ACADEMIC CURRICULUM AND SYLLABI

UNDERGRADUATE DEGREE PROGRAMME

BACHELOR OF SCIENCE

IN

ZOOLOGY

Three Years (Full-Time)

CHOICE BASED CREDIT SYSTEM

(For the Students Admitted from the Academic Year 2018 – 2019)

DEPARTMENT OF ZOOLOGY

SCHOOL OF BASIC SCIENCES

(Estd. Under SRMUS Act, 2013)

Shri Ramasamy Memorial University Sikkim
5th Mile, Tadong, Gangtok, East Sikkim- 737102, India

Shri Ramasamy Memorial University Sikkim
Department of Zoology, School of Basic Sciences

1. Departmental Vision Statement:
1. To create a world-class centre of advanced learning for research and skill development in the realm of Zoology.
2. To provide a learner-centric, outcome-based model of higher education in Zoology and allied biological sciences in the North-East and other region of India.
3. To make learning Zoology globally relevant in the ever-changing social, industrial, research and application scenario.
2. Departmental Mission Statement:
1. To prepare young learners to explore the concepts and ideas of origin, evolution, mechanism life-processes, and interaction between living and non-living factors in biology.
2. To cultivate skill-based learning in students enabling them to apply the acquired knowledge in analysing and evaluating problems and innovating scientific solutions.
3. To develop skilledhuman resources by empowering learners to be globally relevant, technologically competent and creative.
4. Create a niched knowledge base for sustenance of the unique North Eastern Himalayan biodiversity.
5. To cultivate scientific temperament along with sense of social responsibility, morality and unwavering ethics.
3. Program Objectives (PO):
1. To provide a platform for knowledge acquisition in biological sciences and foster academic excellence relevant to global standards.
2. To familiarize the students with the rich biodiversity of the North East Himalayas and envision sustainability.
3. To empower the learners to accomplish a high degree of academic achievement in the areas like Classical Zoology, Immunology, Genetics, Cell and Molecular Biology in light of research and application.
4. To foster employability in the realms of academic,applied, and entrepreneurial pursuitsthroughclassroom, lab and field-based training with special emphasis onsocially relevant ethical framework.

4. Consistency of PO's with Mission of the Department

	Mission Statement - 1	Mission Statement - 2	Mission Statement - 3	Mission Statement - 4	Mission Statement - 5
PO - 1	**H**	**H**	**M**	**M**	**M**
PO - 2	**H**	**H**	**M**	**H**	**M**
PO - 3	**H**	**H**	**H**	**H**	**H**
PO - 4	**H**	**H**	**H**	**H**	**H**

H – High Correlation, M – Medium Correlation, L – Low Correlation

5. Consistency of PO's with Program Learning Outcomes (PLO)

	ProgramLearningOutcomes(PLO)										
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
	Disciplinary/ Professional Knowledge	**Problem Analysis**	**Design and Development of Solutions/ Policies**	**Modern Usage tools**	**Interdisciplinary Development**	**Innovation and Entrepreneurship**	**Ethics**	**Individual or Team Work using effective communication**	**Vocational and Industry Exposure**	**Life-long learning**	**Environment and sustainability**
PO - 1	**H**	**H**	**H**	**H**	**H**	**M**	**M**	**H**	**M**	**H**	**H**
PO - 2	**H**	**H**	**H**	**H**	**M**	**H**	**H**	**H**	**M**	**H**	**H**
PO - 3	**H**	**H**	**H**	**H**	**H**	**H**	**M**	**M**	**H**	**H**	**H**
PO - 4	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**M**	**M**

H – High Correlation, M – Medium Correlation, L – Low Correlation

6. Program Learning Outcomes (PLO)		
PLO-1	**Disciplinary/ Professional Knowledge**	Explain the diversity of life, identify interactions with nature, explain the mechanisms of simple to complex life processes, and interpret everything in the light of evolution.
PLO-2	**Problem Analysis**	Analyse and untangle complex problems in the field of biology systematically by categorizing, correlating observable variables, interpreting underlying biological phenomena, and coming to conclusions supported by scientific explanations.
PLO-3	**Design and Development of Solutions/ Policies**	Develop or invent solutions specific to panoptic problems and play a pivotal role in developing policies concerning a better and sustainable future.
PLO-4	**Modern Usage tools**	Use modern molecular and computational tools in biology with hands-on and field-based training to explore and understand practical aspects, enabling learners to apply and create instrumental solutions through technical analysis skills.
PLO-5	**Interdisciplinary Development**	Design experiments in biology and develop solutions to complex problems using collaborative interdisciplinary approaches invaluable for modern research and application.
PLO-6	**Innovation and Entrepreneurship**	Design and formulate scientific experiments to innovate or invent and have the confidence based on training to actuate the learner to become independent in entrepreneurship ventures.
PLO-7	**Ethics**	Have a strong moral sense of ethics in the ways of scientific research and its application, management of natural resources, and scientific policy development.
PLO-8	**Individual or Team Work using effective communication**	Learn to work as a competent individual as well as a part of a team and use communicationeffectively to quench their scientific quest and put across their ideas, findings effectively to the stakeholders of science.
PLO-9	**Vocational and Industry Exposure**	Vocational exposure through educational trips related to economic and applied zoology and visits to industries/institutes.
PLO-10	**Life-long learning**	Life-long learning instilled through nurturing the instinct of the learner to curiously explore and grow, focused on personal development in the field of biological sciences.
PLO-11	**Environment and sustainability**	Sense of scientific responsibility towards the appraisement of the environment, biodiversity, nature and wildlife, sustainable use of natural resources.

ABILITY ENHANCEMENT COMPULSORY COURSES (AECC)

Course code	Course Title	Hours/Week			
		L	T	P	C
LAE1811	English – I LSRW	2	1	0	3
LAE1821	English – II Communication Skill	2	1	0	3
EVS1817	Environmental Studies	2	0	0	2

CORE COURSES (CC)

Course code	Course Title	Hours/Week			
		L	T	P	C
ZOL1812	Animal diversity: Non-chordatesI:Protista to Pseudocoelomates	4	0	0	4
ZOL1813	Ecology	4	0	0	4
ZOL1822	Animal diversity: Non-chordates II:Coelomates	4	0	0	4
ZOL1823	Cell Biology	4	0	0	4
ZOL1831	Animal diversity: Diversity of Chordates	3	0	0	3
ZOL1832	Physiology: Controlling and Coordinating Systems	3	0	0	3
ZOL1833	Fundamentals of Biochemistry	3	0	0	3
ZOL1841	Animal diversity: Comparative Anatomy of Vertebrates	3	0	0	3
ZOL1842	Physiology: Life Sustaining Systems	3	0	0	3
ZOL1843	Biochemistry of Metabolic Processes	3	0	0	3
ZOL1851	Molecular Biology	4	0	0	4
ZOL1852	Applied Genetics	4	0	0	4
ZOL1861	Developmental Biology	4	0	0	4
ZOL1862	Evolutionary Biology	4	0	0	4

GENERIC ELECTIVE (GE)

Course code	Course Title	Hours/Week			
		L	T	P	C
CHM1812	Structure and Bonding in chemistry	4	0	0	4
CHM1823	Basic Concepts of Organic Chemistry	4	0	0	4
ZOL1833	Fundamentals of Biochemistry	3	0	0	3
BOTA1831	Biodiversity (Microbes, Algae, Fungi and Archegoniate)	3	0	0	3
BOTA1842	Plant Anatomy and Embryology	3	0	0	3

SKILL ENHANCEMENT COURSES (SEC)

Course code	Course Title	Hours/Week			
		L	T	P	C
ZOL1814	Animal diversity: Non-chordates I:Protista to Pseudocoelomates- Practical	0	0	4	2
ZOL1815	Ecology-practical	0	0	4	2
CHM1814	Inorganic Qualitative Analysis-Practical	0	0	4	2
ZOL1824	Animal diversity: Non-chordates II: Coelomates- Practical	0	0	4	2
ZOL1825	Cell Biology – Practical	0	0	4	2
CHM1844	Laboratory course on methods and Synthesis in organic chemistry	0	0	4	2
ZOL1834	Sericulture	2	0	0	2
ZOL1835	Animal diversity: Diversity of Chordates - Practical	0	0	4	2
ZOL1836	Physiology: Controlling and Coordinating Systems -Practical	0	0	4	2

ZOL1837	Fundamentals of Biochemistry Practical	0	0	4	2
BOTA1832	Biodiversity(Microbes, Algae, Fungi and Archegoniate)- Practical	0	0	4	2
ZOL1844	Animal cell biotechnology	2	0	0	2
ZOL1845	Animal diversity: Comparative Anatomy of Vertebrates – Practical	0	0	4	2
ZOL1846	Physiology: Life Sustaining Systems – Practical	0	0	4	2
ZOL1847	Biochemistry of Metabolic Processes Practical	0	0	4	2
BOTA1842	Plant Anatomy and Embryology- Practical	0	0	4	2
ZOL1855	Molecular Biology -Practical	0	0	4	2
ZOL1856	Applied Genetics -Practical	0	0	4	2
ZOL1857	Fish and Fisheries -Practical	0	0	4	2
ZOL1858	Wildlife conservation and Management- Practical				
ZOL1865	Developmental Biology -Practical	0	0	4	2
ZOL1866	Evolutionary Biology- Practical	0	0	4	2
ZOL1867	Immunology -Practical	0	0	4	2
ZOL1868	Parasitology -Practical				

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE)					
Course code	**Course Title**	**Hours/Week**			
		L	**T**	**P**	**C**
ZOL1853	Fish and Fisheries	**4**	**0**	**0**	**4**
ZOL1854	Wildlife conservation and Management				
ZOL1863	Immunology	**4**	**0**	**0**	**4**
ZOL1864	Parasitology				

Course Category	Course Code	Course Name	L	T	P	C
		SEMESTER-I				
AECC	LAE1811	English – I LSRW	2	1	0	3
CORE	ZOL1812	Animal diversity: Non-chordatesI:Protista to Pseudocoelomates	4	0	0	4
CORE	ZOL1813	Ecology	4	0	0	4
GE	CHM1812	Structure andBonding in chemistry	4	0	0	4
SEC	ZOL1814	Animal diversity: Non-chordates I:Protista to Pseudocoelomates- Practical	0	0	4	2
SEC	ZOL1815	Ecology-practical	0	0	4	2
SEC	CHM1814	Inorganic Qualitative Analysis-Practical	0	0	4	2
AECC	EVS1817	Environmental Studies	2			2
		TOTAL			**16**	**23**
		SEMESTER-II	**L**	**T**	**P**	**C**
AECC	LAE1821	English – II Communication Skill	2	1	0	3
CORE	ZOL1822	Animal diversity: Non-chordates II: Coelomates	4	0	0	4
CORE	ZOL1823	Cell Biology	4	0	0	4
GE	CHM1823	Basic Concepts of Organic Chemistry	4	0	0	4
SEC	ZOL1824	Animal diversity: Non-chordates II: Coelomates- Practical	0	0	4	2
SEC	ZOL1825	Cell Biology – Practical	0	0	4	2
SEC	CHM1844	Laboratory course on methods and Synthesis in organic chemistry	0	0	4	2
Extension*	EX*will be S/C/Y	NSS / NCC /Yoga				
		TOTAL			**16**	**21**
		SEMESTER-III	**L**	**T**	**P**	**C**
CORE	ZOL1831	Animal diversity: Diversity of Chordates	3	0	0	3
CORE	ZOL1832	Physiology: Controlling and Coordinating Systems	3	0	0	3
GE	ZOL1833	Fundamentals of Biochemistry	3	0	0	3
GE	BOTA1831	Biodiversity (Microbes, Algae, Fungi and Archegoniate)	3	0	0	3
SEC	ZOL1834	Sericulture	2	0	0	2
SEC	ZOL1835	Animal diversity: Diversity of Chordates - Practical	0	0	4	2
SEC	ZOL1836	Physiology: Controlling and Coordinating Systems -Practical	0	0	4	2
SEC	ZOL1837	Fundamentals of Biochemistry Practical	0	0	4	2
SEC	BOTA1832	Biodiversity(Microbes, Algae, Fungi and Archegoniate)- Practical	0	0	4	2
		TOTAL			**16**	**22**

		SEMESTER-IV	L	T	P	C
CORE	ZOL1841	Animal diversity: Comparative Anatomy of Vertebrates	3	0	0	3
CORE	ZOL1842	Physiology: Life Sustaining Systems	3	0	0	3
CORE	ZOL1843	Biochemistry of Metabolic Processes	3	0	0	3
GE	BOTA1841	Plant Anatomy and Embryology	3	0	0	3
SEC	ZOL1844	Animal cell biotechnology	2	0	0	2
SEC	ZOL1845	Animal diversity: Comparative Anatomy of Vertebrates – Practical	0	0	4	2
SEC	ZOL1846	Physiology: Life Sustaining Systems – Practical	0	0	4	2
SEC	ZOL1847	Biochemistry of Metabolic Processes Practical	0	0	4	2
SEC	BOTA1842	Plant Anatomy and Embryology- Practical	0	0	4	2
		TOTAL			**16**	**22**
		SEMESTER-V	**L**	**T**	**P**	**C**
CORE	ZOL1851	Molecular Biology	4	0	0	4
CORE	ZOL1852	Applied Genetics	4	0	0	4
DSE	ZOL1853	Fish and Fisheries	4	0	0	4
DSE	ZOL1854	Wildlife conservation and Management				
SEC	ZOL1855	Molecular Biology -Practical	0	0	4	2
SEC	ZOL1856	Applied Genetics -Practical	0	0	4	2
SEC	ZOL1857	Fish and Fisheries -Practical	0	0	4	2
SEC	ZOL1858	Wildlife conservation and Management- Practical				
		TOTAL			**12**	**18**
		SEMESTER-VI	**L**	**T**	**P**	**C**
CORE	ZOL1861	Developmental Biology	4	0	0	4
CORE	ZOL1862	Evolutionary Biology	4	0	0	4
DSE	ZOL1863	Immunology	4	0	0	4
DSE	ZOL1864	Parasitology				
SEC	ZOL1865	Developmental Biology -Practical	0	0	4	2
SEC	ZOL1866	Evolutionary Biology- Practical	0	0	4	2
SEC	ZOL1867	Immunology -Practical	0	0	4	2
SEC	ZOL1868	Parasitology -Practical				
		TOTAL			**12**	**18**

L – Language; C – Core; A – Ancillary, SEC- Skill Enhancement Course, E – Elective, P – Practical,
* This courses are suggested to complete through online Swayam and credit will be displayed on the mark sheet.

7. BSC PROGRAM STRUCTURE (TOTAL CREDITS: 124)

Course structure Distribution of different courses in each semester with their credits for B.Sc Zoology (Honours)

Semester	Professional Core Courses (CC)	Discipline Specific Electives (DSE)	Generic Electives (GE)	Skill Enhancement Courses (SEC)	Ability Enhancement Courses (AECC)	Swayam	Total Credit	Total Hours
SEM I	2	-	1	3	3		**23**	**435**
SEM II	2	-	1	3	1	-	**21**	**405**
SEM III	2	-	2	5	-	-	**22**	**480**
SEM IV	3	-	1	5	-	-	**22**	**480**
SEM V	2	2	-	4	-	-	**18**	**360**
SEM VI	2	2	-	4	-	-	**18**	**360**
Grand Total							**124**	**2520**

8. Program Articulation Matrix (PAM)

Course Code	Course Name	Program Learning Outcome										
		PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
LAE1811	English – I LSRW	H	M				M		H		H	M
ZOL1812	Animal diversity: Non-chordatesI: Protista to Pseudocoelomates	H	M								H	H
ZOL1813	Ecology	H	H			M		H				H
ZOL1812	Structure and Bonding in chemistry	H	M								H	
ZOL1814	Animal diversity: Non-chordates I: Protista to Pseudocoelomates- Practical	M	H		H				H		M	M
ZOL1815	Ecology-practical	M	H		H				H			H
CHM1814	Inorganic qualitative analysis - practical	H	H							H		
EVS1817	Environmental Studies											
LAE1821	English – II Communication Skill											
ZOL1822	Animal diversity: Non-chordates II: Coelomates	H	M				H				M	
ZOL1823	Cell Biology	H	M			M					H	M
CHM1823	Basic Concepts of Organic Chemistry	H	H								M	M
ZOL1824	Animal diversity: Non-chordates II: Coelomates- Practical	H				H					H	M
ZOL1825	Cell Biology – Practical Laboratory course on methods and Synthesis in organic chemistry	H	H						M		M	
CHM1844	Laboratory course on methods and Synthesis in organic chemistry	H	H			M					M	
ZOL1831	Animal diversity: Diversity of Chordates	H		M							H	M
ZOL1832	Physiology: Controlling and Coordinating Systems	H	H			M					H	
ZOL1833	Fundamentals of Biochemistry	H	H			H					M	
BOTA1831	Biodiversity (Microbes, Algae, Fungi and Archegoniate)	H	M								H	M
ZOL1834	Sericulture	H	H	M	H	H		M		H		M
ZOL1835	Animal diversity: Diversity of	H	M	M	H			M	M		H	H

	Chordates - Practical											
ZOL1836	Physiology: Controlling and Coordinating Systems -Practical	H	M		M	M	M		H		M	
ZOL1837	Fundamentals of Biochemistry-Practical		H		H	M			H		M	
BOTA1832	Biodiversity(Microbes, Algae, Fungi and Archegoniate)- Practical	H	H		H			M			M	
ZOL1841	Animal diversity: Comparative Anatomy of Vertebrates	H									H	
ZOL1842	Physiology: Life Sustaining Systems	H	H			M				H	M	
ZOL1843	Biochemistry of Metabolic Processes	H	M								H	
BOTA1841	Plant Anatomy and Embryology	H	H			M					H	H
ZOL1844	Animal cell biotechnology		H		H			H		H	H	
ZOL1845	Animal diversity: Comparative Anatomy of Vertebrates – Practical	H			H				H		M	
ZOL1846	Physiology: Life Sustaining Systems– Practical	H	H		H						H	
ZOL1847	Biochemistry of Metabolic Processes Practical		H		H	M					H	
BOTA1842	Plant Anatomy and Embryology-Practical	H	M								H	H
ZOL1851	Molecular Biology	H	H			H		H			H	
ZOL1852	Applied Genetics	H	H		H			H		H	H	
ZOL1853	Fish and Fisheries	H	H		H	H	H			H		H
ZOL1854	Wildlife conservation and Management	H	H	H	H		H	H		H	H	H
ZOL1855	Molecular Biology -Practical		H		H	H	H	M	M	H	H	
ZOL1856	Applied Genetics -Practical	H	H	H	H	H			M	H	M	
ZOL1857	Fish and Fisheries -Practical		H	H	H	H	H			H	H	H
ZOL1858	Wildlife conservation and Management- Practical		H		H	M	M	H		H	H	H
ZOL1861	Developmental Biology	H	H	H		M	M	H			H	H
ZOL1862	Evolutionary Biology	H	H	M	H			H			H	H
ZOL1863	Immunology	H	H	H	H	H	H	H		H	H	
ZOL1864	Parasitology	H	H	H	M						H	
ZOL1865	Developmental Biology -Practical	H	H	M	H				H			
ZOL1866	Evolutionary Biology- Practical	H	H		H				H		H	
ZOL1867	Immunology -Practical	H	H		H		H		H	H	H	
ZOL1868	Parasitology-Practical	H	H	H	H			M				M
	ProgramAverage	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**

SEMESTER I

Course Code	LAE1811	Course Name	English – I LSRW	Course Category	AECC	ABILITY ENHANCEMENT COMPULSORY COURSES	L	T	P	C
							2	1	0	3
Pre-requisite			Nil	Co-requisite		Nil				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Identify strategies to become appreciative and empathetic listeners.	**2**	**M**							**H**		**H**	
CLO-2	Express facts, ideas and opinions with fluency, clarity and confidence.	**2**								**H**		**H**	
CLO-3	Demonstrate critical understanding of written texts.	**4**	**M**	**M**						**H**		**H**	
CLO-4	Compose an array of business correspondence with ease and elegance.	**6**	**H**					**M**		**H**		**H**	
CLO-5	Articulate flawlessly in English Language.	**3**	**H**					**M**		**M**		**H**	
			H	**M**				**M**		**H**		**H**	**M**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Listening Skills** Introduction to Communication- LSRW Active Listening Reasons for poor Listening Types of Listening Barriers to Listening Traits of a goodListener ***Activity*:** Listening to the news and making notes, listening to announcements, listening to speeches, listening to instructions and summarizing them, listening to and differentiating pronunciations.	9	1
2.	**Speaking Skills** Importance of Speaking Skills Effective Speaking- Confidence, Clarity and Fluency Types of Speaking- Task Oriented- Interpersonal – Formal and Semi Formal Persuasive Speaking and Public Speaking Barriers to Speaking Guidelines for conducting a Group Discussion Guidelines for conducting a Meeting ***Activity*:** Peer Introduction, JAM, Public speech, Role play, Product description, debate, GD, panel discussion, Conducting Meeting	9	2
3.	**Reading Skills** Introduction to Reading skills Thesis, Evidence, Evaluation Topic sentence and its role Types of reading- Intensive- Extensive-Skimming - Scanning Reading and its purposes Reading for pleasure Reading for critical interpretation Reading for note making and summarizing ***Activity*:** Reading articles and short stories and verbally summarizing them, reading newspapers and magazines and highlighting the content, reading comprehensions, reading reviews, reading and interpreting the content, identifying the thesis- evidence- evaluation, reading novels (Abridged version)	9	3
4.	**Writing Skills** Introduction and importance of writing Writing a sentence Wrting a paragraph – Topic Sentence, illustration Characteristics of Writing – Accuracy, Clarrity, Correctness, Descriptiveness, Language Appropriateness, Conciseness – Flow Business Writing – Basic principles of Business Communication Letter Writing – Thank you and Follow-up letter, complaint	9	4

	letter, inquiry letter, invitation letter, letter to editor, writing memo, notice, agenda and minutes of the meeting. Report writing, Interpretation of data (flow charts, figures and pictures) Essay and Article Writing Poster Making ***Activity***- Writing a paragraph, Writing different kinds of letters, framing notices and memos and agendas, jotting down minutes of the meeting, reporting an event or the work done, interpreting various pictures, figures anddata.		
5.	***BasicGrammar*** Tense and Articles, Prepositions, Direct and IndirectSpeech Active and PassiveVoice	9	5

Learning Resources	
Text Books	Raman Meenakshi, Sangeeta Sharma, "*Technical Communication Principles and Practice*". Ed Second. Oxford University Press, Delhi, 2013.
Ref. Books	Dhanavel, S.P. "*English and Communication Skills for Students of Science and Engineering*",Orient Blackswan Ltd.,2009 Green,David. "*Contemporary English Grammar Structures and Composition*."Macmilllian Publisher India Ltd, Delhi,2000 Raman, Meenakshi, Prakash Singh, "*Business Communication*". 2nd Edition. Oxford University Press, 2013 Taylor, Shirley, V.Chandra. "*Communicaton for Business*. 4th Ed. Dorling Kindersly India pvt. Ltd., 2011

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	50%	10%	20%	20%
2	Understand	50%	10%	20%	20%
3	Apply		20%	30%	30%
4	Analyze		20%	20%	20%
5	Evaluate		20%	10%	10%
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. Pramila Chettri, Associate Professor, Tadong Govt College, Gangtok	Ms. Manisha Takuri, Assistant Professor, SRM University Sikkim

Course Code	ZOL1812	Course Name	Animal diversity: Non-chordates I: Protista to Pseudocoelomates	Course Category	C	CORE	L	T	P	C
							4	0	0	4
Pre-Requisite			Nil	Co-requisite		ZOL1814				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Define the character and classification of unicellular and multicellular invertebrate animals.	**1**	**H**									**H**	
CLO-2	Describe symmetry and segmentation of Metazoa.	**3**	**H**										
CLO-3	Describe the life cycle and biology of selected invertebrates.	**3**	**H**									**H**	
CLO-4	Interpret the role of Ctenophorain evolution.	**3**	**H**										
CLO-5	Relate the characteristic features of parasitic helminths with its adaptations.	**4**	**H**	**M**								**M**	
			H	**M**								**H**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I:Protista, Parazoa and Metazoa** General characteristics and Classification up to classes. Study of *Euglena, Amoeba and Paramecium* Life cycle and pathogenicity of *Plasmodium vivax*and*Entamoebahistolytica* Locomotion and Reproduction in Protista Evolution of symmetry and segmentation of Metazoa	12	1, 2, 3
2.	**UNIT II:Porifera, Cnidaria** General characteristics and Classification up to classes Canal system in sponges Metagenesis in *Obelia* Polymorphism in Cnidaria Corals and coral reefs	12	1, 3
3.	**UNIT III: Ctenophora** General characteristics and Evolutionary significance	12	1, 3, 4
4.	**UNIT IV: Platyhelminthes** General characteristics and Classification up to classes Life cycle and pathogenicity of *Fasciola hepatica* and *Taeniasolium*	12	1, 3, 5
5.	**UNIT V: Nemathelminthes** General characteristics and Classification up to classes Life cycle, and pathogenicity of *Ascarislumbricoides* and *Wuchereriabancrofti* Parasitic adaptations in helminthes	12	1, 3, 5

Learning Resources	
Text Books	3. E.L. Jordan and P.S. Verma Invertibrate Zoology New edition Edition, S. Chand 4. E.L. Jordan and P.S. Verma Chordate Zoology New edition Edition, S. Chand 5. KotpalR.L.Modern Textbook of Zoology – Invertebrates. Rastogi Publications 6. KotpalR.L.Modern Textbook of Zoology – Vertebrates. Rastogi Publications
Ref. Books	1. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII edition. Holt Saunders International Edition. 2. Barnes, R.S.K., Calow, P., Olive, P.I.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**25%**	**25%**
2	Understand	**40%**	**20%**	**25%**	**25%**
3	Apply	**10%**	**50%**	**25%**	**25%**
4	Analyze		**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1813	Course Name	Ecology	Course Category	C	CORE	L	T	P	C
							4	0	0	4
Pre-Requisite			Nil	Co-requisite		ZOL1815				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO 1 Disciplinary/ Professional Knowledge	PLO 2 Problem Analysis	PLO 3 Design and Development of Solutions/ Policies	PLO 4 Modern Usage tools	PLO 5 Interdisciplinary Development	PLO 6 Innovation and Entrepreneurship	PLO 7 Ethics	PLO 8 Individual or Team Work using effective communication	PLO 9 Vocational and Industry Exposure	PLO 10 Life-long learning	PLO 11 Environment and sustainability
CLO-1	Define ecology and its organization, physical factors.	**1**	**H**				**M**						
CLO-2	Describe the principles and characters of population dynamics.	**2**	**H**	**H**									**M**
CLO-3	Define community, succession and evaluate biodiversity.	**3**	**H**	**H**					**H**				**H**
CLO-4	Compare different types of food chains and food webs, energy flow and nutrient cycles.	**3**	**H**										
CLO-5	Implement ecology in wildlife conservation and plan wildlife management strategies.	**4**	**H**	**H**					**H**				**H**
			H	**H**			**M**		**H**				**H**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I: Introduction to Ecology** History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors	12	1
2.	**UNIT II: Population** 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 Populationinteractions, Gause's Principle with laboratory and field examples, Lotka-Volterra equationfor competition and Predation, functional and numerical responses	12	2
3.	**UNIT III: Community** Community characteristics: species richness, dominance, diversity, abundance, verticalstratification, Ecotone and edge effect; Ecological succession with one example Theories pertaining to climax community	12	3
4.	**UNIT IV: Ecosystem** Types of ecosystems with one example in detail, Food chain: Detritus and grazing foodchains, 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 Human modified ecosystem	12	4
5.	**UNIT V: Applied Ecology** Ecology in Wildlife Conservation and Management	12	5

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**25%**	**25%**
2	Understand	**50%**	**20%**	**25%**	**25%**
3	Apply		**50%**	**25%**	**25%**
4	Analyze		**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Learning Resources	
Text Books	1. Sharma P D.Ecology and Environment.(2017) Rastogi Publications ISBN 9789350781227, 9350781220Edition: ed. 3, 2. Odum. E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
Ref. Books	1. Robert Leo Smith Ecology and Field biology Harper and Row publisher 2. Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Pres

Course Designers		
Experts from Industry: **Name, Designation with official mail id**	**Experts from Higher Education Institutions:** **Name, Designation with official mail id**	**Internal Experts:** **Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	CHM1812	Course Name	Structure and Bonding in chemistry	Course Category	GE	GENERIC ELECTIVE	L	T	P	C
							4	0	0	4
Pre Requisite			Nil	Co-requisite		CHM1814				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Define the fundamentals of atomic structure	**1**	**H**	**M**								**H**	
CLO-2	Describe the arrangement of elements in the periodic table and periodic properties.	**3**	**H**	**M**								**H**	
CLO-3	Apply the basics to construct ionic crystals and metallic bonding.	**3**	**H**	**M**								**M**	
CLO-4	Analyze covalent structures and bonding in molecules	**4**	**H**	**M**									
CLO-5	Evaluate redox reactions by application of bonding theory.	**5**	**H**	**M**								**M**	
			H	**M**								**H**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Atomic Structure** Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and it's limitations, Variation of orbital energy with atomic number.	12	1
2.	**Periodicity of Elements** s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s & p-block. a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic radii (van der Waals) (c) Ionic and crystal radii. (d) Covalent radii (octahedral and tetrahedral) (e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. (f) Electron gain enthalpy, trends of electron gain enthalpy. (g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio	12	2
3.	**Ionic and Metallic Chemical Bonding** (i) *Ionic bond:* General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy. (ii) *Metallic Bond:* Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids	12	3
4.	**Covalent and Weak Chemical Bonding** (i) Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl,	12	4

	BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference. (ii) Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process		
5.	**Oxidation-Reduction** Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class.	12	5

Learning Resources	
Text Books	1. D. F Shriver, P. W Atkins and C. H. Langford, Inorganic Chemistry, 3rd Ed., Oxford University Press, London, 2001 2. 2. B. Douglas, D. McDaniel, and J. Alexander, Concepts and Models of Inorganic Chemistry, 3rd ed., John Wiley, 1994. 3. 3. J. D. Lee, Concise Inorganic Chemistry, 5th ed., Wiley, 2008. 4. P.W. Atkins, J.D. Paula, Physical chemistry, 9th Oxford university press, 2009.
Ref. Books	1. K. F Purcell and J. C. Kotz, Inorganic Chemistry, Saunders, Philadelphia, 1976. 2. T. Moeller, Inorganic Chemistry: A Modern Introduction, Wiley, New York, 1990. 3. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Shoban Lal Nagin Chand and Co, 1996. 4. J. E. Huheey, E. A. Keiter, and Keiter, R. L., Inorganic Chemistry, 4th Ed., Harper and Row, New York, 1983. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.

Bloom's Level of Thinking		Internal Assessment for theory papers (40 % weightage)			Final Examination for theory papers (60 % weightage)
		Cycle test (10)	Assignment (10)	Model Test (20)	End Semester Theory Exam (60)
1	Remember	50%	5%	15%	15%
2	Understand	40%	20%	15%	15%
3	Apply	40%	50%	20%	20%
4	Analyze	10%	25%	20%	20%
5	Evaluate			15%	15%
6	Create			15%	15%
	Total	100%	100%	100%	100%

Course Designers		
Experts from Industry: **Name, Designation with official mail id**	**Experts from Higher Education Institutions:** **Name, Designation with official mail id**	**Internal Experts:** **Name, Designation with official id**
Name: K. Anil Kumar Designation: Chief Scientific Officer- Arna Immuno ingredients Pvt. Ltd. , Email: Anil.kumar@arnaimmuno.com	Name: Dr. Somendra Nath Chakraborthy Designation: Assistant Professor, Sikkim University Email: snchakraborthy@cus.ac.in	Name: Dr. Govind Pratap Singh Designation: Associate Professor, Email: govindpratapsingh.v@srmus.edu.in

Course Code	ZOL1814	Course Name	Animal diversity: Non-chordates I: Protista to Pseudocoelomates Practical	Course Category	SEC	Skill Enhancement courses	L	T	P	C
							0	0	4	2
Pre Requisite			ZOL1812	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Identify protozoa through microscope.	**3**	**M**	**H**		**H**						**M**	
CLO-2	Analyze the diversity of protozoa from pond water.	**4**		**H**		**H**				**H**			**M**
CLO-3	Identify common parasitic and free-living invertebrates from specimens and slides.	**3**		**H**		**H**						**H**	
CLO-4	Analyze the life cycle stages of disease causing helminths	**4**		**H**								**M**	
CLO-5	Analyze the life cycles of specific invertebrates/coral/ coral reefs.	**4**	**M**							**H**			
			M	**H**		**H**				**H**		**M**	**M**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Microscopy and study of protozoa** **1.** Microscope: Basic identification of different parts of microscope **2.** Study of whole mount of *Euglena, Amoeba and Paramecium*. **3.** Examination of pond water collected from different places for diversity in protista	10	1,2,3
2.	**Identification of specimens with reasons** **4.** Study of *Sycon* (T.S. and L.S.), *Hyalonema, Euplectella, Spongilla* **5.** Study of *Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium,* *Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora* **6.** One specimen/slide of any ctenophore	20	3,4,5
3.	**Study of helminths** Study of adult *Fasciola hepatica, Taeniasolium* and their life cycles (Slides/microphotographs) **8.** Study of adult *Ascarislumbricoides* and its life stages (Slides/micro-photographs)	15	4
4.	**Study on life cycles of specific invertebrates /coral/ coral reefs.** **9**.(To submit a Project Report on any related topic on life cycles/coral/ coral reefs.)	15	5

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**25%**	**25%**	**25%**	**25%**
2	Understand	**25%**	**25%**	**25%**	**25%**
3	Apply	**25%**	**25%**	**25%**	**25%**
4	Analyze	**25%**	**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1815	Course Name	Ecology Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			ZOL1813	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Construct life table and survivorship curves.	**4**		**H**									**M**
CLO-2	Evaluate biodiversity and calculate diversity indices.	**4**		**H**						**H**		**H**	**H**
CLO-3	Identify phytoplankton and zooplanktons	**4**		**M**		**H**							**M**
CLO-4	Analyse physical and physicochemical parameters of aquatic ecosystems.	**4**		**H**									**H**
CLO-5	Evaluate the ecosystem and biodiversity from a field visit.	**5**	**M**			**H**				**H**			**H**
			M	**H**		**H**				**H**			**H**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Constructing life tables and plotting survivorship curves** **1.** Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided	15	1
2.	**Determination of population density and biodiversity indices calculation** **2.** Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community	15	2
3.	**Study of an aquatic ecosystem** **3.** 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	18	3,4
4.	**Study on a National Park/Biodiversity Park/Wild life sanctuary** **(4.** Report on a visit to National Park/Biodiversity Park/Wild life sanctuary)	12	5

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**15%**	**15%**	**15%**	**15%**
2	Understand	**25%**	**25%**	**25%**	**25%**
3	Apply	**25%**	**25%**	**25%**	**25%**
4	Analyze	**25%**	**25%**	**25%**	**25%**
5	Evaluate	**10%**	**10%**	**10%**	**10%**
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Learning Resources	
Text Books	
Ref. Books	1. Robert Leo Smith Ecology and Field biology Harper and Row publisher 2. Laboratory Hand Book on Basic EcologySurjya Kumar Saikia, Debangshu Narayan DasScience Publishing Group

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	CHM1814	Course Name	Inorganic Qualitative Analysis-Practical	Course Category	SAC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			CHM1812	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Identify various anions and cations through dry and wet experiments.	**3**	**H**	**H**							**H**		
CLO-2	Identify and detect various anions and cations through colored reactions of metal ions.	**3**	**H**	**H**							**H**		
CLO-3	Demonstrate semi micro chemical analysis.	**3**	**H**	**H**							**H**		
CLO-4	Identify interfering radicals.	**4**	**H**	**H**							**H**		
CLO-5	Evaluate qualitative ionic constituents from unknown mixture	**4**	**H**	**H**							**H**		
			H	**H**							**H**		

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1	**Semi micro qualitative analysis**: Qualitative analysis of a mixture containing two anions and two cations. Analysis of a mixture containing two cations and two anions of which one will be an interfering ion. Anions: Carbonate, sulphate, chloride, bromide, acetate, nitrite, nitrate, borate, chromate, oxalate, tartrate, and phosphate. Cations: Lead, bismuth, copper, cadmium, antimony, iron, zinc, cobalt, nickel, manganese, calcium, strontium, barium, & ammonium, silver, magnesium, mercury.	10	1, 2, 3, 4, 5

Learning Resources	
Text Books	1. V.V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, 3rd edition, The National Publishing Company, Chennai, 1974. 2. Vogel's Text Book of Inorganic Qualitative Analysis,4th edition, ELBS, London, 1974.
Ref. Books	V.Venkateswaran, R.Veerasamy and A.R. Kulandaivelu, Basic principles of Practical Chemistry, 2nd edition, Sultan Chand & Sons, New Delhi, 1997. 4. J. N. Gurtu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co. 6th edition, 2010.

Bloom's Level of Thinking		Internal Assessment for practical papers (40 % weightage)			Final Examination for practical papers (60% weightage)
		Internal Assessment Practical Exam (40)			End Semester Practical Exam (60)
		Experiments (20)	Lab record notebook (10)	Clarity/Viva voce (10)	
1	Remember	**20%**	**20%**	**20%**	**20%**
2	Understand	**20%**	**20%**	**20%**	**20%**
3	Apply	**20%**	**20%**	**20%**	**20%**
4	Analyze	**20%**	**20%**	**20%**	**20%**
5	Evaluate	**20%**	**20%**	**20%**	**20%**
6	Create	**-**	**-**	**-**	**-**
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: **Name, Designation with official mail id**	**Experts from Higher Education Institutions:** **Name, Designation with official mail id**	**Internal Experts:** **Name, Designation with official id**
Name: K. Anil Kumar Designation: Chief Scientific Officer- Arna Immuno ingredients Pvt. Ltd. , Email: Anil.kumar@arnaimmuno.com	Name: Dr. Somendra Nath Chakraborthy Designation: Assistant Professor, Sikkim University Email: snchakraborthy@cus.ac.in	Name: Dr. Govind Pratap Singh Designation: Associate Professor, Email: govindpratapsingh.v@srmus.edu.in

SEMESTER II

Course Code	LAE1821	Course Name	English – II Communication Skill	Course Category	AECC	Ability Enhancement Compulsory Courses	L	T	P	C
							2	1	0	3
Pre Requisite			Nil	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Explain the nature and models of professional communication.	2	**H**							**H**		**H**	
CLO-2	Employ technology ethically as an aid to communication.	3	**H**			**H**			**H**	**H**		**H**	
CLO-3	Demonstrate a conscious practice of verbal and non-verbal communication	3	**H**							**H**		**M**	
CLO-4	Apply the interview skills for professional development	3	**H**							**H**		**M**	
CLO-5	Adapt in a multi-cultural professional scenario	4	**H**							**H**		**H**	
			H			**H**			**H**	**H**		**H**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Understanding Communication** Introduction to Communication, Definition Communication process Methods of Communication- Internal and External communication Networks of communication- Vertical- horizontal- diagonal Barriers of Communication- Linguistic, Psychological, Interpersonal, cultural, physical and organizational	9	1
2.	**Technology- based Communication Aids** Telephone and voicemails Facsimile Machines Internet and computers Emails Conferencing Instant Messaging Groupware NETTIQUETTE Positive and Negative Impact of Technology enabledcommunication Effectiveness in Technology basedcommunication	9	2
3.	**Verbal and Non-VerbalCommunication** Verbal Communication Conversation- importance- essentials- conversation management- non-verbal cues in conversation- Oral Presentation Skills--- Technical aids in Visual Communication,Team Presentation Non- verbal Communication Definition and Significance Significance of Non-verbal Signals in organizations Types of Nonverbal communication- Kinesics- Paralinguistic- Proxemics and Chronemics	9	3
4.	**Interviews** Introduction- Objectives of Interviews Types of interviews Job Interviews- cover letter- Resume Writing- Preparation for interview- Interviewing Process- Mock Interview, Medium of Interview- Telephonic interview- web interview	9	4
5.	**Cross Cultural Communication** Introduction , Concept of Cross- Cultural Communication Ethnocentrism Cultural Variables and Communication Sensitivity Variables of National Culture Cross- Cultural Communication Strategies Potential Hot Spots in Cross- Cultural Communication Cross- Cultural Communication Skills- Basic Tips	9	5

Learning Resources	
Text Books	Raman Meenakshi, Prakash Singh, *Business Communication*, second edition, Oxford University Press, Delhi 2013.
Ref. Books	Raman Meenakshi, Sangeeta Sharma, "*Technical Communication Principles and Practice".* Ed Second. Oxford University Press, Delhi, 2013. Shirley Taylor, V. Chandra, *Communication for Business – A practical Approach* 4th ed Pearson Education Ltd., 2013 Nawal, Mallika, *"Business Communication".* CENGAGE Learning, 2012. Sharma R.C. *Business Correspondence and Report Writing*, McGraw Hill Education (India) Private limited, New Delhi, 2014

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**30%**	**20%**	**20%**	**30%**
2	Understand	**30%**	**20%**	**20%**	**20%**
3	Apply	**10%**	**30%**	**30%**	**20%**
4	Analyze	**30%**		**20%**	**10%**
5	Evaluate			**10%**	**10%**
6	Create		**20%**		
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. Pramila Chettri, Associate Professor, Tadong Govt College, Gangtok	Ms. Manisha Takuri, Assistant Professor, SRM University Sikkim

Course Code	ZOL1822	Course Name	Animal diversity: Non-chordates II: Coelomates	Course Category	C	CORE	L	T	P	C
							4	0	0	4
Pre Requisite			Nil	Co-requisite		ZOL1824				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO 1 Disciplinary/ Professional Knowledge	PLO 2 Problem Analysis	PLO 3 Design and Development of Solutions/ Policies	PLO 4 Modern Usage tools	PLO 5 Interdisciplinary Development	PLO 6 Innovation and Entrepreneurship	PLO 7 Ethics	PLO 8 Individual or Team Work using effective communication	PLO 9 Vocational and Industry Exposure	PLO 10 Life-long learning	PLO 11 Environment and sustainability
CLO-1	Define the evolution of coelom in coelomate invertebrates.	**1**	**H**									**M**	
CLO-2	Comparethe characters and classification of coelomate invertebrate phyla.	**2**	**H**									**H**	
CLO-3	Analyze the evolutionary significance of Onychophora.	**3**	**H**	**M**									
CLO-4	Interpretthe anatomy and physiology ofinvertebrates and describe Pearl culture.	**4**	**H**					**H**			**M**	**M**	
CLO-5	Analyze the affinities of Echinodermata with Chordates	**4**	**H**	**M**									
			H	**M**				**H**				**M**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I: Introduction to Coelomates ,annelida** Evolution of coelom and metamerism General characteristics and Classification up to classes Excretion in Annelida	12	1, 2
2.	**UNIT II:Arthropoda** General characteristics and Classification up to classes Vision and Respiration in Arthropoda Metamorphosis in Insects Social life in bees and termites	14	2
3.	**UNIT III: Onychophora** General characteristics and Evolutionary significance	10	2, 3
4.	**UNIT IV: Mollusca** General characteristics and Classification up to classes Respiration in Mollusca Torsion and detorsion in Gastropoda Pearl formation in bivalves Evolutionary significance of trochophore larva	12	2, 4
5.	**UNIT V: Echinodermata** General characteristics and Classification up to classes Water-vascular system in Asteroidea Larval forms in Echinodermata Affinities with Chordates	12	2, 4, 5

Learning Resources	
Text Books	KotpalR.L.Modern Textbook of Zoology – Invertebrates. Rastogi Publications 2. E.L. Jordan and P.S. VermaInvertibrate Zoology New edition Edition, S. Chand
Ref. Books	Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII edition. Holt Saunders International Edition. 2. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. IIEdition, E.L.B.S. and Nelson

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**25%**	**25%**
2	Understand	**50%**	**30%**	**25%**	**25%**
3	Apply		**40%**	**25%**	**25%**
4	Analyze		**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1823	Course Name	Cell Biology	Course Category	C	CORE	L	T	P	C
							4	0	0	4
Pre Requisite			Nil	Co-requisite		ZOL1824				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Define cell, pro- and eukaryotic microorganisms, virus and prions.	**1**	**H**	**M**			**M**					**H**	**M**
CLO-2	Explain the structure and function of Plasma Membrane and Endomembrane System	**2**	**H**										
CLO-3	Demonstrate the cellular components and their functions.	**3**	**H**									**M**	
CLO-4	Evaluate the role of nucleus and chromosomes.	**3**	**H**										
CLO-5	Analyze cell cycle, cell signalling and regulation.	**4**	**H**	**M**									
			H	**M**			**M**					**H**	**M**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I : Overview of Cells** Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions	10	1
2.	**UNIT II : Plasma Membrane and Endomembrane System** Various models of plasma membrane structure Transport across membranes: Active and Passive transport, Facilitated transport Cell junctions: Tight junctions, Desmosomes, Gap junctions Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes	14	2
3.	**UNIT III : Mitochondria, Peroxisomes and Cytoskeleton** Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis Peroxisomes Structure and Functions: Microtubules, Microfilaments and Intermediate filaments	12	3
4.	**UNIT IV: Nucleus** Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome)	12	4
5.	**UNIT V: Cell Division and Cell Signaling** Mitosis, Meiosis, Cell cycle and its regulation GPCR and Role of second messenger (cAMP)	12	5

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**25%**	**25%**
2	Understand	**50%**	**20%**	**25%**	**25%**
3	Apply		**50%**	**25%**	**25%**
4	Analyze		**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Learning Resources	
Text Books	Powar C. B. (2010) Cell Biology. Himalaya Publishing House 2. T Devasena. Cell Biology. Oxford. 3. P.K.Gupta. (2016) Cell Biology And Genetics: A text Book For Undergraduate Students. Rastogi. 4. S. Halder,D. K.. KarDipak Kumar Kar (2011) Cell Biology Genetics Molecular Biology. New Central Book Agency
Ref. Books	Karp, G.(2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc. 2. Cooper, G.M. and Hausman, R.E. (2009). The cell: A Molecular Approach. V Edition. ASM Press and Sunderland, Wasington, D.C.; Sinauer Associates, MA. 3. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). Molecular Biology of the Cell, V Edition, Garland publishing Inc., New York and London.

Course Designers		
Experts from Industry: **Name, Designation with official mail id**	**Experts from Higher Education Institutions:** **Name, Designation with official mail id**	**Internal Experts:** **Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	CHM1823	Course Name	Basic Concepts of Organic Chemistry	Course Category	*GE*	Generic Elective	L	T	P	C
							4	0	0	4
Pre Requisite			Nil	**Co-requisite**		CHM1844				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO 1 Disciplinary/ Professional Knowledge	PLO 2 Problem Analysis	PLO 3 Design and Development of Solutions/ Policies	PLO 4 Modern Usage tools	PLO 5 Interdisciplinary Development	PLO 6 Innovation and Entrepreneurship	PLO 7 Ethics	PLO 8 Individual or Team Work using effective communication	PLO 9 Vocational and Industry Exposure	PLO 10 Life-long learning	PLO 11 Environment and sustainability
CLO-1	Define the basic concepts in organic chemistry.	**2**	**H**	**M**								**M**	**H**
CLO-2	Evaluate the importance of isomerism and stereochemistry.	**3**	**H**	**M**								**M**	**M**
CLO-3	Apply the basic knowledge of bonding in chemistry to aliphatic hydrocarbons	**3**	**H**	**H**								**M**	
CLO-4	Incorporate the knowledge of general organic chemistry to construct cycloalkanes and conformational analysis	**3**	**H**	**H**								**M**	
CLO-5	Able to demonstrate the knowledge of organic reactions and reaction intermediate in aromatic Hydrocarbons	**3**	**H**	**H**								**M**	**M**

			H	**H**								**M**	**M**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Basics of Organic Chemistry** Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electrometric, resonance and mesomeric effects, hyper conjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape and their relative stability of Carbocation's, Carbanions, Free radicals and Carbenes. Introduction to types of organic reactions and their mechanism: Addition, Elimination andSubstitution reactions.	10	1
2.	**Stereochemistry** Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations	14	2
3.	**Chemistry of Aliphatic Hydrocarbons** A. Carbon-Carbon sigma bonds Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation - relative reactivity and selectivity. B. Carbon-Carbon pi bonds: Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cbreactions. Saytzeff and Hofmann eliminations. Reactions of alkenes: Electrophilic additions their mechanisms	18	2, 3

	(Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes		
4.	**Cycloalkanes and Conformational Analysis** Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams	6	4
5.	**Aromatic Hydrocarbons** Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups	12	5

Learning Resources	
Text Books	1. T. W. Graham Solomons, Organic Chemistry, 6th edition, John Wiley and Sons, New York, 1996. 2. L. G. Wade, Organic Chemistry, 8th edition, Pearson, 2016. 3. Kalsi, P. S. Stereochemistry Confo rmation and Mechanism; New Age International, 2005. 4. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
Ref. Books	1. S.H Pine, Organic Chemistry, 5th edition, McGraw Hill, New York,1987. 2. S.N. Ege, Organic Chemistry Structure and Reactivity, 3rd edition: A.I.T.B.S., New Delhi, 1998. 3. F.A .Carey, Organic Chemistry, 3rd edition, Tata-McGraw Hill Publications, New Delhi, 1999. 4. B.Y. Paula, Organic Chemistry, 3rd edition, Pearson Education Inc., Singapore, 2002. 5. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd edition, Oxford, 2014.

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**40%**	**15%**	**20%**	**20%**
2	Understand	**40%**	**15%**	**20%**	**20%**
3	Apply	**0**	**20%**	**20%**	**20%**
4	Analyze	**20%**	**20%**	**20%**	**20%**
5	Evaluate	**0**	**15%**	**20%**	**20%**
6	Create	**0**	**15%**	**0**	**0**
	Total	**100%**	**100%**	**100%**	**100**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
Name: K. Anil Kumar Designation: Chief Scientific Officer- Arna Immuno ingredients Pvt. Ltd. , Email: Anil.kumar@arnaimmuno.com	Name: Dr. Somendra Nath Chakraborthy Designation: Assistant Professor, Sikkim University Email: snchakraborthy@cus.ac.in	Name: Dr. Govind Pratap Singh Designation: Associate Professor, Email: govindpratapsingh.v@srmus.edu.in

Course Code	ZOL1824	Course Name	Animal diversity: Non-chordates II: Coelomates - Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			Nil	Co-requisite		ZOL1822				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Identify invertebrate specimens.	**3**		**H**								**H**	
CLO-2	Demonstrate the digestive system, and nephridia in earthworm.	**3**	**M**	**H**									
CLO-3	Analyze the histological slides of earthworm.	**4**	**H**				**H**						
CLO-4	Analyse the mouth parts,digestive and nervous system of *Periplaneta*	**4**	**H**				**M**						
CLO-5	Compare different non-chordate larval forms.	**4**	**H**				**H**						**M**
			H				**H**					**H**	**M**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Study of non-chordate specimens** Study of specimens following to: Annelids, Arthropods,Onychophora,Molluscs,Echinodermates	15	1
2.	**Study of digestive system, nephridia and histology of earthworms** **2.** Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm **3.** T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm	15	2,3
3.	**Dissection of *Periplaneta* for study of organ systems.** Mount of mouth parts and dissection of digestive system and nervous system of *Periplaneta*	15	4
4.	**Analysis of larval forms in crustacean, mollusc and echinoderms.** To submit a Project Report on any related topic to larval forms (crustacean, mollusc and echinoderm)	15	5

Learning Resources	
Text Books	1. A Manual of Practical Zoology Invertebrates: P.S. Verma. Kindle Edition. Chand 2. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. IIEdition, E.L.B.S. and Nelson
Ref. Books	

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**25%**	**25%**	**25%**	
2	Understand	**25%**	**25%**	**25%**	
3	Apply	**25%**	**25%**	**25%**	
4	Analyze	**25%**	**25%**	**25%**	
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1825	Course Name	Cell Biology- Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			Nil	Co-requisite		ZOL1823				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Prepare and identify various stages of mitosis.	**3**	**H**	**H**								**M**	
CLO-2	Analyse and identify various stages of meiosis.	**3**	**H**	**H**									
CLO-3	Prepare and identify Barr body in human female blood cells/cheek cells.	**4**		**H**						**M**		**M**	
CLO-4	Demonstrate the presence of DNA and RNA	**4**	**H**	**M**									
CLO-5	Evaluate Mucopolysaccharides and proteins.	**5**		**H**									
			H	**H**						**M**		**M**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Study of mitosis** **1**. Preparation of temporary stained squash of onion root tip to study various stages of mitosis	12	1
2.	**Study of meiosis** **2**. Study of various stages of meiosis.	12	2
3.	**Detection of Barr Body** **3**. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.	12	3
4.	**DNA and RNA identification in cell** Preparation of permanent slide to demonstrate: i DNA by Feulgen reaction ii DNA and RNA by MGP	12	4
5.	**Demonstration of mucopolysaccharide and protein in cell** Preparation of permanent slide to demonstrate: iiiMucopolysaccharides by PAS reaction iv Proteins by Mercurobromophenol blue/Fast Green	12	5

Learning Resources	
Text Books	1. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadrlphia.
Ref. Books	. Becker, W.M., Kleinsmith, L.J., Hardin.J. andBertoni G.P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**20%**	**20%**	**20%**	**20%**
2	Understand	**20%**	**20%**	**20%**	**20%**
3	Apply	**20%**	**20%**	**20%**	**20%**
4	Analyze	**20%**	**20%**	**20%**	**20%**
5	Evaluate	**20%**	**20%**	**20%**	**20%**
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	CHM1844	Course Name	Laboratory course on methods and Synthesis in organic chemistry	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			CHM1823	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Develop the methodology for analysis of functional groups	**3**	**H**	**M**			**M**					**M**	
CLO-2	Apply the basic knowledge of acid base chemistry, solubility and polarity knowledge for purification of organic molecules.	**3**	**H**	**H**			**M**					**M**	
CLO-3	Incorporate the theoretical knowledge of organic chemistry to organic synthesis.	**4**	**M**	**H**								**M**	
CLO-4	Able to construct molecular models and analyze their three dimensional nature.	**5**	**M**	**H**								**M**	
	.		**H**	**H**			**M**					**M**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Functional group Analysis** Qualitative organic functional group analysis - tests for alcohols, phenols, amines, carbonyls, carboxylic acids and nitro compounds.	20	1,2
2.	**Separation and purification techniques** Purification techniques: recrystallization, sublimation, distillation and steam distillation. Thin layer chromatography, column chromatography& paper chromatography. Specific rotation of chiral compounds (sugars) using a polarimeter. Plotting of molecular orbitals of aromatic compounds and conjugated systems. Conformational analysis – butane and substituted butanes, cyclohexane and di-substituted cyclohexane with stress on cis and trans isomerism. Molecular modelling: a) Stereo-chemistry: R-S configuration. b) Modeling on hybridization, geometry of some organic & inorganic compounds	20	1,2
3.	**Organic synthesis** Preparation of organic compounds: Dibenzylidene acetone, Aromatic sulphonation, Nitration of acetanilide, Bromination of acetanilide (Green Synthesis) Preparation of soap - saponification. Preparation of methyl orange and aspirin.	20	2,3,4

Learning Resources	
Text Books	1. Ault, Allyn and Bacon, Techniques and experiments for organic chemistry Inc., 4th Ed., 1983. 2. Laurence M Harwood and Christopher Moody, Experimental organic chemistry, Principles and Practice, Blackwell Scientific Publications, 1989.

	3. Donald Pavia, Gary M. Lampman and George S. Kriz Jr. Introduction to organic laboratory techniques a Contemporary Approach, 2nd Ed., 1982.
Ref. Books	1. L.F. Tietze and T H. Eicher, Reactions and synthesis in the Organic Chemistry Laboratory, University Science Books, 1989. 2. Koichi Tanaka, Solvent –free Organic Synthesis, Wiley-VCH, 2003. 3. Raphael Ikan, Natural Products -A Laboratory Guide,2nd Ed., Academic Press Inc., 1991. 4. Plummer, David. T. Introduction to Practical Biochemistry, Tata McGraw-Hill Publishing Co., 2006. 5. Pushpa Sundararaj and AnupamaSiddhu, Qualitative tests and quantitative procedures in biochemistry, 2nd Ed., Phoenix publishing House Pvt Ltd., 2002. 6. B Sashidhar Rao and V. Deshpande, Experimental biochemistry-A student companion, 2nd Ed., Phoenix publishing House Pvt Ltd., 2002. 7. S. Sadasivam and A. Manickam, Biochemical methods,2nd Ed., New Age International Pvt Ltd., 2005.---

Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**40%**	**15%**	**20%**	**20%**
2	Understand	**40%**	**15%**	**20%**	**20%**
3	Apply	**0**	**20%**	**20%**	**20%**
4	Analyze	**20%**	**20%**	**20%**	**20%**
5	Evaluate	**0**	**15%**	**20%**	**20%**
6	Create	**0**	**15%**	**0**	**0**
	Total	**100%**	**100%**	**100%**	

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
Name: K. Anil Kumar Designation: Chief Scientific Officer- Arna Immuno ingredients	Name: Dr. Somendra Nath Chakraborthy Designation: Assistant Professor,	Name: Dr. Govind Pratap Singh Designation: Associate Professor, Email:

Pvt. Ltd. , Email: Anil.kumar@arnaimmuno.com	Sikkim University Email: snchakraborthy@cus.ac.in	govindpratapsingh.v@srmus.edu.in

SEMESTER III

Course Code	ZOL1831	Course Name	Animal diversity: Diversity of Chordates	Course Category	C	CORE	L	T	P	C
							3	0	0	3
Pre Requisite			Nil	Co-requisite		ZOL1835				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Define Chordates, Protochordata and Origin of Chordata	**1**	**H**									**H**	
CLO-2	Explain the general characteristics and classification of cyclostomes	**2**	**H**										
CLO-3	Describe general characteristics, classification and biology of Pisces and Amphibia	**2**	**H**									**H**	
CLO-4	Describe general characteristics, classification and biology of Reptilia and Aves	**3**	**H**									**H**	
CLO-5	Analyze characters, classification, affinities of the Prototheria and Zoogeography of vertebrates.	**4**	**M**		**M**							**M**	**M**
			H		**M**							**H**	**M**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I : Introduction to Chordates, Protochordata and Origin of Chordata** General characteristics and outline classification General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata Dipleurula concept and the Echinoderm theory of origin of chordates Advanced features of vertebrates over Protochordata	10	1
2.	**UNIT II :Agnatha** General characteristics and classification of cyclostomes up to class	7	2
3.	**UNIT III : Pisces and Amphibia** General characteristics of Chondrichthyes and Osteichthyes, Classification up to order Migration, Osmoregulation and Parental care in fishes Origin of *Tetrapoda*(Evolution of terrestrial ectotherms); General characteristics and classification up to order; Parental care in Amphibians	9	3
4.	**UNIT IV :Reptilia and Aves** General characteristics and classification up to order; Affinities of *Sphenodon*; Poison apparatus and Biting mechanism in snakes General characteristics and classification up to order *Archaeopteryx*-- a connecting link; Principles and aerodynamics of flight, Flight adaptations and Migration in birds	10	4
5.	**Unit V: Mammals and Zoogeography** General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages Zoogeographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms	10	5

Learning Resources	
Text Books	1. E.L. Jordan and P.S. Verma Chordate Zoology New edition Edition, S. Chand 2. KotpalR.L.Modern Textbook of Zoology – Vertebrates. Rastogi Publications
Ref. Books	1. Young , J.Z. (2004). The Life of vertebrates. III Edition. Oxford university press. 2. Pough H. vertebrate life, VIII Edition, Pearson International. 3. Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**25%**	**25%**
2	Understand	**50%**	**20%**	**25%**	**25%**
3	Apply		**50%**	**25%**	**25%**
4	Analyze		**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1832	Course Name	Physiology: Controlling and coordinating Systems	Course Category	C	CORE	L	T	P	C
							3	0	0	3
Pre Requisite			Nil	Co-requisite		ZOL1836				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Define different types of tissue and elaborate their structure and functions.	**1**	**H**									**H**	
CLO-2	Evaluate the different structure and function of bone, cartilage and muscles.	**2**	**H**				**M**						
CLO-3	Express the structure and function of nervous system.	**3**					**M**					**M**	
CLO-4	Analyse the structure and physiology of the reproductive system.	**4**	**H**	**M**			**M**					**H**	
CLO-5	Elaborate the components and function of endocrine system.	**4**	**H**	**H**			**H**					**M**	
			H	**H**			**M**					**H**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I : Tissues** Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue	8	1
2.	**UNIT II : Bone, Cartilage and Muscle** Structure and types of bones and cartilages, Ossification, bone growth and resorption Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus	10	2
3.	**UNIT III : Nervous System** Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc; Physiology of hearing and vision.	9	3
4.	**UNIT IV: Reproductive System** Histology of testis and ovary; Physiology of male and female reproduction; Puberty, Methods of contraception in male and female	8	4
5.	**UNIT V: Endocrine System** Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action; Classification of hormones; Regulation of their secretion; Mode of hormone action, Signal transduction pathways for steroidal and non-steroidal hormones; Hypothalamus (neuroendocrine gland) – principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system; Placental hormones	10	5

Learning Resources	
Text Books	1. Chatterjee C.C.(2012). Human Physiology (Volume 1) CBS 2. Chatterjee C.C.(2012). Human Physiology (Volume 2) CBS
Ref. Books	1. Guyton, A.C. & Hall, J.E. (2006). Text book of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd./W.B. Saunders Company. 2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition Jhon Wiley & sons 3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**25%**	**25%**
2	Understand	**50%**	**20%**	**25%**	**25%**
3	Apply		**50%**	**25%**	**25%**
4	Analyze		**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1833	Course Name	Fundamentals of Biochemistry	Course Category	GE	Generic Elective	L	T	P	C
							3	0	0	3
Pre Requisite			Nil	Co-requisite		ZOL1837				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Define fundamental biochemistry of carbohydrates.	1	**H**				**H**					**M**	
CLO-2	Explainthe biochemistry of lipids and its importance.	2	**H**				**H**					**M**	
CLO-3	Interpret the types and role of protein in biology.	3	**H**				**H**					**M**	
CLO-4	Analyze thestructure and function of DNA and RNA.	4	**H**	**H**			**M**					**M**	
CLO-5	Explain the classification and function of enzyme and its kinetics.	4	**H**	**H**			**H**						
			H	**H**			**H**					**M**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I : Carbohydrates** Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates	8	1
2.	**UNIT II : Lipids** Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids	8	2
3.	**UNIT III: Proteins** **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 proteins; Denaturation; Introduction to simple and conjugate proteins **Immunoglobulins:** Basic Structure, Classes and Function, Antigenic Determinants	9	3
4.	**UNIT IV Nucleic Acids** 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, Hpyo-Hyperchromaticity of DNA	10	4
5.	**UNIT V: Enzymes** Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax, Lineweaver-Burk plot; Multi-substrate reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme action	10	5

Learning Resources	
Text Books	1. Sunjay Jain, J L Jain, Nitin Jain.Fundamentals Of Biochemistry. (2005) S Chand 2. U. Satyanaryan,U.Chakrapani 2017. Biochemistry. Publisher: Elsevier
Ref. Books	1. Cox, M.M and Nelson D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H.Freeman and Co., New York. 2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H.Freeman and Co., New York. 3. 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.

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**25%**	**25%**
2	Understand	**50%**	**20%**	**25%**	**25%**
3	Apply		**50%**	**25%**	**25%**
4	Analyze		**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	BOTA1831	Course Name	Biodiversity (Microbes, Algae, Fungi and Archegoniate)	Course Category	GE	Generic Elective	L	T	P	C
							3	0	0	3
Pre Requisite			Nil	Co-requisite		BOTA1832				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Define the general characters, life cycle and economic importance of virus and bacteria	**1**	**H**	**M**								**H**	**M**
CLO-2	Explain the morphology and life-cycle of different algae and their importance	**2**	**H**									**H**	**M**
CLO-3	Develop a concept on fungi, lichens and mycorrhiza	**3**	**H**	**M**								**H**	**M**
CLO-4	Build concept on archegoniate plants	**3**	**H**									**H**	**M**
CLO-5	Distinguish between bryophytes, pteridophytes, gymnosperms and their economic importance	**4**	**H**									**H**	**M**

			H	**M**								**H**	**M**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I: Microbes** Viruses -Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria -Discovery, General characteristics and cell structure; Reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.	10	1
2.	**UNIT II: Algae** General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas, Oedogonium*, *Vaucheria*, *Fucus, Polysiphonia*. Economic importance of algae.	10	2
3.	**UNIT III: Fungi** Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus*(Zygomycota) *Penicillium, Alternaria*(Ascomycota), *Puccinia*, *Agaricus* (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance	10	3
4.	**UNIT IV: Introduction to Archegoniate** Unifying features of archegoniates, Transition to land habit, Alternation of generations.	5	4
5.	**UNIT V: Bryophytes**, **Pteridophytes and Gymnosperms** Bryophyte: General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia*and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*. Pteridophytes: General	10	5

	characteristics, classification, Early land plants (*Cooksonia*and *Rhynia*). Classification (up tofamily), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included). Heterospory and seed habit, stellar evolution. Ecological and economical importance of Pteridophytes. Gymnosperms: Generalcharacteristics; Classification (up to family), morphology, anatomy and reproduction of*Cycas*and *Pinus*(Developmental details not to be included). Ecological and economicalimportance.		

Learning Resources	
Text Books	1. Mitra, D., Guha, J. and Chowdhury, S.K. Studies in Botany Volume I.& Volume II Moulik Library. 2. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi.2nd edition. 3. Rashid, A. (2016). An introduction to Archigoniate Plants. Vikas Publishing. 4. Vashishta, P.C., Sinha, A.K. and Kumar, A. (2010). Pteridophyta, S. Chand. Delhi, India. 5. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
Ref. Books	1. Tortora, G.J., Funke, B.R. and Case, C.L. (2010). Microbiology: An Introduction, 10th edition., Pearson Benjamin Cummings, U.S.A. 2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (1996). Introductory Mycology, 4th edition John Wiley and Sons (Asia), Singapore. 3. Santra, S.C., Chatterjee, T.P. and Das, A.P. (2010). College Botany Practical, volume 1 and 2. New Central Book Agency (P) Limited.

Bloom's Level of Thinking		**Internal Assessment for practical papers (40% weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle Test (10)	**Model Examination (20)**	**Assignment (10)**	
1	Remember	50%	**25%**	**10%**	**25%**
2	Understand	50%	**25%**	**30%**	**25%**
3	Apply	0	**25%**	**30%**	**25%**
4	Analyze	0	**25%**	**30%**	**25%**
5	Evaluate	0	-	-	-
6	Create	0	-	-	-
	Total	100%	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NIL	1. r. Dhani raj Chhetri, Associate Professor, Sikkim University. drchhetri@cus.ac.in **2.** r. B. C. Basistha, Additional Director, Science & Technology, Govt. of Sikkim. basisthabharat@gmail.com	Dr. Anand Sharma, Assistant Professor, SRM University Sikkim. anandsharma.a@srmus.edu.in

Course Code	ZOL1834	Course Name	Sericulture	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							2	0	0	2
Pre Requisite			Nil	Co-requisite		Nil				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Define different types and distribution of silkworms.	**1**	**H**				**H**				**M**	**M**	
CLO-2	Describe the biology and life cycle of silk worms.	**2**	**H**								**M**	**M**	
CLO-3	Organize the setup of a silkworm rearing house.	**3**			**M**						**H**		
CLO-4	Analyse and implement prevention and control of pests and diseases in silkworm rearing.	**4**		**H**		**H**	**M**		**M**		**H**		**M**
CLO-5	Designa Sericulture set-up for developing entrepreneurship.	**6**		**M**	**M**		**H**		**M**		**H**		
			H	**H**	**M**	**H**	**H**		**M**		**H**		**M**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I : Introduction** Sericulture: Definition, history and present status; Silk route Types of silkworms, Distribution and Races Exotic and indigenous races Mulberry and non-mulberry Sericulture	6	1
2.	**UNIT II : Biology of Silkworm** Life cycle of *Bombyxmori* Structure of silk gland and secretion of silk	5	2
3.	**UNIT III : Rearing of Silkworms** 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 Spinning, harvesting and storage of cocoons	7	3
4.	**UNIT IV: Pests and Diseases** 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	5	4
5.	**UNIT V: Entrepreneurship in Sericulture** Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture. Visit to various sericulture centres.	7	5

Learning Resources	
Text Books	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.
Ref. Books	1. Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988. 2. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan1972.

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**20%**	**20%**
2	Understand	**50%**	**20%**	**20%**	**20%**
3	Apply		**30%**	**20%**	**20%**
4	Analyze		**25%**	**20%**	**20%**
5	Evaluate		**10%**	**10%**	**10%**
6	Create		**10%**	**10%**	**10%**
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1835	Course Name	Animal diversity: Diversity of Chordates - Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			ZOL1831	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Identify Protochordata and Agnatha	**3**	**H**										
CLO-2	Identify fish scales and types.	**3**	**H**									**M**	
CLO-3	Analyze amphibian diversity in the ecosystem.	**4**	**H**	**M**									**H**
CLO-4	Categorize different types of snakes and other reptiles.	**4**	**H**	**M**	**M**				**M**	**M**		**H**	**H**
CLO-5	Demonstrate different types of birds and mammals.	**4**	**H**			**H**				**M**		**H**	**H**
			H	**M**	**M**	**H**			**M**	**M**		**H**	**H**

Summary of Course Content			
S. No	Course Content	**Hour**	**Alignment to CLO**
1.	Study of Protochordata and Agnatha **1. Protochordataand Agnatha** *Balanoglossus, Herdmania, Branchiostoma,* Colonial Urochordata, Sections of *Balanoglossus*through proboscis and branchiogenital regions, Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions. Permanent slide of *Herdmania*spicules *Petromyzon, Myxine*	12	1
2.	Study on Fishes **2. Fishes** *Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/ Diodon, Anabas,* Flat fish	12	2
3.	Identification and biology of Amphibia **3.Amphibia** *Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandra*	10	3
4.	Reptilian identification including snakes **4. Reptilia** *Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus* Key for Identification of poisonous and non-poisonous snakes	12	4
5.	Study of Aves and Mammalia **5. Aves and Mammalia** Study of six common birds from different orders. Types of beaks and claws *Sorex*, Bat (Insectivorous and Frugivorous), *Funambulus, Loris, Herpestes, Erinaceous.* Mount of weberianossicles of *Mystus*, pecten from Fowl head Dissection of Fowl head (Dissections and mounts subject to permission) Power point presentation on study of any two animals from two different classes by students (may be included if dissections not given permission) Classification from Young, J. Z. (2004) to be followed	14	5

Learning Resources	
Text Books	Young , J.Z. (2004). The Life of vertebrates. III Edition. Oxford university press. 2. A Manual of Practical Zoology: Chordates P.S. Verma10th Revised edition Edition, Kindle Edition S. Chand 3. A Manual of Practical Zoology Invertebrates: P.S. Verma.S Chand
Ref. Books	

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**25%**	**25%**	**25%**	**25%**
2	Understand	**25%**	**25%**	**25%**	**25%**
3	Apply	**25%**	**25%**	**25%**	**25%**
4	Analyze	**25%**	**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: **Name, Designation with official mail id**	**Experts from Higher Education Institutions:** **Name, Designation with official mail id**	**Internal Experts:** **Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1836	Course Name	Physiology: Controlling and Coordinating Systems -Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			ZOL1832	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Demonstrate simple muscle twitch with electrical stimulation.	**3**	**M**			**M**	**M**						
CLO-2	Analyse unconditioned reflex action pattern.	**4**	**H**			**M**							
CLO-3	Demonstrate preparation and identification of temporary mounts.	**4**	**H**										
CLO-4	Identify permanent slides of mammalian endocrine glands.	**4**	**M**	**M**								**M**	
CLO-5	Prepare permanent slides from mammalian tissues.	**4**		**M**		**H**		**M**		**H**			
			H	**M**		**M**	**M**	**M**		**H**		**M**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Study of simple muscle twitch** **1.** Experiment of Recording of simple muscle twitch with electrical stimulation (or Virtual)	10	1
2.	**Study of unconditioned reflex action pattern.** **2.** Experiment of Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)	10	2
3.	**Preparation and identification of temporary mounts.** **3.** Experiment of Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells	12	3
4.	**Histological identification of mammalian endocrine glands.** **4.** Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid	14	4
5.	**Microtomy and preparation of permanent slides.** **5.** Microtomy: Preparation of permanent slide of any five mammalian (Goat/white rat) tissues	14	5

Learning Resources	
Text Books	1. Chatterjee C.C.(2012). Human Physiology (Volume 1) CBS 2. Chatterjee C.C.(2012). Human Physiology (Volume 2) CBS
Ref. Books	1. Guyton, A.C. & Hall, J.E. (2006). Text book of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd./W.B. Saunders Company. 2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition Jhon Wiley & sons 3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**25%**	**25%**	**25%**	**25%**
2	Understand	**25%**	**25%**	**25%**	**25%**
3	Apply	**25%**	**25%**	**25%**	**25%**
4	Analyze	**25%**	**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha, Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1837	Course Name	Fundamentals of Biochemistry Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			ZOL1833	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Demonstrate qualitative test of bio -molecules.	**3**		**H**		**H**	**M**						
CLO-2	Analyse and separate bio-molecules.	**4**		**H**		**H**							
CLO-3	Demonstrate the experiment showing the action of enzymes	**4**		**H**		**H**							
CLO-4	Evaluate action of enzyme in different conditions.	**4**		**H**		**H**							
CLO-5	Demonstrate protein separation using modern tools.	**4**		**H**		**H**				**H**		**M**	
				H		**H**	**M**			**H**		**M**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	Qualitative tests of functional groups in carbohydrates, proteins and lipids.	12	1
2.	Paper chromatography of amino acids.	12	2
3.	Action of salivary amylase under optimum conditions.	12	3
4.	Effect of pH, temperature and inhibitors on the action of salivary amylase.	12	4
5.	Demonstration of proteins separation by SDS-PAGE.	12	5

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**25%**	**25%**	**25%**	**25%**
2	Understand	**25%**	**25%**	**25%**	**25%**
3	Apply	**25%**	**25%**	**25%**	**25%**
4	Analyze	**25%**	**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	BOTA1832	Course Name	Biodiversity (Microbes, Algae, Fungi and Archegoniate)- Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			BOTA1831	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Analyze the different types of reproduction in bacteria, lytic, lysogenic cycle and Gram staining technique	3	**H**	**H**	**M**	**H**			**M**			**M**	
CLO-2	Distinguish the vegetative and reproductive structures of different algae from fresh and permanent slides	4	**H**	**H**		**H**							
CLO-3	Compare the life cycle pathogenic fungi	4	**H**	**H**		**H**							
CLO-4	Examine the different types and life cycle pattern of lichens and mycorrhiza	4	**H**	**M**									

CLO-5	Evaluate the general vegetative and reproductive characteristic of various archegoniates	5	**H**										
			H	**H**		**H**			**M**			**M**	

Learning Resources	
Text Books	Mitra, D., Guha, J. and Chowdhury, S.K. Studies in Botany Volume I.& Volume IIMoulik Library. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd.Delhi.2nd edition. Rashid, A. (2016). An introduction to Archigoniate Plants. Vikas Publishing. Vashishta, P.C., Sinha, A.K. and Kumar, A. (2010). Pteridophyta, S. Chand. Delhi,India. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) LtdPublishers, New Delhi, India.
Ref. Books	Tortora, G.J., Funke, B.R. and Case, C.L. (2010). Microbiology: An Introduction,10th edition., Pearson Benjamin Cummings, U.S.A. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (1996). Introductory Mycology, 4th edition John Wiley and Sons (Asia), Singapore. Santra, S.C., Chatterjee, T.P. and Das, A.P. (2010). College Botany Practical, volume 1 and 2. New Central Book Agency (P) Limited.

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
NIL	1. r. Dhani raj Chhetri, Associate Professor, Sikkim University. drchhetri@cus.ac.in **2.** r. B. C. Basistha, Additional Director, Science & Technology, Govt. of Sikkim. basisthabharat@gmail.com	Dr. Anand Sharma, Assistant Professor, SRM University Sikkim. anandsharma.a@srmus.edu.in

SEMESTER IV

Course Code	ZOL1841	Course Name	Animal diversity: Comparative Anatomy of Vertebrates	Course Category	C	CORE	L	T	P	C
							3	0	0	3
Pre Requisite			Nil	Co-requisite		ZOL1845				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Define the fundamentals of Integumentary and skeletal system	**1**	**H**									**H**	
CLO-2	Describe digestive system, glands and dentition.	**2**	**H**									**H**	
CLO-3	Describe the structure and function of respiratory and circulatory system	**2**	**H**									**H**	
CLO-4	Demonstrate the structure and functions of urino-genital system	**3**	**H**									**H**	
CLO-5	Analyse the components and functioning of nervous system and sense organs	**4**	**H**									**H**	
			H									**H**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I : Integumentary System and Skeletal System** Structure, functions and derivatives of integument Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches	9	1
2.	**UNIT II : Digestive System** Alimentary canal and associated glands, dentition	9	2
3.	**UNIT III : Respiratory System and Circulatory System** Skin, gills, lungs and air sacs; Accessory respiratory organs General plan of circulation, evolution of heart and aortic arches	9	3
4.	**UNIT IV: Urinogenital System** Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri	7	4
5.	**UNIT V: Nervous System and Sense Organs** Comparative account of brain Autonomic nervous system, Spinal cord, Cranial nerves in mammals Classification of receptors Brief account of visual and auditory receptors in man	11	5

Learning Resources	
Text Books	1. R. K. SaxenaSumitraSaxena (2015) Comparative Anatomy of VertebratesEurospan 2. VirenderTomar (2012) Anatomy of Vertebrates. Sonali Publications
Ref. Books	1. Kardong, K.V. (2005) Vertebrates Comparative Anatomy, Functional and Evolution. IV Ed. McGraw-Hill Higher Education. 2. Kent, G.C and Carr R.K. (2000). Comparative anatomy of the vertebrates. IX ed. McGraw-Hill Higher Education.

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**25%**	**25%**
2	Understand	**50%**	**20%**	**25%**	**25%**
3	Apply		**50%**	**25%**	**25%**
4	Analyze		**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1842	Course Name	Physiology: Life Sustaining Systems	Course Category	C	CORE	L	T	P	C
							3	0	0	3
Pre Requisite			Nil	Co-requisite		ZOL1846				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO 1 Disciplinary/ Professional Knowledge	PLO 2 Problem Analysis	PLO 3 Design and Development of Solutions/ Policies	PLO 4 Modern Usage tools	PLO 5 Interdisciplinary Development	PLO 6 Innovation and Entrepreneurship	PLO 7 Ethics	PLO 8 Individual or Team Work using effective communication	PLO 9 Vocational and Industry Exposure	PLO 10 Life-long learning	PLO 11 Environment and sustainability
CLO-1	Define the basics of the physiology of digestion	**1**	**H**									**M**	
CLO-2	Describe the histology, anatomy and function of respiration.	**2**	**H**									**M**	
CLO-3	Express the structural and functional aspects of kidney and excretion.	**3**	**H**									**M**	
CLO-4	Analyse the different components of blood, and its grouping system.	**4**	**H**	**H**		**H**					**H**	**H**	
CLO-5	Explainheart anatomy, its regulation and function; Analyze ECG and BP.	**4**	**H**	**H**		**H**	**M**				**H**	**M**	
			H	**H**			**M**				**H**	**M**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I : Physiology of Digestion** Structural organization and functions of gastrointestinal tract and associated glands;Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins,water, minerals and vitamins; Hormonal control of secretion of enzymes in Gastrointestinal tract.	9	1
2.	**UNIT II : Physiology of Respiration** Histology of trachea and lung; Mechanism of respiration, Pulmonary ventilation; Respiratoryvolumes and capacities; Transport of oxygen and carbon dioxide in blood; Respiratorypigments, Dissociation curves and the factors influencing it; Carbon monoxide poisoning; Control of respiration	9	2
3.	**UNIT III : Renal Physiology** Structure of kidney and its functional unit; Mechanism of urine formation; Regulation ofwater balance; Regulation of acid-base balance	9	3
4.	**UNIT IV: Blood** Components of blood and their functions; Structure and functions of haemoglobin Haemostasis: Blood clotting system, Kallikrein-Kinninogen system, Complement system&Fibrinolytic system, Haemopoiesis Blood groups: Rh factor, ABO and MN	9	4
5.	**UNIT V: Physiology of Heart** Structure of mammalian heart; Coronary circulation; Structure and working of conducting myocardial fibers. 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	9	5

Learning Resources	
Text Books	1. Chatterjee C.C.(2012). Human Physiology (Volume 1) CBS 2. Chatterjee C.C.(2012). Human Physiology (Volume 2) CBS
Ref. Books	1. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons COURSE CODE COURSE TITLE L T P C ZOL1842 Physiology: Life Sustaining Systems 3 0 0 3 38 2. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition.Lippincott W. & Wilkins. 3. Gyton, A.C. & Hall, J.E. (2006). Textbook of Medical physiology. XI ed. Hercourt Asia PTE Ltd. W.B. Saunders Company.

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**25%**	**25%**
2	Understand	**50%**	**20%**	**25%**	**25%**
3	Apply		**50%**	**25%**	**25%**
4	Analyze		**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1843	Course Name	Biochemistry of Metabolic Processes	Course Category	C	CORE	L	T	P	C
							3	0	0	3
Pre Requisite			Nil	Co-requisite		ZOL1847				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Define biochemical reactions within a living cell and organism.	**1**	**H**									**H**	
CLO-2	Describe biochemical reactions of carbohydrates.	**2**	**H**	**H**									
CLO-3	Express the biochemical reactions of lipids.	**2**	**H**										
CLO-4	Construct biochemical reactions of proteins.	**3**	**H**	**M**								**H**	
CLO-5	Explain oxidative phosphorylation in respiration.	**4**	**H**	**M**									
			H	**M**								**H**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I : Overview of Metabolism** Catabolism *vs*Anabolism, Stages of catabolism, Compartmentalization of metabolic pathways, Shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; coupled reactions; Use of reducing equivalents and cofactors; Intermediary metabolism and regulatory mechanisms	9	1
2.	**UNIT II : Carbohydrate Metabolism** Sequence of reactions and regulation of glycolysis, Citric acid cycle, Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis	9	2
3.	**UNIT III : Lipid Metabolism** β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis	9	3
4.	**UNIT IV: Protein Metabolism** Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids	9	4
5.	**UNIT VOxidative Phosphorylation** Redox systems; Review of mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System	9	5

Learning Resources	
Text Books	1. Sunjay Jain, J L Jain, Nitin Jain.Fundamentals Of Biochemistry. (2005) Schand 2. U. Satyanaryan,U.Chakrapani 2017. Biochemistry. Publisher: Elsevier
Ref. Books	1. Cox, M.M and Nelson D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H.Freeman and Co., New York. 2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition,W.H.Freeman and Co., New York. 3. 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.

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**25%**	**25%**
2	Understand	**40%**	**20%**	**25%**	**25%**
3	Apply	**10%**	**50%**	**25%**	**25%**
4	Analyze		**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	BOTA1841	Course Name	Plant Anatomy and Embryology	Course Category	GE	Generic Elective	L	T	P	C
							3	0	0	3
Pre Requisite			Nil	Co-requisite		BOTA1842				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Outline the plant tissue system and tissue origination in different plant parts	2	**H**									**H**	
CLO-2	Explain the tissue structure of adaptive organs that develop in plants growing in extreme ecological conditions	2	**H**	**H**			**M**					**M**	
CLO-3	Develop concept on histological features of reproductive parts of plantS	3	**H**										
CLO-4	Distinguish the various pollination mechanism and the post fertilization anatomical changes occurring	4	**H**	**H**									**H**

	in plants												
CLO-5	Examine the structure and function of endosperms, embryo and their inter-relationship	4	**H**	**M**									
			H	**H**			**M**					**H**	**H**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I: Plant Organs and tissues** Structure of dicot and monocot root, stem and leaf. Meristematic and permanent tissues: Root and shoot apical meristems; Simple and complex tissues. Secondary Growth: Vascular cambium-structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood)	15	CLO 1
2.	**UNIT II: Adaptive and protective systems** Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes	8	CLO 2
3.	**UNIT III: Structural organization of flower** Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.	8	CLO 3
4.	**UNIT IV: Pollination and fertilization** Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms	7	CLO 4
5.	**UNIT V: Embryo and endosperm, polyembryony** Endosperm types, structure and Functions; Dicot and monocot embryo; Embryo endosperm relationship. Apomixis and polyembryony: Definition, types and Practical applications	7	CLO 5

Learning Resources	
Text Books	1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). Embryology of Angiosperms. 5th edition.Vikas Publication House Pvt. Ltd., New Delhi.
Ref. Books	1. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA. 2. Cutler, D.F., Stevenson, D.W. and Botha, C.E.J. (2008). Plant Anatomy: An AppliedApproach. John Wiley & Sons. Blackwell Publishing. 3. Sharma, H.P. (2009). Plant Embryology: Classical and Experimental. Alpha Science International.

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**10%**	**25%**	**25%**
2	Understand	**50%**	**30%**	**25%**	**25%**
3	Apply		**30%**	**25%**	**25%**
4	Analyze		**30%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
NIL	1. r. Dhani raj Chhetri, Associate Professor, Sikkim University. drchhetri@cus.ac.in **2.** r. B. C. Basistha, Additional Director, Science & Technology, Govt. of Sikkim. basisthabharat@gmail.com	Dr. Anand Sharma, Assistant Professor, SRM University Sikkim. anandsharma.a@srmus.edu.in

Course Code	ZOL1844	Course Name	Animal cell biotechnology	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							2	0	0	2
Pre Requisite			Nil	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Define the fundamental concepts and scopes of biotechnology.	**1**				**H**			**M**			**H**	
CLO-2	Demonstrate the role of enzymes in the field of genetic engineering.	**2**				**H**							
CLO-3	Apply vectors and constructs in recombinant DNA technology.	**3**		**H**		**H**					**M**		
CLO-4	Apply genetic engineering techniques and PCR along with ethical issue and bio-safety.	**4**		**H**		**H**			**H**		**H**		
CLO-5	Apply the basics of animal cell culture and other molecular techniques.	**4**		**H**		**H**			**H**		**H**		
				H		**H**			**H**		**H**	**H**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I : Introduction** Concept and scope of Biotechnology	6	1
2.	**UNIT II :Basic concepts in genetic engineering** Restriction enzymes, Polymreases, DNA ligases etc.	6	2
3.	**UNIT III :Cloning vectors** Plasmids, cosmids, lambdaphage, Phage vectors Recombinant DNA technology, Transgenic animals.	6	3
4.	**UNIT IV :Gene libraries** Construction of cDNA and genomic libraries. Ethical issues and biosafetyregulations Elementary idea of PCR and its application.	6	4
5.	**UNIT V: Basic about animal cell culture** Basic techniques in animal cell culture and organ culture, Primary Culture and Cell lines, Culture media- Natural and Synthetic, Stem cells, Cryopreservation of cultures. Agarose and Polyacrylamide Gel Electrophoresis, Southern, Northern and Western blotting, DNA sequencing: Sanger method, DNA Fingerprinting and DNA microarrays	6	5

Learning Resources	
Text Books	1. P.K. Gupta: Biotechnology and Genomics, Rastogi publishers (2003). 2. B.D. Singh: Biotechnology, Kalyani publishers, 1998 (Reprint 2001).
Ref. Books	1. Animal Cells Culture and Media, D.C. Darling and S.J. Morgan, 1994. BIOS Scientific Publishers Limited. 2. Methods in Gene Biotechnology, W. Wu, M.J. Welsh, P.B. Kaufman & H.H. Zhang, 1997, CRC Press, New York 3. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**25%**	**25%**
2	Understand	**50%**	**20%**	**25%**	**25%**
3	Apply		**50%**	**25%**	**25%**
4	Analyze		**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1845	Course Name	Animal diversity: Comparative Anatomy of Vertebrates – Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			ZOL1841	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Identify different types of fish scales.	**4**		**M**		**H**				**H**		**M**	
CLO-2	Analyze the skeleton system of frog, Varanus, fowl, and Rabbit and mammalian skulls.	**4**	**H**									**M**	
CLO-3	Dissect rat to show arterial and urinogenital system.	**4**	**H**										
CLO-4	Demonstrate the structure of carapace and plastron of turtle/tortoise.	**4**	**H**										
CLO-5	Evaluate skeletal modifications in vertebrates.	**5**	**H**									**H**	
			H			**H**				**H**		**M**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Identification of fish scales** Study of placoid, cycloid and ctenoid scales through permanent slides/photographs	12	1
2.	**Study of Skeletal systems** Disarticulated skeleton of Frog, *Varanus,* Fowl, Rabbit Mammalian skulls: One herbivorous and one carnivorous animal	12	2
3.	**Dissection of Rat** Dissection of rat to study arterial and urinogenital system(subject to permission) Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted)	12	3
4.	Study of carapace and plastron **3.** Carapace and plastron of turtle /tortoise	12	4
5.	Study on skeletal modifications in vertebrates. Project on skeletal modifications in vertebrates (may be included if dissection not permitted)	12	5

Learning Resources	
Text Books	1. R. K. SaxenaSumitraSaxena (2015) Comparative Anatomy of Vertebrates Eurospan 2. VirenderTomar (2012) Anatomy of Vertebrates. Sonali Publications
Ref. Books	1. Kardong, K.V. (2005) Vertebrates Comparative Anatomy, Functional and Evolution. IV Ed. McGraw-Hill Higher Education. 2. Kent, G.C and Carr R.K. (2000). Comparative anatomy of the vertebrates. IX ed. McGraw-Hill Higher Education.

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**20%**	**20%**	**20%**	**20%**
2	Understand	**20%**	**20%**	**20%**	**20%**
3	Apply	**20%**	**20%**	**20%**	**20%**
4	Analyze	**20%**	**20%**	**20%**	**20%**
5	Evaluate	**20%**	**20%**	**20%**	**20%**
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1846	Course Name	Physiology: Life Sustaining Systems – Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			ZOL1842	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Analyze ABO Blood group and other haematologicaltests.	**4**	**H**	**H**		**H**						**H**	
CLO-2	Demonstrate haemin and haemochromogen crystals.	**4**		**H**		**H**							
CLO-3	Demonstrate cardiac cycle in frog.	**4**	**H**			**H**							
CLO-4	Evaluate blood pressure using a sphygmomanometer	**4**		**H**		**H**						**H**	
CLO-5	Identify sections of mammalian organ systems.	**4**	**H**			**H**						**H**	
			H	**H**		**H**						**H**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	ABO Blood group analysis and haematological tests. Experiment of determination of ABO Blood group Enumeration of red blood cells and white blood cells using haemocytometer	16	1
2.	Preparation of haemin and haemochromogen crystals. Estimation of haemoglobin using Sahli'shaemoglobinometer	10	2
3.	Study of cardiac cycle in frog. Preparation of haemin and haemochromogen crystals **5.** Recording of frog's heart beat under *in situ* and perfused conditions	10	3
4.	Study of blood pressure using a sphygmomanometer Recording of blood pressure using a sphygmomanometer	8	4
5.	Identification of sections of mammalian organ systems. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney	16	5

Learning Resources	
Text Books	1. Gyton, A.C. & Hall, J.E. (2006). Textbook of Medical physiology. XI ed. Hercourt Asia PTE Ltd. W.B. Saunders Company. 2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
Ref. Books	

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**25%**	**25%**	**25%**	**25%**
2	Understand	**25%**	**25%**	**25%**	**25%**
3	Apply	**25%**	**25%**	**25%**	**25%**
4	Analyze	**25%**	**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1847	Course Name	Biochemistry of Metabolic Processes Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			ZOL1843	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Estimate proteins from samples.	**3**		**H**		**M**						**H**	
CLO-2	Analyze activity of liver enzymes and biological oxidation.	**4**		**H**		**H**	**M**					**H**	
CLO-3	Demonstrate activity of digestive enzymes	**4**		**H**		**H**						**H**	
CLO-4	Demonstrate acid and alkaline phosphatase assay	**4**		**H**		**H**	**M**					**H**	
CLO-5	Evaluate the TCA cycle at a molecular level in dry lab.	**5**		**H**		**H**	**M**					**H**	
				H		**H**	**M**					**H**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	Protein Estimation Estimation of total protein in given solutions by Lowry's method.	12	1
2.	Study of liver enzymes and biological oxidation Detection of SGOT and SGPT or GST and GSH in serum/ tissue Study of biological oxidation (SDH) [goat liver]	12	2
3.	Study of trypsin and lipase activity To study the enzymatic activity of Trypsin and Lipase.	12	3
4.	Acid and alkaline phosphatase assay To perform the Acid and Alkaline phosphatase assay from serum/ tissue	12	4
5.	Tracing labelled carbons in TCA cycle in dry lab Dry Lab: To trace the labelled C atoms of Acetyl-CoA till they evolve as CO2in the TCA cycle	12	5

Learning Resources	
Text Books	1. Cox, M.M and Nelson D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H.Freeman and Co., New York. 2. Sunjay Jain, J L Jain, Nitin Jain.Fundamentals Of Biochemistry. (2005) Schand
Ref. Books	Wilson K Walker J2005Principles and Techniques of Biochemistry and Molecular Biology Keith, John Cambridge University Press

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**20%**	**20%**	**20%**	**25%**
2	Understand	**20%**	**20%**	**20%**	**25%**
3	Apply	**20%**	**20%**	**20%**	**25%**
4	Analyze	**20%**	**20%**	**20%**	**25%**
5	Evaluate	**20%**	**20%**	**20%**	
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	BOTA1842	Course Name	Plant Anatomy and Embryology-Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			BOTA1841	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Develop skills on sectioning of different anatomical structures in monocots and dicots and adaptive anatomy	3	**H**									**H**	
CLO-2	Analyze the male and female gametophyte	4	**H**	**M**									
CLO-3	Distinguish the different pollination types and other seed dispersal mechanism	4	**H**	**M**									**H**
CLO-4	Evaluate the embryogenesis process and different endosperm of monocot and dicot	5	**H**	**H**								**H**	
CLO-5	Demonstrate the dissection of plant	**5**	**H**										

	embryos.												
			H	**M**								**H**	**H**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1	Study of meristems through permanent slides and photographs. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs). Stem: Monocot: *Zea mays;* Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides). Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides). Leaf: Dicot and Monocot leaf (only Permanent slides). Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem)	15	CLO 1
2	Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides). Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/campylotropous (Photographs). Female gametophyte: *Polygonum*(monosporic) type of Embryo sac Development (Permanent slides). Ultrastructure of mature egg apparatus cells through electron micrographs photographs.	15	CLO 2
3	Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens)	15	CLO 3
4	Dissection of embryo/endosperm from developing seeds	15	CLO 4

Learning Resources	
Text Books	1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). Embryology of Angiosperms. 5th Edition. Vikas Publication House Pvt. Ltd., New Delhi. 2. Pandey, B.P. (2012). Plant Anatomy. S. Chand Publishing. Plant Anatomy and Embryology 3. Bhojwani, S.S., Bhatnagar, S.P. and Dantu, P.K. (1979). The Embryology of angiosperms, 6th Edition. Vikas Publishing House. 4. Sharma, H.P. (2009). Plant Embryology: Classical and Experimental. Alpha Science

	International.
Ref. Books	1. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA. 2. Cutler, D.F., Stevenson, D.W. and Botha, C.E.J. (2008). Plant Anatomy: An Applied Approach. John Wiley & Sons. Blackwell Publishing. 3. Sharma, H.P. (2009). Plant Embryology: Classical and Experimental. Alpha Science International.

Bloom's Level of Thinking		Continuous Learning Assessment (40% weightage)			Final Examination (60 % weightage)
		Experiment (20)	Lab record notebook (10)	Clarity/Viva voce (10)	End Semester Practical Exam (60)
1	Remember	25%	25%	25%	20%
2	Understand	25%	25%	25%	20%
3	Apply	25%	25%	25%	20%
4	Analyze	25%	25%	25%	20%
5	Evaluate	0	0	0	20%
6	Create	0	0	0	0
	Total	100%	1000%	100%	100%

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
NIL	1. r. Dhani raj Chhetri, Associate Professor, Sikkim University. drchhetri@cus.ac.in	Dr. Anand Sharma, Assistant Professor, SRM University

	2. r. B. C. Basistha, Additional Director, Science & Technology, Govt. of Sikkim. basisthabharat@gmail.com	Sikkim. anandsharma.a@srmus.edu.in

SEMESTER V

Course Code	ZOL1851	Course Name	Molecular Biology	Course Category	C	CORE	L	T	P	C
							4	0	0	4
Pre Requisite			Nil	Co-requisite		ZOL1855				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Define the basic concepts of nucleic acids.	**1**	**H**				**H**		**H**			**H**	
CLO-2	Expresscentral dogma, replication, transcription, and translation.	**3**	**H**									**H**	
CLO-3	Analyze post transcriptional modifications and processing of eukaryotic RNA	**4**	**H**	**H**									
CLO-4	Express the processes of gene regulation	**4**	**H**	**H**			**H**					**H**	
CLO-5	Evaluate the mechanism of DNA repair and regulation by RNA.	**5**	**H**	**H**									
			H	**H**			**H**		**H**			**H**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I : Nucleic Acids** Salient features of DNA and RNA Watson and Crick model of DNA	12	1
2.	**UNIT II : DNA Replication, Transcription, Translation** DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication,Semiconservative,bidirectional and semi-discontinuous replication, RNA priming, Replication of circular and linear *ds*-DNA, replication of telomeresRNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of proteinsynthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of proteinsynthesis, aminoacyl Trna synthetasis and charging of tRNA; Proteins involved in initiation,elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation	12	2
3.	**UNIT III : Post Transcriptional Modifications and Processing of Eukaryotic RNA** Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA	12	3
4.	**UNIT IV: Gene Regulation** Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from *lac* operon and *trp*operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing, Genetic imprinting	12	4
5.	**UNIT V: DNA Repair Mechanisms 3 and Regulatory RNAs 3** Pyrimidine dimerization and mismatch repair Ribo-switches, RNA interference, miRNA, siRNA	12	5

Learning Resources	
Text Books	**1.** Lewin B. (2008). Gene XI, Jones and Bartlett **2.** De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and MolecularBiology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia. **3.** Powar C. B. (2010) Cell Biology. Himalaya Publishing House
Ref. Books	**1.** Cooper, G.M. and Hausman, R.E. (2009). The cell: A Molecular Approach. V Edition. ASM Press and Sunderland, Wasington, D.C.; Sinauer Associates, MA. **2.** De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and MolecularBiology. VIIIEdition. Lippincott Williams and Wilkins, Philadelphia.

	3. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**20%**	**20%**
2	Understand	**40%**	**20%**	**20%**	**20%**
3	Apply	**10%**	**50%**	**20%**	**20%**
4	Analyze		**25%**	**20%**	**20%**
5	Evaluate			**20%**	**20%**
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1852	Course Name	Applied Genetics	Course Category	C	CORE	L	T	P	C
							4	0	0	4
Pre Requisite			Nil	Co-requisite		ZOL1856				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Define the basics of Mendelian Genetics	**1**	**H**								**M**	**H**	
CLO-2	Demonstrate the Linkage, Crossing Over and Chromosomal Mapping	**2**	**H**	**H**							**H**	**H**	
CLO-3	Analyze mutations and mechanism of sex determination	**4**	**H**	**H**	**M**	**H**			**H**		**H**	**M**	
CLO-4	Demonstrate extra-chromosomal and polygenic inheritance.	**4**	**H**	**H**									
CLO-5	Explain recombination in bacteria, viruses and transposable genetic elements	**4**	**H**	**M**		**H**			**H**			**H**	
			H	**H**		**H**			**H**		**H**	**H**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I :Mendelian Genetics and its Extension** Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sex-influenced and sex-limited characters inheritance.	12	1
2.	**UNIT II : Linkage, Crossing Over and Chromosomal Mapping** Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses, Interference and coincidence, Somatic cell hybridization.	12	2
3.	**UNIT III : Mutations and Sex Determination** Types of gene mutations (Classification), Types of chromosomal aberrations (Classification, figures and with one suitable example of each), Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached *X* method. Chromosomal mechanisms of sex determination in Drosophila and Man	12	3
4.	**UNIT IV: Extra-chromosomal Inheritance, Polygenic Inheritance** Criteria for extra-chromosomal inheritance, Antibiotic resistance in *Chlamydomonas*, Mitochondrial mutations in *Saccharomyces*, Infective heredity in *Paramecium* and Maternal Effects Polygenic inheritance with suitable examples; simple numericals based on it.	12	4
5.	**UNIT V: Recombination in Bacteria, Viruses andTransposable Genetic Elements** Conjugation, Transformation, Transduction, Complementation test in Bacteriophage Transposons in bacteria, Ac-Ds elements in maize and P elements in *Drosophila*, Transposons in humans	12	5

Learning Resources	
Text Books	**1.** Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India **2.** Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition **3.** Gupta Pk (2013) Genetics Classical To Modern. Rastogi Publications
Ref. Books	**1.** Russell, P. J. (2009). *Genetics- A Molecular Approach*.III Edition. Benjamin Cummings **2.** Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**25%**	**25%**
2	Understand	**50%**	**20%**	**25%**	**25%**
3	Apply		**50%**	**25%**	**25%**
4	Analyze		**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1853	Course Name	Fish and Fisheries	Course Category	DSE	Discipline Specific Elective	L	T	P	C
							4	0	0	4
Pre Requisite			Nil	Co-requisite		ZOL1857				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Define fish and its classification.	**1**	**H**								**M**	**H**	
CLO-2	Describe the morphologyand physiology of fish.	**2**	**H**								**M**		
CLO-3	Apply the concept of different types of fisheries.	**3**	**M**	**H**			**M**	**H**			**H**		**H**
CLO-4	Analyze different aquaculture practices and its management.	**4**	**M**	**H**	**H**		**H**	**H**			**H**		**H**
CLO-5	Evaluate the role of fish in research.	**5**	**H**	**M**		**H**		**H**			**H**		
			H	**H**		**H**	**H**	**H**			**H**		**H**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I : Introduction and Classification:** General description of fish; Account of systematic classification of fishes (upto classes); Classification based on feeding habit, habitat and manner of reproduction.	12	1
2.	**UNIT II : Morphology and Physiology:** Types of fins and their modifications; Locomotion in fishes; Hydrodynamics; Types of Scales, Use of scales in Classification and determination of age of fish; 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	12	2
3.	**UNIT III : Fisheries** 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	12	3
4.	**UNIT IV: Aquaculture** 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	12	4
5.	**UNIT V: Fish in research** Transgenic fish, Zebrafish as a model organism in research	12	5

Learning Resources	
Text Books	1. C.B.L. Srivastava, Fish Biology, Narendra Publishing House 2. S.S. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House
Ref. Books	1. Q Bone and R Moore, Biology of Fishes, Talyor and Francis Group, CRC Press, U.K. 2. D. H. Evans and J. D. Claiborne, The Physiology of Fishes, Taylor and Francis Group, CRC Press, UK von der Emde, R.J. Mogdans and B.G. Kapoor.

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**20%**	**20%**
2	Understand	**50%**	**20%**	**20%**	**20%**
3	Apply		**50%**	**20%**	**20%**
4	Analyze		**25%**	**20%**	**20%**
5	Evaluate			**20%**	**20%**
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1854	Course Name	Wildlife conservation and Management	Course Category	DSE	Discipline Specific Elective	L	T	P	C
							4	0	0	4
Pre Requisite			Nil	Co-requisite		ZOL1858				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Define wildlife and conservation ethics.	**1**	**H**						**H**			**H**	**H**
CLO-2	Apply wildlife evaluation and management strategies.	**3**	**H**	**H**	**H**			**H**			**H**		**H**
CLO-3	Analyze habitats and management strategies of wildlife populations	**4**		**H**	**H**								**H**
CLO-4	Estimate population dynamics of the wild.	**4**	**H**	**H**	**H**	**H**							**H**
CLO-5	Plan the management of protected areas and its wildlife.	**5**	**M**	**H**	**H**							**H**	**H**
			H	**H**	**H**	**H**		**H**	**H**		**H**	**H**	**H**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I :Introduction to Wild Life** Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies.	12	1
2.	**UNIT II Evaluation and management of wild life** Habitat analysis, Physical parameters: Topography, Geology, Soil and water; Biological Parameters: food, cover, forage, browse and cover estimation; Standard evaluation procedures: remote sensing and GIS.	12	2
3.	**UNITIII:Management of habitats and Management of excess population** Setting back succession; Grazing logging; Mechanical treatment; Advancing the successional process; Cover construction; Preservation of general genetic diversity. Bio- telemetry; Care of injured and diseased animal; Quarantine; Common diseases of wild animal	12	3
4.	**UNIT IV : Population estimation** Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation; Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, Hair identification, Pug marks and census method.	12	4
5.	**UNIT V: Protected areas and Management planning of wild life in protected areas** National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve. Estimation of carrying capacity; Eco tourism / wild life tourism in forests; Concept of climax persistence; Ecology of perturbence.	12	5

Learning Resources	
Text Books	1. Balakrishnan M. (2016) Wildlife Ecology and Conservation. Scientific Publishers *2.* Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). *Problem-Solving in Conservation* 3. *Biology and Wildlife Management: Exercises for Class, Field, and Laboratory*. Blackwell Publishing.
Ref. Books	1. Caughley, G., and Sinclair, A.R.E. (1994). *Wildlife Ecology and Management*. Blackwell Science. 2. Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**20%**	**20%**
2	Understand	**40%**	**20%**	**20%**	**20%**
3	Apply	**10%**	**50%**	**20%**	**20%**
4	Analyze		**25%**	**20%**	**20%**
5	Evaluate			**20%**	**20%**
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1855	Course Name	Molecular Biology -Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			ZOL1851	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Demonstrate Polytene chromosomes	**3**				**H**							
CLO-2	Demonstrate microbiological and aseptic sterile techniques required in molecular biology.	**3**		**H**		**H**	**H**	**H**	**M**		**H**	**H**	
CLO-3	Analyse the antibiotic sensitivity/resistance of *E. Coli.*	**4**		**H**		**H**	**H**			**M**	**H**		
CLO-4	Quantify DNA and RNA	**4**		**H**		**H**	**H**				**H**		
CLO-5	Interpret replication, transcription, and split genes.	**4**				**H**							
				H		**H**	**H**	**H**	**M**	**M**	**H**	**H**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Study of polytene chromosome** Study of Polytene chromosomes from Chironomous / Drosophila larvae	12	1
2.	**Basics of microbiological and aseptic sterile techniques** Estimation of the growth kinetics of *E. coli* by turbidity method Preparation of solid culture medium (LB) and growth of *E. coli* by spreading and streaking	12	2
3.	**Study of antibiotic sensitivity/resistance of *E. Coli.*** Demonstration of antibiotic sensitivity/resistance of *E. coli* to antibiotic pressure and interpretation of results	12	3
4.	**DNA and RNA quantification** Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement) Quantitative estimation of RNA using Orcinol reaction	12	4
5.	**Study of replication, transcription, and split genes.** Study and interpretation of electron micrographs/ photograph showing (a) DNA replication (b) Transcription (c) Split genes	12	5

Learning Resources	
Text Books	1. K. V. Chaitanya (2013) Cell and Molecular Biology : A Lab Manual. PHI Learning Press 2. PriyankaSiwach Molecular Biology First Edition (2007) Laxmi Publications-New 3. Delhi
Ref. Books	1. Wilson K Walker J2005Principles and Techniques of Biochemistry and Molecular Biology Keith, John Cambridge University Press

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**25%**	**25%**	**25%**	**25%**
2	Understand	**25%**	**25%**	**25%**	**25%**
3	Apply	**25%**	**25%**	**25%**	**25%**
4	Analyze	**25%**	**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1856	Course Name	Applied Genetics -Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			ZOL1852	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Analyse experimental results based on Mendelian laws.	**4**	**H**	**H**								**H**	
CLO-2	Analyzeexperimental data using Chi-square test.	**4**	**H**	**H**			**H**						
CLO-3	Produce gene maps based on data from conjugation, transformation,transduction and *Drosophila* crosses.	**4**		**H**		**H**							
CLO-4	Analyze human karyotypes to understand genetic disorders	**4**		**H**	**H**					**M**	**H**	**M**	
CLO-5	Evaluatepedigree chartsfor inherited traits.	**5**		**H**	**H**								
			H	**H**	**H**	**H**	**H**			**M**	**H**	**M**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Mendelian laws and gene interactions** To study the Mendelian laws and gene interactions.	12	1
2.	**Chi-square analysis** Chi-square analyses using seeds/beads/*Drosophila*.	12	2

3.	**Linkage maps** Linkage maps based on data from conjugation, transformation and transduction. Linkage maps based on data from *Drosophila* crosses.	12	3
4.	**Study of human karyotype** Study of human karyotype (normal and abnormal).	12	4
5.	**Pedigree analysis** Pedigree analysis of some human inherited traits.	12	5

Learning Resources	
Text Books	Russell, P. J. (2009). *Genetics- A Molecular Approach.*III Edition. Benjamin Cummings
Ref. Books	Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc

Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**25%**	**25%**	**25%**	**25%**
2	Understand	**25%**	**25%**	**25%**	**25%**
3	Apply	**25%**	**25%**	**25%**	**25%**
4	Analyze	**25%**	**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: **Name, Designation with official mail id**	**Experts from Higher Education Institutions:** **Name, Designation with official mail id**	**Internal Experts:** **Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1857	Course Name	Fish and Fisheries –Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			ZOL1853	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Identify different types of fisheswith systemic positions.	**3**		**H**								**H**	
CLO-2	Identify scales, air breathing organs of different types of fish.	**3**		**M**		**H**							
CLO-3	Analyse water quality parameters.	**4**		**H**	**H**	**H**	**H**	**H**			**H**	**H**	**H**
CLO-4	Demonstrate the induced breeding and parental care in fishes.	**4**		**H**	**H**			**H**			**H**		**M**
CLO-5	Evaluate the functioning of a fish farm/ pisciculture unit/Zebrafish rearing Lab.	**5**		**M**	**H**			**H**			**H**		**H**
				H	**H**	**H**	**H**	**H**			**H**	**H**	**H**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Identification of fish** Study of *Petromyzon*, *Myxine*, *Pristis*, *Chimaera*, *Exocoetus*, *Hippocampus*, *Gambusia*, *Labeo*, *Heteropneustes*, *Anabas*	12	1
2.	**Identification of scales and air breathing organs** Study of different types of scales (through permanent slides/ photographs). Study of air breathing organs in *Channa*, *Heteropneustes*, *Anabas* and *Clarias*	12	2
3.	**Water quality analysis** Water quality criteria for Aquaculture: Assessment of pH, conductivity, Total solids, Total dissolved solids	12	3
4.	**Crafts and gears of fisheries and Study of parental care** Study of crafts and gears used in Fisheries Demonstration of parental care in fishes (video)	12	4
5.	**Study on a fish farm/ pisciculture unit/Zebrafish rearing Lab.** Project Report on a visit to any fish farm/ pisciculture unit/Zebrafish rearing Lab.	12	5

Learning Resources	
Text Books	C.B.L. Srivastava, Fish Biology, Narendra Publishing House
Ref. Books	S.S. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**25%**	**20%**	**20%**	**25%**
2	Understand	**25%**	**20%**	**20%**	**25%**
3	Apply	**25%**	**20%**	**20%**	**25%**
4	Analyze	**25%**	**20%**	**20%**	**25%**
5	Evaluate		**20%**	**20%**	
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1858	Course Name	Wildlife conservation and Management- Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			ZOL1854	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Identify major flora, and fauna.	**3**										**H**	**H**
CLO-2	Demonstrate the use of basic equipment needed in wildlife studies	**3**				**H**							**H**
CLO-3	Identify animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc.	**4**		**H**					**M**		**H**	**H**	**H**
CLO-4	Demonstrate of different field techniques for analysis of flora.	**4**		**H**		**H**	**M**		**H**		**H**		**H**
CLO-5	Implement Trail / transect monitoring for abundance and diversity estimation.	**5**		**H**		**H**		**M**	**H**		**H**		**H**
				H		**H**	**M**	**M**	**H**		**H**	**H**	**H**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Identification of major flora and fauna** Identification of flora, mammalian fauna, avian fauna, herpeto-fauna	12	1
2.	**Equipment used in wildlife studies** Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses)	12	2
3.	**Animal identification** Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc. Demonstration of different field techniques for flora and fauna	12	3
4.	**Field techniques for analysis of flora.** PCQ, Ten tree method, Circular, Square & rectangular plots, Parker's 2 Step and other methods for ground cover assessment, Tree canopy cover assessment, Shrub cover assessment.	12	4
5.	**Trail / transect monitoring** Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences)	12	5

Learning Resources	
Text Books	1. Balakrishnan M. (2016) Wildlife Ecology and Conservation. Scientific Publishers 2. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). *Problem-Solving in Conservation* 3. *Biology and Wildlife Management: Exercises for Class, Field, and Laboratory*. Blackwell Publishing.
Ref. Books	1. Caughley, G., and Sinclair, A.R.E. (1994). *Wildlife Ecology and Management*. Blackwell Science. 2. Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**20%**	**20%**	**20%**	**25%**
2	Understand	**20%**	**20%**	**20%**	**25%**
3	Apply	**20%**	**20%**	**20%**	**25%**
4	Analyze	**20%**	**20%**	**20%**	**25%**
5	Evaluate	**20%**	**20%**	**20%**	
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

SEMESTER VI

Course Code	ZOL1861	Course Name	Developmental Biology	Course Category	C	CORE	L	T	P	C
							4	0	0	4
Pre Requisite			Nil	Co-requisite		ZOL1865				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Define the basics of developmental biology.	**1**	**H**									**H**	
CLO-2	Describe the process of early embryo development.	**2**	**H**										
CLO-3	Express the detailed late embryonic development.	**3**	**H**										
CLO-4	Evaluate the post embryonic development process, metamorphosis and regeneration.	**4**	**H**										
CLO-5	Analyse the ill effect of teratogens and implementation of modern techniques in developmental	**4**	**H**	**H**	**H**		**M**	**M**	**H**				**H**

	biology.												
			H	**H**	**H**		**M**	**M**	**H**			**H**	**H**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I : Introduction** Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division	12	1
2.	**UNIT II : Early Embryonic Development** Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizers	12	2
3.	**UNIT III : Late Embryonic Development** Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)	12	3
4.	**UNIT IV: Post Embryonic Development** Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and Theories	12	4
5.	**UNIT V: Implications of Developmental Biology** Teratogenesis: Teratogenic agents and their effects on embryonic development; *In vitro* fertilization, Stem cell (ESC), Amniocentesis	12	5

Learning Resources	
Text Books	Verma P.S., Agarwal V.K. (2010) C hordate Embryology Paperback .S.Chand. Das N.Fundamental Concepts of Developmental Biology Affiliated East-West Press Pvt. Ltd.-New Delhi
Ref. Books	Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press Carlson, R. F. Patten's Foundations of Embryology Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers

	Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press

Bloom's Level of Thinking		Internal Assessment for theory papers (40 % weightage)			Final Examination for theory papers (60 % weightage)
		Cycle test (10)	Assignment (10)	Model Test (20)	End Semester Theory Exam (60)
1	Remember	**50%**	**5%**	**25%**	**25%**
2	Understand	**50%**	**20%**	**25%**	**25%**
3	Apply		**50%**	**25%**	**25%**
4	Analyze		**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1862	Course Name	Evolutionary Biology	Course Category	C	CORE	L	T	P	C
							4	0	0	4
Pre Requisite			Nil	Co-requisite		ZOL1866				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Define the concept and theories of origin of life and evolution.	**1**	**H**									**H**	
CLO-2	Describe the different evolutionary forces acting on populations and natural selection.	**2**	**H**									**H**	
CLO-3	Express ideas of speciation and extinction.	**3**	**H**		**M**				**H**			**H**	**H**
CLO-4	Analyze the origin and evolution of human	**4**	**H**									**M**	
CLO-5	Construct phylogenetic trees of evolutionary relationshipusing bio-informatics	**5**	**M**	**H**		**H**							
			H	**H**	**M**	**H**			**H**			**H**	**H**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I :Introduction, Lamarckism, Darwinism, Neo-Darwinism, Evidences of Evolution** Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse, Molecular (universality of genetic code and protein synthesising machinery, three domains of life, neutral theory of molecular evolution, molecular clock example of globin gene family, rRNA/cyt c Sources of variations: Heritable variations and their role in evolution	12	1
2.	**UNIT II :Hardy-Weinberg Law, selection, Genetic Drift, Migration and Mutation** Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population);Evolutionary forces upsetting H-W equilibrium. Natural selection (concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, densitydependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies	12	2
3.	**UNIT III :Product of evolution,Extinctions** Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation macroevolution (exemplified by Galapagos finches Back ground and mass extinctions (causes and effects), detailed example of K-T extinction	12	3
4.	**UNIT IV :Origin and evolution of man,** Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from *Dryopithecus*leading to *Homo sapiens*, molecular analysis of human origin	12	4
5.	**UNIT V Phylogenetic trees** Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees, interpretation of trees	12	5

Learning Resources	
Text Books	1. RastogiVB (2017) Organic EvolutionMedtech 2. Rajeev Tyagi (2011) Understanding Evolutionary BiologyPublished by Discovery Publishing House Pvt. Ltd.
Ref. Books	1. Ridley,M (2004) Evolution III Edition Blackwell publishing 2. Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers. 3. Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings. 4. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**20%**	**20%**
2	Understand	**50%**	**20%**	**20%**	**20%**
3	Apply		**50%**	**20%**	**20%**
4	Analyze		**25%**	**20%**	**20%**
5	Evaluate			**20%**	**20%**
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1863	Course Name	Immunology	Course Category	DSE	Discipline Specific Elective	L	T	P	C
							4	0	0	4
Pre Requisite			Nil	Co-requisite		ZOL1867				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Describe the basics of immune system.	**1**	**H**									**H**	
CLO-2	Explain innate and adaptive immunity	**2**	**H**			**H**						**H**	
CLO-3	Compare Antigens and immunoglobulins.	**3**	**H**	**H**		**H**		**M**					
CLO-4	Analyze the functioning of major histocompatibility complex, cytokines and complement system	**4**	**H**	**H**		**H**		**M**				**M**	
CLO-5	Evaluate the role of hypersensitivity and vaccines in health.	**5**	**M**	**H**	**H**		**H**	**H**	**H**		**H**		
			H	**H**	**H**	**H**	**H**	**H**	**H**		**H**	**H**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I : Overview of Immune System** Historical perspective of Immunology, Early theories of Immunology, Cells and organs of the Immune system	12	1
2.	**UNIT II : Innate and Adaptive Immunity** Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral), Passive: Artificial and natural Immunity, Active: Artificial and natural Immunity, Immune dysfunctions (brief account of autoimmunity with reference to Rheumatoid Arthritis and tolerance, AIDS).	12	2
3.	**UNIT III : Antigens and Immunoglobulins** Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA and RIA), Polyclonal sera, Hybridoma technology: Monoclonal antibodies in therapeutics and diagnosis	12	3
4.	**UNIT IV: Major Histocompatibility Complex, Cytokines and Complement System** Structure and functions of MHC molecules. Endogenous and exogenous pathways of antigen processing and presentation Properties and functions of cytokines, Therapeutics Cytokines Components and pathways of complement activation.	12	4
5.	**UNIT V: Hypersensitivity and Vaccines** Gell and Coombs' classification and brief description of various types of hypersensitivities Various types of vaccines.	12	5

Learning Resources	
Text Books	1. Chakravarty AK Immunology and Immunotechnology oxford publisher 2. Ramesh. (2016) Immunology Mcgraw Higher Ed
Ref. Books	1. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). *Immunology*, VIEdition. W.H. Freeman and Company. 2. Abbas, K. Abul and Lechtman H. Andrew (2003.) *Cellular and MolecularImmunology.* VEdition. Saunders Publication.

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**20%**	**20%**
2	Understand	**50%**	**20%**	**20%**	**20%**
3	Apply		**50%**	**20%**	**20%**
4	Analyze		**25%**	**20%**	**20%**
5	Evaluate			**20%**	**20%**
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1864	Course Name	Parasitology	Course Category	DSE	Discipline Specific Elective	L	T	P	C
							4	0	0	4
Pre Requisite			Nil	Co-requisite		ZOL1868				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Define the basics of parasitology, and host parasite relation.	**1**	**H**	**H**								**H**	
CLO-2	Describe the biology of parasitic protozoa	**2**	**H**	**H**		**M**							
CLO-3	Express the life cycle, pathogenicity and control of parasitic platyhelminthes and nematodes.	**3**	**H**	**H**	**H**								
CLO-4	Demonstrate the biology and implement the control measures of Parasitic Arthropods	**3**	**H**	**H**	**H**								
CLO-5	Analyze the biology of vertebrate parasites with examples.	**4**	**H**	**H**									
			H	**H**	**H**	**M**						**H**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**UNIT I : Introduction to Parasitology** Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector) Host parasite relationship	12	1
2.	**UNIT II : Parasitic Protists** Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Entamoebahistolytica, Giardia intestinalis, Trypanosomagambiense, Leishmaniadonovani, Plasmodium vivax*	12	2
3.	**UNIT III : Parasitic Platyhelminthes and Nematodes** Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Fasciolopsisbuski, Schistosomahaematobium,Taeniasolium*and *Hymenolepis nana* Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascarislumbricoides*, *Ancylostomaduodenale*, *Wuchereriabancrofti*and *Trichinellaspiralis.* Study of structure, life cycle and importance of *Meloidogyne*(root knot nematode), *Pratylencus*(lesion nematode)	12	3
4.	**UNIT IV: Parasitic Arthropoda** Biology, importance and control of ticks, mites, *Pediculushumanus*(head and body louse), *Xenopsyllacheopis*and *Cimexlectularius*	12	4
5.	**UNIT V: Parasitic Vertebrates** A brief account of parasitic vertebrates; Cookicutter Shark, Candiru, Hood Mockingbird and Vampire bat	12	5

Learning Resources	
Text Books	1. K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS ***Publishers*** & Distributors (P) Ltd. 2. Arora, D. R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributors 3. Rattan LalIchhpujani and Rajesh Bhatia. Medical Parasitology, III Edition, Jaypee Brothers Medical 4. Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007) *Biology of Disease.* Taylor and Francis Group Publishers (P) Ltd., New Delhi
Ref. Books	1. E.R. Noble and G.A. Noble (1982) Parasitology: The biology of animal parasites. V Edition, Lea &Febiger 2. Meyer, Olsen & Schmidt's Essentials of Parasitology, Murray, D. Dailey, W.C. Brown Publishers 3. Thomas C. Cheng (1986). *General Parasitology*, II Edition, Academic Press Inc

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for theory papers (40 % weightage)**			**Final Examination for theory papers (60 % weightage)**
		Cycle test (10)	**Assignment (10)**	**Model Test (20)**	**End Semester Theory Exam (60)**
1	Remember	**50%**	**5%**	**25%**	**25%**
2	Understand	**50%**	**20%**	**25%**	**25%**
3	Apply		**50%**	**25%**	**25%**
4	Analyze		**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1865	Course Name	Developmental Biology - Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			ZOL1861	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Identify different developmental stage of frog embryo.	3	H	H		H							**H**
CLO-2	Demonstrate the developmental stages of chick embryo.	3	H	H		H							
CLO-3	Distinguish the developmental stages and life cycle of *Drosophila.*	3	H	M		H							
CLO-4	Analyzethe different sections of placenta.	4	H	H		H							
CLO-5	Develop a study on*Drosophila* culture/Chick embryo.	5	M	H	M	H				H			H
			H	H	M	H				H			

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Study of frog embryo** Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)	12	1
2.	**Study of chick embryo** Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)	12	2
3.	**Developmental stages and life cycle of *Drosophila.*** Study of the developmental stages and life cycle of *Drosophila* from stock culture	12	3
4.	**Study of different sections of placenta** Study of different sections of placenta (photomicropgraph/ slides)	12	4
5.	***Drosophila* culture/chick embryo development** Project report on *Drosophila* culture/chick embryo development	12	5

Learning Resources	
Text Books	1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates,. Inc., Publishers, Sunderland, Massachusetts, USA
Ref. Books	Verma P.S., Agarwal V.K. (2010) C hordate Embryology Paperback .S.Chand. 4. Das N. Fundamental Concepts of Developmental Biology Affiliated East-West Press Pvt. Ltd.-New Delhi

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**20%**	**20%**	**20%**	**20%**
2	Understand	**20%**	**20%**	**20%**	**20%**
3	Apply	**20%**	**20%**	**20%**	**20%**
4	Analyze	**20%**	**20%**	**20%**	**20%**
5	Evaluate	**20%**	**20%**	**20%**	**20%**
6	Create				
	Total	**100%**	**100%**	**100%**	**100%**

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1866	Course Name	Evolutionary Biology- Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			ZOL1862	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Demonstrate different types of fossils from models/ pictures.	**3**	**H**	**M**									
CLO-2	Analyze homology and analogy from suitable specimen.	**4**	**H**	**H**								**H**	
CLO-3	Demonstrate natural selection and genetic drift and Hardy-Weinberg Law by Chi square analysis	**4**	**H**	**H**								**H**	
CLO-4	Demonstrate graphical representation of evolutionary data	**4**	**H**	**H**		**H**							
CLO-5	Construct phylogenetic trees and demonstrate through bioinformatics tools.	**5**	**H**	**H**		**H**				**H**			
			H	**H**		**H**				**H**		**H**	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Study of fossils** 1. Study of fossils from models/ pictures	12	1
2.	Study of homology and analogy 2. Study of homology and analogy from suitable specimens	12	2
3.	**Natural selection and genetic drift, Hardy-Weinberg Law by Chi square analysis** 3. Study and verification of Hardy-Weinberg Law by chi square analysis 4. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies	12	3
4.	**Graphical representation and interpretation of evolutionary data** 5. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.	12	4
5.	**Construction of phylogenetic trees** 6. Construction of phylogenetic trees with the help of bioinformatics tools (Clustal X, Phylip, NJ) and its interpretation	12	5

Learning Resources	
Text Books	1. RastogiVB (2017) Organic EvolutionMedtech 2. Rajeev Tyagi (2011) Understanding Evolutionary Biology Published by Discovery Publishing House Pvt. Ltd.
Ref. Books	1. Ridley,M (2004) Evolution III Edition Blackwell publishing 2. Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett3. Publishers. 4. Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings. 6. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**20%**	**20%**	**20%**	**20%**
2	Understand	**20%**	**20%**	**20%**	**20%**
3	Apply	**20%**	**20%**	**20%**	**20%**
4	Analyze	**20%**	**20%**	**20%**	**20%**
5	Evaluate	**20%**	**20%**	**20%**	**20%**
6	Create				
	Total	**100%**	**100%**	**100%**	

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1867	Course Name	Immunology –Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			ZOL1863	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Identify various lymphoid organs	3	H			H							
CLO-2	Demonstrate the histological components of different lymphoid organs	3	H			H							
CLO-3	Analyze various types of blood cells.	4	H	H		H				H		H	
CLO-4	Analyse ABO blood group, cell counting and viability test.	4	H	H		H		H		H	H	H	
CLO-5	Demonstrate immunological analysis techniques and immunoassays.	4	H	H		H		H		H	H	H	
			H	H		H		H		H	H	H	

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Lymphoid organs** Demonstration of lymphoid organs.	12	1
2.	**Histological study** Histological study of spleen, thymus and lymph nodes through slides/ photographs	12	2
3.	**Preparation of stained blood film to study various types of blood cells.** Preparation of stained blood film to study various types of blood cells.	12	3
4.	**ABO blood group determination, cell counting and viability test** ABO blood group determination. Cell counting and viability test from splenocytes of farm bred animals/cell lines.	12	4
5.	**Immunological analysis techniques and immunoassays** Ouchterlony's double immuno-diffusion method. Demonstration of a. ELISA b. Immunoelectrophoresis	12	5

Learning Assessment					
Bloom's Level of Thinking		**Internal Assessment for practical papers (40 % weightage)**			**Final Examination for practical papers (60% weightage)**
		Internal Assessment Practical Exam (40)			**End Semester Practical Exam (60)**
		Experiments (20)	**Lab record notebook (10)**	**Clarity/Viva voce (10)**	
1	Remember	**25%**	**25%**	**25%**	**25%**
2	Understand	**25%**	**25%**	**25%**	**25%**
3	Apply	**25%**	**25%**	**25%**	**25%**
4	Analyze	**25%**	**25%**	**25%**	**25%**
5	Evaluate				
6	Create				
	Total	**100%**	**100%**	**100%**	

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA	Dr. B. C. Basistha Director Science & Technology , Govt. of Sikkim Dr. Kshetrimayum Birla Singh Associate Professor , Dept. of Zoology Sikkim University	Dr. Sudarshna Nandi, Assistant Prof. Department of Zoology

Course Code	ZOL1868	Course Name	Parasitology –Practical	Course Category	SEC	Skill Enhancement Courses	L	T	P	C
							0	0	4	2
Pre Requisite			ZOL1864	Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO1 Disciplinary/ Professional Knowledge	PLO2 Problem Analysis	PLO3 Design and Development of Solutions/ Policies	PLO4 Modern Usage tools	PLO5 Interdisciplinary Development	PLO6 Innovation and Entrepreneurship	PLO7 Ethics	PLO8 Individual or Team Work using effective communication	PLO9 Vocational and Industry Exposure	PLO10 Life-long learning	PLO11 Environment and sustainability
CLO-1	Identify parasites from slides and photographs	**3**	**H**	**H**		**H**						**H**	**M**
CLO-2	Describe the life cycle stages of helminthic parasites	**3**		**H**	**H**								**M**
CLO-3	Analyze plant root and soil parasites.	**4**		**H**		**H**							**M**
CLO-4	Identify exo-parasites.	**4**		**H**									**M**
CLO-5	Dissect and identify parasites collected from fish, poultry and livestock.	**4**		**H**	**H**	**H**			**M**				**H**
			H	**H**	**H**	**H**			**M**				**M**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1.	**Identification of parasites** **1.** Study of life stages of *Entamoebahistolytica, Giardia intestinalis, Trypanosomagambiense, Leishmaniadonovani*and *Plasmodium vivax*through permanent slides/micro photographs	12	1
2.	**Life cycle stages of helminthic parasites** Study of adult and life stages of *Fasciolopsisbuski, Schistosomahaematobium,Taeniasolium*and *Hymenolepis nana* through permanent slides/micro photographs Study of adult and life stages of *Ascarislumbricoides, Ancylostomaduodenale,Wuchereriabancrofti*and *Trichinellaspiralis*through permanent slides/micro photographs	12	2
3.	**Analysis of plant root and soil parasites** Study of plant parasitic root knot nematode, *Meloidogyne*from the soil sample	12	3
4.	**Identification of exo-parasites** Study of *Pediculus humanus*(Head louse and Body louse), *Xenopsylla cheopis* and *Cimex lectularius* through permanent slides/ photographs	12	4
5.	**Collection and identification of parasites from fish, poultry and livestock.** Study of monogenea from the gills of fresh/marine fish [Gills can be procured from fish market as by product of the industry] Study of nematode/cestode parasites from the intestines of Poultry bird [Intestine can be procured from poultry/market as a byproduct] Submission of a brief report on parasitic vertebrates	12	5

Learning Resources	
Text Books	1. K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS *Publishers* & Distributors (P) Ltd. 2. Arora, D. R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributors
Ref. Books	1. Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai, Delhi 2. Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007) *Biology of Disease.* Taylor and Francis Group Publishers (P) Ltd., New Delhi

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