

**M. G. SCIENCE INSTITUTE, AHMEDABAD
(AUTONOMOUS)
AFFILIATED TO GUJARAT UNIVERSITY**

**B.Sc. (Hons.) Zoology
(Effective from 2024-25)**

**ZOOLOGY SYLLABUS
(Semester I and II)**



Bachelor of Science- Zoology Syllabus 2024
4 Year, 8 Semesters Full -Time Programme
National Education Policy-2020
Outcome Based Education Pattern

Preamble:

Present day Zoology is a fusion of the traditional components with the modern aspects of biochemistry, molecular biology and biotechnology. Over the years, animal science (Zoology) has shown enormous gain in information and applications owing to tremendous inputs from research in all its aspects. With the global need for conservation, field biologists have contributed significantly in assessing and exploring newer dimensions for animal diversity. New insights have been gained in for zoological research and conservation. Challenging areas of teaching and research have emerged in animal ecology and reproductive biology. Concern for ever increasing pollution and climate change is at its highest than ever before. Keeping the above mentioned advancements and animal resources in India in view, a curriculum is offered at the undergraduate level as per the National Education Policy-2020 so that the undergraduate Zoology students shall have the benefit of a balanced, carefully-crafted course structure taking care of different aspects of animal science, namely animal diversity, physiology, biochemistry, molecular biology, reproduction, genetics, anatomy, ecology, economic zoology, wildlife biology and the impact of environment on the living organism. All these aspects have been given due weightage over the eight semesters. It is essential for the undergraduate students to acquaint themselves with various updated tools and techniques. Keeping view of employment entrepreneurship, applied courses such as apiculture, sericulture, home aquarium management etc. have also been introduced. These courses shall provide the students hands on experience and professional inputs. On the whole, the curriculum is a source of lot of information and is supported by rich resource materials. It is hoped that a student graduating in Zoology with this curriculum will be able to explore the rich biodiversity of India.

Programme Specific Outcomes (PSOs):

STUDENTS WOULD BE ABLE TO -

- PSO 1. Demonstrate a comprehensive understanding of the principles, concepts and theories of zoology including animal taxonomy, anatomy, physiology, genetics, animal behavior, ecology, toxicology, wildlife etc.
- PSO 2. Apply scientific methods and experimental techniques to conduct research and investigate zoological phenomena.
- PSO 3. Demonstrate proficiency in laboratory and fieldwork techniques used in zoological research.
- PSO 4. Understand and apply ethical principles in treatment and conservation of animal species and ecosystem.

PSO 5. Apply the knowledge and understanding in using modern techniques and tools relevant to zoological research including genetic analysis, IVF techniques, animal tissue culture, etc.

PSO 6 Analyze complex interactions among various animals of different phylum, their distribution and their relationship with the environment

PSO 7. These outcomes aim to prepare graduates for diverse career opportunities in fields such as wildlife conservation, environmental management, research, education and zoological parks and museums.

Sr. No.	Course Type	Credits	Nature	CCE Marks	ECE Marks	Total Marks
1	Major Course	8	Compulsory	50	50	100
2	Minor Course	4	Compulsory	25	25	50
3	Multidisciplinary Course	4	Elective	50	50	100
4	Skill Enhancement Course	2	Elective	25	25	50
5	Ability Enhancement Course	2	Elective	25	25	50
6	Indian Knowledge System	2	Elective	25	25	50
7	Value Added Courses	2	Elective	25	25	50

Annexure 1
Detailed Course List
Major Courses

(Compulsory Course – 4 Credits Each)

Course Code	Course Title	Semester
DSC-C- ZOO-111 (T)	Animal diversity, physiology , wildlife biology & genetics	1
DSC-C- ZOO-112 (P)	Practicals based on theory paper- DSC-C- ZOO-111 (T)	1
DSC-C- ZOO-121 (T)	Animal diversity, physiology and cytology	2
DSC-C- ZOO-122 (P)	Practicals based on theory paper- DSC-C- ZOO-121 (T)	2

Minor Courses
(Compulsory Course – 4 Credits Each)

Course Code	Course Title	Semester
DSC-M-ZOO-113 (T+P)	Non-chordates Systematics & human digestive system physiology	1
DSC-M-ZOO-123 (T+P)	Animal diversity and type study (non-chordates)	2

Multidisciplinary Courses
(Elective Course – 4 Credits Each)

Course Code	Course Title	Semester
MDC-ZOO- 114 (T+P)	Environment, climate change and pollution	1
MDC-ZOO- 124 (T+P)	Introduction to some diseases and dietary disorders	2

Skill Enhancement Courses
(Elective Course – 2 Credits Each)

Course Code	Course Title	Semester
SEC-ZOO-116 (T+P)	Apiculture	1
SEC-ZOO-126 (T+P)	Home aquarium management	2

M. G. SCIENCE INSTITUTE, AHMEDABAD (AUTONOMOUS)
B.Sc. SEMESTER – I
Detailed Syllabus for Each Course

Semester: I	Course No.:	Course Code: DSC-C- ZOO-111 (T) Course Title:- Animal diversity, physiology wildlife biology & genetics
Credits:04		Course Category: Major

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

CO #	Cognitive Abilities	Course Outcomes
CO 1	Remembering	Recall and identify various animal phyla and classes. Students will memorize key characteristics of different animal groups. Recall the basic anatomy and histology of the human digestive system.
CO 2	Understanding	On completion of the course students will be able to understand general taxonomic rules of animal classification. Students will be able to understand and classifying the invertebrate animals and this will help them to understand diversity also
CO 3	Applying	Students will be aware about zoological parks and their significance in conservation of wildlife. This knowledge enables them to understand the importance of wildlife, Why conservation needed and how this application introduced in practices.
CO 4	Remembering and Applying	Students will develop understanding of basic concepts of genetics, principles of inheritance, preparation of pedigree charts and analysis of certain genetics diseases.
CO 5	Creating	These outcomes aim to prepare graduates for diverse career opportunities in fields such as wildlife conservation, environmental management, research education and zoological parks and museums.

Unit No.	Unit Contents	Sessions Allotted
1	Animal Diversity <ul style="list-style-type: none"> ▪ Introduction and scopes of Zoology ▪ Outline of taxonomic categories in hierarchical arrangement (from Kingdom to Species) ▪ Difference between Chordates and Non-chordates ▪ Animal diversity (Nonchordates) – Systematics <ul style="list-style-type: none"> • Protozoa - General characters and classification up to class 	15

	<ul style="list-style-type: none"> • Type study : Paramecium <ul style="list-style-type: none"> - Systematic position with salient features - External & internal structure (in brief) - Locomotion - Food & feeding mechanism - Osmoregulation - Reproduction: Binary fission and conjugation 	
2	<p>Anatomy, Histology and Physiology of human digestive system and dentition in mammals</p> <ul style="list-style-type: none"> ▪ Definition: Nutrition, Balance diet ▪ Anatomy - Overview of digestive system ▪ Histology of Liver, Stomach, Pancreas, Small Intestine ▪ Physiology - Digestion and absorption of following dietary components in mammals: Carbohydrates, Proteins, Lipids, Nucleic acids ▪ Dentition in Mammals <ul style="list-style-type: none"> - Definition - Differentiation (based on shape & according to attachment of teeth) - Succession of teeth, - Types of teeth (Incisors, Canine, Premolar, Molar) - Dental formula (Human, Horse, Dog) 	15
3	<p>Wildlife Biology</p> <ul style="list-style-type: none"> ▪ Difference between National parks and Sanctuaries ▪ National parks and sanctuaries of Gujarat <ul style="list-style-type: none"> • Marine national park, Velavadar national park, Gir national park and sanctuary, Vansda national park, Wild ass sanctuary and Nalsarovar bird sanctuary [Location, Area (sq.km), Major faunal diversity] ▪ Biosphere reserves of India <ul style="list-style-type: none"> • Three zones (Core, Buffer and Transitional) • List of biosphere reserves of India ▪ Brief account of categories of IUCN red data list. <ul style="list-style-type: none"> • Extinct, Critically Endangered, Endangered, Vulnerable, Least concerned ▪ Animal Conservation Projects – Project Tiger, Cheetah re-introduction project ▪ Significance and need of zoological parks and museums. 	15
4	<p>Genetics</p> <ul style="list-style-type: none"> ▪ Mendelian inheritance (Experiments on pea plant) ▪ Incomplete dominance (e.g. <i>Mirabilis jalapa</i>) ▪ Co-dominance (e.g. Roan cattle) ▪ Multiple alleles <ul style="list-style-type: none"> • ABO blood groups in human 	15

	<ul style="list-style-type: none">• Rh Factor- Erythroblastosis foetalis▪ Complementary genes (Flower colour in <i>Odoratus lathyrus</i>)▪ Epistasis (Dominant e.g. Dog and Recessive e.g. Coat colour in Mice)▪ Extra chromosomal inheritance (Kappa particles in Paramecium & Shell coiling in snail)▪ Human pedigree analysis	
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Semester: I	Course No.:	Course Code: DSC-C- ZOO-112 (P) Course Title:- Animal diversity, physiology, wildlife biology & genetics
Credits:04		Course Category: Major

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

CO#	Cognitive Abilities	Course Outcomes
CO 1	Remembering	Recall the concept of Zoology. Students will gain fundamental knowledge of animal Systematics.
CO 2	Understanding	Conduct experiments to demonstrate physiological processes in the digestive system, such as enzyme activity.
CO 3	Applying	Students will be able to accurately identify and classify specimens from various animal phyla using taxonomic keys and field guides. Demonstrate proficiency in wildlife observation and data collection using field techniques.
CO 4	Remembering and Applying	Participate in habitat restoration projects and conservation initiatives.
CO 5	Creating	Analyze pedigrees to trace the inheritance of genetic traits. Identify and interpret patterns of genetic disorders within family trees.

Unit No.	Unit Contents	Sessions Allotted
1	Animal Diversity <ul style="list-style-type: none"> ▪ Identification & classification of invertebrates (Kingdom to Class) Protozoa: Amoeba, Paramecium, Polystomella, Euglena, Vorticella, Plasmodium. ▪ Preparation and observation of protozoan culture ▪ Paramecium: Whole mount, Binary fission and Conjugation 	15
2	Anatomy, Histology and Physiology of human digestive system and dentition in mammals <ul style="list-style-type: none"> ▪ Action of human salivary amylase (ptyalin) on starch ▪ Study through permanent slides: Liver, Pancreas, Stomach, Small Intestine ▪ Dentition in mammals(Study through specimens/charts) <ul style="list-style-type: none"> • Dental formula (Human, Horse, Dog) 	15
3	Wildlife Biology <ul style="list-style-type: none"> ▪ National park & Sanctuary (as per theory syllabus) spotting in map of 	15

	<p>Gujarat.</p> <ul style="list-style-type: none"> ▪ Identification of animal evidences in the field: Pug marks, Hoof marks, Scats, Nests, Antlers. ▪ Visit to nearby zoological park and submit the report. 	
4	<p>Genetics</p> <p>a) Study of genetics through charts (example as per theory syllabus).</p> <ul style="list-style-type: none"> ▪ Monohybrid cross ▪ Dihybrid cross ▪ Incomplete dominance ▪ Co-dominance ▪ Multiple alleles ▪ Complementary genes ▪ Epistasis (Dominant and Recessive) ▪ Extra chromosomal inheritance ▪ Human pedigree analysis <p>b) Genetics problems:</p> <ul style="list-style-type: none"> ▪ As per list 	15

List of genetics problems:

1. In guinea pig a dominant gene B produces black and its recessive allele b produces white. What are the possible mating types? What is the genotype and phenotype of the F1 offspring?

Solution Hint: Possible mating type:

(1) $BB \times BB$; (2) $BB \times Bb$; (3) $BB \times bb$; (4) $Bb \times Bb$; (5) $Bb \times bb$; (6) $bb \times bb$

2. In rabbit, the colored coat (C) is dominant to albino coat (c). What type of offspring would you expect if cross a pure line colored rabbit, with an albino rabbit? Show both genotypes in the first and second generations.

Solution Hint: P: $CC \times cc$ 1st generation: Cc- colored 2nd generation: CC-colored
Cc- Colored; cc - albino

3. Red fruit (R) is dominant to yellow (r) and tallness (T) is dominant over short (t) in plants. What phenotypic and genotypic ratio would result if one of the parent plants is red homozygous & tall homozygous and other is red heterozygous & tall heterozygous?

Solution Hint: P: $RRTT \times RrTt$; Result : Same Phenotype in all offspring, and
Genotype = $RRTT, RRTt, RrTT, RrTt$.

4. In the mouse the gene for colored coat (C) is dominant to the gene for albino (c) and the gene for straight whiskers (W) is dominant to the allele for bent whiskers (w). Find out the phenotypes of the following crosses. 1. $Ccww \times ccww$ 2. $ccww \times ccWw$ 3. $CcWw \times CcWw$

Solution Hint: 1st Cross: colored & bent whiskers. 2nd Cross: albino & straight whiskers; albino & bent whiskers. 3rd cross: colored & straight whiskers; colored

& bent whiskers; albino & straight whiskers; albino & bent whiskers

5. In four o'clock plants, red colour of flowers (R) is incompletely dominant over white (r), the heterozygous having pink flower color. What will be the offsprings in a cross between plants of red flowers and pink flowers?

Solution Hint: P – RR × Rr offsprings: Red and Pink

6. A roan bull is bred to three cows. Cow A has the same genotype as the roan bull. Cow B is red and cow C is white. What proportions of roan progeny are expected from each of the above three crosses?

Solution Hint: In all three crosses 50 % Roan cows are expected.

7. A couple preparing for marriage, a man has blood group B and woman has A. They ask you what type of blood group their children may have. What would you tell them and how would you explain your conclusions?

Solution Hint: - All four A, B, AB, & O types of blood groups are possible if both parents are heterozygous

- AB and A are possible if man is heterozygous and woman is homozygous.

- AB and B are possible if man is homozygous and woman is heterozygous.

8. Two white flowered varieties of pea plant when crossed produced purple flowered in F1 progeny. Selfing of F1 plants produced total 112 progeny of which 62 plants with purple flowers and 50 with white flowers. Find out:

(i) What type of interaction is involved?

(ii) Give a phenotypic ratio approximated by the F2 progeny.

(iii) Give the genotype of the parents.

Solution Hint:

(i) Complementary gene interaction

(ii) Phenotypic ratio - 9:7

(iii) P : CCpp × ccPP

9. In a Plant, the gene for white fruit color (W) is epistatic to yellow (Y) which is dominant over green (y). Determine the fruit color of the offsprings of following crosses.

I. Wwyy × wwyy ; II. wwYy × wwyy ; III. WwYy × WwYy

Solution Hint: 1st Cross: White & green; 2nd Cross: Yellow & green; 3rd Cross:
White: Yellow: green (12:3:1)

10. When dogs from a true breeding brown coat line were mated to dogs from a true breeding white coat line, all F1 progeny were with white coat color. Mating of F1 progeny produced F2 offsprings having phenotypes in the ratio of 132 white: 33 black: 11 brown. Explain results.

Solution Hint: Cross: BBII × bbii Where B = Black; I=epistatic and bb= brown Here dominant epistatic gene I inhibit the expression of associated genes.

Reference:

1. Agarwal VK, Verma PS, Genetics, 9th ed. New Delhi (DL) S. Chand & Company, 2020
2. Ayyar EK, Ananthakrishnan TN: A Manual of Zoology- Vol. I &II, Ananda Book depot
3. Barrington EJW: Structure and Functions of Invertebrates; 2nd ed.; 1976
4. Dhama PS, Dhama JK: Textbook of Invertebrates, 5th ed. New Delhi (DL): S. Chand & Company; 2021
5. Gautam S, Mazumdar S: Wildlife Biology: An Indian Perspective, New Delhi (DL); PHI Learning, 2017
6. George Howard Bell, Donald Emslie-Smith, Colin Ralston Paterson: Textbook of Physiology, 10th illustrated ed.; Churchill Livingstone, 2008
7. Israel S, Sinclair T: Indian Wildlife: Srilanka Nepal (Insight Guide), Single ed. APA Publications, 1989
8. John EH, Michael EH: Guyton and Hall Textbook of medical physiology, 14th ed.; Elsevier Pub, 2020
9. Jordan EL, Verma PS: Invertebrate Zoology. New Delhi (DL): S. Chand & Company; 2019.
10. Kedar Nath Ram Nath: Textbook of Genetics. 2020th ed. Meerut (UP): Veerbala Rastogi, 2020.
11. Kotpal RL: Textbook of Invertebrates and vertebrates. 12th ed. Meerut (UP): Rastogi Publishers; 2020.
12. Monroe W. Strickberger: Genetics. 2nd revised edition; Collier Macmillan Ltd, 1976
13. Rastogi VB: cytology Genetics and infectious diseases, Meerut (UP); According to NEP., 2020
14. Sharma BB: Indian Wildlife Resources Ecology and Development; Daya publication house, 1999
15. Tortora GJ, Brayn D: Principal of Anatomy and Physiology, Global ed. Wiley Pub., 2017
16. Wallace AF, Dyson RH: Principles of Animal Taxonomy, George Gaylord Simpson. Columbia University Press, 1961

Semester: I	Course No.:	Course Code: DSC-M-ZOO-113 (T) Course Title:- Non-chordates Systematics & human digestive system physiology
Credits:02		Course Category: Minor

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

CO#	Cognitive Abilities	Course Outcomes
CO 1	Remembering	Recall the concept of Zoology. Students will gain fundamental knowledge of animal Systematics.
CO 2	Understanding	On completion of the course students will be able to understand general taxonomic rules of animal classification. Students will be able to understand and classifying the invertebrate animals by applying taxonomic rules. This will help them to understand diversity also
CO 3	Applying	Students will be able to identify invertebrate animals. This is in demand for various integrated research projects
CO 4	Remembering and Applying	The identification of animals will help society to establish and maintaining their habitats. This is essential now a day to restore biodiversity and ecosystem.
CO 5	Creating	Understand the physiological processes involved in digestion, absorption, and nutrient assimilation.

Unit No.	Unit Contents	Sessions Allotted
1	Non-chordates Systematics <ul style="list-style-type: none"> ▪ Introduction and scopes of Zoology ▪ Outline of taxonomic categories in hierarchical arrangement (from Kingdom to Species) ▪ Difference between Chordates and Non-chordates ▪ Animal diversity (Nonchordates) – Systematics <ul style="list-style-type: none"> • Protozoa - General characters and classification up to class • Type study : Paramecium <ul style="list-style-type: none"> - Systematic position with salient features - External & internal structure (in brief) - Locomotion - Food & feeding mechanism - Osmoregulation - Reproduction: Binary fission and conjugation 	15
2	Human digestive system physiology <ul style="list-style-type: none"> ▪ Definition: Nutrition, Balance diet 	15

	<ul style="list-style-type: none">▪ Anatomy - Overview of digestive system▪ Histology of Liver, Stomach, Pancreas, Small Intestine▪ Physiology - Digestion and absorption of following dietary components in mammals: Carbohydrates, Proteins, Lipids, Nucleic acids▪ Dentition in Mammals<ul style="list-style-type: none">- Definition- Differentiation (based on shape & according to attachment of teeth)- Succession of teeth,- Types of teeth (Incisors, Canine, Premolar, Molar)- Dental formula (Human, Horse, Dog)	
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Semester: I	Course No.:	Course Code: DSC-M-ZOO-113 (P) Course Title:- Non-chordates Systematics & human digestive system physiology
Credits:02		Course Category: Minor

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

CO#	Cognitive Abilities	Course Outcomes
CO 1	Remembering	Recall the concept of Zoology. Students will gain fundamental knowledge of animal Systematics.
CO 2	Understanding	On completion of the course students will be able to understand general taxonomic rules of animal classification. Students will be able to understand and classifying the invertebrate animals by applying taxonomic rules. This will help them to understand diversity also
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CO 5	Creating	Understand the physiological processes involved in digestion, absorption, and nutrient assimilation.

Unit No.	Unit Contents	Sessions Allotted
1	Non-chordates Systematics <ul style="list-style-type: none"> ▪ Identification & classification of invertebrates (Kingdom to Class) Protozoa: Amoeba, Paramecium, Polystomella, Euglena, Vorticella, Plasmodium. ▪ Preparation and observation of protozoan culture ▪ Paramecium: Whole mount, Binary fission and Conjugation 	15
2	Human digestive system physiology <ul style="list-style-type: none"> ▪ Action of human salivary amylase (ptyalin) on starch ▪ Study through permanent slides: Liver, Pancreas, Stomach, Small Intestine ▪ Dentition in mammals(Study through specimens/charts) <ul style="list-style-type: none"> • Dental formula (Human, Horse, Dog) 	15

Reference:

1. Ayyar EK, Ananthkrishnan TN: A Manual of Zoology- Vol. I &II, Ananda Book depot
2. Dhama PS, Dhama JK: Textbook of Invertebrates, 5th ed. New Delhi (DL): S. Chand & Company; 2021
3. George Howard Bell, Donald Emslie-Smith, Colin Ralston Paterson: Textbook of Physiology, 10th illustrated ed.; Churchill Livingstone, 2008
4. John EH, Michael EH: Guyton and Hall Textbook of medical physiology, 14th ed.; Elsevier Pub, 2020
5. Jordan EL, Verma PS: Invertebrate Zoology. New Delhi (DL): S. Chand & Company; 2019.
6. Kotpal RL: Textbook of Invertebrates and vertebrates. 12th ed. Meerut (UP): Rastogi Publishers; 2020.
7. Tortora GJ, Brayn D: Principal of Anatomy and Physiology, Global ed. Wiley Pub., 2017
8. Wallace AF, Dyson RH: Principles of Animal Taxonomy, George Gaylord Simpson. Columbia University Press, 1961

Semester: I	Course No.:	Course Code: MDC-ZOO-114 (T) Course Title:- Environment, climate change and pollution
Credits:02		Course Category: Multidisciplinary / Interdisciplinary

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

CO #	Cognitive Abilities	Course Outcomes
CO 1	Remembering	Recall and define the term "environment" and its significance in the context of ecosystems and human activities. Recall the four main components of the environment.
CO 2	Understanding	Comprehend the interactions within ecosystems and the balance required for sustainable environmental health. Apply knowledge of acid rain causes and sources, including the role of pollutants. Analyze the chemical processes leading to acid rain formation.
CO 3	Applying	Apply knowledge to identify common greenhouse gases and understand their sources.
CO 4	Remembering and Applying	Students will develop understanding of basic concepts of global warming and climate change.
CO 5	Applying	Demonstrate proficiency in using modern techniques and tools relevant to analysis of pollutants.
CO 6	Creating	Create educational materials and awareness campaigns about environmental issues.

Unit No.	Unit Contents	Sessions Allotted
1	<p>Environment and Its Impacts</p> <ul style="list-style-type: none"> ▪ Definition ▪ Components of environment: <ul style="list-style-type: none"> ... Atmosphere ... Hydrosphere ... Lithosphere ... Biosphere <p>Climate Change</p> <ul style="list-style-type: none"> ▪ Greenhouse gases and global warming ▪ Acid rain ▪ Ozone layer depletion ▪ Effect of climate change on human health 	15

2	<p>Pollution:</p> <ul style="list-style-type: none">▪ Definition <p>Sources, causes, effects and control measures of:</p> <ul style="list-style-type: none">▪ Air pollution▪ Water pollution▪ Soil pollution▪ Noise pollution▪ Radioactive pollution	15

Semester: I	Course No.:	Course Code: MDC-ZOO-114 (P) Course Title:- Environment, climate change and pollution
Credits:02		Course Category: Multidisciplinary / Interdisciplinary

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

CO #	Cognitive Abilities	Course Outcomes
CO 1	Remembering	Recall and define the term "environment" and its significance in the context of ecosystems and human activities. Recall the four main components of the environment.
CO 2	Understanding	Comprehend the interactions within ecosystems and the balance required for sustainable environmental health. Apply knowledge of acid rain causes and sources, including the role of pollutants. Analyze the chemical processes leading to acid rain formation.
CO 3	Applying	Apply knowledge to identify common greenhouse gases and understand their sources.
CO 4	Remembering and Applying	Students will develop understanding of basic concepts of global warming and climate change.
CO 5	Applying	Demonstrate proficiency in using modern techniques and tools relevant to analysis of pollutants.
CO 6	Creating	Create educational materials and awareness campaigns about environmental issues.

Unit No.	Unit Contents	Sessions Allotted
1	Environment and its impacts Study through chart/model: <ul style="list-style-type: none"> ▪ Green house effect ▪ Effects of global warming ▪ Acid rain ▪ Effects of ozone layer depletion 	15
2	Pollution: Study through chart/model <ul style="list-style-type: none"> ▪ Air pollution ▪ Water pollution ▪ Soil pollution ▪ Noise pollution ▪ Radioactive pollution 	15

	<p>Titrimetric:</p> <ul style="list-style-type: none">▪ Acidity▪ Alkalinity▪ Calcium hardness▪ Total Hardness▪ Ca⁺⁺ & Mg⁺⁺.	
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Reference:

1. Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
2. Joseph F Louvar and B Diane Louver Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey 1997.
3. Kasperson, J.X. and Kasperson, R.E. and Kasperson, R.E., Global Environmental Risks, V.N.University Press, New York, 2003.
4. Kofi Asante Duah "Risk Assessment in Environmental management", John Wiley and sons, Singapore, 1998.
5. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff "Risk Assessment and Management Handbook", McGraw Hill Inc., New York, 1996.
6. Concepts of Ecology- R.L.Kotpal and N.P.Bali, Rastogi publication
7. Ecology and environment- P.D.Sharma, Rastogi publication

Semester: I	Course No.:	Course Code: SEC-ZOO-116 (T+P) Course Title:- Apiculture
Credits:02		Course Category: Skill enhancement course

Course Outcomes: On successful completion of the course the learner will be able to:

CO #	Cognitive Abilities	Course Outcomes
CO 1	Remembering	Acquire knowledge about different species and casts of the honey bees and about economic importance of honey bees, enemies/ predator of honey bees.
CO 2	Understanding	Understand role of honey bees in nature and in agricultural productivity, various product of honey bees and value addition in these products.
CO 3	Applying	Apply knowledge and skill to establish their own apiary or provides services to apiary.
CO 4	Remembering and Applying	Students will develop the skill of beekeeping tools, equipment, and managing beehives.
CO 5	Creating	Create scope for entrepreneurship, self employment and conservation of nature,

Unit No.	Unit Contents	Sessions Allotted
1	<p>Biology of Bees, Rearing of Bees, Diseases and Enemies, Bee Economy and Entrepreneurship in Apiculture</p> <ul style="list-style-type: none"> ▪ History, Classification and Life Cycle of Honey Bees ▪ Social organization of bee colony ▪ Behavioural patterns (bee dance, swarming) ▪ Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth ▪ Selection of bee species for apiculture –<i>Apis cerana indica</i>, <i>Apis mellifera</i>, <i>Apis floreae</i>, <i>Apis dorsata</i> ▪ Bee keeping equipment ▪ Methods of extraction of honey (Indigenous and Modern) ▪ Apiary management - Honey flow period and lean period, effects of pollutants on honeybees. ▪ Bee diseases, control and preventive measures ▪ Enemies of bees and their control. ▪ Products of apiculture industry (Honey, Bees Wax, Propolis, Royal jelly, 	15

	<p>Pollen etc.) and their uses;</p> <ul style="list-style-type: none"> ▪ Roll of Bees in cross pollination in horticulture and agriculture ▪ Stationary and migratory bee keeping ▪ Bee keeping industries – Recent advancements, employment opportunities, economics in small and large-scale beekeeping ▪ Scope for women entrepreneurs in beekeeping sector ▪ Study of development programs and organizations involved in beekeeping in India 	
2	<p>Practicals</p> <ul style="list-style-type: none"> ▪ Study of the life history of honey bees: <i>Apis cerana indica</i>, <i>Apis mellifera</i>, <i>Apis dorsata</i>, <i>Apis florea</i>, <i>Melipona sp.</i> from specimen/ photographs - Egg, larva, pupa, adult (queen, drone, worker). ▪ Study of morphological structures of honey bees through permanent slides/photographs– mouthparts, antenna, wings, sting apparatus and temporary mount of legs (antenna cleaner, mid leg, pollen basket). ▪ Study of natural beehive and identification of queen cells, drone cells and brood. ▪ Distinguishing characters of workers of bee species. ▪ Study of an artificial hive (Langstroth/Newton), its various parts and beekeeping equipment: draw diagrams of bee boxes proportionate to the body size and measure the body length and wing size. ▪ Preparation of mount of pollen grains from flowers. ▪ Diagnosis of honeybee diseases: Protozoan diseases, Bacterial diseases, Viral diseases (one each)-symptoms, nature of damage and control. ▪ Identification of honeybee enemies: Predators-Insects and non-insects. ▪ Video demonstration of wax extraction and preparation of comb foundation sheets. ▪ Analysis of honey – purity, physical and biochemical parameters (any two constituents). ▪ Study of bee pasturage – visit to fields/gardens/orchards for studying the bee activity (role in pollination, nectar collection, videography of honeybee activity) and preparation of herbarium of nectar and pollen yielding flowering plants (floral mapping). ▪ Visit to an apiary/honey processing unit/institute and submission of a report. 	15

Books/References:

1. Singh, S. (1962) Beekeeping in India, Indian Council of Agricultural Research, New Delhi.
2. Mishra, R.C. (1995). Honeybees and their management in India. Indian Council of Agricultural Research, New Delhi.
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