DHANAMANJURI UNIVERSITY, MANIPUR

SYLLABUS

FOR

THREE YEARS B.Sc. ZOOLOGY REGULAR

UNDER UGC CHOICE BASED CREDIT SYSTEM

2020

COURSE STRUCTURE OF B.Sc. ZOOLOGY (REGULAR) UNDER UGC-CBCS

Semester	Subject Code	Paper Title/Course Content	Credits	No. of lectures
I	DZO-101	Animal Diversity	4	60
	DZO-102	Practical based on DZO-101	2	30
	AEC-001	English Communication	2	50
			8	**140**
II	DZO-103	Comparative Anatomy and Developmental Biology of vertebrates	4	60
	DZO-104	Practical based on DZO-103	2	30
	AEC-002	Environmental Studies	2	50
			8	**140**
III	DZO-205	Physiology and Biochemistry	4	60
	DZO-206	Practical based on DZO-205	2	30
	SZO-001	Sericulture	2	30
			8	**120**
IV	DZO-207	Genetics and Evolutionary Biology	4	60
	DZO-208	Practical based on DZO-207	2	30
	SZO-002	Medical Diagnostics	2	30
			8	**120**
V	DZO-309	Animal Biotechnology	4	60
	DZO-310	Practical based on DZO-309	2	30
	SZO-003	Aquarium Fish keeping	2	30
			8	**120**
VI	DZO-311	Immunology	4	60
	DZO-312	Practical based on DZO-311	2	30
	SZO-004	Apiculture	2	30
			8	**120**
Total			**48**	**760**

B.Sc. 1st SEMESTER (ZOOLOGY REGULAR)

DZO-101
(ANIMAL DIVERSITY)

No. of Credits: 4
Total marks: 75

Unit 1: Phylum Protozoa, Porifera and Cnidaria **10 lectures/13 marks**

1. General characters and classification of Protozoa up to classes
2. Locomotion in Protozoa; Life cycle of *Plasmodium vivax*
3. General characters and classification of Porifera up to classes; Canal System in *Sycon*
4. General characters and classification of Cnidaria up to classes; Polymorphism in Hydrozoa

Unit 2: Phylum Platyhelminthes and Nemathelminthes (Aschelminthes) **8 lectures/10 marks**

1. General characters and classification of Platyhelminthes up to classes
2. Life history of *Taenia solium*
3. General characters and classification of Nemathelminthes up to classes
4. Life history of *Ascaris lumbricoides* and its parasitic adaptations

Unit 3: Phylum Annelida and Arthropoda **8 lectures/10 marks**

1. General characters and classification of Annelida up to classes
2. Metamerism in Annelida
3. General characters and classification of Arthropoda up to classes
4. Vision in Arthropoda; Metamorphosis in Insects

Unit 4: Phylum Mollusca and Echinodermata **8 lectures/10 marks**

1. General characters and classification of Mollusca up to classes
2. Torsion in gastropods
3. General characters and classification of Echinodermata up to classes
4. Water-vascular system in Asteroidea

Unit 5: Protochordata, Agnatha and Pisces **8 lectures/10 marks**

1. General features and Phylogeny of Protochordata
2. General features of Agnatha and classification of Cyclostomata up to classes
3. General features and classification of Pisces up to orders
4. Osmoregulation in Fishes

Unit 6: Amphibia and Reptilia **8 lectures/10 marks**

1. General features and classification of Amphibia up to orders
2. Parental care in Amphibia
3. General features and classification of Reptilia up to orders
4. Poisonous and non-poisonous snakes; Biting mechanism in snakes

Unit 7: Aves and Mammalia **10 lectures/12 marks**

1. General features and classification of Aves up to orders
2. Flight adaptations and migrations in birds
3. Classification of Mammalia up to orders
4. Origin of mammals and Placentation in mammals

Note: Classification of Phylum in Unit 1-4 shall be followed from "Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition"

DZO-102

(PRACTICAL BASED ON DZO-101)

No. of Credits: 2
Total marks: 25

1. **Study of Permanent slides** **4 marks**
   Amoeba (W. M.), *Euglena* (W.M.), *Paramecium* (W.M.), *Sycon* (T.S. and L.S.); T.S. of *Taenia*; Scolex of *Taenia*; T.S. of *Ascaris* (male and female).

2. **Study of museum specimens** **8 marks**
   Porifera: *Sycon*, *Hyalonema,* and *Euplectella,*
   Cnidaria: *Obelia*, *Physalia, Aurelia, Tubipora,* and *Metridium*
   Platyhelminthes: *Fasciola hepatica*, and *Taenia solium*
   Nemathelminthes: *Ascaris* and *Wuchereria*
   Annelida: *Aphrodite, Nereis, Pheretima,* and *Hirudinaria*
   Arthropoda: *Palaemon, Cancer*, *Limulus*, *Palamnaeus, Scolopendra*, *Julus*, *Periplaneta, Apis*
   Mollusca: *Chiton, Dentalium, Pila, Unio, Loligo, Sepia,* and *Octopus*
   Echinodermata: *Pentaceros, Ophiura, Ophiothrix, Echinus, Cucumaria* and *Antedon*
   Protochordates: *Balanoglossus, Herdmania,* and *Branchiostoma*
   Cyclostomata: *Petromyzon*
   Fishes: *Sphyrna, Pristis, Torpedo, Labeo, Exocoetus,* and *Anguilla*
   Amphibia: *Ichthyophis/Ureotyphlus, Salamandra, Bufo,* and *Hyla*
   Reptilia: *Chelone, Testudo, Hemidactylus, Chameleon, Draco, Vipera, Naja, Bungarus* and *Crocodylus*
   Aves: *Columba, Corvus, Psittacula, Eudynamus, Pavo, Milvus*
   Mammalia: Bat, *Sorex*, *Pteropus*, *Rattus*

3. **Key for Identification of poisonous and non-poisonous snakes** **5 marks**

4. **Laboratory Record Book** **3 marks**

5. **Viva Voce** **5 marks**

SUGGESTED READINGS

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
2. Jordan, E.L. and Verma, P.S. (2017). *Invertebrate Zoology*. 20th Edn. S. Chand & Company Ltd., New Delhi.
3. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
4. Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
5. Pough H. *Vertebrate life,* VIII Edition, Pearson International
6. Marshall A.J., Parker, T.J. & Haswell, W.A.: *Text Book of Zoology*, 7th Edn. 1995, Vol. 2. A.I.T.B.S. Publishers & Distributors, Delhi
7. Kotpal, R.L.: *Modern Text Book of Zoology, Vertebrates*. 2nd Edn. 1998. Rastogi Publications, Meerut.
8. Jordan, E.L. and Verma, P.S. (2017). *Chordate Zoology*. 20th Edn. S. Chand & Company Ltd., New Delhi.

[***All the books shall be of latest editions***]

B.Sc. 2nd SEMESTER (ZOOLOGY REGULAR)

DZO-103
(COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES)

No. of Credits: 4
Total marks: 75

Unit 1: Integumentary and Skeletal System **7 lectures/8 marks**

1. Derivatives of integument with reference to glands and digital tips
2. Evolution of visceral arches

Unit 2: Digestive and Respiratory System **9 lectures/12 marks**

1. Brief account of alimentary canal and digestive glands
2. Brief account of gills, lungs, air sacs and swim bladder

Unit 3: Circulatory and Urinogenital System **8 lectures/10 marks**

1. Evolution of heart and aortic arches
2. Succession of kidney and Evolution of urinogenital ducts

Unit 4: Nervous System and Sense Organs **6 lectures/8 marks**

1. Comparative account of brain
2. Types of receptors

Unit 5: Early Embryonic Development **12 lectures/15 marks**

1. Spermatogenesis and oogenesis with reference to mammals; vitellogenesis in birds
2. Fertilization: external (amphibians), internal (mammals), blocks to polyspermy
3. Early development of frog and human up to the formation of gastrula; structure of mature egg and its membranes; patterns of cleavage and fate map
4. Types of morphogenetic movements; Fate of germ layers
5. Neurulation in frog embryo.

Unit 6: Late Embryonic Development **10 lectures/12 marks**

1. Brief account on implantation of embryo in humans
2. Formation of human placenta and functions; other types of placenta on the basis of histology
3. Metamorphic events in frog life cycle and its hormonal regulation

Unit 7: Control of Development **8 lectures/10 marks**

Fundamental processes in development (brief idea): gene activation, determination, induction, differentiation, morphogenesis, intercellular communication, cell movements and cell death

DZO-104

(PRACTICAL BASED ON DZO-103)

No. of Credits: 2
Total marks: 25

1. **Osteology** **5 marks**
   a. Disarticulated skeleton of bird/fowl and rabbit
   b. Carapace and plastron of turtle /tortoise
   c. Skulls: Frog/Toad, *Calotes* and Guinea pig

2. **Developmental Biology** **12 marks**
   a. Study of different developmental stages of frog through permanent slides: whole mounts and sections of cleavage, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages
   b. Study of different types of placenta: histological sections through permanent slides or photomicrographs
   c. Study of gametes of frog/rat through permanent slides or photomicrographs

3. **Laboratory Record Book** **3 marks**

4. **Viva Voce** **5 marks**

SUGGESTED READINGS

1. Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education.
2. Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill International Company.
3. Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons.
4. Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House.
5. Gilbert, S. F. (2006). *Developmental Biology*, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
6. Balinsky, B.I. (2008). *An introduction to Embryology*, International Thomson Computer Press.
7. Carlson, Bruce M (1996). *Patten's Foundations of Embryology*, McGraw Hill, Inc.
8. Rastogi, V. B. and M.S. Jayaraj: *Developmental Biology*, Kedarnath Ramnath, Meerut.
9. Verma, P.S. and Agarwal, V.K.: *Chordate Embryology*, S. Chand & Co. Ltd., New Delhi.

[***All the books shall be of latest editions***]

B.Sc. 3rd SEMESTER (ZOOLOGY REGULAR)

DZO-205
(PHYSIOLOGY AND BIOCHEMISTRY)
(Physiology should be with special reference to mammal/man)

No. of Credits: 4
Total marks: 75

Unit 1: Nerve and Muscle **8 lectures/10 marks**

1. Structure of a neuron; Resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres.
2. Ultra-structure of skeletal muscle; Molecular and chemical basis of muscle contraction.

Unit 2: Digestion and Respiration **10 lectures/12 marks**

1. Physiology of digestion and absorption of carbohydrates, proteins and lipids.
2. Pulmonary ventilation; Respiratory volumes and capacities
3. Transport of Oxygen and Carbon dioxide in blood

Unit 3: Excretion and Cardiovascular Physiology **12 lectures/13 marks**

1. Structure of nephron; Mechanism of Urine formation; Counter-current Mechanism
2. Composition of blood; Mechanism of blood coagulation
3. Structure of Heart; Origin and conduction of the cardiac impulse
4. Cardiac cycle

Unit 4: Reproduction and Endocrine Glands **8 lectures/10 marks**

1. Male reproductive System; Hormonal control of spermatogenesis
2. Female reproductive System: Hormonal control of oogenesis and menstrual cycle
3. Structure and function of pituitary, thyroid, parathyroid, pancreas and adrenal

Unit 5: Carbohydrate Metabolism **8 lectures/10 marks**

1. Glycolysis, Krebs Cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogenesis and Glycogenolysis
2. Electron transport chain and oxidative phosphorylation

Unit 6: Lipid and Protein Metabolism **8 lectures/12 marks**

1. Biosynthesis and β oxidation of palmitic acid
2. Transamination, Deamination and Urea Cycle

Unit 7: Enzymes **6 lectures/8 marks**

1. Introduction; Mechanism of Enzyme action; Enzyme Kinetics
2. Enzyme Inhibition

SUGGESTED READINGS

1. Arthur C. Guyton and John E. Hall: *Text book of Medical Physiology*, 12th Edn. Elsevier Saunders.
2. Kim E. Barrett, Scott Boitano, Susan M. Barman and Heddwen L. Brooks: *Ganong's Review of Medical Physiology*, 23rd Edn. 2010. Tata McGraw Hill Education Private Limited, New Delhi.
3. A.K. Jain: *Text book of Physiology, Vol. I & II*, 4th Edn. 2011. Avichal Publishing Company, New Delhi.
4. Michael M. Cox and David L. Nelson: In Lehninger Principles of Biochemistry, 5th Edn.2010; W.H. Freeman and Company, New York.
5. Victor W. Rodwell, David A. Bender, Kathleen M Botham, Peter J. Kennelly, P. Anthony Weil: Harper's Illustrated Biochemistry, 30th Edn. 2015; Mc Graw Hill Education.
6. Satyanaraya, U: Biochemistry, 3rd Edn. 2006; Books and Allied (P) Ltd., Kolkata.

[All the books shall be of latest editions]

DZO-206

(PRACTICAL BASED ON DZO-205)

Number of Credits: 2
Total marks: 25

Physiology **6 marks**

1. Preparation and demonstration of haemin crystals in human blood.
2. Study of activity of salivary amylase under optimum conditions.

Endocrinology **5 marks**

1. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas and adrenal gland.

Biochemistry **6 marks**

1. Qualitative test of carbohydrates, proteins and lipids in the given solutions.
2. Estimation of total protein in the given solution by Lowry's method.

Laboratory Record Book **3 marks**

Viva Voce **5 marks**

SZO-001
(SERICULTURE)

Number of Credits: 2
Total marks: 50

Unit 1: Introduction **5 lectures/8 marks**

1. Sericulture: Definition, History and Present status; Silk route
2. Types of silkworms, Distribution and Races
3. Exotic and indigenous races
4. Mulberry and non-mulberry Sericulture

Unit 2: Biology of Silkworm **5 lectures/8 marks**

1. Life cycle of *Bombyx mori*
2. Structure of silk gland and secretion of silk

Unit 3: Rearing of Silkworms **10 lectures/18 marks**

1. Selection of mulberry variety and establishment of mulberry garden
2. Rearing house and rearing appliances
3. Disinfectants: Formalin, bleaching powder, RKO
4. Silkworm rearing technology: Early age and Late age rearing
5. Types of mountages
6. Spinning, harvesting and storage of cocoons

Unit 4: Pests and Diseases **5 lectures/8 marks**

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

Unit 5: Entrepreneurship in Sericulture **5 lectures/8 marks**

1. Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture.
2. Visit to various sericulture centres.

SUGGESTED READINGS

1. *Manual on Sericulture*; Food and Agriculture Organisation, Rome 1976
2. *Handbook of Practical Sericulture*: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
3. *Silkworm Rearing and Disease of Silkworm*, 1956, Ptd. By Director of Ptg., Stn. & Pub. Govt. Press, Bangalore
4. *Appropriate Sericultural Techniques*; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
5. *Handbook of Silkworm Rearing: Agriculture and Technical Manual-1*, Fuzi Pub. Co. Ltd., Tokyo, Japan1972.
6. *Manual of Silkworm Egg Production*; M. N. Narasimhanna, CSB, Bangalore 1988.
7. *Silkworm Rearing*; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.

8. *A Guide for Bivoltine Sericulture*; K. Sengupta, Director, CSR & TI, Mysore 1989.
9. *Improved Method of Rearing Young age silkworm*; S. Krishnaswamy, reprinted CSB, Bangalore, 1986.

[All the books shall be of latest editions]

B.Sc. 4th SEMESTER (ZOOLOGY REGULAR)

DZO-207
(GENETICS AND EVOLUTIONARY BIOLOGY)

No. of Credits: 4
Total marks: 75

Unit 1: Introduction to Genetics **3 lectures/5 marks**

1. History of Genetics
2. Symbols and Terminology used in Genetics
3. Molecular basis of genetic information

Unit 2: Mendelian Genetics and its Extension **15 lectures/18 marks**

1. Mendel's Principles of Segregation and Independent Assortment
2. Extensions of Mendelian Principles: Incomplete dominance, Co-dominance, Supplementary genes, Complementary genes, Epistasis, Pleiotropy (lethal genes) and Multiple alleles.
3. Extra-chromosomal Inheritance.

Unit 3: Linkage, Crossing over, Chromosome mapping and Sex-linked Inheritance
5 lectures/8 marks

1. Linkage and Crossing over
2. Chromosome mapping
3. Sex-linked Inheritance in *Drosophila* and man

Unit 4: Sex-determination and Mutation **5 lectures/8 marks**

1. Sex-determination in *Drosophila* and man; Dosage compensation
2. Chromosome and Gene mutation
3. Common human genetic diseases (cause and clinical features)

Unit 5: History of life and Introduction to Evolution **8 lectures/10 marks**

1. Modern hypothesis of origin of life (Biochemical or Chemosynthetic origin of life)
2. Concept of Evolution and historical background

Unit 6: Evidences of Evolution and Theories of Evolution 10 lectures/12 marks

1. Evidences from Comparative anatomy, Comparative Embryology, Palaeontology, Biochemistry and Physiology.
2. Lamarckism, Darwinism and Neo-Darwinism

Unit 7: Process of Evolutionary changes and Species Concept
6 lectures/7 marks

1. Organic variations; Isolating mechanisms; Natural (Example: Industrial melanism) and Artificial Selection; Types of Natural Selection.
2. Biological Species Concept (Advantages and Limitations); Speciation.

Unit 8: Macro-evolution and Extinction **6 lectures/7 marks**

1. Macro-evolutionary Principles (Example: Darwin's Finches)
2. Mass extinction (causes, five major extinctions, K-T extinction)
3. Role of extinction in evolution

DZO-208
(PRACTICAL BASED ON DZO-207)

Number of Credits: 2
Total marks: 25

Experiments **17 marks**

1. Study of Mendelian Inheritance and gene interactions (Non-Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.
2. Study of Linkage, recombination, gene mapping using the data.
3. Study of Human Karyotypes (normal and abnormal).
4. Study of fossil evidences from plaster cast models and pictures
5. Study of homology and analogy from suitable specimens/ pictures
6. Charts:
   a. Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors
   b. Darwin's Finches with diagrams/ cut outs of beaks of different species
7. Visit to Natural History Museum and submission of report

Laboratory Record Book **3 marks**

Viva Voce **5 marks**

SUGGESTED READINGS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India.
2. Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings.
4. Russell, P. J. (2009). *Genetics- A Molecular Approach.* III Edition. Benjamin Cummings.
5. 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.
6. Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing
7. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). *Evolution*. Cold Spring, Harbour Laboratory Press.
8. Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers
9. Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings.
10. Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates.

[All the books shall be of latest editions]

SZO-002
(MEDICAL DIAGNOSTICS)

Number of Credits: 2
Total marks: 50

Unit 1: Introduction **2 lectures/3 marks**

1. Definition and scope of medical diagnostics.
2. Importance of medical diagnostics.

Unit 2: Diagnostic Methods used for Blood analysis **9 lectures/16 marks**

1. Composition of blood
2. Total Erythrocyte Count by haemocytometry
3. Total Leucocyte Count by haemocytometry and Differential Leucocyte Count (D.L.C.) using Leishman's stain.
4. Erythrocyte Sedimentation Rate (E.S.R).
5. Packed Cell Volume (P.C.V.)/Haematocrit value

Unit 3: Diagnostic Methods Used for Urine Analysis **3 lectures/5 marks**

1. Physical and Chemical characteristics of urine
2. Microscopical examination of urine.
3. Abnormal constituents of urine

Unit 4:Non-infectious Diseases **5 lectures/8 marks**

1. Causes, types, symptoms, complications, diagnosis and prevention of Diabetes mellitus (Type I and Type II).
2. Hypertension (Primary and secondary).
3. Testing of blood glucose using Glucometer/Kit.

Unit 5: Infectious Diseases **3 lectures/5 marks**

1. Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis.

Unit 6: Tumours **5 lectures/8 marks**

1. Types (Benign/Malignant); Metastasis.
2. Detection, diagnosis and treatment of Cancer.
3. Prevention of cancer as per World Cancer Research Fund.

Unit 7: Medical imaging **3 lectures/5 marks**

1. X-Ray and Ultrasonography
2. PET, MRI and CT scan

SUGGESTED READINGS

1. Park, K. (2007), *Preventive and Social Medicine*, B.B. Publishers
2. Godkar P.B. and Godkar D.P. *Textbook of Medical Laboratory Technology*, II Edition, Bhalani Publishing House
3. Cheesbrough M., *A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses*
4. Guyton A.C. and Hall J.E. T*extbook of Medical Physiology*, Saunders
5. Robbins and Cortan, *Pathologic Basis of Disease*, VIIIEdition, Saunders
6. Prakash, G. (2012), *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chand and Co. Ltd.

[All the books shall be of latest editions]

B.Sc. 5th SEMESTER (ZOOLOGY REGULAR)

DZO-309
(ANIMAL BIOTECHNOLOGY)

No. of Credits: 4
Total marks: 75

Unit 1: Introduction **8 lectures/10 marks**

1. Historical background of Biotechnology
2. Definition, Scope and Perspectives of Biotechnology

Unit 2: Molecular Techniques in Gene manipulation **22 lectures/30 marks**

1. Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics).
2. Restriction enzymes: Definition, Types and Functions.
3. Transformation techniques: Calcium chloride method and electroporation
4. Construction of genomic and cDNA libraries and screening by colony and plaque hybridization
5. Southern, Northern and Western blotting
6. DNA sequencing: Sanger method
7. Polymerase Chain Reaction; DNA Finger Printing and DNA micro array

Unit 3: Genetically Modified Organisms **18 lectures/20 marks**

1. Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection.
2. Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knock out mice.
3. Production of transgenic plants: *Agrobacterium* mediated transformation.
4. Applications of transgenic plants: insect and herbicide resistant plants.

Unit 4: Culture Techniques and Applications **12 lectures/15 marks**

1. Culture media and reagents for Animal cell and Tissue culture.
2. Basic techniques of mammalian cell culture; Expression of cloned genes in mammalian cells.
3. Molecular diagnosis of genetic diseases (Cystic fibrosis and Sickle cell anaemia).
4. Production of human insulin and human growth hormone using rDNA technology.
5. rDNA technology and gene therapy.

DZO-310
(PRACTICAL BASED ON DZO-309)

Number of Credits: 2
Total marks: 25

Experiments **14 marks**

1. Isolation of DNA from any living cell/tissue/organism.
2. Digestion of plasmid DNA by restriction enzyme.
3. Construction of circular and linear restriction map from the data provided.
4. Calculation of transformation efficiency from the data provided.
5. To study the following techniques through photographs and/or video:
   a. Southern Blotting
   b. Northern Blotting
   c. Western Blotting
   d. DNA Sequencing (Sanger's method)
   e. Polymerase Chain Reaction (PCR)
   f. DNA Fingerprinting

Submission of Project Report on Animal cell culture **3 marks**

Laboratory Record Book **3 marks**

Viva Voce **5 marks**

SUGGESTED READINGS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India.
11. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. *An Introduction to Genetic Analysis*. W. H. Freeman and Co., New York, USA.
2. Brown, *T.A. Molecular Biology Labfax II; Gene Cloning and DNA Analysis.* Academic Press, California, USA.
3. Glick, B.R. and Pasternak, J.J. (2009). *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. IV Edition, ASM press, Washington, USA.
4. Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc.
5. B.D. Singh. *Biotechnology*. Kalyani Publishers, Delhi, Kolkata, Madras
6. Das, H.K. *Text book of Biotechnology*. Wiley India Pvt. Ltd. New Delhi

[All the books shall be of latest editions]

SZO-003
(AQUARIUM FISH KEEPING)

No. of Credits: 2
Total marks: 50

Unit1: Introduction to Aquarium Fish Keeping **5 lectures/8 marks**

1. The potential scope of Aquarium Fish Industry as a Cottage Industry.
2. Exotic and Endemic species of Aquarium Fishes

Unit 2: Biology of Aquarium Fishes **10 lectures/18 marks**

1. Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish

Unit 3: Food and feeding of Aquarium fishes **5 lectures/8 marks**

1. Use of live fish feed organisms
2. Preparation and composition of formulated fish feeds

Unit 4: Fish Transportation **5 lectures/8 marks**

1. Live fish transport - Fish handling, packing and forwarding techniques.

Unit 5: Maintenance of Aquarium **5 lectures/8 marks**

1. General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry

SUGGESTED READINGS

1. Dawes, J.A. (1984). *The Freshwater Aquarium*. Roberts Royee Ltd. London
2. Walter James (2021). *Freshwater Aquarium for Beginners*.
3. Martin, A. Moe (2009). *Marine Aquarium Handbook*.
4. N. Arumugam, K.V. Jayashree, C.S. TharaDevi. *Home Aquarium and Ornamental fish culture*. Saras Publications.

[All the books shall be of latest editions]

B.Sc. 6th SEMESTER (ZOOLOGY REGULAR)

DZO-311
(IMMUNOLOGY)

No. of Credits: 4
Total marks: 75

Unit 1: Introduction **5 lectures/10 marks**

1. Historical perspective of Immunology.
2. Scope, Prospect and Importance of Immunology.
3. Cells and organs of the Immune System.

Unit 2: Immunity **15 lectures/20 marks**

1. Definition, Types (Innate and Acquired Immunity; Passive and Active Immunity) and Mechanism of Immunity.
2. Cell mediated and Humoral Immunity.
3. Maturation, activation and differentiation of B- & T- lymphocytes.

Unit 3: Antigens and Antibodies **10 lectures/15 marks**

1. Antigenicity and Immunogenicity; Immunogens, Adjuvants and haptens.
2. Factors influencing immunogenicity; B- & T- Cell epitopes.
3. Structure and functions of different classes of immunoglobulins.
4. Antigen-antibody interactions.

Unit 4: Antigen presentation and Major Histocompatibility Complex (MHC) **10 lectures/10 marks**

1. Structure and functions of MHC molecules.
2. Endogenous and exogenous pathways of antigen processing and presentation.

Unit 5: Cytokines **10 lectures/10 marks**

1. Types and functions of Cytokines.
2. Therapeutic cytokines.

Unit 6: Complement System, Hypersensitivity and Vaccines **10 lectures/10 marks**

1. Components and pathways of complement activation.
2. Gell and Coombs' classification and brief description of various types of hypersensitivities.
3. Types of vaccines and recent approaches in vaccine production.

DZO-312
(PRACTICAL BASED ON DZO-311)

Number of Credits: 2
Total marks: 25

Experiments **17 marks**

1. Study of permanent histological sections of spleen, thymus, tonsil, and lymph nodes.
2. Ouchterlony's double immuno-diffusion method.
3. Cell counting and viability test from splenocytes of farm bred animals/cell lines.
4. Demonstration of ELISA using ELISA reader.
5. Demonstration of Immunoelectrophoresis.

Laboratory Record Book **3 marks**

Viva Voce **5 marks**

SUGGESTED READINGS

1. Roitt, I.M. : Essential Immunology, ELBS Edition.
2. Paul, W.E.: Fundamentals of Immunology, Lippincott-Raven Pub., Philadelphia, New York.
3. Kuby: Immunology , W.H. Freeman, USA.
4. Lal, S.S.: Immunology, Rastogi Pub., Meerut, India (3rd ed., 2012).
5. Tizzard, I: Immunology.

[All the books shall be of latest editions]

SZO-004
[APICULTURE]

Number of Credits: 2
Total marks: 50

Unit 1: Biology of Bees **6 lectures/10 marks**

1. History, Classification and Biology of Honey Bees
2. Social Organization of Bee Colony

Unit 2: Rearing of Bees **10 lectures/15 marks**

1. Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth
2. Bee Pasturage
3. Selection of Bee Species for Apiculture
4. Bee Keeping Equipment
5. Methods of Extraction of Honey (Indigenous and Modern)

Unit 3: Diseases and Enemies **5 lectures/10 marks**

1. Bee Diseases and Enemies
2. Control and Preventive measures

Unit 4: Bee Economy **3 lectures/5 marks**

1. Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen, etc.

Unit 5: Entrepreneurship in Apiculture **6 lectures/10 marks**

1. Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial
2. Beehives for cross pollination in horticultural gardens

SUGGESTED READINGS

1. Prost, P. J. (1962). *Apiculture*. Oxford and IBH, New Delhi.
2. Bisht D.S., *Apiculture*, ICAR Publication.
3. Singh S., *Beekeeping in India*, Indian council of Agricultural Research, New Delhi.

[All the books shall be of latest editions]