M. Sc. ZOOLOGY

Semester III & IV

SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

(Revised, w.e.f. June 2019)

DEPARTMENT OF LIFE SCIENCES

BHAKTA KAVI NARSINH MEHTA UNIVERSITY

Junagadh – 362263

Department of Life Sciences

1. The Course

    - The course is full time course comprising of four semesters. There will be four theory papers (three core papers and one interdisciplinary / multidisciplinary paper) and one combined practicals in first two semesters. The last two semesters offer choice of courses to the students where two core courses and one elective (to be chosen from three available) courses will be taught. Any elective course will be taught only when prerequisite number of the student enrols for that course. Students shall be required to submit at the time of practical examination at the end of each semester.
        - The laboratory Journal and diary of field work (Tour report) duly signed by the teachers concerned from time to time.
        - A set of assignments, submissions, preparations or materials illustrating the subject - matter as per syllabus for each semester.

2. Eligibility

    - The candidate with B.Sc. degree in Botany with minimum 45% is eligible for admission to M.Sc. Botany course.
    - Students, who have cleared B.Sc. with Botany as the second subject in S.Y. B.Sc. will also be considered for admission, provided the seats are available. A total of 20 seats are available in the Botany.
    - Students will be admitted as per the reservation policy in effect from time to time, as directed by the University.

3. Educational tour

    - The study/ educational tour is compulsory and part of Curriculum to study different ecosystems, botanical, zoological and microbiological places of interest anywhere in the country. Since the tour or tours are part of the curriculum, these can be conducted during any or all of the four semesters. However, in special cases, alternative of the educational tour will be decided and assigned to the student concerned, by the Staff Council of the Department.

4. Seminars / Assignments / Submission
    - Regular seminars will be organised on I and II Semesters and it is compulsory. Presentation on relevant topics, mostly from syllabus (oral and / or poster), is mandatory for the enrolled student. For each seminar, a student will be given marks, which will be added in the III Semester marksheet.
5. Attendance
    - Admitted students have to attend all the Lectures, Practicals and Seminars. A minimum prescribed attendance as per University rules is required to sanction a term grant. Students whose term is not granted will not be allowed to appear in the examination, and will have to join the same semester in the following year.
6. Semester wise distribution of marks
    - SEMESTER-I:

4 Papers (100 Marks each*)	: 400
1 Combined Practical	: 200
Total	**: 600**

    - SEMESTER-II:

4 Papers (100 Marks each*)	: 400
1 Combined Practical	: 200
Total	**: 600**

      *** 70 external + 30 internal**
    - SEMESTER-III:

4 Papers (100 Marks each*)	: 400
1 Combined Practical	: 200
Total	**: 600**

    - SEMESTER-IV:

1 Papers (100 Marks each*)	: 100
1 Combined Practical	: 50
Dissertation / Project	: 400 (300 + 100 viva)
Seminar course	: 50
Total	**: 600**

7. The M.Sc. courses run by this Department are full time studies and as such, a student admitted to the Department is not allowed to join any other courses or study, or take up any paid service.
8. The candidate should bring all original mark sheets, certificates etc. At the time of the interview.

M. Sc. Zoology

Semester - III

Course code	Paper title	Hours / week	Credits	Marks		
				Int.	Ext.	Total
ZOO 313	Structure And Functions In Invertebrates And Vertebrates, Phylogeny (Core) (Core)	04	04	30	70	100
ZOO 314	Mammalian Physiology (Core)	04	04	30	70	100
ZOO 315	Aquaculture & Fisheries Technology (Core)	04	04	30	70	100
$ZOO 316 A	Wildlife And Animal Behavior (Elective)	04	04	30	70	100
$ZOO 316 B	Developmental Biology (Elective)					
ZOO PRAC 317	Combined Practicals	12	12	-	200	200
*ZOO 419	Dissertation / Project	09	00	-		
	Total	**37**	**24**	**-**		**600**

$ Out of two elective papers 316 A and 316 B ***any one*** **is to be selected**

* ***Dissertation / Project*** commences in III Semester but evaluated and Grade Points are to be added in 4th Semester.

Semester - IV

Course code	Paper title	Hours / week	Credits	Marks		
				Int.	Ext.	Total
ZOO 418	Research Methodology, IPR and Biosafety (Core)	04	04	30	70	100
ZOO 419	*Dissertation / Project	16	16	-	400	400
ZOO PRAC 420	Practicals	04	04	-	50	50
ZOO 106 + 212	#Seminar course 1 & 2	-	04			50
	Total	**24**	**30**	**-**		**600**

***Seminar / Tutorial Courses*** may be carried out in first two Semesters but evaluated and Grade Points are to be added in the final (4th) Semester only.

***** ***Dissertation / Project*** commences in III Semester but evaluated and Grade Points are to be added in 4th Semester.

Zoo 313: STRUCTURE AND FUNCTIONS IN INVERTEBRATES AND VERTEBRATES, PHYLOGENY (CORE)

Unit: 1

1.1 Classification organization and general characteristics of invertebrate phyla.
1.2 Classification and organization of lower vertebrates.
1.3 Classification, organization and general characteristics of vertebrate phyla. Strategies and evolutionary significance of larval forms.
1.4 Larval forms of free living invertebrates. Evaluation of Biodiversity indices with brief reference to Shannon-Weinner index.

Unit: 2

2.1 Locomotory organs and mode of locomotion in Invertebrates.
2.2 Excretion in Invertebrates.
2.3 Reproduction in Invertebrates.
2.4 Organisms of health and agricultural importance: Common parasites and pathogens of humans and domestic animals.

Unit: 3

3.1 Concept of evolutionary biology.
3.2 Speciation and geological time scale.
3.3 Evolution of tetrapod and land vertebrates.
3.4 Zoogeographical realms.

Unit: 4

4.1 Agricultural pests and their pathogenicity.
4.2 Pests of stored grains and their pathogenicity.
4.3 Insect pest management: Chemical, environmental and biological control.
4.4 Useful insects; Sericulture, Lac culture and Apiculture.

Proposed Practicals

1. Classification of invertebrates.
2. Classification of vertebrates.
3. Identification of larval forms through slides.
4. Study of different types of fossils.
5. Study zoogeographic realms and its examples.
6. Study of metamorphosis.
7. Specimens following taxonomic methods and principles.

Reference Books:

1. Principles of Insect Morphology, Snodgrass, R. E., Cornell Univ. Press, USA

2. Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F.,M Saunders College Publication, USA
3. Ecology of insects, Speight, M. R., Hunter, M. D., & Watt, A. D., Wiley-Blackwell, UK
4. Entomology & Pest Management, Pedigo, L. P.,Prentice Hall, New Jersey, USA
5. Invertebrate Zoology, Ruppert and Barnes, R.D. (2006). VIII Edition. Holt Saunders International Edition.
6. Invertebrates: A New Synthesis,Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The* III Edition, Blackwell Science
7. An introduction to Embryology Balinsky, B.I. (2008)., International Thomson Computer Press.
8. The Principles of Insect Physiology Wigglesworth, V. B., ELBS and Chapman and Hall.
9. Modern text book of zoology: invertebrates, R.L. Kotpal
10. Modern text book of zoology: vertebrates, R.L. Kotpal
11. Principles of Zoology – Touching the Structure, Development, Distribution, and Natural Arrangement of the Races of Animals, Living and Extinct" by Louis Agassiz
12. Perspectives in animal phylogeny and evolution, alessandro minelli,Oxford university press
13. Principle of animal taxonomy, G.G. simpson, Oxford IBH publication company

Zoo 314: MAMMALIAN PHYSIOLOGY (CORE)

Unit 1: Digestive System and Excretory system

1.1 Physiology of digestion and absorption.
1.2 Energy balance, BMR.
1.3 Comparative physiology of excretion, Kidney, urine formation, urine concentration, waste elimination, micturition.
1.4 Regulation of water balance, Blood pressure, electrolyte balance, acid-base balance.

Unit 2: Cardiovascular System

2.1 Comparative anatomy of heart structure, myogenic heart, specialized tissue.
2.2 ECG – its principle and significance, cardiac cycle, heart as a pump, neural and chemical regulation of all above.
2.3 Blood corpuscles, haemopoiesis and formed elements, plasma function.
2.4 Blood volume, blood volume regulation, blood groups, haemoglobin, Immunity, haemostasis.

Unit 3: Nervous system and Endocrinology

3.1 Neurons, action potential, gross neuroanatomy of the brain and spinal cord.
3.2 Central and peripheral nervous system, neural control of muscle tone and posture.
3.3 Endocrinology and reproduction: Endocrine glands, basic mechanism of hormone action, hormones and diseases.
3.4 Reproductive processes, neuroendocrine regulation.

Unit 4: Sense organs, Thermoregulation

4.1 Vision, hearing and tactile response.

4.2 Thermoregulation: Comfort zone, body temperature – physical, chemical, neural regulation acclimatization.

4.3 Stress and adaptation.

4.4 Introduction to Computer Oriented statistical techniques.

Proposed Practicals:

1. Anatomical and Physiological perspectives of mammalian circulatory system.
2. Anatomical and Physiological perspectives of mammalian Digestive system.
3. Anatomical and Physiological perspectives of mammalian Urino-genital system.
4. Anatomical and Physiological perspectives of mammalian Brain and cranial nervous system.
5. Anatomical and Physiological perspectives of mammalian neck nerves.
6. Physiological characteristics of skeletal muscle, pectin, medullated and non-medullate nerves.
7. Demonstration of Tissue (block) preparation for the histological studies of mammalian tissues.
8. Permanent histological preparation of tissues.
9. Study of permanent histological slides.
10. Introduction to Computer Oriented statistical techniques.

Reference Books:

1. Text book of Medical Physiology by A. C. Guyton and J. E. Harcourt.
2. Text book of Medical Physiology by Ganong.
3. Principles of anatomy and physiology by Gerard Tortora and Bryan Derrickson, 12th edition
4. Invertebrate Structure and function. 2nd ed. ELBS & Nelson.
5. Analysis of Vertebrate Structure. Hildebrand, M. (1995). John Wiley & Sons.
6. Vertebrates: Comparative anatomy, function evolution. Kardong, K. V. (2002). Tata McGraw Hill.
7. Comparative anatomy of the Vertebrates. Kent, G. C. & Carr, R. K. (2001). 9th ed. Mc Graw Hill.
8. Biology of the Invertebrates Pechenik, J. A. (1998). 4th Ed. McGraw Hill.
9. The vertebrate body. Weichert, C. K. & Presch, W. (1984). Elements of Chordate Anatomy. Tata-McGraw Hill Pub. Comp.
10. Comparative Vertebrate Endocrinology, Bentley, P. J., Cambridge University Press, UK
11. Vertebrate Endocrinology, Norris D. O., Elsevier Academic Press,
12. Hand Book of Physiology, American Physiological Society, Oxford University Press, Section 7: Multiple volumes set.

Zoo 315: AQUACULTURE & FISHERIES TECHNOLOGY (CORE)

Unit 1:

1.1 Classification of Pisces, Crustacea and Molluscan up to level of order with examples of commercially important species.

1.2 Aquaculture and its importance: Advantages, scope and status of aquaculture in India and Gujarat. Gujarat Fisheries Act, Coastal Aquaculture Authority Act, Biodiversity Act.

1.3 Different types of Fishing boats and gears used in Fisheries.

1.4 Ornamental fishes and its maintenance of fresh water and marine aquarium.

Unit 2:

2.1 Freshwater capture and culture fisheries status in India and Gujarat. Estuarine capture and culture fisheries status in Gujarat and India.

2.2 Marine capture fisheries (Pisces): Pomfret fishery, Bombay duck fishery.

2.3 Marine capture fisheries (Other than Pisces): Shrimps, Prawn fishery, Lobster, Crab, Molluscan, Pearl Oyster fisheries.

2.4 Culture practices: Indian major carps and exotic carps.

Unit 3:

3.1 Induced breeding: Fish breeding, hypophysation technique, factors controlling induced breeding, fish seed collection, transport and stocking.

3.2 Induced Breeding: Hormonal regulation of gonadal development, Activity of Gonadotropin releasing hormone, application of hormones in aquaculture.

3.3 Fish diseases and control: Common fungal, bacterial, protozoan and other diseases of fish, symptoms and control methods.

3.4 Microbial hazards in seafood (a few examples only).

Unit -4:

4.1 Fish Preservation: Need of preservation, methods of preservation and their advantages.

4.2 Fish Processing methods used in industries with their advantages and applications,Fish by-products and their uses.

4.3 Role of biopesticides in aquaculture, application of monoclonal antibodies; Vaccines and immunostimulants; Drug resistance Aquafeed: Nutrition, Feed formulation, Feed additives, Alternative feed ingredients.

4.4 Physical parameters of Water quality and their effect on fisheries. Global and local environmental water pollution and their effect on fisheries.

Proposed Practicals:

1. Systematic identification of some fishes from Gujarat.
2. Study of various fish products.
3. Demonstration of different organ systems of fish by pictures.

4. Techniques of induced breeding in fish.
5. Physico- chemical parameters of freshwater bodies.
6. Biochemical estimation of protein, lipid and carbohydrate from fish tissues.
7. Detection of food and feeding habit by analyzing gill rakers, buccopharynx and gut content.
8. Identification and mounting of some common freshwater Zooplankton, benthos, aquatic weeds and insects).
9. Limnological studies.
10. Visit to fish processing industry.

Reference Books:

1. Aquaculture. Bardach, J. E. & Ryther, J. H. (1972). John Willey and Sons.
2. Fish Nutrition in Aquaculture. DE Silva, S. S. & Anderson, T. A. (1995). Chapman & Halll, London.
3. Nutrition and Feeding of Fish and Crustaceans. Guillaume, J., Kaushik, S., Bergot, P. & Metailler, R. (2001). Springer and Praxis, U. K.
4. Fish Nutrition. Halver, J. E. (1972). Academic Press, New York & London.
5. Fish and Fisheries of India. Jhingran, V. G. (1991). 3rd ed., Hindusthan Pub. Corp.
6. Aquaculture. Pillay, T.V.R. (1993). Fishing News Books.
7. Fish Biology. Srivastava, C. B. L. (1999). Narendra Pub. House.
8. A Text Book of Fishery Science & Indian Fisheries.Srivastava, C. B. L. (2006). Kitab Mahal. Allahabad.
9. The fresh water fishes of India, Pakistan, Bangladesh, Burma and Sri Lanka. Jayaram K. C. 1981.
10. Prawns and Prawn fisheries of India. Kurian, C. V. and Sebastian, V. O. 1986.
11. Fish Migration. Jones, F. R. H. 1968.
12. India's water wealth. Rao, K. L. 1975.
13. A textbook of marine ecology. Balakrishnan, N. N. and Thampy, D. M. 1980.
14. Fisheries Biotechnology. Lakra W. S., Abidi SAH, Mukherjee SC and Ayyappan S. 2004.
15. Theory and practice of induced breeding in fishes. Harvey, B. J. and Hoar, W. S. 1979.
16. Aquaculture – Principles and Practices. Fishing News Book. T. V. R. Pillay. 1993.
17. Aquaculture. Bardach, J. E. & Ryther, J. H. (1972). John Willey and Sons.
18. Biotechnology & Genetics in Fisheries and Aquaculture. Beaumont, A. R. & Hoare, K. (2003). Blackwell Publishing.
19. Biology of Fishes. Bond, C. E. (1996). 2nd ed. Saunders Pub.
20. Chakrabarti, N. M. (1998).
21. Biology, Culture and Production of Indian Major Carps – A Review. Narendra Publishing House. New Delhi.
22. The Physiology of Fishes. Evans, D. H. (1998). CRC Press.
23. Aquaculture. Pillay, T. V. R. (1993).. Fishing News Books.

24. Textbook of Fish Genetics and Biotechnology. Reddy, P. V. G. K., Ayyappan, S., Thampy, D. M. & Krishna, G. (2005). ICAR, New Delhi.
25. Fish Biology. Srivastava, C. B. L. (1999). Narendra Pub. House.
26. Fishponds in Farming Systems, Zijpp, V. D., Verreth, J. A. J., Tri, L. Q., van Mensvoort, M. E. F., Bosma, R. H., and Beveridge, M. C. M., Wageningen Academic Publishers, Netherlands
27. Aquaculture Principles and Practices, Pillay, T. V. R., Blackwell Publishing, USA
28. Aquaculture and Fisheries Biotechnology Genetic Approaches, Dunham, R. A., CABI Publishing, USA

Zoo 316 A WILDLIFE AND ANIMAL BEHAVIOR (ELECTIVE)

Unit 1 Wildlife

1.1 Population genetics – populations, gene pool, gene frequency; Hardy-Weinberg law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift.

1.2 Methods in field biology: Methods of estimating population density of animals, ranging patterns through direct, indirect and remote observations, sampling methods in the study of behavior, habitat characterization-ground and remote sensing methods.

1.3 Adaptive radiation and modifications; isolating mechanisms; speciation; allopatricity and sympatricity; convergent evolution; sexual selection; co-evolution.

1.4 Ecological sub divisions of Indian wildlife (marine ecology).

Unit 2 Conservation & Development

2.1 Causes of wildlife depletion & legislation.

2.2 Biosphere reserves, national park & sanctuaries of India.

2.3 Wildlife management, Instruments used in wildlife poaching and man-wildlife conflicts; Wildlife protection act, Projects, trades in wildlife.

2.4 Bio-resource and uses of biodiversity; Biosensors.

Unit 3 Marine & Coastal Ecology

3.1. The shore environment. Physico-chemical and biological factors of intertidal zone. Distribution of life on rocky shores, sandy shores and muddy shores.

3.2. Zonation and adaptation of organisms in the intertidal habitats.

3.3. Benthos: Distribution of shallow water benthic organisms. Distribution and adaptation of deep-seabenthic organisms. Marine animal associations: commensalisms symbiosis and parasitism.

3.4. Coral reef ecology: Special features of coral reef habitats and distribution of coral reef organisms.Mangrove systems: Special features of mangrove habitats and distribution of plants and animals in mangrove ecosystems.

Unit-4 Animal Behavior

4.1 Animal behavior: Classification, instinct, imprinting, learning, foraging and feeding behavior. Aggressive behavior; habitat selection and optimality in foraging; migration, orientation and navigation; domestication and behavioral changes.

4.2 Sexual behavior, social behavior and parental care development of behavior; social communication; social dominance; use of space and territoriality; mating systems, parental investment and reproductive success, Socio-biology of selected birds and mammals.

4.3 Circadian rhythm, neural basis of learning, memory, cognition, sleep and arousal; biological clocks, Approaches and methods in study of behavior; proximate and ultimate causation; altruism, reciprocal altruism and evolution-group selection, Kin selection concept, its importance in hymenoptera and altruism.

4.4 Migration of fish and birds.

Proposed Practicals

1. Studies on the population indices.
2. Studies on Quadrate Sampling method and Transect Sampling method.
3. Studies on the community indices.
4. Study of animals in different habitats.
5. Field Study: Bird watching.
6. Field study: Behavioral activity of wild animals.
7. Field study: Educational visit and observations at Zoo.
8. Field study: Study captive animal at Zoo.
9. To make a behavioral ethogram of animal activity.
10. Tools and techniques used in wildlife.
11. Advance techniques: 3S technique.
12. Functional anatomy of animals.
13. Studies on the animals from different ecological habitats of the intertidal zones.

Reference Books

1. Field Sampling: Principles and Practices in Environmental Analysis, Conklin, A.R. Jr., (2004), CRC Press.
2. Principles and Standards for Measuring Primary Production, Fahey, T.J. and Knapp, A.K., (2007), Oxford University Press, UK
3. Ecological Modeling, Grant, W.E. and Swannack, T.M., (2008), Blackwell.
4. Fundamental Processes in Ecology: An Earth system Approach, Wilkinson, D.M., (2007), Oxford University Press, UK
5. Mechanism of Animal Behaviour, Peter Marler and J. Hamilton; John Wiley & Sons, USA
6. Animal Behaviour, David McFarland, Pitman Publishing Limited, London, UK

7. Animal Behaviour, John Alcock, Sinauer Associate Inc., USA
8. Perspective on Animal Behaviour, Goodenough, McGuire and Wallace, John Wiley & Sons, USA
9. Exploring Animal Behaviour, Paul W. Sherman & John Alcock, Sinauer Associate Inc.,Massachusetts, USA
10. An Introduction to Animal Behaviour, A. Manning and M.S Dawkins, Cambridge University Press, UK
11. Field Guide to the Indian mammals, Vivek menon
12. Life of birds, welty
13. Biodiversity concepts and conservation, B.B. Hosetti
14. Forest ecology, Barnes
15. The book of Indian reptiles and amphibians, Daniel J C
16. Ecology and tropical biology, Jan Deshmukh, Blackwell scientific publications
17. Man and ecosystem, L Loyd, JR Macmillan edu. Ltd.
18. Marine biodiversity, Ormond, Cambridge Uni
19. Animal behavior by Rina Mathur
20. Animal behavior by David Macfarland, Pitman publication ltd.
21. Animal behvaior M.P. Arora
22. Animal behavior: an evolutionary approach by Alcock J.
23. The theory of Evolution- J. Maynard Smith
24. Molecular Evolution and Origin of Life- Widney W. Fox and Klous Dose
25. Animal species and their evolution- A.J. Cain
26. Evidences for Macroevolution- Douglas Theobald (http://www.talkorigins.org/faqs/comdesc/)
27. Textbook for Environmental Studies- Erach Bharucha, UGC, New Delhi (2004)
28. Environmental Biology- K.C. Agrawal
29. Ecology & Environment- P.D.Sharma

Zoo 316 B: DEVELOPMENTAL BIOLOGY (ELECTIVE)

Unit 1:

1.1 Basic concepts of development: Potency, commitment, specification.
1.2 Basic concepts of development: induction, competence, determination and differentiation.
1.3 Morphogenetic gradients; cell fate and cell lineages; stem cells.
1.4 Genomic equivalence.

Unit 2:

2.1 The cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.
2.2 Gametogenesis, fertilization and early development.
2.3 Production of gametes, cell surface molecules in sperm-egg recognition in animals.
2.4 Embryo sac development; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals.

Unit 3:

3.1 Embryogenesis, establishment of symmetry.

3.2 Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium.

3.3 Axes and pattern formation in Drosophila, amphibia and chick.

3.4 Organogenesis – vulva formation in Caenorhabditis elegans; eye lens induction, limb development and regeneration in vertebrates.

Unit 4:

4.1 Differentiation of neurons post embryonic development-larval formation, metamorphosis.

4.2 Environmental regulation of normal development.

4.3 sex determination.

4.4 Aging.

Proposed Practicals

1. Studies on the permanent slides of different stages of frog embryo.
2. Studies on the permanent slides of different stages of chick embryo.
3. Studies on the different stages of chick embryo.
4. Permanent preparation of chick embryo
5. Chick embryo transplantation (Introduction).

Reference Books:

1. Developmental biology by Gibert
2. Reproduction I animals by Austen and short
3. Molecular Biology of Development by Scott. F. Gilbert
4. Human Reproduction by R. G. Edwards
5. Introduction to Embryology by Balisnsky
6. Molecular Biology of Fertilization by Schatten and Schatten.

Semester – IV

Zoo 418: Research Methodology, IPR and Biosafety (Core)

Unit 1- Basic research methodology

1. Research problem, Aims & Objectives, Thesis, report, paper writing
2. Hypotheses testing, Mentoring and mentor-mentee responsibility
3. Optimization of protocol, Graphical data analysis, data validation,
4. Multivariate analysis and Plagiarism

Unit 2- Intellectual Property Right

1. IP: Fundamentals of patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP.
2. IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS.
3. Patent Application: Types of patents, Patent application- forms and guidelines, fee structure, time frames;
4. Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs

Unit 3- Scientific writing

1. Types of scientific research
2. Research scheme and research proposal writing
3. National and international Funding agency and its role
4. Review writing and submission

Unit 4- Biosafety and bioethics

1. Biosafety fundamentals: Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals;
2. Biosafety regulation : Biosafety guidelines-Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture;
3. Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication;
4. Overview of National Regulations and relevant International Agreements including Cartagena Protocol. Transgenic animals and plants

Suggested practical

1. Research and review paper writing
2. Research proposal preparation
3. Multivariate tools and its application
4. Optimization of research methods using various tools
5. Data validation using statistical tools
6. Graphical data analysis
7. Data validation using statistical tools
8. Case study of environmental risk and environmental disaster
9. Biosafety Level-1 and 2 specification and features
10. Preparation of project proposal

Suggested Books

1. IPR, Biosafety and Bioethics, Goel and Parashar, Person
2. A Book on Indian Patenting System and Patent Agent Examination, Sheetal Chopra, Notion Press
3. Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers, Anil Kumar, Ramakrishna, Notion Press
4. Intellectual Property Rights (IPRs): TRIPS Agreement & Indian Laws, E. T. Lokganathan, New Century Publications
5. How to Patent an Idea in India, Prasad Karhad
6. Building Biotechnology: Biotechnology Business, Regulations, Patents, Law, Policy and Science Paperback, Yali Friedman, Logos Press
7. Bioethics and Biosafety M.K. Sateesh, I K International Publishing House
8. Biosafety and Regulation for Genetically Modified Organisms, Xue, lpha Science International Ltd
9. Kothari, Research Methodology, Methods and Techniques
10. Gurumani, An Introduction to Biostatistics

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Question paper Skeleton

SECTION-I

1. Answer the following (Two short Questions)
   A. Write a short note…….. 07
   B. Explain ……. 07

OR

1. Answer the question (One long Question) 14

2. Answer the following (Two short Questions)
   C. Write a short note…….. 07
   D. Explain ……. 07

OR

2. Answer the question (One long Question) 14

Note: Question 1 and 2 from the unit-1 and 2 respectively.

3. Do as direct (any seven out of eight questions each of one mark) 07

Note: Question 3 from the unit-1 and 2.

SECTION-II

1. Answer the question (One long Question) 14

OR

1. Answer the following (Two short Questions)
   A. Write a short note…….. 07
   B. Explain ……. 07

2. Answer the question (One long Question) 14

OR

2. Answer the following (Two short Questions)
   A. Write a short note…….. 07
   B. Explain ……. 07

Note: Question 1 and 2 from the unit-3 and 4 respectively

3. Do as direct (any seven out of eight questions each of one marks) 07

Note: Question 3 from the unit-3 and 4.