to develop basic understanding of structure-function relationships of nucleic acids and proteins.

Course Learning Outcome:

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

- Describe the basic structure and chemistry of nucleic acids, DNA and RNA;
- Compare and contrast DNA replication machinery and mechanisms in prokaryotes and eukaryotes.
- Elucidate the molecular machinery and mechanism of information transfer processes-transcription and translation-in prokaryotes and eukaryotes;
- Explain post-transcriptional modification mechanisms for the processing of eukaryotic RNAs;
- Discuss general principles of transcription regulation in prokaryotes by exploring the structure and function of lactose and tryptophan metabolism operons;
- Give an overview of gene expression regulation in eukaryotes;
- Explain the significance of DNA repair mechanisms in controlling DNA damage;
- Recognise role of RNAs (riboswitches, siRNA and miRNA) in gene expression regulation.
- Describe giant (polytene) chromosomes.
- Quantitatively estimate concentration of DNA and RNA by colorimetric methods.

Course content:

Credits: **Theory: 03**
Practical: 01
Total: 04

Theory (03 Credits): **45 hours**

UNIT I: Nucleic Acid **3 hours**

Physical and Chemical properties of Nucleic acid (Coiling and Supercoiling)

UNIT II: DNA Replication **10 hours**

DNA replication in prokaryotes and eukaryotes – replication machinery and mechanisms, semi-conservative, bidirectional and semi-discontinuous replication, Replication of circular and linear double stranded DNA, Telomeric replication.

UNIT III: Transcription **8 hours**

Machinery and mechanism of transcription in prokaryotes and eukaryotes (mRNA, tRNA and rRNA). RNA polymerases & types, Transcription unit, Transcription factors.

UNIT IV: Translation **10 hours**

Genetic code, Degeneracy of the genetic code and Wobble hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure, aminoacyl-tRNA synthetases and charging of tRNA; Factors involved in translation; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation.

UNIT V: Post Transcriptional Modifications and Processing of Eukaryotic RNA 4 hours

Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing.

UNIT VI: Gene Regulation and DNA Repair mechanisms **10 hours**

Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from *lac* operon and *trp* operon; Overview of transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing and Genetic imprinting. Pyrimidine dimerization and mismatch repair. Regulatory RNAs, Ribo-switches; RNA interference: miRNA and siRNA.

Recommended Readings:

- Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene.VI edition. Cold Spring Harbour Lab. Press, Pearson Pub.
- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
- Cooper G. M. and Robert E. Hausman R. E. The Cell: A Molecular Approach, V Edition, ASM Press and Sinauer Associates.
- Lewin B. (2008). Gene XI. Jones and Bartlett.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: Molecular Biology of the Cell, IV Edition.

Practical (01 credit): **30 hours**

1. Study of Polytene chromosomes from *Chironomous*/ *Drosophila* larvae.
2. Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement).
3. Quantitative estimation of RNA using Orcinol reaction.
4. To understand working of the *lac* operon in the presence/absence of lactose and/or glucose by using simulations.
5. Study and interpretation of electron micrographs/ photograph showing: DNA replication, Transcription, Split genes.
6. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Practical Examination: **25 Marks**

1. Study of Polytene chromosomes from *Chironomous*/ *Drosophila* larvae. (5 marks)
2. Quantitative estimation of DNA/ Quantitative estimation of RNA (6 marks)
3. To understand working of the *lac* operon in the presence/absence of lactose and/or glucose by using simulations. (4 marks)
4. Study and interpretation of DNA replication/ Transcription/ Split genes. (4 marks)
5. Practical record (3 Marks)
6. Viva-voce (3 Marks)

MJ 14: Microbiology

Course learning objective: -

The aim of the course Microbiology is to let students understand about various microbes. The course aims to make students able to understand about various pathogens and disease caused by them. It is designed to enable students to know about pathogenesis, diagnosis, prophylaxis and therapy of various diseases.

Course learning outcome: -

Upon completion of Microbiology course students will be able to

1) understand about the diversity of microbes
2) to learn about the host- pathogen interaction
3) understand about the viral diseases, causative agents, pathogenesis, diagnosis, prophylaxis and therapy
4) to learn and understand about the various bacterial diseases
5) to get to know about the various fungal diseases

Course content:

Credits: **Theory :03**
Practical :01
Total: 04

Theory: 03 credits **45 hours**

Unit I: Brief introduction to microbiology **5 hours**

Brief history of microbiology- germ theory of disease, discovery of Penicillin

Unit II: Diversity of microbes **5 hours**

Diversity of Viruses, bacteria and fungi

Unit III: Host-pathogen interaction **6 hours**

lnvasion, antigenic heterogeneity, toxins and enzymes secretions

Unit IV: Viral diseases **12 hours**

Polio, rabies, hepatitis, influenza, dengue, AIDS, chicken pox, swine flu, chikungunya with emphasis on their causative agents, pathogenesis, diagnosis prophylaxis and chemotherapy.

Unit V: Bacterial diseases **12 hours**

Bacterial diseases caused by *Bacillus anthracis*, *Streptococcus pneumoniae, Salmonella typhi, Escherichia coli, Helicobacter pylori, Mycobacterium tuberculosis, Vibrio cholerae.*

Unit VI: Fungal diseases **5 hours**

Ringworm infection, aspergillosis, Candidiasis.

Recommended Readings

- Prescott Microbiology
- Jawetz, M. and Adelberg (2015): Medical Microbiology 27th Edition

Practical (01 Credit) **30 hours**

1. Preparation of liquid culture medium.
2. Preparation of solid culture medium.
3. Demonstration of streaking and spreading techniques.
4. Staining and identification of Gram- positive and Gram- negative bacteria.

Pattern of Practical Examination **(25 marks)**

1. Preparation of liquid /solid culture medium. (7 marks)
2. Streaking /spreading technique (5 marks)
3. Staining and Identification of Gram (+) /Gram (-) bacteria (5 marks)
4. Practical record (4 marks)
5. Viva-voce (4 marks)

MJ 15: Immunology

Course Learning Objective:

The aim of the course in immunology is to apprise the student with the working of the immune system in normal health and how it fights the disease and may sometimes contributes to disease. The immune system is incredibly complex. This course is hence designed to enable understanding the molecular and cellular basis of the development and function of the immune system and identification of its biological, clinical and therapeutic implications.

Course Learning Outcome:

- After completion of the course the students will be able to:
- Describe the basic mechanisms, distinctions and functional interplay of innate and adaptive immunity
- Define the cellular/molecular pathways of humoral/cell-mediated adaptive responses including the role of Major Histocompatibility Complex
- Explain the cellular and molecular aspects of lymphocyte activation, homeostasis, differentiation, and memory
- Understand the molecular basis of complex, humoral (Cytokines and Complement) and cellular processes involved in inflammation and immunity, in states of health and disease
- Describe basic and state-of-the-art experimental methods and technologies
- Integrate knowledge of each subsystem to see their contribution to the functioning of higher-level systems in health and disease including basis of vaccination, autoimmunity. immunodeficiency, hypersensitivity and tolerance
- Prepare stained blood film to describe various types of blood cells
- Determine ABO blood group antigen by hemagglutination
- Describe ELISA and Immunoelectrophoresis

Theory (03 Credits): 45 hours

UNIT I: Overview of Immune System 8 hrs

Historical perspective of Immunology, Early theories of Immunology, Clonal Selection Theory, Cardinal features of vertebrate immune system, Hematopoiesis, Cells and organs of the Immune system.

UNIT II: Innate and Adaptive Immunity 8 hrs

Anatomical barriers, Inflammation, Cell and molecules involved in innate Immunity, Adaptive Immunity (Cell-mediated and Humoral), Passive immunity; Active: Artificial and natural Immunity, Immunological Tolerance.

UNIT III: Antigens 6 hrs

Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes

UNIT IV: Immunoglobulins 8 hrs

Structure and functions of different classes of immunoglobulins, Antigenic determinants on Immunoglobulins, Antigen-antibody interactions with respect to blood groups A, B, O, H and

Bombay phenotype (Precipitation reactions, Agglutination reactions, Immunofluorescence and ELISA), Polyclonal sera, Hybridoma technology: Monoclonal antibodies in therapeutics and diagnosis.

UNIT V: Major Histocompatibility Complex 4 hrs

Structure and functions of MHC molecules (MHC I and II), Endogenous and exogenous pathways of antigen processing and presentation.

UNIT VI: Cytokines and Complement System 5 hrs

Properties and functions of cytokines. Components and pathways of complement activation, Biological consequences of complement activation

UNIT VII: Vaccines and Immune Dysfunction 7 hrs

Various types of vaccines. Hypersensitivity, various types of hypersensitivities; Autoimmunity: Brief account with reference to Hashimoto's Thyroiditis (Organ Specific) and Rheumatoid arthritis (Systemic). Immunodeficiency: Brief account with reference to SCID (Primary) and AIDS (Secondary)

Recommended Readings:

- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J. (2006). Immunology, VI Edition, W.H. Freeman and Company.
- David, M., Jonathan, B., David, R. B. and Ivan, R. (2006). Immunology, VII Edition, Mosby, Elsevier Publication.
- Abbas, K. Abul and Lechtman H. Andrew (2003) Cellular and Molecular Immunology. V Edition, Saunders Publication.
- Kenneth Murphy and Casey Weaver. Janeway's Immunobiology, IX Edition, Garland Science

Practical (01 Credit): 30 hours

1. Histological study of bone marrow, thymus, spleen and lymph nodes through slides/photographs.
2. Basic patterns of precipitation by Ouchterlony's double immuno-diffusion method.
3. ABO Blood group antigen determination by heamagglutination.
4. Demonstration of:
   (a) ELISA
   (b) Immunoelectrophoresis
5. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Practical Examination: 25 Marks

1. Spotting (3 spots × 3 Marks = 9 Marks)
   a. Any two histological slides: bone marrow/ thymus/ spleen/ lymph nodes
   b. ELISA/ Immunoelectrophoresis
2. Identification of blood groups. (5 Marks)
3. Basic patterns of precipitation by Ouchterlony's double immuno-diffusion method (5 Marks)
4. Practical record (3 Marks)
5. Viva-voce (3 Marks)

Semester VII

MN- 1D: Genetic Counselling

Course Learning Objective:

The course on Genetic counselling will introduce the basic concepts of inheritance patterns, genetic and genomic basis of traits. It will inculcate a holistic understanding about the genetic basis of a particular clinical disorder. Updated information regarding causative genes, disease diagnosis and available treatment options for several single gene and complex genetic disorders will be provided. Training will be imparted in genetic counselling skills, so that the students could participate in effective genetic counselling.

Course Learning Outcome:

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

- Get acquainted with the diseases caused by genetic abnormalities.
- Develop the basic understanding of counselling the individuals based on the deductive methods.
- Deal with the various social and ethical aspects in relation to genetic diseases inheritance and its predictability in a responsible manner.
- Collect data about the history of a disease in a family and arrange it into a pedigree.
- Be aware and competent of the legalities and national and international policies in the area.
- Understand their risk for developing a genetic disease and to make informed decisions.

Course content:

Credits: **Theory: 03**
Practical: 01
Total: 04

Theory (03 Credits): **45 hours**

UNIT I: Nucleic Acids **5 hours**

Overview of the structure of DNA and RNA; Replication, transcription and translation (in brief)

UNIT II: Chromosomes **5 hours**

Basics of human cytogenetic nomenclature; Chromosome identification; Various techniques of karyotyping; Autosomal and sex chromosomal abnormalities

UNIT III: Mendelian Genetics **5 hours**

Mendel's experiments- laws and their exceptions

UNIT IV: Genetics of Human Diseases **10 hours**

Molecular genetics of Human disease; Genetic basis of various diseases like Sickle cell anemia, PKU, Thalassemia, Alzheimer's', Diabetes, Hypertension, cardiovascular, Cancer, Pedigree analysis (symbols, preparation and analysis)

UNIT V: Genetic Counselling **20 hours**

History, Famous Case Studies, Theory and Practice; Psycho-social aspects for the individual and the family in connection with genetic investigations; Legal aspects related to genetics, Medical termination of pregnancy act, PC-PNDT act and other aspects of medical jurisprudence.

Recommended Readings:

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008) Principles of Genetics. VIII Edition. Wiley India
- Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece, Neil A. Campbell (2016) Campbell's Biology (2016) Xi edition, Pearson's Education
- Harper, Peter S. (2010) Practical Genetic Counselling VII Edition; London, Hodder Arnold
- Singh, V.P. (2016) Legal Issues In Medical Practice: Medicolegal Guidelines For Safe Practice
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012) Concepts of Genetics. X Edition, Benjamin Cummings
- Uhlmann W R., Jane L. Schuette, B. Yashar (2009). A Guide to Genetic Counselling

Practical (01 Credit): **15 hours**

1. Introduction to genetic testing and its types, pre and post-test counselling and evaluation.
2. Recording of family and personal history, Pedigree construction and prediction of genetic traits.
3. Analysis for Mendelian diseases and Multifactorial disorders.
4. Case Studies (Any three popular ones).
5. Colour vision deficiency test using Ishihara cards.
6. PTC Test-The genetics of bitter taste (Consent form to be filled by students/ parents before test).
7. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Examination: **(25 Marks)**

1. Pedigree construction and prediction of genetic traits (10 Marks)
2. Colour vision deficiency test using Ishihara cards. (9 Marks)
3. Practical record (3 Marks)
4. Viva-voce (3 Marks)

Major Paper 16 (MJ 16): Biotechnology

Course Learning Objective:

Biotechnology is the advanced branch of biological sciences which mostly deals with technological application on biological systems. It is basically the management of biological processes for industrial and other human welfare purposes. The present paper on biotechnology attempts to give a wholesome idea of biotechnology at a basic level. It provides a tool kit in the form of a number of various techniques and processes developed over time to solve problems involving primarily human welfare with focus on health and medicine. It will equip the students with basic tools of biotechnology which are a must for everyone interested in pursuing a career in biotechnology. It makes one aware of the scope of this field which encompasses almost every field of science like engineering, research, commercialization and academics.

Course Learning Outcome:

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

• Use or demonstrate the basic techniques of biotechnology like DNA isolation, PCR, transformation, restriction digestion etc.

• Make a strategy to manipulate genetic structure of an organism for the improvement in any trait or its well-being based on the techniques learned during this course.

• Understand better the ethical and social issues regarding GMOs.

• Use the knowledge for designing a project for research and execute it.

Course Content:

Credits: Theory: 03
Practical: 01
Total: 04

Theory (03 Credits): 45 hours

UNIT I: Introduction to Biotechnology & Basic tools for gene manipulation 15 hours

Concept and scope of biotechnology. Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics). Restriction enzymes: Nomenclature, detailed study of Type II, DNA modifying enzymes. Transformation techniques: Calcium chloride method, electroporation and biolistic method. Construction of genomic and cDNA libraries and screening by colony and plaque hybridization.

UNIT II: Advanced Tools & Techniques 10 hours

Southern, Northern and Western blotting, DNA sequencing, Polymerase Chain Reaction, DNA Finger Printing and DNA micro array, Gene Editing Tools.

UNIT III: Genetically Modified Organisms 10 hours

Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA

microinjection; Applications of transgenic animals.

UNIT IV: Applications of Genetic Engineering 10 hours

Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia), Recombinant DNA in medicines: Recombinant insulin and human growth hormone, Gene therapy.

Recommended Readings:

- Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons In.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cumming
- Pierce B. A. (2012). Genetics-A Conceptual Approach. IV Edition. W. H. Freeman and Company
- Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition. Benjamin Cummings
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co.
- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India
- Brown, T.A. (2010) Gene Cloning and DNA Analysis. VI Edition,Wiley- Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
- Glick, B.R., Pasternak, J.J. and Patten, C.L. (2010). Molecular Biotechnology - Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA. ISBN: 978-1-55581-498-4 (HC).
- Primrose, S.B., and Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. VII Edition, Blackwell publishing (Oxford, UK) ISBN: 13: 978-1- 4051-3544- 3.
- Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007) Recombinant DNA-Genes and Genomes- A Short Course. III Edition, Freeman and Co., N.Y., USA.
- Clark, D. P. and Pazdernik, N.J. (2012) Biotechnology. Academic Press, ISBN: 978-0- 12-385063-8

Practical (01 Credit): 30 hours

1. Demonstration of Restriction digestion of Plasmid/Lambda DNA.
2. Construction of circular and linear restriction map from the data provided.
3. To demonstrate following techniques: Southern/ Northern/Western blotting, PCR, DNA fingerprinting, DNA Sequencing.
4. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Practical Examination:

1. Demonstration of Restriction digestion of Plasmid/Lambda DNA. 5 Marks
2. Construction of circular and linear restriction map from the data provided. 5 Marks

3. Demonstration of any one of the following technique/principles: 9 Marks
    a. Blotting Techniques (Southern/Northern/Western)
    b. Polymerase Chain Reaction
    c. DNA Fingerprinting/DNA Sequencing
4. Practical Record 3 Marks
5. Viva-voce 3 Marks

Major Paper 17 (MJ 17) : Biostatistics and Bioinformatics

Course Learning Objective:

This course offers an overview of fundamental concepts of Biostatistics and Bioinformatics, an interdisciplinary course. It emphasizes integration of Computer Science with Biology and introduces the students to various computational methods and software tools for understanding biological databases, gene sequence alignments, gene annotation, protein structure predictions, drug discovery, molecular phylogeny, metagenomics, etc. The broad aim of this course is to make students get basic hands-on training and develop skill-set required for computational analysis of biological data. Recently many interest groups, such as governments, universities, research institutes and industries find Bioinformatics as a crucial area of research and development due to generation of large-scale genome sequencing data. In view of above, this course is designed to motivate the undergraduate students to pursue postgraduate program in Biostatistics and Bioinformatics.

Course Learning Outcome:

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

• Explain the basic concepts of Biostatistics and Bioinformatics and its various applications in different fields of biological sciences

• Measure variability (standard deviation, standard error, co-efficient of variance) and hypothesis testing (Z-test, t-Test, chi-square test)

• Describe theoretically sources of biological data, and list various biological databases –nucleic acids, protein sequence, metabolic pathways and small molecule

• Identify various file formats of sequence data and tools for submission of data in databases as well as retrieval of gene and protein data from databases

• Annotate gene sequence and protein structure prediction

• Perform and explain the underlying mechanisms of pair-wise and multiple sequence alignments and determine phylogenetic relationships

• Describe various computational tools and methodologies and their application in structural bioinformatics, functional genomics and in silico drug discovery

Course Content:

Credits: Theory: 03
Practical: 01
Total: 04

Theory (03 Credits): 45 hours

UNIT I: Data collection, distribution, presentation, authentication and analysis 8 hours

Collection and classification of data. Graphical representation of data: Pie chart, Bar diagram, Histogram, Frequency polygon. Cumulative frequency curve (Ogive), Box plot. Probability theory: Binomial distribution, Poisson distributions. Measures of central tendency: Arithmetic Mean, Median, Mode; Measures of dispersion: Variance, Standard deviation and Standard error, Concept of Coefficient of variation.

UNIT II: Correlation, regression, analysis of variance 12 hours

Correlation: Types of correlation, Calculation of correlation in continuous data and ordinal data. Regression: Linear regression, regression coefficient. Analysis of variance (ANOVA): One way, post-hoc tests. Hypothesis testing: Parametric tests (Paired and unpaired t-test, z-test, F-test) & Non-Parametric tests (Chi-square test, Mann-Whitney U-test).

UNIT III: Introduction to bioinformatics and Biological Databases 10 hours

Introduction and scope of bioinformatics. Genomics, Proteomics, Transcriptomics, Systems Biology, Functional Genomics, Metabolomics, Molecular Phylogeny; Applications and Limitations of Bioinformatics. Introduction to biological databases; Primary, secondary and composite databases; Nucleic acid databases (GenBank, DDBJ, EMBL and NDB); Protein databases (PIR, SWISS-PROT, TrEMBL, PDB); Metabolic pathway database (KEGG, EcoCyc, and MetaCyc); Small molecule databases (PubChem, Drug Bank, ZINC, CSD).

UNIT IV: Data Generation and Retrieval, Sequence Alignment 15 hours

Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez). Scoring Matrices (PAM, BLOSUM), Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Local and global alignment, pair wise and multiple sequence alignments; Similarity, identity and homology of sequences.

Recommended Readings:

- Zar, Jerrold H. (1999). Biostatistical Analysis. IV Edition, Pearson Education Inc and Dorling Kindersley Publishing Inc. USA.
- Antonisamy, B., Christopher S. and Samuel, P. P. (2010). Biostatistics: Principles and Practice. Tata McGraw Hill Education Private Limited, India.
- Pagana, M. and Gavreau, K. (2000). Principles of Biostatistics. Duxberry Press, USA.
- Ghosh, Z. and Mallick, B. (2008). Bioinformatics: Principles and Applications. Oxford University Press.
- Lesk M. Arthur (2014). Introduction to Bioinformatics. Oxford University Press.
- Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition, Wiley Blackwell.
- Attwood Teressa K. and David Parry- Smith (2007). Introduction to Bioinformatics. Pearson Education.
- Mount, D. W. (2005). Bioinformatics: Sequence and Genome Analysis. CBS Publishers and Distributers Pvt. Ltd., Delhi.
- Zvelebil, Marketa and Baum O. Jeremy (2008). Understanding Bioinformatics. Garland Science, Taylor and Francis Group, USA.
- R. Durbin, S. Eddy, A. Krogh, and G. Mitchson (1998). Biological sequence analysis:

Probablistic models of proteins and nucleic acids. Cambridge University Press

Practical (01 Credits): 30 hours

1. Calculation of mean, standard deviation and standard error.
2. To perform a "paired-sample t- test" for a given set of data
3. To learn graphical representations of statistical data with the help of computers (e.g. MS Excel).
4. Accessing different biological databases and retrieval of nucleotide and protein sequences from the databases.
5. To perform pair-wise alignment of sequences (BLAST) and interpret the output.
6. Translate a nucleotide sequence and select the correct reading frame of the polypeptide from the output sequences.
7. Predict the structure of protein from its amino acid sequence.
8. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Practical Examination:

1. Calculation of standard deviation and standard error of a given data / Paired sample t-test. 6 Marks
2. Accessing biological databases and retrieval of nucleotide or protein sequences/ To perform pair pair-wise alignment of sequences (BLAST) 7 Marks
3. Translate a nucleotide sequence and select the correct reading frame of the polypeptide/ Predict the structure of protein from its amino acid sequence. 6 Marks
4. Practical Record 3 Marks
5. Viva-voce 3 Marks

Major Paper 18 (MJ 18): Animal Behaviour and Chronobiology

Course Learning Objective:

Animal Behaviour is the scientific study of the wild and wonderful ways in which animals interact with each other, with other living beings, and with the environment in which they live in. One important aspect pertaining to the studies on Animal Behaviour is that it can be conducted anywhere and at any time, depending on the interest of the researcher. Moreover, it is not confined to the four walls of the classroom or the laboratory. The behavioural biology has high applied value and currently linked to conservation biology, molecular biology, behavioural ecology and integrated pest management. The chronobiology addresses some periodic and cyclic nature of various life phenomena occurring in living beings in nature. They often correlate with the external environmental factors. Chronopharmacology, chronomedicine and chronotherapy are some of the direct applications of chronobiology in human health. This course aims to provide an overview of animal behaviour and chronobiology starting from historical perspective to types of behaviours and their evolutionary significance. The course also highlights types, mechanisms and importance of the biological rhythms and biological clocks operating in the living organisms. This course will help the learners to understand and appreciate different types of animal behaviours, their adaptive, evolutionary and practical significance.

Course Learning Outcome:

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

• Understand types of animal behaviour and their importance to the organisms.

• Enhance their observation, analysis, interpretation and documentation skills by taking short projects pertaining to Animal behaviour and chronobiology.

• Relate animal behaviour with other subjects such as Animal biodiversity, Evolutionary biology, Ecology, Conservation biology and Genetic basis of the behaviour.

• Understand various process of chronobiology in their daily life such as jet lag.

• Learn about the biological rhythm and their application in pharmacology and modern medicine.

• Realize, appreciate and develop passion to biodiversity; andy will respect the nature and environment.

Course Content:

Credits: Theory:03
Practical: 01
Total: 04

Theory (03 Credits): 45 hours

UNIT I: Introduction to Animal Behaviour & Patterns of Behaviour 8 hours

Origin and history of Ethology; Pioneers of Modern Ethology: Karl von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen; Proximate and ultimate causes of behaviour. Stereotyped

behaviours (Orientation, Reflexes); Individual behavioural patterns; Instinct versus Learned behaviour; Associative learning, Classical and Operant conditioning, Habituation, Imprinting.

UNIT II: Social & Sexual Behaviour 15 hours

Social Behaviour: Concept of Society, Communication and the senses (Chemical, Tactile, Auditory, Visual); Altruism, Inclusive fitness, Hamilton's rule; Insects' society (Example: Honey bee); Foraging in honey bee and advantages of the waggle dance. Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Courtship behaviour; Parental care, sexual conflict in parental care.

UNIT III: Introduction to Chronobiology & Biological Rhythm 18 hours

Historical developments in chronobiology, Biological oscillation: the concept of Average, amplitude, phase and period. Adaptive significance of biological clocks. Characteristics of biological rhythms; Short-and Long-term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and non- photic zeitgebers; Circannual rhythms; Photoperiod and regulation of seasonal reproduction of vertebrates; Role of melatonin.

UNIT IV: Biological Clocks 4 hours

Relevance of biological clocks; Chronopharmacology, Chronomedicine, Chronotherapy.

Recommended Readings:

- Alcock J. (2013). Animal Behaviour. Sinauer Associate Inc., USA.
- McFarland D. Animal Behaviour. (1982). Pitman Publishing Limited, London, UK.
- Vinod Kumar (2002) Biological Rhythms. Narosa Publishing House, Delhi/ Springer-Verlag, Germany
- Dunlap J. C, Loros J. J, DeCoursey P. J. (2004) Chronobiology Biological Timekeeping.Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
- Manning, A. and Dawkins, M. S. (2012). An Introduction to Animal Behaviour. Cambridge, University Press, UK.
- Paul W. Sherman and Alcock J. (2013). Exploring Animal Behaviour. Sinauer Associate Inc., Massachusetts, USA.
- Saunders D. S. (2002). Insect Clocks. III Edition, Barens and Noble Inc. New York, USA

Practical (01 Credit): 30 hours

1. To study nests and nesting behaviour of the birds and social insects.
2. To study the behavioural responses of wood lice to dry and humid conditions.
3. To study geotaxis behaviour in earthworm/ phototaxis behaviour in insect larvae.
4. Study of courtship behaviour in birds and insects from short videos/films.
5. Visit to Forest/Wild life Sanctuary/Biodiversity Park/Zoological Park to study and record the behavioural activities of animals and prepare a short report.

6. Study and actogram construction of locomotor activity of suitable animal models.
7. To study circadian functions in humans (daily eating, sleep and temperature patterns).
8. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Practical Examination:

1. Study of nests and nesting behaviour of the birds/ Study of courtship behaviour in birds and insects. 6 Marks
2. Study of the behavioural responses of wood lice/ Study of geotaxis behaviour in earthworm/ phototaxis behaviour in insect larvae. 5 Marks
3. Actogram construction/explanation of locomotor activity of any suitable animal models. 5 Marks
4. Visit Report 3 Marks
5. Practical Record 3 Marks
6. Viva-voce 3 Marks

Major Paper 19 (MJ 19): Endocrinology

Course Learning Objective:

The main goal of this course is to provide students with a basic understanding of human endocrine glands, neuro-endocrine glands and their structure, function and signalling pathways. Students will also study the influence of biological rhythm on hormones secretion. In addition, the course will facilitate the understanding of the biosynthesis and biochemistry of hormones. Also, emphasis would be laid on understanding the maintenance of homeostasis by the hormones. The course will also try to integrate the basic and clinical aspects of endocrinology to enhance the understanding of students about the consequences due to hyposecretion, hypersecretion and absence of hormones leading to various diseases and metabolic disorders**.**

Course Learning Outcome:

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

• Understand endocrine system and the basic properties of hormones.

• Appreciate the importance of endocrine system and the crucial role it plays along with the nervous system in maintenance of homeostasis.

• Gain insight into the molecular mechanism of hormone action and its regulation.

• Know the regulation of physiological process by the endocrine system and its implication in diseases.

• Gain knowledge about the prevalent endocrine disorders and critically analyze their own and their family`s health issues.

Course Content:

Credits: Theory: 03
Practical: 01
Total: 04

Theory (03 Credits): 45 hours

UNIT I: The chemical messengers 6 hours

Histroy of Endocrinology. Hormone: definition and classification. Endocrine, paracrine and autocrine modes of hormone delivery, Feedback mechanism.

UNIT II: Social & Sexual Behaviour 15 hours

Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction; Structure of hypothalamus, Hypothalamic nuclei and their functions; Regulation of neuroendocrine glands, Feedback mechanisms; Structure of pituitary gland, Its hormones and their functions; Hypothalamo-hypophysial portal system; Disorders of pituitary gland.

UNIT III: Peripheral Endocrine Glands 16 hours

Structure, Hormones, Functions and Regulation of Thyroid gland; Parathyroid & Adrenal glands; Pancreas; Ovary and Testis; Hormones in homeostasis; Disorders of endocrine glands.

UNIT II: Regulation of Hormone Action **8 hours**

Concept of receptors and their location; Mechanism of action of peptide hormones (with special reference to adrenaline, insulin and growth hormone); Mechanism of action of steroid hormones through gene level; Regulation of hormonal action

Recommended Readings:

- Turner, C. D. (1971) General Endocrinology, Pub- Saunders Toppan.
- Nussey, S.S.; and Whitehead, S.A. (2001) Endocrinology: An Integrated Approach, Oxford: BIOS Scientific Publishers.
- Hadley, M.E. and Levine J.E. (2007) Endocrinology (6th edition) Pearson Prentice-Hall, New Jersey.
- David, O.N. (2013) Vertebrate Endocrinology.
- Brook & Marshall: Endocrinology Blackwell publication

Practical (01 Credit): **30 hours**

1. Study of the permanent slides of all the endocrine glands.
2. Estimation of plasma level of any hormone using ELISA.
3. Estimation of levels of stress in a captive animal through cortisol analysis to observe different stages of stress- alarm, resistance & exhaustion.
4. Group discussion or Seminar presentation on one or two related topics from the list.

Pattern of Practical Examination:

1. Spotting (any four endocrine gland) $4 \times 3 = 12$ Marks
2. Estimation of plasma level of any hormone using ELISA/ Estimation of levels of stress in a captive animal through cortisol analysis to observe different stages of stress- alarm, resistance & exhaustion. 7 Marks
3. Practical Record 3 Marks
4. Viva-voce 3 Marks

Semester VIII

MN- 2D: Aquarium Fish Keeping

Course Learning Objective:

The course will impart basic knowledge of ornamental fish Industry and inculcate its scope as an avenue for career development as an entrepreneur or as an aquari-culturist. It will provide a clear understanding of the basics of biology and habits of aquarium fish, so as to facilitate taking up ornamental fish keeping as an enterprise, even at the household level. The skill capacity building of students will be promoted by teaching the techniques of aquarium constructions, feed formulation and preparation, transportation, maintenance and management of the system. Students will have 'hands-on' experience by exposure to technology, production, functioning or operation of an institution through visits to public aquariums in the markets, ornamental fish farms, hatcheries, and fish feed production plant as study tours or field visits.

Course Learning Outcome:

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

- Acquire knowledge about different kinds of fish their compatibility in aquarium.
- Become aware of Aquarium as commercial, decorative and of scientific studies.
- Develop personal skills on maintenance of aquarium.
- Know about the basic needs to set up an aquarium, i.e., dechlorinated water, reflector, filters, scavenger, aquatic plants etc. and the ways to make it cost-effective.

Course content:

Credits: **Theory: 03**
Practical: 01
Total: 04

Theory (03 Credits): **45 hours**

Unit I: Introduction to Aquarium Fish Keeping **4 hours**

The potential scope of Aquarium Fish Industry as a Cottage Industry; Exotic and Endemic species of Aquarium Fish

Unit II: Biology of Aquarium Fish **9 hours**

Study of different species of Aquarium fish and biology (Breeding, Feeding economic importance etc) of exotic and endemic fish. Common characters and sexual dimorphism of Fresh water and marine aquarium fish such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish.

Unit III: Food and Feeding of Aquarium Fish **12 hours**

Use of live fish feed organisms (Advantages and disadvantages of live food), Use of formulated feeds, Types of formulated feed, Formulation and preparation of feed, Advantages and disadvantages of formulated feed

Unit IV: Fish Transportation **12 hours**

Live fish transport (Capture and Pre-transport maintenance, capture and handling techniques); Fish packing and transport (Closed and open transport system, Preparation for packaging, Procedure for packaging, Precautions, Post transport maintenance) General handling techniques

Unit V: Maintenance of Aquarium **8 hours**

General aquarium maintenance- budget for setting up an Aquarium Fish Farm as a cottage industry.

Recommended Books:

- Dawes, J. A. (1984) The Freshwater Aquarium, Roberts Royee Ltd. London.
- Gunther, A. (1980) An Introduction to the Study of Fishes. A and C. Black Edinburgh.
- Jhingran, V.G. (1982) Fish and Fisheries in India. Hindustan publication Corp, India.
- Pandey, K and J.P. Shukla (2013) Fish and Fisheries. Rastogi publication

Practical (1 credit) **30 hours**

1. Study of different species of Aquarium fish and biology (Breeding, Feeding economic importance etc.) of exotic and endemic fish.
2. Study of sexual dimorphism of fresh water and marine aquarium fish (Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish, Butterfly fish)
3. Type, composition and formulation of fish feed (using Pearson Square Methods)
4. Construction and maintenance of Glass Aquarium and Filter System using indigenous locally available materials.
5. Monitoring of aquarium water quality (temperature, pH, dissolved oxygen, carbon dioxide, ammoniacal N-load) through titrimetric methods.
6. To write a project proposal for setting up a small aquarium fish keeping as a cottage industry to a funding agency for self-employment of youths or for helping poor farmers; after visiting any farm/enterprise.

Pattern of Examination: **(25 Marks)**

1. Spotting ($3 \times 3 = 9$ Marks)
   a) Any one aquarium fish
   b) Sexual dimorphism in any one aquarium fish
   c) Composition of any one fish feed
2. Construction and maintenance of Glass Aquarium and Filter System using indigenous locally available materials/ Monitoring of aquarium water quality (temperature, pH, dissolved oxygen, carbon dioxide, ammoniacal N-load) through titrimetric methods. (6 Marks)
3. Project report (4 Marks)
4. Practical record (3 Marks)
5. Viva-voce (3 Marks)

Major Paper 20 (MJ 20): Tools and Techniques

Course Learning Objective:

Course on tools and techniques focuses full hands-on approach to expose the students to modern techniques and methodologies used in zoology. The diverse techniques from centrifugation to chromatography, spectroscopy, microscopy, ELISA, electrophoresis and DNA sequencing technologies are included to make the student well versed with these protocols and methods.

Course Learning Outcome:

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

- Understand the purpose of the technique, its proper use and possible modifications/ improvement.
- Learn the theoretical basis of technique, its principle of working and its correct application.
- Learn the accuracy of technique.
- Learn the maintenance laboratory equipment/ tools, safety hazards and precautions.
- Understand the various biophysical methods, microscopy, histochemical and immunotechniques along with electrophoresis and DNA sequencing technologies.

Course Content:

Credits: Theory: 03
Practical: 01
Total: 04

Theory (03 Credits): 45 hours

UNIT I: Biophysical methods 15 hours

Centrifugation, Chromatography: Paper and Thin layer chromatography, Column chromatography, Gel filtration, Ion-exchange and Affinity chromatography, HPLC Spectroscopy: UV/Vis, Fluorescence, Circular dichroism, Atomic Absorption Spectroscopy: NMR and ESR; Mass Spectrometry.

UNIT II: Microscopy 10 hours

Introduction to microscopy and its application, Light microscopy, Fluorescence microscopy, Confocal Microscopy; Electron microscopy: SEM and TEM.

UNIT III: Histochemical and Immunotechniques 10 hours

Basic histochemical techniques (using Periodic Acid- Schiff, Sudan, Mallory's triple stain, etc.) and Immunohistochemistry, Detection of molecules using ELISA, RIA, Western blot, immunoprecipitation, flowcytometry and immunofluorescence microscopy, Detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.

UNIT IV: Molecular Biology and Recombinant DNA techniques 10 hours

Electrophoresis: Agarose and polyacrylamide gel, Two-dimensional, Isoelectric focussing, Next generation DNA sequencing techniques, RFLP, RAPD and AFLP techniques.

Recommended Readings:

- Wilson K. and Walker J. (2009) Principles and Techniques of Biochemistry, VII Edition, Cambridge Univ. Press
- Boyer: Modern Experimental Biochemistry and Molecular biology, Benjamin/ Cumin
- Freifelder: Physical Biochemistry, Freeman
- Holme and Peck: Analytical Biochemistry, Tata McGraw Hill
- Plumer: An Introduction to Practical Biochemistry, Tata-McGraw Hill
- Switzer and Garrity: Experimental Biochemistry, Freeman

Practical (01 Credit): **30 hours**

1. Isolation of Genomic DNA from *E. coli* and its quantification using spectrophotometer
2. Plasmid DNA isolation (pUC 18/19) and its detection on agarose gel electrophoresis.
3. To demonstrate following techniques: Southern, Northern, Western blotting, PCR DNA fingerprinting, DNA Sequencing (Sanger's Method).
4. Demonstration of ELISA and Immunoelectrophoresis.
5. Demonstration of paper chromatography/ TLC/ Column chromatography.
6. Understanding the difference between TEM and SEM using EM micrographs.
7. Project report on animal cell culture OR on a visit to any biotechnology Institute.
8. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Practical Examination:

1. Isolation of Genomic DNA from *E. coli* and its quantification / Plasmid DNA isolation (pUC 18/19) and its detection on agarose gel electrophoresis. 8 marks
2. Demonstration of ELISA/Immunoelectrophoresis/ Demonstration of paper chromatography/ TLC/ Column chromatography/ Identification and distinction between TEM and SEM using EM micrographs. 8 Marks
3. Visit Report 3 Marks
4. Practical Record 3 Marks
5. Viva-voce 3 Marks

Research Course (RC): Research Internship/ Field Work/ Dissertation

Credits: 12 (FM - 300)

Course Learning objective:

This research course focuses on understanding the concept of research and different types of research in the context of biology, develop laboratory experiment related skills. Students will learn to develop competence on data collection and process of scientific documentation and analyse the ethical aspects of research. The course also aims to evaluate the different methods of scientific writing and reporting.

Course Learning Outcome:

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

- Practical Expertise – Develop hands-on skills in laboratory techniques, fieldwork, and data analysis.
- Research Proficiency – Gain experience in designing, executing, and documenting scientific projects.
- Problem-Solving Ability – Apply theoretical knowledge to real-world chemical and environmental challenges.
- Effective Communication – Enhance skills in scientific writing, presentations, and technical discussions.

The Research Courses will be of 300 marks divided into two papers.

Paper (A) Research Methodology will be of 25 marks (Internal Assessment) + 75 marks (End Sem Exam) = 100 marks.

Paper (B), based on synopsis, thesis and viva voce, will be of 200 marks.

RC (I) - Research Methodology

(FM−100 Marks), Credits: 04

End Semester University Examination (75) and Semester Internal Examination (25)

Unit	Content	Hours
1	**Introduction to Research** Basics of Research (Meaning, Objectives and Motivations), Types of Research, Research Design (Definition and Essentials, Types, Errors and	12 hours

	Challenges, Selection and Formulation of Research Problems, Hypothesis Formulation), Review of Literature (Importance, Sources, Organization of Literature Review)	
2	**Data Collection and Sampling** Understanding Data in Research (Types, Characteristics of Good Data), Methods of Data Collection (Survey, Interview, Observation, Case Study), Sampling Techniques in Research (Concept of Sampling, Types of Sampling Techniques, Factors Affecting Sampling Quality), Data Processing and Management (Editing, Coding, Classification, Tabulation)	12 hours
3	**Statistical Analysis and Research Report Writing** Statistical Techniques (Mean, Median, Mode, Variance, Standard Deviation). Data Analysis Tools (Introduction to SPSS, R, and Excel). Research Report Writing (Structure: Introduction, Literature Review, Methodology, Results, Discussion, Conclusion). Data Presentation (Tables, charts, and graphs). Journal Article Writing (Components: Title, Abstract, Keywords, Introduction, Methods, Results, Discussion, Conclusion, References). Thesis & Dissertation Writing (Formatting: Title page, chapters, citations, bibliography, Plagiarism Detection.	12 hours
4	**Ethics in Research** Plagiarism in Research (Definition & Importance, Types, Prevention Methods). Copyright & Intellectual Property Rights (Copyright Laws, Intellectual Property Rights (IPR): Patents, trademarks, and their role in research, Fair Use & Ethical Citations), Ethical Issues in Research (Data Collection, Authorship Ethics, Publication Ethics).	12 hours
5	**ICT Tools for Research** Role of ICT in Research (Data Organization, Literature Review Management, Research Presentation Tools), Software for Data Management & Citation (Mendeley, EndNote, Zotero, SPSS, MATLAB, R for statistical and computational research). Web Search Techniques (Google Scholar, ResearchGate, Scopus, Web of Science, Boolean operators, filters, citation tracking). Graphical Representation of Data (Charts, graphs, and pivot tables).	12 hours

RC (II) - Synopsis & Dissertation Writing

F.M.=200, Credits: 08

Guidelines for Project Work Evaluation

The broad guidelines for the distribution of marks are as follows:

1. **Research Proposal/Synopsis and Dissertation Writing – 150 Marks**
2. **Viva-Voce – 50 Marks**

Components of the Paper

The paper will consist of the following elements:

(a) Field Work / Lab Work related to the selected project.

(b) Preparation of a Dissertation based on the research and experimental findings.

(c) Presentation of the Project in a seminar conducted by the Department of Zoology.

Note: The research internship/ field work/ dissertation needs to be carried out based on research proposal undertaken by the student. Depending on the logistics of limited resources and limited faculty members, a student may opt to do dissertation (theoretical/ practical) in parent institute or any other institute under guidance of any of the faculty members from parent university. This will be purely on mutual agreement between the student and the faculty member.

Advanced Major Paper – 1 (AMJ-1): Entomology

Course Learning Objective:

This course on Entomology aims to identify the major morphological features of insects and classify insects up to orders and describe the unique physiological characteristics of insects. Students will learn the insect behaviour specially the social organization of insects. Students will also be taught about various plant pests and their control measures.

Course Learning Outcome:

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

- Describe general characteristics of insects and identify them up to order level
- Describe morphological features of insects especially eyes, antennae, mouth parts, wings and legs.
- Understand physiology of insects.
- Understand insect behaviour and control of plant pests.

Course Content:

Theory (04 Credits): 60 hours

UNIT I: Introduction 10 hours

General Features of Insects; Basis of insect classification; Classification of insects up to orders; Elementary knowledge of collection, preservation and culture techniques of insects.

UNIT II: General Morphology of Insects 15 hours

Head – Eyes, Types of antennae, Mouth parts with respect to feeding habits; Thorax: Wings: Typical structure of insect wing and its modifications, Types of Legs adapted to diverse habitat; Abdomen: Typical structure.

UNIT III: Physiology of Insects 20 hours

Structure and physiology of Insect body systems (*w.r.t.* cockroach)–Integumentary (structure of integument & process of moulting), digestive, excretory, circulatory, respiratory, reproductive, and nervous system; Detailed structure and function of a compound eye.

UNIT IV: Insect Behavior & Insects as plant pests 15 hours

Social organization in insects – honey bees, termites. Bionomics and control of following plant pests (mechanical/ chemical/ biological): Agricultural pests (*Papiliodemoleus, Leucinodesorbonalis, Spodopteralitura)*; Stored grain pests (*Callosobruchus chinensis, Corcyra cephalonica, Sitophilus oryzae*).

Recommended Readings:

- Imms, A. D. A. General Text Book of Entomology. Chapman & Hall, UK
- Chapman, R. F. The Insects: Structure and Function. Cambridge University Press, UK
- Snodgrass, R. E. Principles of Insect Morphology. Cornell Univ. Press, USA

- Borror, D. J., Triplehorn, C. A., and Johnson, N. F. Introduction to the Study of Insects. M Saunders College Publication, USA
- Wilson, E. O. The Insect Societies. Harvard Univ. Press, UK
- Gullan, P. J., and Cranston, P. S. The Insects, An outline of Entomology. Wiley Blackwell, UK
- Nation, J. L. Insect Physiology and Biochemistry. CRC Press, USA

Advanced Major Paper – 2 (AMJ-2): Fish and Fisheries

Course Learning Objective:

This course will give the students an understanding of the classification of fishes, their morphology and physiology, types of fisheries and principles of aquaculture, including production systems, water quality, nutrition, spawning, larval culture and culture methodologies. The course will include an opportunity to conduct hands-on activities related to culture and production of fishes.

Course Learning Outcome:

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

- Understand fish morphology, physiology and classification
- Understand types of fisheries, impact of environmental factors, various fishing-crafts and gears,
- Understand the aquaculture systems, polyculture, various fish diseases and fish byproducts.

Course Content:

Theory (04 Credits): 60 hours

UNIT I: Introduction and Classification 10 hours

General description of fish; Account of systematic classification of fishes (upto classes); Classification based on feeding habit, habitat and manner of reproduction.

UNIT II: Morphology & Physiology 15 hours

Types of fins and their modifications; Locomotion in fishes; Hydrodynamics; Types of Scales, Gills and gas exchange; Swim Bladder: Types and role in Respiration, buoyancy; Osmoregulation in Elasmobranchs; Reproductive strategies (special reference to Indian fishes); Electric organs; Bioluminiscience; Mechanoreceptors; Schooling; Parental care; Migration.

UNIT III: Fisheries & Fish in Research 15 hours

Inland Fisheries; Marine Fisheries; Environmental factors influencing the seasonal variations in fish catches in the Arabian Sea and the Bay of Bengal; Fishing crafts and Gears; Depletion of fisheries resources; Application of remote sensing and GIS in fisheries; Fisheries law and regulations. Transgenic fish, Zebra fish as a model organism in research; Fish research laboratories/ institution/ universities in India.

UNIT IV: Aquaculture 20 hours

Sustainable Aquaculture; Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Polyculture; Composite fish culture; Brood stock management; Induced breeding of fish; Management of finfish hatcheries; Preparation and maintenance of fish aquarium; Preparation of compound diets for fish; Role of water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic; Preservation and processing of harvested fish, Fishery by-products.

Recommended Readings:

- Srivastava, C.B.L. Fish Biology. Narendra Publishing House.
- Jhingran, V.G. (1982) Fish and Fisheries in India. Hindustan publication Cooperation, India.
- Pandey, K. and Shukla, J.P. (2013) Fish and Fisheries. Rastogi publication, India
- Norman, J.R. A History of Fishes. Hill and Wang Publishers.
- Khanna, S.S. and Singh, H.R. A text book of Fish Biology and Fisheries. Narendra Publishing House.
- Bone, Q. and Moore, R. Biology of Fishes. Talyor and Francis Group, CRC Press, U.K.

Advanced Major Paper – 3 (AMJ-3) : Practical (based on AMJ -1 & AMJ – 2)

Practical (04 Credits): 120 hours

1. Study of one specimen from each insect order along with taxonomic description.
2. Morphological Study of different kinds of antennae, legs, mouth parts, head, sclerites, wings with venation and spiracles of insects
3. Methodology of collection, preservation and identification of insects
4. Morphological studies of various castes of *Apis*, *Camponotus* and *Odontotermes*
5. Study of fishes found in local markets and museum specimens along with taxonomic description: *Pristis, Chimaera, Exocoetus, Hippocampus, Gambusia, Labeo, Heteropneustes, Anabas* (at least one fish from each class).
6. Study of different types of fish scales (through permanent slides/ photographs).
7. Study of crafts and gears used in Fisheries.
8. Water quality criteria for Aquaculture: Assessment of pH, conductivity, Total solids, Total dissolved solids, dissolved oxygen.
9. Study of air breathing organs in *Channa*, *Heteropneustes, Anabas* and *Clarias*.
10. Demonstration of induced breeding in Fishes (video/visit to fisheries institute/fish farm) or Demonstration of parental care in fishes (video).
11. Field study of insects and submission of an insect box representing insect diversity.
12. Visit Report on a visit to any fish farm/pisciculture unit/Zebrafish rearing Lab.
13. Group discussion or Seminar presentation from any topic from the paper.

Pattern of Practical Examination: Full Marks: 100

1. Spotting (10 specimens) 10 × 3 = 30 Marks
   - i) Insects from any order (any **two**)
   - ii) Antenna/ leg/ mouthpart type (any **one**)
   - iii) Sclerite of any insect (any **one**)
   - iv) Wing and their venation (any **one**)
   - v) Insect spiracle (any **one**)
   - vi) Identification of fishes (any **two**)
   - vii) Fish scale (any **one**)
   - viii) Fishing craft/ gear (any **one**)
2. Methodology of collection, preservation and identification of insects/ Morphological studies of various castes of *Apis*/ *Camponotus* or *Odontotermes* 10 Marks
3. Description of air breathing organ in any one fish 10 Marks
4. Description of induced breeding in fishes/ parental care in fishes 5 Marks
5. Assessment of pH/ conductivity/ Total solids/ Total dissolved solids/ dissolved oxygen in water for aquaculture 5 Marks
6. Submission of an insect box representing insect diversity 10 Marks
7. Visit Report on a visit to any fish farm/pisciculture unit/Zebrafish rearing Lab 10 Marks
8. Practical Record 10 Marks
9. Viva-voce 10 Marks