DEPARTMENT OF ANIMAL SCIENCE

Guidelines, Curricula and Syllabi for 5 years Integrated M.Sc., M.Sc. in Animal Science and Ph.D. Programme

KAZI NAZRUL UNIVERSITY
Asansol - 713340

Brief History of the Department:

The development of biological sciences leadsto the upgradation of general life-style of animal and mankind. Technological intervention (based on physics, chemistry and mathematics) on the biological sciences is growing rapidly. This is the need of the time to focus on the holistic approach of life sciences, especially to animal studies for the sustainability of animal as well as human. The environmental factors and physiological response should be monitored very closely for an overall understanding of the subject and society. Since the inception in the year 2016, the mission of the department to provide an in-depth exposure to the students in the emerging field of animal science with an overview of life sciences and subsequently prepare them to be leaders in the field of research and development in academia and industry with a vision of societal sustainability.

Vision of the Department:

Be recognized as a centre of excellence that teaches the biotechnological intervention on animal studies with a holistic approach of Life Sciences. The scientific approach may take the leadership for the sustainability of both animal and mankind. The synchronization of body physiology and environmental stimuli will be focused to understand the individual and societal interaction.

Mission of the Department:

To translate the vision into reality, the Department is committed to

A. Emerge as a centre of excellence in animal science by providing training at both undergraduate and post-graduate level.
B. Create an interdisciplinary approach in teaching.
C. Establish state-of-the-art facility for cutting edge research.
D. Develop the minds of students with logical questions and power to analyse them for becoming skilled human resource.
E. Organize meaningful seminars, workshop for scientific and social awareness.

Programme/ Course Offered:

Name of the Course	Duration	Year from which the Course Started	Total Intake Capacity
5 years Integrated MSc	5 yrs	2016	20
MSc (lateral entry)	2 yrs	2018	20
PhD	5 yrs	2019	As per UGC rules

Curriculum & Syllabus: attached

Faculty:

Professor

Vacant-01

Associate Professor

Dr Asamanja Chattoraj (Head, Specialization: Physiology and Endocrinology)
Vacant-01

Assistant Professor

Dr.Suprabhat Mukherjee (Specialization: Biochemistry & Molecular Biology)
Dr. Sourabh Sulabh (Specialization: Animal Genetics & Breeding)
Dr. Prem Rajak (Specialization: Molecular Biology & Genetics)
Dr. Manas Paramanik (Specialization: Entomology)

Collaborations:

MOU with IASST, Guwahati (An Autonomous R&D National Research Institute) Regarding Research and Teaching.

Research Programmes:

i. Environmental factor and rhythm physiology
ii. Molecular parasitology and therapeutic immunointervention
iii. Animal breeding and genetics
iv. Endocrine physiology
v. Entomology

Research Fellows / Research Scholars / Research Associate / Project Fellows:

Admission procedure is going on.

Seminar / Workshop / Conference / Symposium Organized:

Sl. No	Title	Duration	Sponsored By	Level	Remarks
1	To familiar the course to the school students	1 Day (March 2018)	University	Local	

Contact us:

Department of Animal Science, Kazi Nazrul University, Nazrul Road, Kalla Bypass P.O.-Kalla , Asansol-713340, Dist.- Paschim Burdwan, West Bengal

a) Name of H.O.D: Dr Asamanja Chattoraj
b) Contact Number of H.O.D: 09436280230
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Photo Gallery:

KAZI NAZRUL UNIVERSITY

Integrated B.Sc + M.Sc Animal Science (W.E.F. 2019-2020)

Course of Study Code	Discipline Code	Discipline	Semester	Course Name	Course Type	Course Code	Course Details	L - T - P	Course Credit	Semister Credit	Internal Marks		End Sem Marks		Total Marks	Sem Marks
											Practical	Theoretical	Practical	Theoretical		
BSCH	IBSMSAS	Integrated B.Sc. + M.Sc. In Animal Science	I	Invertebrate Diversity	C	IBSMSASC101	CC- 1	4 - 0 - 4	6	22	30	10	20	40	100	350
				Ecology	C	IBSMSASC102	CC- 2	4 - 0 - 4	6		30	10	20	40	100	
				Generic Electives offered by other than Animal Science Department	GE	See Pool	GE-1	4 - 0 - 4	6		30	10	20	40	100	
				Environment Studies	AE	AECE101	AEC (Elective)-1	4 - 0 - 0	4			10		40	50	
			II	Vertebrate Diversity	C	IBSMSASC201	CC- 3	4 - 0 - 4	6	20	30	10	20	40	100	350
				Biology of Cell	C	IBSMSASC202	CC- 4	4 - 0 - 4	6		30	10	20	40	100	
				Generic Electives offered by other than Animal Science Department	GE	See Pool	GE-2	4 - 0 - 4	6		30	10	20	40	100	
				English/ MIL	AE	AECE201	AEC (Elective)-2	2 - 0 - 0	2			10		40	50	
			III	Live Stock Production and Management	C	IBSMSASC301	CC-5	4 - 0 - 4	6	28	30	10	20	40	100	450
				Animal Physiology and Comparative Anatomy	C	IBSMSASC302	CC-6	4 - 0 - 4	6		30	10	20	40	100	
				Animal Biochemistry	C	IBSMSASC303	CC-7	4 - 0 - 4	6		30	10	20	40	100	
				Generic Electives offered by other than Animal Science Department	GE	See Pool	GE-3	4 - 0 - 4	6		30	10	20	40	100	
				Economic Importance of Animals	SE (Any One)	IBSMSASSEC301	SEC-1	4 - 0 -0	4			10		40	50	
				Basics of Animal Breeding		IBSMSASSEC302		4 - 0 -0								
			IV	Animal Food and Animal Nutrition	C	IBSMSASC401	CC-8	4 - 0 - 4	6	28	30	10	20	40	100	450
				Animal Genetics	C	IBSMSASC402	CC-9	4 - 0 - 4	6		30	10	20	40	100	
				Microbiology and Immunology	C	IBSMSASC403	CC-10	4 - 0 - 4	6		30	10	20	40	100	
				Generic Electives offered by other than Animal Science Department	GE	See Pool	GE-4	4 - 0 - 4	6		30	10	20	40	100	
				Diagnostic Biochemistry	SE (Any One)	IBSMSASSEC401	SEC-2	4 - 0 -0	4			10		40	50	
				Laboratory Animal Management		IBSMSASSEC402		4 - 0 -0								
			V	Developmental Biology of Animals	C	IBSMSASC501	CC-11	4 - 0 - 4	6	24	30	10	20	40	100	400
				Basics of Bioinformatics and Biostatistics	C	IBSMSASC502	CC-12	5 - 1 - 0	6		30	10	20	40	100	
				Biology of Insecta	DSE	IBSMSASDSE501	DSE-1	4 - 0 - 4	6		30	10	20	40	100	
				Ethology and Chronobiology	DSE	IBSMSASDSE502	DSE-2	4 - 0 - 4	6		30	10	20	40	100	
			VI	Adaptation and Evolution of Animals	C	IBSMSASC601	CC-13	4 - 0 - 4	6	24	30	10	20	40	100	400
				Basics of Animal Biotechnology	C	IBSMSASC602	CC-14	4 - 0 - 4	6		30	10	20	40	100	
				Animal Parasitology	DSE	IBSMSASDSE601	DSE-3	4 - 0 - 4	6		30	10	20	40	100	
				Aquatic Biology	DSE	IBSMSASDSE602	DSE- 4	4 - 0 - 4	6		30	10	20	40	100	
			VII	Animal Bioresources	C	IBSMSASC701	CC-15	4- 0 - 0	4	22		10		40	50	300
				Advanced Cellular and Molecular Biology	C	IBSMSASC702	CC-16	4- 0 - 0	4			10		40	50	
				Biochemistry and Immunology	C	IBSMSASC703	CC-17	4- 0 - 0	4			10		40	50	
				Advanced Ecology and Conservation Biology	C	IBSMSASC704	CC-18	4- 0 - 0	4			10		40	50	
				Practical I (Based on IBSMSASC701 & IBSMSASC702)	C	IBSMSASC705	CC-19	0 - 0 -8	4		30		20		50	
				Practical II (Based on IBSMSASC703 & IBSMSASC704)	C	IBSMSASC706	CC-20	0- 0 -8	4		30		20		50	
			VIII	Advanced Animal Physiology and Hisotechnology	C	IBSMSASC801	CC-21	4- 0 - 0	4	26		10		40	50	350
				Inheritance Biology and Developmental Biology	C	IBSMSASC802	CC-22	4- 0 - 0	4			10		40	50	
				Parasitology and Microbiology	C	IBSMSASC803	CC-23	4- 0 - 0	4			10		40	50	
				Livestock Management and Animal Breeding	C	IBSMSASC804	CC-24	4- 0 - 0	4			10		40	50	
				Practical III (Based on IBSMSASC801 & IBSMSASC802)	C	IBSMSASC805	CC-25	0 - 0 -8	4		30		20		50	
				Practical IV (Based on IBSMSASC803 & IBSMSASC804)	C	IBSMSASC806	CC-26	0 - 0 -8	4		30		20		50	
				Environmental Health	MIE	IBSMSASMIE801	MIE-1	4 - 0 -0	4			10		40	50	

KAZI NAZRUL UNIVERSITY

Integrated B.Sc + M.Sc Animal Science (W.E.F. 2019-2020)

Course of Study Code	Discipline Code	Discipline	Semester	Course Name	Course Type	Course Code	Course Details	L - T - P	Course Credit	Semister Credit	Internal Marks		End Sem Marks		Total Marks	Sem Marks
											Practical	Theoretical	Practical	Theoretical		
M.Sc.			IX	Animal Biotechnology and Biophysics	C	IBSMSASC901	CC-27	4- 0 - 0	4	22		10		40	50	300
				Animal Health and Pathology	C	IBSMSASC902	CC-28	4- 0 - 0	4			10		40	50	
				Entomology and Ichthyology	C	IBSMSASC903	CC-29	4- 0 - 0	4			10		40	50	
				Bioinformatics, Biostatistics and Bioethics	C	IBSMSASC904	CC-30	4- 0 - 0	4			10		40	50	
				Practical V (Based on IBSMSASC901 & IBSMSASC902)	C	IBSMSASC905	CC-31	0 - 0 -8	4		30		20		50	
				Practical VI (Based on IBSMSASC903 & IBSMSASC904)	C	IBSMSASC906	CC-32	0 - 0 -8	4		30		20		50	
			X	Environmental Factors and Rhythm Physiology I	MJE (Any One)	IBSMSASMJE1001	MJE-1	4- 0 - 0	4	20		10		40	50	250
				Molecular Parasitology and Immunology I		IBSMSASMJE1002		4- 0 - 0								
				Animal Breeding and Laboratory Animals I		IBSMSASMJE1003		4- 0 - 0								
				Cell and Molecular Biology I		IBSMSASMJE1004		4- 0 - 0								
				Entomology I		IBSMSASMJE1005		4- 0 - 0								
				Environmental Factors and Rhythm Physiology II	MJE (Any One)	IBSMSASMJE1006	MJE-2	4- 0 - 0	4			10		40	50	
				Molecular Parasitology and Immunology II		IBSMSASMJE1007		4- 0 - 0								
				Animal Breeding and Laboratory Animals II		IBSMSASMJE1008		4- 0 - 0								
				Cell and Molecular Biology II		IBSMSASMJE1009		4- 0 - 0								
				Entomology II		IBSMSASMJE1010		4- 0 - 0								
				Environmental Factors and Rhythm Physiology III Practical	MJE (Any One)	IBSMSASMJE1011	MJE-3	0 - 0 -8	4		30		20		50	
				Molecular Parasitology and Immunology III Practical		IBSMSASMJE1012		0 - 0 -8								
				Animal Breeding and Laboratory Animals III Practical		IBSMSASMJE1013		0- 0 -8								
				Cell and Molecular Biology III Practical		IBSMSASMJE1014		0- 0 -8								
				Entomology III Practical		IBSMSASMJE1015		0 - 0 -8								
				Project Work / Term Paper related to MJE	C	IBSMSASC1001	CC-33	0 - 0 -8	4			40		60	100	
								Total Credits =		**238**		**Total Marks =**				**3600**

Students of an Honours department may choose one Generic Elective Paper each semester from the pool offered by Different Dept.

POOL OF GENERIC ELECTIVE COURSES

INTEGRATED B.SC. + M.SC. Course
IN ANIMAL SCIENCE
(WITH EFFECT FROM 2019-20)
[CHOICE BASED CREDIT SYSTEM]

DEPARTMENT OF ANIMAL SCIENCE
KAZI NAZRUL UNIVERSITY
ASANSOL - 713340
WEST BENGAL, INDIA

Summary of the course and credits

B.Sc.

	Core Course (C)		Discipline Specific Elective (DSE)		Skill Enhancement Course (SEC)	Generic Elective (GE) *Interdisciplinary*		Ability Enhancement Compulsory Courses (AECE)	Total credits
	Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Theory**	**Practical**		
Semester - I	8	4	-	-	-	4	2	4	22
Semester - II	8	4	-	-	-	4	2	2	20
Semester - III	12	6	-	-	4	4	2	-	28
Semester - IV	12	6	-	-	4	4	2	-	28
Semester - V	8	4	8	4	-	-	-	-	24
Semester - VI	8	4	8	4	-	-	-	-	24
Total	**56**	**28**	**16**	**8**	**8**	**16**	**8**	**6**	**146**

M.Sc.

	Core Course (C)		Major Elective Course (MJE)		Minor Elective Course (MIE)	Project / Term Paper / Dissertation	Total credits
	Theory	**Practical**	**Theory**	**Practical**			
Semester - I	16	6	-	-	-	-	22
Semester - II	16	6	-	-	4	-	26
Semester - III	16	6	-	-	-	-	22
Semester - IV	-	-	8	6	-	6	20
Total	**48**	**18**	**8**	**6**	**4**	**6**	**90**

Core Courses: Course that should compulsorily be studied by a candidate as a core requirement.

Discipline Specific Elective Course: Course offered by the main discipline/ subject of study, which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope and which may be chosen from a pool of courses.

Skill Enhancement Course: Value-based and/ or skill-based course, aimed at providing hand-on training, competency, skill etc.

Generic Elective Course (Interdisciplinary Course): Course chosen generally from an unrelated discipline/ subject of study with an intention to seek an exposure to other subjects.

Ability Enhancement Compulsory Courses: Courses based on the contents that lead to knowledge enhancement and consist of (i) Environmental Studies & (ii) English/ MIL Communication.

Major Elective Courses (Specialization): Students will opt one out of the Major Electives offered by the department in PG level.

Minor Elective Courses (Interdisciplinary Course): M.Sc. Zoology students will opt one Minor Elective course of 4 credits in the Semester II offered by other PG Departments

Project Work/ Term Paper/ Dissertation: Involves application of knowledge in solving / analyzing /exploring a real life situation / problem.

B.Sc. Course Details

Semester	Course Code	Course Name	Objectives	Outcomes
I	IBSMSASC 101	Invertebrate Diversity	To acquire distinct idea about invertebrate animal diversity	To get familiar with the invertebrate world
	IBSMSASC 102	Ecology	To get familiar with relationships between biotic and abiotic factors	To be able to deal with evolving ecological hazards
	GE1	*Chemistry - 1*	Make familiar with the requirement of the knowledge	Better Understanding of the subject
	AECE101	Environment Studies	To get familiar with different environmental aspects	To be able to deal with evolving environmental crisis
II	IBSMSASC 201	Vertebrate Diversity	To acquire distinct idea about vertebrate animal diversity	To get familiar with the vertebrate world
	IBSMSASC 202	Biology of Cell	To understand the molecular mechanism underlying biological phenomenon of cell	Understand the utility of cellular interactions in biological phenomenon
	GE2	*Chemistry - 2*	Make familiar with the requirement of the knowledge	Better Understanding of the subject
	AECE201	English/MIL	Knowledge of English for present study	Better Understanding of the subject
III	IBSMSASC 301	Livestock Management	To get acquainted with the techniques of management and economics of domestic animals	Entrepreneurship development related with Animal Husbandry
	IBSMSASC 302	Animal Physiology and Comparative Anatomy	To have basic understandings of the principles of animal systems	Understand the working of animal systems and applications in development of molecular tools
	IBSMSASC 303	Animal Biochemistry	To understand the complexity, structural organization and function of cellular biomolecules	Enrich the fundamental knowledge on cellular and molecular chemistry of living system
	GE3	*Botany - 1 (Plant Physiology)*		
	IBSMSASSEC301	Economic Importance of Animals	To understand the relevance of animals for betterment of human community. Use of breeding strategies for development of animal stocks with required production.	To imbibe the understanding of importance and development of animals for the benefit of human.
	IBSMSASSEC302	Basics of Animal Breeding		
IV	IBSMSASC 401	Animal Food and Nutrition	To get acquainted with the basics of animal nutrition and feeding of domestic animals	Entrepreneurship development related with Animal Husbandry
	IBSMSASC 402	Animal Genetics	To study about the mechanism of Heredity	To have clear concepts about genetic basis of traits
	IBSMSASC 403	Microbiology and Immunology	To explore the basis of microbial community and to do systematic study on Animal Immune System	Understand the relationship between disease and immune system
	GE4	*Botany - 2 (Plant Biochemistry)*		
	IBSMSASSEC401	Diagnostic Biochemistry	Teachings related to the use of biochemistry for diagnosis of human and animal health problems. Proper and ethical handling of laboratory animals for improvement of research facilities.	To assimilate the understanding of biochemical diagnostic methods or management of laboratory animals.
	IBSMSASSEC402	Laboratory Animal Management		
V	IBSMSASC 501	Developmental Biology of Animals	To acquire knowledge about pre and post embryonic development	Application in developing animal based commercial sectors
	IBSMSASC 502	Basics of Bioinformatics and Biostatistics	To impart understanding of computer-based approaches to solve biological problems	Implementation of information in analysis of biological data
	IBSMSASDSE501	Biology of Insecta	To know the insect world	Application of insect products for animal or human welfare
	IBSMSASDSE502	Ethology and Chronobiology	Study animal behavioural pattern according to change of environment	Application of animal behaviour for benefits of animals as well as humans

VI	IBSMSASC 601	Adaptation and Evolution of Animals	To have knowledge on origin of life and adaptation to the changing environment	To predict future evolution in relation to the past evolutions
	IBSMSASC 602	Basics of Animal Biotechnology	To acquire basic understandings of tools and technique of biotechnology	To apply knowledge of biotechnology in development of animal production and welfare
	IBSMSASD SE601	Animal Parasitology	Enhance the knowledge on animal parasites and their pathological outcomes	Identification, management and control of parasitic diseases
	IBSMSASD SE602	Aquatic Biology	Implementation of clear understanding of aquaculture development	Development of basic concepts of farm based and marine based fisheries

M.Sc. Course Details

Semester	Course Code	Course Name	Objectives	Outcomes
VII	IBSMSASC701	Animal Bioresources	Understanding of diversity and resources of animals	Use of diversity and resources for welfare of humans and animals
	IBSMSASC702	Advanced Cellular and Molecular Biology	To understand the molecular mechanism underlying cellular and biological phenomenon	Understand the utility of molecular and cellular interactions in biological phenomenon
	IBSMSASC703	Biochemistry and Immunology	To develop the knowledge of chemical process and immune system in living organisms	To use the understanding in development of drug candidate, diagnostic tools and vaccine
	IBSMSASC704	Advanced Ecology and Conservation Biology	To study the relationship between biotic and abiotic components and conservation of environment	Application of ecological understanding for conservation of environment
	IBSMSASC705	Practical	Acquire the knowledge of practical	Implement the knowledge of practical
VIII	IBSMSASC801	Advanced Animal Physiology and Histotechnology	To have advanced understandings of the principles of animal systems and study of histological tools	Use of the advances in animal physiology and histological techniques for evolving better research concepts
	IBSMSASC802	Inheritance Biology and Developmental Biology	To acquire knowledge about the development of pre and post embryonic stages	Application in developing solutions for embryological development-based complexities
	IBSMSASC803	Parasitology and Microbiology	To implement the understanding of parasitic infestations, microbiological community and diseases	To use the knowledge to formulate strategies for epidemiological studies and preventive measures
	IBSMSASC804	Livestock Management and Animal Breeding	Imparting the knowledge of management of animals and improvement of stocks of animals	Using the knowledge to understand the importance of animal production and economics
	IBSMSASC805	Practical	Acquire the knowledge of practical	Implement the knowledge of practical
	IBSMSASMIE801	Environmental Health	To understand the implications of changing environment on animal and human health	To formulate strategies to revert the effects of environmental changes
IX	IBSMSASC901	Animal Biotechnology and Biophysics	To acquire basic understandings biotechnology methods and to acquire basic knowledge of tools and technique of biophysics	To apply knowledge of biotechnological tools in development of animal production and welfare.
	IBSMSASC902	Animal Health and Pathology	To understand the importance of animal health and its deviation from normal leading to pathological outcomes	To use the understanding in development of strategies for enhancing animal and human health

	IBSMSASC903	Entomology and Ichthyology	To know about the insect and fish world	Application of insect and fish products for animal or human welfare
	IBSMSASC904	Bioinformatics, Biostatistics and Bioethics	To implement the understanding of software-based tools in bioinformatics and biostatistics and to understand basics of bioethics	To use the tools for research studies and humane treatment of animals
	IBSMSASC905	Practical	Acquire the knowledge of practical	Implement the knowledge of practical
X	IBSMSASMJE1001	Environmental Factors and Rhythm Physiology I	Theoretical and practical understanding in detail of the specialized topic	Detailing of the subject
	IBSMSASMJE1002	Molecular Parasitology and Immunology I		
	IBSMSASMJE1003	Animal Breeding and Laboratory Animals I		
	IBSMSASMJE1004	Cell and Molecular Biology I		
	IBSMSASMJE1005	Entomology I		
	IBSMSASMJE1006	Environmental Factors and Rhythm Physiology II	Theoretical and practical understanding in detail of the specialized topic	Detailing of the subject
	IBSMSASMJE1007	Molecular Parasitology and Immunology II		
	IBSMSASMJE1008	Animal Breeding and Laboratory Animals II		
	IBSMSASMJE1009	Cell and Molecular Biology II		
	IBSMSASMJE1010	Entomology II		
	IBSMSASMJE1011	Environmental Factors and Rhythm Physiology III Practical	Theoretical and practical understanding in detail of the specialized topic	Detailing of the subject
	IBSMSASMJE1012	Molecular Parasitology and Immunology III Practical		
	IBSMSASMJE1013	Animal Breeding and Laboratory Animals III Practical		
	IBSMSASMJE1014	Cell and Molecular Biology III Practical		
	IBSMSASMJE1015	Entomology III Practical		
	IBSMSASC1001	Project Work / Term Paper related to MJE	To realize the results of the entire course	Reflect the overall understanding and knowledge acquired during the entire course

INTEGRATED B.SC. + M.SC. PROGRAMME IN ANIMAL SCIENCE

(WITH EFFECT FROM 2019-20)

[CHOICE BASED CREDIT SYSTEM]

DEPARTMENT OF ANIMAL SCIENCE

KAZI NAZRUL UNIVERSITY

ASANSOL - 713340

WEST BENGAL, INDIA

Summary of the courses and credits

B.Sc.

	Core Course (C)		Discipline Specific Elective (DSE)		Skill Enhancement Course (SEC)	Generic Elective (GE) *Interdisciplinary*		Ability Enhancement Compulsory Courses (AECE)	Total credits
	Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Theory**	**Practical**		
Semester - I	8	4	-	-	-	4	2	4	22
Semester - II	8	4	-	-	-	4	2	2	20
Semester - III	12	6	-	-	4	4	2	-	28
Semester - IV	12	6	-	-	4	4	2	-	28
Semester - V	8	4	8	4	-	-	-	-	24
Semester - VI	8	4	8	4	-	-	-	-	24
Total	**56**	**28**	**16**	**8**	**8**	**16**	**8**	**6**	**146**

M.Sc.

	Core Course (C)		Major Elective Course (MJE)		Minor Elective Course (MIE)	Project / Term Paper / Dissertation	Total credits
	Theory	**Practical**	**Theory**	**Practical**			
Semester - I	16	8	-	-	-	-	24
Semester - II	16	8	-	-	4	-	28
Semester - III	16	8	-	-	-	-	24
Semester - IV	-	-	8	4	-	4	16
Total	**48**	**18**	**8**	**6**	**4**	**6**	**92**

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Discipline Specific Elective Course: Course offered by the main discipline/ subject of study, which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope and which may be chosen from a pool of courses.

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Generic Elective Course (Interdisciplinary Course): Course chosen generally from an unrelated discipline/ subject of study with an intention to seek an exposure to other subjects.

Ability Enhancement Compulsory Courses: Courses based on the contents that lead to knowledge enhancement and consist of (i) Environmental Studies & (ii) English/ MIL Communication.

Major Elective Courses (Specialization): Students will opt one out of the Major Electives offered by the department in PG level.

Minor Elective Courses (Interdisciplinary Course): M.Sc. Zoology students will opt one Minor Elective course of 4 credits in the Semester II offered by other PG Departments

Project Work/ Term Paper/ Dissertation: Involves application of knowledge in solving / analyzing /exploring a real life situation / problem.

B.Sc. Course Details

Semester	Course Code	Course Name		Credits (Th + Pr)	Marks
I	IBSMSASC101	Invertebrate Diversity		4+2	100
	IBSMSASC102	Ecology		4+2	100
	GE1	*Chemistry - 1 (Basic, Physical, Inorganic and Organic Chemistry)*		4+2	100
	AECE101	Environmental Studies		4+0	50
II	IBSMSASC201	Vertebrate Diversity		4+2	100
	IBSMSASC202	Biology of Cell		4+2	100
	GE2	*Chemistry - 2 (Supramolecular and Medicinal Chemistry)*		4+2	100
	AECE201	English/MIL		2+0	50
III	IBSMSASC301	Livestock Production and Management		4+2	100
	IBSMSASC302	Animal Physiology and Comparative Anatomy		4+2	100
	IBSMSASC303	Animal Biochemistry		4+2	100
	GE3	*Botany - 1 (Plant Physiology)*		4+2	100
	IBSMSASSEC301	Economic Importance of Animals	**any one**	4+0	50
	IBSMSASSEC302	Basics of Animal Breeding			
IV	IBSMSASC401	Animal Food and Nutrition		4+2	100
	IBSMSASC402	Animal Genetics		4+2	100
	IBSMSASC403	Microbiology and Immunology		4+2	100
	GE4	*Botany - 2 (Plant Biochemistry)*		4+2	100
	IBSMSASSEC401	Diagnostic Biochemistry	**any one**	4+0	50
	IBSMSASSEC402	Laboratory Animal Management			
V	IBSMSASC501	Developmental Biology of Animals		4+2	100
	IBSMSASC502	Basics of Bioinformatics and Biostatistics		4+2	100
	IBSMSASDSE501	Biology of Insecta		4+2	100
	IBSMSASDSE502	Ethology and Chronobiology		4+2	100
VI	IBSMSASC601	Adaptation and Evolution of Animals		4+2	100
	IBSMSASC602	Basics of Animal Biotechnology		4+2	100
	IBSMSASDSE601	Animal Parasitology		4+2	100
	IBSMSASDSE602	Aquatic Biology		4+2	100
		Total =		**146**	**2400**

M.Sc. Course Details

Semester	Course Code	Course Name		Credits (Th + Pr)	Marks
VII	IBSMSASC701	Animal Bioresources		4+0	50
	IBSMSASC702	Advanced Cellular and Molecular Biology		4+0	50
	IBSMSASC703	Biochemistry and Immunology		4+0	50
	IBSMSASC704	Advanced Ecology and Conservation Biology		4+0	50
	IBSMSASC705	Practical 1 (based on IBSMSASC701 & IBSMSASC702)		0+4	50
	IBSMSASC706	Practical 1 (based on IBSMSASC703 & IBSMSASC704)		0+4	50
VIII	IBSMSASC801	Advanced Animal Physiology and Hisotechnology		4+0	50
	IBSMSASC802	Inheritance Biology and Developmental Biology		4+0	50
	IBSMSASC803	Parasitology and Microbiology		4+0	50
	IBSMSASC804	Livestock Management and Animal Breeding		4+0	50
	IBSMSASC805	Practical 1 (based on IBSMSASC801 & IBSMSASC802)		0+4	50
	IBSMSASC806	Practical 1 (based on IBSMSASC803 & IBSMSASC804)		0+4	50
	IBSMSASMIE801	Environmental Health (Minor Elective)		4+0	50
IX	IBSMSASC901	Animal Biotechnology and Biophysics		4+0	50
	IBSMSASC902	Animal Health and Pathology		4+0	50
	IBSMSASC903	Entomology and Ichthyology		4+0	50
	IBSMSASC904	Bioinformatics, Biostatistics and Bioethics		4+0	50
	IBSMSASC905	Practical 1 (based on IBSMSASC901 & IBSMSASC902)		0+4	50
	IBSMSASC906	Practical 1 (based on IBSMSASC903 & IBSMSASC904)		0+4	50
X	IBSMSASMJE1001	Environmental Factors and Rhythm Physiology I	any one	4+0	50
	IBSMSASMJE1002	Molecular Parasitology and Immunology I			
	IBSMSASMJE1003	Animal Breeding and Laboratory Animals I			
	IBSMSASMJE1004	Cell and Molecular Biology I			
	IBSMSASMJE1005	Entomology I			
	IBSMSASMJE1006	Environmental Factors and Rhythm Physiology II	any one	4+0	50
	IBSMSASMJE1007	Molecular Parasitology and Immunology II			
	IBSMSASMJE1008	Animal Breeding and Laboratory Animals II			
	IBSMSASMJE1009	Cell and Molecular Biology II			
	IBSMSASMJE1010	Entomology II			
	IBSMSASMJE1011	Environmental Factors and Rhythm Physiology III Practical	any one	0+4	50
	IBSMSASMJE1012	Molecular Parasitology and Immunology III Practical			
	IBSMSASMJE1013	Animal Breeding and Laboratory Animals III Practical			
	IBSMSASMJE1014	Cell and Molecular Biology III Practical			
	IBSMSASMJE1015	Entomology III Practical			
	IBSMSASC1001	Project Work / Term Paper related to MJE		4+0	100
		Total =		**92**	**1200**

NOTES ON MARKS DISTRIBUTION:

SEMESTER: I - VI

1. In a course (paper) of 100 marks, 50 will be Theory and 50 will be Practical. Courses which are without any Practical, full marks will be 50.
2. In each course, 20% marks in Theory & 60% marks in Practical is allotted for Internal Assessments i.e., in Theory of 50 marks, **10 marks** will be allotted for Internal Assessment & **40 marks** for End Semester Examination and in Practical of 50 marks, **30 marks** will be allotted for Internal Assessment & **20 marks** for End Semester Examination.
3. Marks distribution for each theoretical paper of End Semester Examination will be as follows:

   UNIT I (Total Marks 20)*: Four questions (out of five) of **1** mark each, four questions (out of five) of **2** marks each and one question (out of two) of **8** marks are to be answered*

   UNIT II (Total Marks 20)*: Four questions (out of five) of **1** mark each, four questions (out of five) of **2** marks each and one question (out of two) of **8** marks are to be answered*

SEMESTER: VII - X

1. Each course (paper) is of 50 marks for both Theory and Practical.
2. In each Theory course 20% marks & Practical course 60% marks is allotted for Internal Assessments i.e., in Theory of 50 marks, **10 marks** will be allotted for Internal Assessment & **40 marks** for End Semester Examination and in Practical of 50 marks, **30 marks** will be allotted for Internal Assessment & **20 marks** for End Semester Examination.
3. Marks distribution for each theoretical paper of End Semester Examination will be as follows:

   UNIT I (Total Marks 20)*: Four questions (out of five) of **1** mark each, four questions (out of five) of **2** marks each and one question (out of two) of **8** marks are to be answered*

   UNIT II (Total Marks 20)*: Four questions (out of five) of **1** mark each, four questions (out of five) of **2** marks each and one question (out of two) of **8** marks are to be answered*

IBSMSASC101: Invertebrate Diversity

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Animal classification:** 1. Concept of Classification, Systematics, Taxonomy, Taxonomic hierarchy, Taxonomic types. 2. Codes of Zoological nomenclature, Principal of priority, Synonymy and Homonymy. 3. Five and Six kingdom and Domain concept of classification. 4. Minor phyla.	5
	Protista: 1. General characteristics and classification up to Phylum (Levine et. al., 1980). 2. Basic idea of nutrition and reproduction in Protozoa. 3. Type study: *Paramoecium.*	6
	Porifera: 1. General characteristics and classification up to Classes (Ruppert & Barnes, 1994). 2. Canal system and Spicules in Porifera. 3. Type study: *Sycon.*	5
	Cnidaria and Ctinophora: 1. General characteristics and classification up to Classes (Ruppert & Barnes, 1994). 2. Polymorphism in Cnidaria. 3. Coral and coral reefs - diversity, formation, importance and conservation. 4. Type study: Sea-anemone.	6
	Platyhelminthes: 1. General characteristics and classification up to Classes (Ruppert & Barnes, 1994). 2. Type study: *Fasciola hepatica.*	4
	Nematoda: 1. General characteristics and classification up to Classes (Ruppert & Barnes, 1994). 2. Type study: *Ascaris lumbricoides.*	4
II	**Annelida:** 1. General characteristics and classification up to Classes (Ruppert & Barnes, 1994). 2. Metamerism in Annelida. 3. Type study: *Pheretima.*	5
	Arthropoda and Onychophora: 1. General characteristics and classification up to Classes (Ruppert & Barnes, 1994). 2. General characteristics and Evolutionary significance of Onychophora. 3. Type study: *Macrobrachium.*	5
	Mollusca: 1. General characteristics and classification up to Classes (Ruppert & Barnes, 1994). 2. Torsion and distortion in Gastropoda. 3. Type study: *Pila.*	5
	Echinodermata: 1. General characteristics and classification up to Classes (Ruppert & Barnes, 1994). 2. Larval forms in Echinodermata, their evolutionary significance. 3. Type study: *Asterias.*	5
		50

Suggested Readings:

1) Barnes, R. D. & Ruppert, E. E. (1994). Invertebrate Zoology. 6th Ed. Brooks Cole.
2) Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4th Ed. Sinauer Associates.
3) Chatterjee, A. & Chakraborty, C. (2015). Text Book of Zoology. Nirmala Library
4) Ganguly, B. B., Sinha, K. S. & Adhikari, S. (2012). Biology of Animals. Vol. I. New Central Book Agency.
5) Jordan, E. L. & Verma, P. S. (2006). Invertebrate Zoology. S. Chand & Company Ltd.
6) Kotpal, R.L. (2019). Modern Text Book of Zoology: Invertebrates. 11th Ed. Rastogi Publications.
7) Mayr, E. & Ashlock, P. D. (1991). Principles of Systematic Zoology. 2nd Ed., McGraw-Hill.
8) Parker, T. J. & Haswell, W. (1972). Text Book of Zoology, Volume I: Marshall and Williams (Eds.) 7th Ed. Macmillan.

Practical (2 credits)
1. Identification (Systematic Position and specimen characters): *Amoeba, Euglena, Paramoecium, Sycon, Obelia, Physalia, Aurelia, Gorgonia, Pennatula, Fungia, Adamsia, Fasciola, Ascaris, Aphrodite, Nereis, Pheretima, Hirudo, Limilus, Palamnaeus, Balanus, Palaemon, Hippa, Cancer, Scolopendra, Periplaneta, Patella, Chiton, Pila, Doris, Achatina, Lamellidens, Dentalium, Nautilus, Sepia, Octopus, Antedon, Astropecten, Asterias, Ophiura* 2. Study of Digestive System and Nervous system of Cockroach. 3. Mounting: Mouthparts of Cockroach and Mosquito, Compound eye of Prawn. 4. Visit to any biodiversity reach place to study the Invertebrate diversity and habitats.

End Semester Examination Pattern: Full marks – 20

1) Identification (6 from item no. 1): 12 marks
2) Dissection (1 from item no. 2): 6 marks
3) Mounting (1 from item no. 3): 2 marks
4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.

Suggested Readings:

1) Ghosh, K. C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
2) Lal, S. S. (2016). Practical Zoology - Invertebrate. Rastogi Publication.
3) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.

IBSMSASC102: Ecology

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Introduction to Ecology:** 1. Levels of organization, Laws of limiting factors. 2. Autecology and Synecology. 3. Biosphere and study of physical factors.	4
	Ecosystem: 1. Types of ecosystems with example of marine ecosystem in detail. 2. Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web; Energy flow through the ecosystem. 3. Ecological pyramids and Ecological efficiencies. 4. Nutrient and biogeochemical cycle with example of Nitrogen cycle.	10
	Population Ecology: 1. Attributes of a Population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, dispersal and dispersion. 2. Exponential and logistic growth patterns, equation and Patterns. 3. r and k strategies.	6
	Regulation of population: 1. Density-dependent and density-independent factors. 2. Different interactions in a population. 3. Gause's Principle with laboratory and field examples. 4. Lotka-Volterra equation for competition.	5
II	**Community:** 1. Characteristics of Community: Species diversity, richness, dominance, abundance, vertical stratification. 2. Ecotone and edge effect.	6
	Ecological Succession: 1. Ecological succession, Primary, secondary and Cyclic Succession. 2. Seral community, Theories pertaining to Climax community.	7
	Wildlife & Conservation 1. Wildlife Conservation (ideas of *in-situ* and *ex-situ* conservation with examples). 2. Management strategies for tiger conservation; Protection laws for wildlife conservation.	6
	Wetland conservation 1. Wetland conservation laws and global efforts, Major laws and conventions relating to wetland conservation. 2. Indian conservation strategies and implementations.	6
		50

Suggested Readings:

1) Kormondy, E. J. (2002). Concepts of Ecology. 4th Indian Reprint, Pearson Education.
2) Krebs, C. J. (2001). Ecology. Benjamin Cummings.
3) Krebs, C.J. (2016). Ecology: The Experimental Analysis of Distribution and Abundance. Pearson Edu Ltd.
4) Molles, Jr. M.C. (2005). Ecology: Concepts and Applications. 3rd Ed. McGraw- Hill.
5) Odum, E. P. & Barret, G. W. (2005). Fundamentals of Ecology. 5th Ed. Thompson Brooks/Cole.
6) Ricklefs, R. E. & Miller, G. L. (2000). Ecology. 4th Ed. W. H. Freeman & Company.
7) Russel, P.J., Wolfe, L. S., Hertz, P.E. Starr, C. & McMillan, B. (2008). Ecology.

8) Brooks/Cole. Saharia, V. B. (1998). Wildlife in India. Natraj Publishers.
9) Smith, R. L. & Smith, T. M. (2001). Ecology and Field Biology. Benjamin Cummings. Pearson Education.
10) Smith, T. M & Smith, R. L. (2006). Elements of Ecology. 6th Ed. Pearson Education.
11) Stiling, P. (2009). Ecology- Theories and Applications. 4th Ed. Prentice Hall of India.

Practical (2 credits)

1) Preparation of nested quardrat and estimation of effective quardrat size. Determination of population density in a natural/ hypothetical community by quadrat method and calculation of Sorenson's Similarity & Shannon-Weiner diversity indices for the same community.
2) Study of an aquatic ecosystem: Major Phytoplankton and zooplankton (Up to Genus).
3) Determination of temperature, turbidity/ penetration of light; determination of pH, and Dissolved Oxygen content (Winkler's method) and free CO_2.
4) Estimation of Primary productivity by light & dark bottle method.
5) Field observations/ study at National Park/ Biodiversity Park/ Wild life Sanctuary/ Sea Shore.

End Semester Examination Pattern: Full marks – 20

1) Biochemical test (1 from item no. 3 & 4): 7 marks
2) Determination of population density (1 from item no. 1): 4 marks
3) Identification (2 from item no. 2): 4 marks
4) Field report/ educational tour report: 5 marks
5) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
6) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.

Suggested Readings:

1) Ghosh, K. C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
2) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.

GE1: Chemistry - 1 *(Basic, Physical, Inorganic and Organic Chemistry)*

To be offered by the Department of Chemistry, KNU

AECE101: Environmental Studies

Theory (4 credits)

Unit	Course content	Class
I	**Multidisciplinary nature of environmental studies** i) Definition, Nature, Scope and importance ii) Types andComponents of environment iii) Environmental education. iv) Global environmental crisis.	5
	Natural Resources: Renewable and Non-renewable resources i) Forest resources: Uses types and importance, deforestation and its effects ii) Water resources: Distribution of water on earth, use and overuse iii) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies iv) Food resources: World food production & distribution. Food crisis- its causes v) Energy resources: Renewable and Non-renewable energy sources, Use of alternate energy sources vi) Land resources: Land as a resource, Land degradation, Landslides, Soil erosion vii) Role of an individual in the conservation of natural resources viii) Equitable use of resources for sustainable life style.	10
	Ecology and Ecosystems: i) Concept of ecology, autecology and synecology ii) Concept of an ecosystem: Different types of ecosystem, Biomes iii) Energy flow in the ecosystem, Energy flow models iv) Food chains, food webs and ecological pyramids v) Biogeochemical cycles: Nitrogen and Phosphorus	5

	Bio-diversity and its conservation i) Introduction- Defination: Genetics, species and ecosystem diversity ii) Threats to bio-diversity: Value of bio-diversity, Hot-spots of bio-diversity iii) Conservation of bio-diversity: *In situ* and *Ex situ* conservation of bio-diversity iv) Endangered and endemic species of India	5
II	**Environmental Pollution** i) Air pollution: Definition, Sources, Causes, Effects and Control measures ii) Water pollution: Definition, Sources, Causes, Effects and Control measures iii) Soil pollution: Definition, Sources, Causes, Effects and Control measures iv) Noise pollution: Definition, Sources, Causes, Effects and Control measures v) Fireworks pollution: Definition, Composition/Ingredients, Effects, Monitring strategies vi) Thermal Pollution: Brief concepts vii) Nuclear Pollution: Brief concepts	10
	Social Issues and the Environment i) Water conservation, rain water harvesting ii) Climate change, global warming, acid rain, ozone layer depletion iii) From unsustainable to sustainable development iv) Urban problem related to energy v) Govt. Agencies viz. CPCB, SPCB and their functions vi) Constitutional Provisions for protecting environment-Articles 48(A), 51A (g) vii) The Environment (protection) Act, 1986 viii) Environment protection movements in India: Chipko Movements, Silent Valley Movements in Karnataka	10
	Human Population and the Environment i) Definition, characteristic; Human population growth ii) Population explosion- Family Welfare Programme iii) Environment and human health: Concept of health & disease iv) Human rights, value education, role of Information technology in environment	5
		50

Suggested Readings:

1) Basu, M. and Xavier, S., Fundamentals of Environmental Studies, Cambridge University Press, 2016.
2) Mitra, A. K and Chakraborty, R., Introduction to Environmental Studies, Book Syndicate, 2016.
3) Enger, E. and Smith, B., Environmental Science: A Study of Interrelationships, Publisher: McGraw-Hill Higher Education; 12th edition, 2010.
4) Basu, R.N, Environment, University of Calcutta, 2000.
5) Bharucha, E. Text Book of Environmental Studies (UGC).

IBSMSASC201: Vertebrate Diversity

Theory (4 credits)		
Unit	**Course content**	**Class**
I	1. General characteristics and outline classification of Phylum Chordata (Young, 1981). 2. Origin of Chordates.	3
	Protochordata: 1. Concept of Protochordata (Hemichordata, Urochordata and Cephalochordata). 2. Retrogressive metamorphosis in *Ascidia.* 3. Type study: *Balanoglossus* and *Branchiostoma.*	10
	Pisces: 1. General characteristics and classification of Chondrichthyes and Osteichthyes up to Sub-Classes (Nelson, 2006). 2. Accessory respiratory organ, Migration and Swim bladder in Fishes. 3. Anatomical peculiarity, distribution and evolutionary significance of *Dipnoi.* 4. Type study: *Scoliodon.*	12
	Amphibia: 1. General characteristics and classification up to living Orders (Young, 1981). 2. Metamorphosis and Parental Care in Amphibia. 3. Type study: *Bufo.*	8
II	**Reptilia:** 1. General characteristics and classification up to living Orders (Young, 1981). 2. Poison apparatus, biting mechanism and venom in Snakes. 3. Anatomical peculiarity, distribution and evolutionary significance of *Sphenodon.*	9

	4. Type study: *Calotes.*	
	Aves: 1. General characteristics and classification up to Sub-Classes (Young, 1981). 2. Migration and Flight (principal and aerodynamics) in Birds. 3. Type study: *Columba.*	8
	Mammals: 1. General characteristics and classification up to living Orders (Young, 1981). 2. Affinities of Prototheria. 3. Echolocation in Micro-chiropterans and Cetaceans. 4. Type study: *Cavia.*	10
		60

Suggested Readings:

1) Chatterjee, A. & Chakraborty, C. (2015). Text Book of Zoology. Nirmala Library
2) Jordan, E. L. & Verma, P. S. (2003). Chordate Zoology. S. Chand & Company Ltd.
3) Kotpal, R. L. (2019). Modern Text Book of Zoology: Vertebrates. 4th Ed. Rastogi Publications.
4) Nelson, J. S. (2006): Fishes of the World, 4th Ed. Wiley.
5) Parker, T. J. & Haswell, W. (1972). Text Book of Zoology, Volume II: Marshall and Williams (Eds.) 7th Ed. Macmillan.
6) Romer, A. S. & Parsons, T. S. (1986).The vertebrate body. 6th Ed. Saunders College Pub.
7) Sinha, K. S., Adhikari, S., Ganguly, B. B. & Goswami B. (2012). Biology of Animals. Vol. II. New Central Book Agency.
8) Young, J. Z. (1981). The Life of Vertebrates. 3rd Ed. Oxford University Press.

Practical (2 credits)

1. Identification (Systematic Position and specimen characters): *Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Myxine, Scoliodon, Sphyrna, Pristis, Torpedo, Harpadon, Labeo, Mystus, Anguilla, Exocoetus, Hippocampus, Echeneis, Ichthyophis, Necturus, Salamandra, Axolotl* larva, *Bufo, Rana, Hyla, Alytes*, Tadpole, *Chelone, Tryonyx, Hemidactylus, Chamaeleon, Draco, Bungarus, Vipera, Naja, Hydrophis, Psittacula , Passer, Alcedo, Pteropus, Funambulus, Suncus*.
2. Key for Identification of poisonous and non-poisonous snakes.
3. Study of different types of beaks and claws in birds.
4. Dissection of Digestive System and Brain of Carp.
5. Dissection of Vth & VIIth Cranial Nerve of Fowl.
6. Mounting: Different types of scales in Fish, Pecten from Fowl.
7. Visit to any biodiversity reach place to study the Vertebrate diversity and habitats.

End Semester Examination Pattern: Full marks – 20

1) Identification (4 from item no. 1 and 1 each from item no. 2 & 3): 12 marks
2) Dissection (1 from item no. 4 & 5): 6 marks
3) Mounting (1 from item no. 6): 2 marks
4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.

Suggested Readings:

1) Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
2) Lal, S. S. (2016). Practical Zoology - Vertebrate. Rastogi Publication.
3) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.

IBSMSASC202: Biology of Cell

Theory (4 credits)

Unit	Course content	Class
I	**Overview of Cells** 1. Basic structural architecture of Prokaryotic and Eukaryotic cells. 2. Virus, Viroids, Prions and diseases.	3
	Plasma Membrane 1. Models of plasma membrane structure with special reference to fluid mosaic model. 2. Structure and Significance of common Cell junctions: Tight junctions, Desmosomes, Gap junctions	4
	Cytoplasmic organelles 1. Structure and Functions of Endoplasmic Reticulum, Golgi apparatus and Lysosomes. 2. Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis. 3. Basic structure and function of Peroxisome.	6

	Cytoskeleton 1. Structure and Functions of Microtubules, Microfilaments and Intermediate filaments	4
	Nucleus 1. Structure of Nucleus: Nuclear envelope, Nuclear pore complex. 2. Chromatin: Euchromatin and Hetrochromatin. 3. Chromosome: Chemical and physical structure, Structure and classification of Nucleic acids. 4. Mechanism of DNA replication in prokaryotes, Semi-conservative, bidirectional and semi-discontinuous replication, replication of telomeres.	8
II	**Transport *across membranes*** 1. Concepts of Active and Passive transport, Facilitated transport.	3
	Cell cycle 1. Stages and regulation through checkpoints. **Cell division** 2. Process and significance of mitosis and meiosis. **Spindle apparatus** 3. Assembly of Spindle apparatus and its significance, Motor proteins.	6
	Cell signaling 1. Basic concepts of cell signaling mechanism. 2. Types of signaling molecules and their receptors, GPCR. 3. Role of second messengers with special reference to cAMP.	6
	Mitochondrial function physiology 1. Mitochondrial Respiratory Chain. 2. Chemi-osmotic hypothesis	4
	Central Dogma 1. Mechanism of Transcription and Translation in prokaryotes.	6
		50

Suggested Readings:

1) Albert Bruce, 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.
2) Cooper, G.M. and Hausman, R.E. (2009). The Cell: AMolecularApproach.5thEdition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
3) Hardin, J. Bertoni, G and Klein smith, J. L. (2012). Becker's World of the Cell. 8th Edn, Pearson Benjamin Cummings, San Francisco.
4) Harvey, L. (2004). Molecular Cell Biology. 5th Edn. W.H. Freeman.
5) Karp, G. (2008). Cell and Molecular biology: Concepts and Application. 5th Edn, John Wiley.
6) Pollard and Earnshaw (2007). Cell Biology. 2nd. Edn Saunders.
7) Lodish, Berk, Matsudaira, Kaiser, Bretscher, Ploegh, Amon, and Martin (2016) Molecular Cell Biology. 8th Edn. W.H. Freeman

Practical (2 credits)

1) Preparation of temporary stained squash of Onion root tip to study various stages of mitosis.
2) Study of various stages of meiosis in Grasshopper testis.
3) Preparation of permanent slide to show the presence of Barr body/ drum stick in human female blood cells/ cheek cells.
4) Polytene chromosome preparation from *Drosophila*/ Chironomid larvae.

End Semester Examination Pattern: Full marks – 20

1) Squash preparation and stage identification (1 from item no. 1 & 2): 8 marks
2) Preparation for Barr body/ drum stick: 8 marks
3) Preparation of Polytene Chromosome: 4 marks
4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.

Suggested Readings:

1) Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
2) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.

GE1: Chemistry - 2 *(Supramolecular and Medicinal Chemistry)*

To be offered by the Department of Chemistry, KNU

AECE201: English/ MIL

To be offered by the Department of English, KNU

IBSMSASC301: Livestock Production and Management

Theory (4 credits)		
Unit	**Course content**	**Class**
I	1. Various indigenous breeds of livestock including poultry. 2. Exotic breeds experienced in India, 3. Origin, distribution and breed description of important breeds.	6
	1. Dentition and ageing of animals. 2. Disbudding, marking of animals, Grooming, Dipping, Castration, Isolation, quarantine, Disinfection and disposal of carcasses.	5
	1. Drug administration, Vices of animals, their prevention and care. 2. Opportunities in dairy farming, Dairying under mixed and specialized farming.	4
	1. Management of calves, heifer, pregnant, lactating and dry animals, bulls and bullocks.	4
	1. Housing systems, Layout and design of different buildings for dairy animals. 2. Methods of milking and precautions. 3. Factors affecting quality and quantity of milk. 4. Organic Livestock Production.	6
II	1. Importance of grasslands and fodders in livestock production. 2. Feed and fodder requirements of individual animal.	6
	1. Supply of greens throughout the year. 2. Scarcity fodder, 3. Recycling of animal wastes and washings for fodder production.	6
	1. Sheep and Goat Farming: Homestead farming vs. Commercial farming, Goat as poor man's cow.	6
	1. Economic Importance of commercial poultry farming, 2. Backyard poultry farming. 3. Brooding management. Incubation and hatching, 4. Management of broilers, layers and breeder flock.	7
		50

Suggested Readings:

1)A Textbook Of Animal Husbandry- GC Banerjee.
2) Animal husbandry & veterinary science- TNPalanivelu.
3)Animal Husbandry- Gyan Deep Singh, Anmol Publishers.
4) Livestock productionand management. NSR Sastry and CK Thomas.

Practical (2 credits)
1. Identification of different breeds of cow, buffalo, pigs and poultry. 2. Incubation of Eggs. 3. Routes of administration of drugs. 4. Visit to a farm.
End Semester Examination Pattern: Full marks – 20 1) Identify the breeds (5 from item no. 1): 10 marks 2) Identification (1 from item no. 2): 2 marks 3) Experiment (1 from item number 3): 6 marks 4) Field report: 2 marks 5) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***. 6) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.

Suggested Readings:
1) A Textbook Of Animal Husbandry - GC Banerjee
2) Animal husbandry & veterinary science – TN Palanivelu
3) Animal Husbandry - Gyan Deep Singh, Anmol Publishers
4) Livestock production and management. - NSR Sastry and CK Thomas.

IBSMSASC302: Animal Physiology and Comparative Anatomy

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Tissue:** Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue	4
	Bone and Cartilage: Structure and types of bones and cartilages, Ossification	3
	Nervous System: 1. Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers. 2. Types of synapse, Synaptic transmission and Neuro-muscular junction; 3. Reflex action and its types	5
	Muscular System: 1. Histology of different types of muscle; 2. Ultrastructure of skeletal muscle; 3. Molecular and chemical basis of muscle contraction; Characteristics of muscle fibre	4
	Reproductive System: 1. Histology of testis and ovary 2. Physiology of Reproduction (Estrus and Menstrual cycle)	4
	Endocrine System: 1. Histology and function of pituitary, thyroid, pancreas and adrenal 2. Classification of hormones; 3. Mechanism of Hormone action: Signal transduction pathways for Steroidal and Nonsteroidal hormones 4. Hypothalamus (neuroendocrine gland) – principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system 5. Placental hormones	5
II	**Integumentary System**: Structure, function and derivatives of integument in amphibian, birds and mammals	3
	Skeletal System: Overview of axial and appendicular skeleton; Jaw suspension; Visceral arches.	3
	Digestive System: 1. Comparative anatomy of stomach. 2. Dentition in mammals	3
	Respiratory System: Respiratory organs in fish, amphibian, birds and mammals	3
	Circulatory System: 1. General plan of circulation, 2. Comparative account of heart and aortic arches	4
	Urinogenital System: 1. Succession of kidney, 2. Evolution of urinogenital ducts, 3. Types of mammalian uteri	3
	Nervous System: 1. Comparative account of brain, 2. Cranial nerves in mammals	3
	Sense Organs: 1. Classification of receptors, 2. Brief account of auditory receptors invertebrate	3
		50

Suggested Readings:
1) Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edn. W.B. Saunders Company.
2) Hill, Wyese and Anderson (2012). Animal Physiology. 3rd Edn. SineuerAssociaes
3) Rastogi, S.C. (2007). Essentials of Animal Physiology4th Edn. New Age Pub., N. Delhi
4) Kent, G.C. and Carr R.K. (2000).Comparative Anatomy of the Vertebrates. IX Edition.
5) Saxena, R.K. & Saxena, S.C. (2008): Comparative Anatomy of Vertebrates, Viva Books Pvt. Ltd.

Practical (2 credits)
Animal Physiology: 1. Recording of simple muscle twitch with electrical stimulation (or Virtual) 2. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex) 3. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres 4. Identification of permanent slides of Mammalian Cartilage, Bone, Pituitary, Liver, Kidney, Intestine, Lung, Pancreas, Testis, Ovary, Adrenal, Thyroid 5. Microtomy: Preparation of permanent slide of any five mammalian (Goat/ white rat) tissues. **Comparative Anatomy:** 6. Mounting of cycloid and ctenoid scales 7. Study of disarticulated skeleton of Toad, Pigeon and Guineapig 8. Demonstration of Carapace and plastron of turtle from model/ chart 9. Identification of mammalian skulls: One herbivorous (Guineapig) and one carnivorous animal (Dog) 10. Study and Dissection of Afferent arterial system, brain, pituitary in Carp
End Semester Examination Pattern: Full marks – 20 1) Performance (1 from item no. 1, 2 & 3): 5 marks 2) Identification (3 from item no. 4, 7, 8 & 9): 6 marks 3) Preparation (1 from item no. 5): 4 marks 4) Dissection (1 from item no. 10): 5 marks 5) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***. 6) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.
Suggested Readings: 1) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.

IBSMSASC303: Animal Biochemistry

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Structural Biochemistry:** **Carbohydrate:** 1. Structure, types and biological importance of carbohydrates (mono-, di- and polysacharides); 2. Open chain and ring structures, optical activity, isomerism and epimerism.	5
	Protein: 1. Biochemistry of amino acids and Proteins, hierarchial organization of protein structure; 2. Protein as biocatalyst: Nomenclature and classification of Enzymes; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Mentene quation, Concept of Km and Vmax, Lineweaver-Burkplot; Multi-substrate reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme action.	12
	Lipid: 1. Structure, classification and function of simple, complex and derived lipids. 2. Nomenclature of fatty acids, long chain alcohols, prostaglandin and leukotrienes.	4
	Amino acids: 1. Structure and classification of DNA and RNA; 2. Linking number; Supercoiling; 3. Differences among different types DNA and RNA.	4
II	**Carbohydrate Metabolism:** . Sequence of reactions and regulation of glycolysis, Citric acid cycle, Electron transport chain and Oxidative phosphorylation, Phosphatepentose pathway, . Gluconeogenesis, Glycogenolysis and Glycogenesis.	12
	ProteinMetabolism: 1. Catabolism of amino acids: Transamination, Deamination, Ureacycle; 2. Fate of C-skeleton of glucogenic and Ketogenic amino acids	4
	LipidMetabolism: 1. β-oxidation and omega-oxidation of saturated fatty acids with even and odd number of carbon atoms; 2. Biosynthesis of palmitic acid; Ketogenesis	5
	Nucleic acid Metabolism: Synthesis (de novo & salvage) and degradation nucleotides.	4
		50

Suggested Readings:

1) Lehninger's Principles of Biochemistry by Nelson & Cox; 7th Edition.
2) Biochemistry by Voet & Voet; 3rd Edition
3) Biochemistry by Stryer; 5th Edition
3) Principle of Biochemistry by Horton, Moran, Perry and Rawn, 5th Edition
4) Textbook of Biochemistry by Thomas M. Devlin; 5th Edition

Practical (2 credits)
1. Qualitative and quantitative analyses of glucose (Anthrone/ DNS method), ascorbic acid (DCPIP), total lipid (Sudan III method) and Cholesterol (ZAK's method). 2. Estimation of total protein (Lowry/ Bradford Method). 3. Estimation of DNA (DPA method) and RNA (Orcinol method). 4. Assay of salivary amylase under optimum conditions and determination of the enzyme kinetics.
End Semester Examination Pattern: Full marks – 20 1) Estimation of a biomolecule from item no. 1 and 2 - 8 marks 2) Estimation of nucleic acid from item no. 3 – 6 marks Assay from item no. 4 - 6 Marks 3) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***. 4) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.
Suggested Readings: 1) Practical Biochemistry by David T Plummer, 3rd Edition 2) Biochemical Methods by S. Sadasivan and A. Manikam, 3rd Edition 3) Modern Experimental Biochemistry by Rodney Boyer, 3rd Edition 4) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.

GE3: Plant Physiology

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Water relations**: 1. Diffusion, Osmosis and Imbibition; 2. Water movement through Plants.	7
	Nutrition: 1. Essential and beneficial elements, macro and micronutrients, 2. Methods of study and use of nutrient solutions, 3. Criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.	8
	Photosynthesis: 1. Pigment systems, Light energy trapping reactions, 2. Photosynthetic electron transport; 3. Carbon-Di-Oxide fixation pathways, 4. Factor influencing photosynthesis.	10
II	**Hormones**: 1. Major hormones in Plants-Chemical nature, 2. Biosynthesis and physiological roles	10
	Movement of fluids: 1. Transpiration in plants; Translocation of assimilates in plants. 2. Pressure flow Hypothesis (phloem loading and unloading); Source sink hypothesis.	8
	Important Physiological functions and disturbances in Plants: 1. Flowering, Role of Phytochromes and Cryptochromes, 2. Senescence, dormancy, Drought resistance and Salinity tolerance.	7
		50

Suggested Readings:

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi

Practical (2 credits)
1. Study of the effect of Humidity and light on the rate of transpiration in excised twig/ leaf. 2. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte. 3. Study of the phenomenon of seed dormancy (TTZ). 4. Demonstration on the effect of different concentrations of IAA on Plant (Locally Available) coleoptile elongation (IAA Bioassay). 5. Study of the induction of amylase activity in germinating grains.
End Semester Examination Pattern: Full marks – 20 1) Performance (1 from sl no 1, 2): 7 marks 2) Performance (1 from sl no 3, 4): 7 marks 3) Performance (1 from sl no 5): 6 marks 4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***. 5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.
Suggested Readings: 1) Bendre A. (2009). A text Book of Practical Botany (Vol. 1 & 2). Rastogi Publication. 2) Pandey B.P. (2011). Modern Practical Botany (Vol. 1-3). S. Chand & Co.

IBSMSASSEC301: Economic Importance of Animals

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Sericulture:** 1. Rearing and cocoon production; Rearing trays, Silk varieties in India, Mulberry Silkworm culture. 2. Life cycle of *Bombyx mori*. Structure of silk gland, Chemical nature of silk, diseases and pests and their control in *Bombyx mori.*	8
	Vermicomposting: 1. Principle, participating organisms, process and required physical conditions	5
	Apiculture: 1. Types of Indian Honey bees, Methods of Rearing, Methods of Extraction and Preservation of Honey.	8
	Shell fisheries: 1. Edible oysters farming and nutritional importance of oysters. 2. Chank fisheries. 3. Pearl culture.	4
II	**Pisciculture:** 1. Extensive, semi-intensive and intensive culture of fish. 2. Pen and cage culture; Polyculture. 3. Composite fish culture; Brood stock management. 4. Induced breeding of fish. 5. Freshwater prawn culture (*Macrobrachium rosenbergii*).	10
	Ornamental fish culture and Aquarium management: 1. Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish. 2. Management of aquarium..	6
	Poultry: 1. Major fowl breeds. 2. Deep Litter System of rearing. 3. Common diseases of fowl and their control measures.	5
	Animal Husbandry: 1. Types and distribution of cattle breeds (cow only) in India. 2. Merits and demerits of artificial cattle breeding.	4
		50

Suggested Readings:

1) Ahsan, J. & Sinha, S. P. (2009). A Handbook on Economic Zoology. S. Chand & Company Ltd.
2) Shukla, G. S. & Upadhyay, V. B. (1998). Economic Zoology. 4th Ed. Rastogi Publication.

IBSMSASSEC302: Basics of Animal Breeding

Theory (4 credits)		
Unit	**Course content**	**Class**
I	1. History of Animal Breeding. 2. Classification of breeds.	7
	Economic characters of livestock and poultry and their importance.	4
	Selection, types of selection, response to selection and factors affecting it.	4
	Bases of selection: individual, pedigree, family, sib, progeny and combined, indirect selection.	7
	Method of selection, Single and Multi-trait.	3
II	1. Classification of mating systems. 2. Inbreeding coefficient and coefficient of relationship.	4
	Genetic and phenotypic consequences of inbreeding, inbreeding depression, application of inbreeding.	6
	1. Out breeding and its different forms. 2. Genetic and phenotypic consequences of outbreeding, application of outbreeding, heterosis.	6
	1. Systems of utilization of heterosis; 2. Selection for combining ability (RS and RRS).	4
	Breeding strategies for the improvement of cattle, buffalo, sheep, goat, swine and poultry.	5
		50

Suggested Readings:

1) Falconer DS & Mackay TFC. 1996. An Introduction to Quantitative Genetics. Longman.
2) Jain JP. 1982. Statistical Techniques in Quantitative Genetics. Tata McGrawHill.
3) Tomar SS. Text Book of Animal Breeding. Kalyani Publishers.

IBSMSASC401: Animal Food and Nutrition

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Livestock Feeds:** Common feeds and fodder and their classification.	4
	Energy Nutrition: 1. Energy sources, Measures of food energy and their application such as Gross Energy, Digestible Energy, Metabolisable Energy, Net Energy, Total Digestible Nutrients. 2. Energy requirement for maintenance, growth, pregnancy and lactation in milk producing livestock.	7
	Protein Nutrition: 1. Biological value of protein, Protein efficiency ratio, digestible crude protein. 2. Use of NPN in ruminants, bypass protein. 3. Protein requirements for maintenance, growth, pregnancy and lactation in milk producing livestock. 4. Improvement of poor quality roughages.	7
	Mineral and Vitamin Nutrition: 1. Major and trace minerals, their sources, physiological functions and deficiency symptoms. 2. Role of vitamins, their sources and deficiency symptoms.	7
II	**Feed Additives:** 1. Role of probiotics, prebiotics, antibiotics, enzymes, antioxidants, buffers, mould inhibitors and methane inhibitors. 2. Antinutritional and toxic factors present in livestock feed and fodder.	6
	Storage & Conservation of Feeds and Fodders: 1. Storage of feeding redients. 2. Conservation of fodder through hay and silage making and their use in livestock feeding.	6
	ComputationofRation: 1. Balance dration, Formulation of ration and feeding of dairy cattle and buffaloes during different phases of growth and production (young, pregnant, lactating and dry animals).	8
	Formulation of ration and feeding of sheep, goat, pig and poultry.	5

	50

Suggested Readings:

1) Animal Nutrition Paperback – by Peter McDonald, J.F.D. Greenhalgh, Dr CA Morgan, Dr R Edwards, Liam Sinclair
2) Advanced Animal Nutrition - D.V Reddy
3) Blaxter K. 1989. Energy Metabolism in Animal and Man. Cambridge Univ. Press.
4) Bondi A. 1987. Animal Nutrition. Wiley Inter Science.
5) Cramptan EW & Harris LE. 1969. Applied Animal Nutrition. WH Freeman.
6) Maynard LA, Loosli JK, Hintz HF & Warner RG. 1987. Animal Nutrition. McGraw-Hill.
7) McDonald P, Edwards RA & Greenhalgh JFD. 1995. Animal Nutrition. Longman.
8) Ponds WG, Church DC, Pond KR & Schoknecht PA. 2005. Basic Animal Nutrition and Feeding. Wiley Dreamtech India.
9) Singh UB. 1987. Advanced Animal Nutrition for Developing Countries. IndoVision.

Practical (2 credits)

1. Formulation of composition of concentrate ration.
2. Identification of different types of fodder.
3. Computation of ration for cattle and buffalo.
4. Identification of deficiency syndrome in cows and poultry birds.

End Semester Examination Pattern: Full marks – 20

1) Formulate the composition of a concentrate. (6)
2) Compute daily ration requirement for a cow/ buffalo according to the specifications. (10)
3) Identify the fodder. (4)
4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.

Suggested Readings:

1) Animal Nutrition Paperback – by Peter McDonald, JFD Greenhalgh, CA Morgan, R Edwards and Liam Sinclair
2) Advanced Animal Nutrition - D.V Reddy

IBSMSASC402: Animal Genetics

Theory (4 credits)

Unit	Course content	Class
I	1. History of Genetics. 2. Mitosis versus Meiosis. 3. Chromosome numbers and types in livestock and poultry. 4. Overview of Mendelian principles.	4
	1. Modified Mendelian inheritance. 2. Pleiotropy, Penetrance and expressivity	4
	1. Multiple alleles; lethal genes; 2. Sex-linked, sex limited and sex influenced inheritance.	6
	1. Gene interactions with examples. 2. Cytoplasmic inheritance.	6
	1. Sex Determination in Drosophila and Man.	5
II	1. Crossing over and Linkage. 2. Coupling and repulsion.	5
	1. Chromosomal aberrations. 2. Mutation and its types and molecular mechanism.	7
	1. Genetic Code. 2. Epigenetics and Phenocopies.	6
	1. Cytogenetics: Karyotype, Ideogram. 2. Different types of chromosomal banding techniques.	7
		50

Suggested Readings:

1) WM Becker, LJ Kleinsmith, J Hardinand GP Bertoni. *The World of the Cell.* VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2) Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: *Molecular Biology of the Cell*, IV Edition.

3) GM Cooper and Robert E Hausman. *The Cell: A Molecular Approach***,** V Edition, ASM Pressand Sinauer Associates.
4) De Robertis, EDP and De Robertis, E.M.F. *Cell and Molecular Biology*. VIII Edition. Lippin cott Williams and Wilkins, Philadelphia.
5) G Karp. *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and sons. Inc.
6) Lewin B. *Gene XI*, Jones and Bartlett
7) A McLennan, A Bates, P Turnerand M. White. *Molecular Biology* IV Edition. GS, Taylor and Francis Group, New York and London.

Practical (2 credits)
1. Karyotype preparation 2. PCR-RFLP of DNA preparation. 3. Identification of mutant variety of *Drosophila* 4. Pedigree Analysis
End Semester Examination Pattern: Full marks – 20 1) Experiment on item number 1. (6) 2) Experiment on item number 2. (6) 3) Experiment on item number 3 and 4. (8) 4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***. 5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.
Suggested Readings: 1) GM Cooper and Robert E Hausman. *The Cell: A Molecular Approach***,** V Edition, ASM Pressand Sinauer Associates. 2) G Karp. *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and sons. Inc. 3) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.

IBSMSASC403: Microbiology & Immunology

Theory (4 credits)		
Unit	**Course content**	**Class**
I	1. History of microbiology. 2. Types of microbes: Bacteria, viruses and fungi. 3. Difference between prokaryote and eukaryote. 4. Morphology of bacteria and ultrastructure of cell wall.	5
	1. Non cellular microbes: characterization and structural composition of virions and their types (animal viruses). 2. Isolation and characterization of bacteriophages and their types.	6
	1. Common zoonotic bacterial and viral diseases: epidemiology and pathogenesis, pathogenicity, diagnosis, prevention and control of Anthrax, Tuberculosis, Tetanus, Rabies, Flu and Nipah virus infection.	7
	1. Introduction, classification, general properties of fungi; 2. Growth and Reproduction of fungi. 3. Fungal diseases caused by following genera: Candida and Cryptococcus; *Aspergillus*; *Penicillium*	7
II	**Innate immunity**: 1. Historical perspectives, cardinal signs of inflammation, types of immunity, 2. Cells and organs of the Immune system. 3. Anatomical barriers; Phagocytes and phagocytosis, Tissue and humoral factors	6
	Adaptive immunity: 1. Concept of antibody and cell mediated immunity; 2. Antigenicity and immunogenicity, Adjuvants and haptens, Factors influencing immunogenicity, 3. Structure and functions of MHC molecules, 4. Immunoglogulin structure, types and function, 5. Mono- and polyclonal antibodies, antigen-antibody interaction (agglutination and precipitation), 6. Properties and functions of cytokines, Complement pathways and their regulation.	15
	Clinical immunology: 1. Determination antigen-antibody interactions (ELISA, RIA, Immuno-fluorescence, FACS), 2. Hybridomatechnology: Monoclonal antibodies in therapeutics and diagnosis.	4
		50
Suggested Readings: 1) Immunology by Kuby (Free man publication), 8th Edition. 2) Immunology and Immunotechnology by Ashim K. Chakravarty. (Oxford University Press)		

3) Essentials of immunology by Roitt (Blackwell scientific publication), 3rd Edition
4) Cellular & Molecular Immunology by Abbas & Lichtman, 5th Edition.
5) S. Peter Borriello, Patrick R. Murray and Guido Funke. Topley and Wilson's Microbiology and Microbial Infections, Bacteriology Volumes I & II. Hodder Arnold
6) Glen Sonder J & Karen W Post 2005. *Veterinary Microbiology: Bacterial and Fungal Agents of Animal Diseases.* Cold Spring Harbor Lab. Press.
7) Prescot LM, Harley JP & Klen DA. 2005. *Microbiology*. Wm. C. Brown Publ.

Practical (2 credits)
1. Simple staining, Gram staining, Endospore staining of Bacteria. 2. Analysis of Bacterial growth using colorimetric method. 3. Isolation of Bacteria from soil and water, Ppeparation of pure culture on LB agar plate. 4. Histological study of spleen, thymus and lymph nodes through stained slides/ photographs. 5. Determination of blood group and preparation of blood smear to study various types of white blood cells. 6. Determination of antigen-antibody interaction by colorimetric agglutination assay and Ouchterlony's double immuno-diffusion method. 7. Demonstration of ELISA.
End Semester Examination Pattern: Full marks – 20 1) Staining and identification (from item 1) - 5 marks 2) Any experiment (from item no. 2 tand 3) - 5 marks 3) Identification (from item no. 4) - 3 marks 4) Immunological assay (from item 5 & 6) - 7 5) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***. 6) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.
Suggested Readings: 1) Biotechnolgy Practical Book by Vincent. 2) Glen Sonder J & Karen W Post 2005. *Veterinary Microbiology: Bacterial and Fungal Agents of Animal Diseases.* Cold Spring Harbor Lab. Press. 3) Prescot LM, Harley JP & Klen DA. 2005. *Microbiology*. Wm. C. Brown Publ. 4) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.

IBSMSASCGE401: Plant Biochemistry

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Carbon metabolism: Photosynthesis:** 1. Light harvesting complexes; 2. Mechanisms of electron transport; 3. Photoprotective mechanisms; 4. CO_2 fixation- C3, C4 and CAM pathways.	15
	Respiration and photorespiration: 1. Citric acid cycle; 2. Plant mitochondrial electron transport and ATP synthesis; 3. Alternate oxidase; 4. Photorespiratory pathway.	10
II	**Nitrogen metabolism:** 1. Nitrate and ammonium assimilation; 2. Amino acid biosynthesis.	10
	Plant Hormones: 1. Biosynthesis, storage, breakdown and transport; 2. Physiological effects and mechanisms of action.	15
		50

Suggested Readings:

1) Plant Biochemistry by Hans-Walter Heldt; 3rd Edition.
2) Plant Physiology by Noggle & Fritz, 2nd edition
3) Plant Physiology by Hopkins; 2nd edition
4) Plant Physiology by Taiz & Zeiger

Practical (2 credits)
1. Assay of amylase activity in germinating rice. 2. Separation of plant pigments and amino acids by solvent extraction and paper chromatography. 3. Assay of plant hormones by spectrophotometric methods. 4. Extraction of reducing and non-reducing sugar from common crop plants.
End Semester Examination Pattern: Full marks – 20 1) Activity study (from item no. 1) - 7 marks 2) Estimation (from item no. 2 and 3) - 7 marks 3) Extraction (from item no. 4) – 6 marks 4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***. 5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.
Suggested Readings: 1) Modern Practical Botany by B.P. Pandey.

IBSMSASSEC401: Diagnostic Biochemistry

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Diagnosis of in born errors in metabolism**: 1. Metabolic disorders of carbohydrates - galactosemia, glycogen storage disease, deficiency of glucose-6-phosphate dehydrogenase, Hypoglycemia, Diabetes mellitus. 2. Metabolic disorder of lipid: Tay-Sachs disease, Nieman Pick disease. 3. Metabolic disorder of amino acid: phenylketonuria, alkaptonuria, Maple syrup urine disease. 4. Metabolic disorder of nucleotides: gout, Lesch -Nyhan Syndrome.	15
	Diagnostic Enzymes: 1. Functional plasma enzymes, isozymes and diagnostic tests. 2. Enzyme pattern in health and diseases as is special reference to plasma lipase, amylase, alkaline and acid phosphatase, cholinesterase, LDH and CPK.	10
II	**Organ function test:** 1. Liver function test (SGPT, SGOT, ALP, GGTP, Bilirubin) for Jaundice, Hepatitis. 2. Renal function test (creatine and inulin clearance). 3. Cardiac function test (ECG & EKG). 4. Brain function test (CT scan and MRI).	12
	Diagnostic Imaging: Basic principles and uses of X-rays, USG, MRI, PET, SPET.	13
		50
Suggested Readings: 1) Notes on clinical chemistry - Whitby-Smith-Beekett-Walker. Balackwell Sci, Inc. 2) Clinical Biochemistry by Teitz.		

IBSMSASCSEC402: Laboratory Animal Management

Theory (4 credits)		
Unit	**Course content**	**Class**
I	1. Introduction - Importance of rabbit for meat and fur production, 2. Rats, mice and guinea pigs, - Common breeds and strains.	7
	1. System of housing. 2. Identification of body parts and handling, weighing, sexing and weaning of laboratory animals.	5
	1. Marking for identification of laboratory animals for purpose of their individual recording.	5
	1. Computation, feeding schedule of balanced diet for high breeding efficiency of laboratory animals.	4
	1. Breeding - Age at maturity, litter size - Weaning – Feeding of growers – Selection of replacement stock.	4

II	1. Common diseases and their control measure.	10
	1. Management of specific pathogen free and gnotobiotic animals	5
	1. Transportation of Laboratory animals – marketing of meat and fur.	5
	1. Concepts related to welfare of laboratory animals	5
		50

Suggested Readings:

1) Van Vleck LD, Pollak EJ & Bltenacu EAB. 1987. Genetics for Animal Sciences. WH Freeman.
2) Handbook of Animal Husbandry. Indian Council of Agricultural Research.

IBSMSASC501: Developmental Biology of Animals

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Introduction:** 1. Basicconcepts: Phases of Development, Cell-cell interaction. 2. Differentiation and growth. 3. Differential gene expression.	5
	Early Embryonic Development: 1. Gametogenesis, Spermatogenesis, Oogenesis. 2. Types of eggs, Egg membranes. 3. Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy. 4. Planes and patterns of cleavage. 5. Types of Blastula; Fate maps (including Techniques). 6. Early development of frog and chick up to gastrulation. 7. Embryonic induction and organizers.	20
II	**Late Embryonic Development:** 1. Fate of Germ Layers. 2. Extra-embryonic membranes in birds. 3. Implantation of embryo in humans. 4. Placenta(Structure, types and functions of placenta).	10
	Post Embryonic Development: 1. Development of brain and Eye in Vertebrate. 2. Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each).	8
	Implications of Developmental Biology: 1. Teratogenesis: Teratogenic agents and their effects on embryonic development. 2. *In vitro* fertilization. 3. Stem cell (ESC). 4. Amniocentesis.	7
		50

Suggested Readings:

1) Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, USA
2) Carlson, B.M. (2014). Human Embryology and Developmental Biology. 5th Edn. Elsvier
3) Verma and Agarwal. Developmental Biology. S. Chand Pub. New Delhi.

Practical (2 credits)
1. 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). 2. Identification of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 to 18 hours), 21-33h, 36-48h and 72-96 hours of incubation (Hamilton and Hamburger stages) 3. Study and identification of different sections of placenta (through photo micrograph/ slides). 4. Study of developmental stages and life cycle of *Drosophila* from stock culture. 5. Project report on *Drosophila* culture/ chick embryo development.
End Semester Examination Pattern: Full marks – 20

1) Identification (from sl no. 1, 2 & 4): 10 marks
2) One question from sl no. 3: 6 marks
3) Project report (on item no. 5): 4 marks
4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.

Suggested Readings:

1) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.

IBSMSASC502: Basics of Bioinformatics and Biostatistics

Theory (4 credits)

Unit	Course content	Class
I	1. Computer fundamentals - programming languages in bioinformatics, role of supercomputers in biology. Historical background.	4
	2. Biological databases: NCBI-GenBANK, PDB database 8L+2T.	5
	3. Scope of bioinformatics - genomics, proteomics, computer aided drug design (structure based and ligand based approaches) and Systems Biology. Applications of bioinformatics.	6
	4. Biological sequence alignments ; pair wise and multiple sequence alignments; familiarity with BLAST, FASTA and CLUSTALW.	10
II	1. Primary and secondary data, Frequency distribution, Diagrammatic representation, Population and sample, law of statistical regularity.	5
	2. Mean, Median, Mode, Standard deviation and their simple problems.	5
	3. Methods of sampling, Basic concepts of probability, Poisson distribution, Normal distribution.	7
	4. Theory and problems of Chi-square distribution, Student's distribution, Test of Significance.	8
		50

Suggested Readings:

1) Bioinformatics: Sequence and Genome Analysis by David W. Mount, D.W. Cold Spring Harbor Laborator Press.
2) Bioinformatics and Functional Genomics by J. Pevsner, John Wiley & Sons, Inc. (New Jersey).
3) Biostatistics by K.S Negi
4) Statistical Methods Vol I and II by N. G. Das

Practical (2 credits)

1. Retrieval of amino acid and nucleotide sequence of a given query.
2. Alignment of amino acid/ nucleotide sequence and construction of phylogenetic tree.
3. Calculation of central tendency from a given set of grouped/ ungrouped data.
4. Probability-based simple problems.

End Semester Examination Pattern: Full marks – 20

1) Data mining from item 1 - 6 marks
2) Experiment (1 from item 2) - 8 marks
3) Statistical analysis (1 from item no 3 & 4) – 6 marks
4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.

Suggested Readings:

1) Biostatistics by K.S Negi
2) Statistical Methods Vol I and II by N. G. Das
3) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.

IBSMSASDSE501: Biology of Insecta

Theory (4 credits)		
Unit	**Course content**	**Class**
I	1. General characteristics and classification of Insects up to Orders (Ruppert & Barnes, 1994). 2. Distribution and Success of Insects on the Earth.	4
	General morphology of Insects: 1. External Features 2. Head: Eyes, Types of antennae, Mouth parts. 3. Thorax: Wings and wing articulation, Types of legs adapted to diverse habitat. 4. Abdominal appendages and genitalia.	8
	Physiology of Insects: 1. Structure and physiology of Insect body systems - Integumentary, digestive, excretory, circulatory, respiratory, endocrine, reproductive and nervous system. 2. Metamorphosis: Types and Neuroendocrine control of metamorphosis	20
II	**Social life of Insects:** 1. Group of social insects and their social life 2. Social organization and social behaviour of Termites. 3. Trophallaxis.	6
	Insect Plant interaction: 1. Theory of co-evolution, role of allelochemicals in host plant mediation. 2. Host-plant selection by phytophagous Insects. 3. Life cycle, Damage and Management of any two major Insect pests.	6
	Insects as Vectors: 1. Insects as mechanical and Biological vectors. 2. Brief discussion on House flies and Mosquitoes as important insect vector.	6
		50

Suggested Readings:

1) Bernays, E.A. and Chapman, R.F. (1994). Host Selection by Phytophagous insects. Chapman and Hall.
2) Bigness, Roisin and Lo (2011). Biology of Termites: A Modern Synthesis. Springer.
3) Chapman, R.F. (2013). The Insects: Structure and function. Cambridge University Press.
4) Gullan, P.J. and Cranston, P.S. (2014). The Insects: An Outline of Entomology. Wiley Blackwell.
5) Hati, A.K. (2010). Medical Entomology. Allied Book Agency, Kolkata.
6) Richards O.W. and Davies R.G. (1977). Imms general text book of Entomology (Vol I) Structure, Physiology & Development. Chapman & Hall.
7) Richards O.W. and Davies R.G. (1977). Imms general text book of Entomology (Vol II) Classification & Biology. Chapman & Hall.
8) Wilson, E.O. (1971). The Insect Societies. Harvard University Press.

Practical (2 credits)

1. Identification (Systematic Position and specimen characters): One each from major Insect orders.
2. Study and identification of different kinds of antennae, legs and mouth parts of insects.
3. Morphological studies of various castes of *Apis*, *Camponotus* and *Odontotermes.*
4. Study of any three insect pests and their damages
5. Study of any three beneficial insects and their products
6. Study of life cycle of Mosquito and three major species of Mosquitoes.
7. Field visit to study insect diversity.

End Semester Examination Pattern: Full marks – 20

1) Identification (3 from item no. 1): 6 marks
2) Identification (3 from item no. 2 and 1 from item no. 3): 4 marks
3) Identification with importance (1 each from item no. 4, 5 & 6): 6 marks
4) Submission of life cycle stages of any one species of Mosquito: 4 marks
5) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
6) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.

Suggested Readings:

1) Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
2) Lal, S.S. (2016). Practical Zoology- Inertebrate. Rastogi Publication.
3) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.

IBSMSASDSE502: Ethology and Chronobiology

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Introduction to Ethology,** 1. Proximate and ultimate reasoning, 2. Development of Behaviour,	3
	1. Social communication and Dominance, 2. Approaches and Methods in study of Behaviour, 3. Altruism and evolution group selection, kin selection, reciprocal altruism.	6
	Learning, Neural basis of learning, memory, cognition, sleep and arousal.	6
	1. Mating system, parental investment and reproductive success, 2. Aggressive behaviour, Habitat selection and Optimality in foraging.	10
II	**Introductionto Chronobiology**: 1. Historical developments in chronobiology; 2. Biological oscillation: the concept of Average, amplitude, phase and period 3. Adaptive significance of biological clocks	10
	Biological Rhythm: 1. Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; 2. Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; 3. Photoperiod and regulation of seasonal reproduction of vertebrates; 4. Role of melatonin	15
		50

Suggested Readings:

1. Alcock, J. (2001). Animal Behaviour: An Evolutionary Approach. , Sinauer Associate Inc., USA.
2. Chattopadhyay, S. (2012). Life: Evolution, Adaptation, Ethology. 3rd Edn. Books and Allied, Kolkata.
3. Dujatkin, L.A. (2014). Principles of Animal Behaviour. 3rd Edn. W.W.Norton and Co.
4. Dunlap, J.C., Loros, J.J. and De Coursey, J.P. (2004). Chronobiology: Bioloigcal Time keeping. Sinauer Associates, Inc. Publishers, Sunderland, MA, USA

Practical (2 credits)
1. Study of nests and nesting habits of the birds and social insects. 2. Study of the behavioral responses of woodlice to dry and humid conditions. 3. Study of geotaxis behaviour in earthworm. 4. Study of photo taxis behaviour in insect larvae. 5. Visit to Forest/ Wildlife Sanctuary/ Biodiversity Park/ Zoological Park to study behavioural activities of animals and prepare a short report. 6. Study and actogram construction of locomotor activity of suitable animal models. 7. Study of circadian functions in humans (daily eating, sleep and temperature patterns).
End Semester Examination Pattern: Full marks – 20 1) Performance from sl no 1 to 4: 8 marks 2) Performance from sl. No. 6: 7 marks 3) Field report: 5 4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***. 5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.
Suggested Readings: 1) Alcock, J. (2001). Animal Behaviour: An Evolutionary Approach. , Sinauer Associate Inc., USA. 2) Dujatkin, L.A. (2014). Principles of Animal Behaviour. 3rd Edn. W.W.Norton and Co.

IBSMSASC601: Adaptation and Evolution of Animals

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Life's Beginnings:** 1. Chemogeny, RNA world, Origin of Life. 2. Evolution of eukaryotes, Experiments supporting biogeny.	5
	Theories of evolution*:* 1. Historical review of Evolutionary concepts: Lamarckism, Darwinism and Neo Darwinism.	6
	Major events in history of life: 1. Geological time scale, Fossil records of Hominids (from *Australopithecus* to *Homo sapiens*). 2. Eevolution of horse. 3. Neutral theory of molecular evolution, Molecular clock	6
	Speciation: 1. Species concept and modes of speciation. 2. Isolating mechanisms, Sexual selection. 3. Adaptive radiation/macroevolution (exemplified by Galapagos finches)	8
II	**Processes of Evolutionary Change:** 1. Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism). 2. Types of natural selection (Directional, Stabilizing, Disruptive), Artificial selection. 3. Hardy-Weinberg principle	10
	Phylogenesis: 1. Phylogenetic trees, Construction & interpretation of Phylogenetic tree using parsimony. 2. Convergent & Divergent evolution. 3. Co-evolution.	4
	Extinction: 1. Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail). 2. Role of extinction in evolution.	4
	Adaptive strategies of animals: 1. Adaptive features (morphological and physiological) of aquatic vertebrates (fish and whale), adaptive features of desert animals (reptiles and mammals). 2. Adaptive significance of Coloration and Mimicry in animal world.	7
		50

Suggested Readings:

1) Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing.
2) Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). *Evolution*. Cold Spring, Harbour Laboratory Press.
3) Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers.
4) Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings.

Practical (2 credits)

1) Study of fossils from models/pictures.
2) Study of homology and analogy from suitable specimens.
3) Study and verification of Hardy-Weinberg Law by chi-square analysis.
4) Graphical representation and interpretation of data of height /weight of a sample of 100 humans relation to the age and sex.

End Semester Examination Pattern: Full marks – 20

1) Identification of fossils/ from models/photographic plates (any two): 6
2) Identification of homology/analogy using models/photographic plates (any two): 6
3) Problems based on Hardy Weinberg Law and verification of data by Chi Square test: 8
4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.

Suggested Readings:

1) Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing.
2) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.

IBSMSASC602: Animal Biotechnology

Theory (4 credits)		
Unit	**Course content**	**Class**
I	1. **Restriction modification system**- construction of restriction map of *E. coli*, vectors plasmids, cosmids, phagemids, definition of genomic DNA library and cDNA library.	8
	2. **Gene cloning**: Basic concept of cloning and expression of eukaryotic gene in prokaryotic system (example insulin, growth hormone), genomic and cDNA library construction strategies.	10
	3. **Techniques of animal biotechnology**: Southern blot, northern blot and western blot techniques, polymerase Chain reaction –DNA synthesis and amplification *in vitro*, Steps and enzymes of PCR.	7
II	1. **Transgenesis and transgenic organisms**: Gene delivery techniques in plant and animal, transgenic plants (rice and tomato), transgenic animals (sheep, goat and mice)	6
	2. **Animal Cell Culture:** Introduction to basic tissue culture techniques; chemically defined and serum free media; animal cell culture, their maintenance and preservation; various types of cultures suspension cultures, continuous flow cultures, immobilized cultures; somatic cell fusion; cell cultures as a source of valuable products; organ cultures.	10
	3. **Application of animal biotechnology**: Preliminary ideas for application of RDT in agriculture (examples of genetically modified crop, herbicide and pest resistance) and pharmaceuticals (recombinant vaccine);	9
		50

Suggested Readings:

1) Animal Biotechnology. Ranga M.M. Agrobios India Limited, 2002
2) Text Book of Animal Biotechnology. Ramadass P, Meera Rani S. Akshara Printers, 1997.
3) Masters J.R.W. Animal Cell Culture: Practical Approach. Oxford University Press. 2000
4) Gene IX by B. Lewin; 2008.
5) Molecular Biotechnology by Jones & Bartlett. Primrose SB. 2001.

Practical (2 credits)
1. Restriction digestion of a given DNA sample and determination of the digested DNA by gel electrophoresis. 2. Transformation of a recombinant plasmid in *E. coli*. 3. Demonstration of PCR. 4. Western blotting of a given animal protein.
End Semester Examination Pattern: Full marks – 20 1) Experiment (from item 1) - 8 marks 2) Experiment (from item 2) - 5 marks 3) Experiment (from item 4) - 7 marks 4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***. 5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.
Suggested Readings: 1) Ranga M.M. (2002) Animal Biotechnology. Agrobios India Limited, 2) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.

IBSMSASDSE601: Animal Parasitology

Theory (4 credits)		
Unit	**Course content**	**Class**
I	1. **Basic concept**: Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector). Host parasite relationship, Effect of parasitism in the host, sources of parasitic infections	10
	2. **Protozoa:** Study of Morphology, Life Cycle, Pathogenicity of Amoeboid group and Flagellates - *Intestinal, Hemoflagellates,* Sporozoa and Microspora	7
	3. **Trematodes:** Study of Morphology, Life Cycle, Pathogenicity of *Schistosoma haematobium, S.mansoni, S.japonicum, Fasciola hepatica*.	7
II	1. **Cestodes:** Study of Morphology, Life Cycle, Pathogenicity of Intestinal Tapeworms and extra intestinal tape worm.	8

	2. **Nematodes:** Study of Morphology, Life Cycle, Pathogenicity of Intestinal, Blood and tissues Nematodes.	8
	3. **Medical parasitology:** Diagnosis, Prophylaxis and Treatment of *Entamoeba histolytica*, *Plasmodium vivax*, *Taenia solium*, *Ascaris lumbricoides*, *Wuchereria bancrofti*, *Trypanosoma* 4. Mosquitoes, Sandflies, Ratflea, Houseflies.	14
		50

Suggested Readings:

1) General parasitology - Thomas C Cheng
2) Human parasitology - Burton J Bogtish.
3) Medical parasitology - Markell and Voges
4) Foundation of parasitology - Roberts and Janovy
5) Molecular Parasitology by Marr

Practical (2 credits)
1. Gut content analysis of Toad, cockroach, goat and chicken. 2. Histological stating of goat/ chicken parasite. 3. Identification of different parasites (permanent slide) commonly found in India.
End Semester Examination Pattern: Full marks – 20 1) Dissection and exploration from item 1 - 5 marks 2) Histology and staining from item 2 - 7 marks 3) Identification (4 from item no. 3) - 8 marks 4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***. 5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.
Suggested Readings: 1) General parasitology - Thomas C Cheng 2) Human parasitology - Burton J Bogtish. 3) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.

IBSMSASDSE602: Aquatic Biology

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Aquatic Biomes:** Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.	10
	Freshwater Biology of Lakes: 1. Origin and classification, Lake as an Ecosystem, Lake morphometry. 2. Physico-chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates, Nitrates, Turbidity, Dissolved gases (Oxygen, Carbon dioxide). 3. Nutrient Cycles in Lakes - Nitrogen, Sulphur and Phosphorous.	15
II	**Freshwater Biology of Streams:** 1. Different stages of stream development. 2. Physico-chemical environment. 3. Adaptation of hill-stream fishes.	7
	Marine Biology: 1. Salinity and density of Sea water 2. Continental shelf 3. Adaptations of deep sea organisms 4. Coral reefs, Sea weeds.	8
	Management of Aquatic Resources: 1. Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills. 2. Eutrophication 3. Management and conservation (legislations). 4. Sewage treatment. 5. Water quality assessment - BOD and COD.	10
		50

Suggested Readings:
1) Ananthakrishnan T.N. (1989): Bioresources Ecology. 3rd Ed. Oxford & IBH Pub. Co.
2) Horne A.J. and Goldman C.R. (1994): Limnology. 2nd Ed. McGraw-Hill Education.
3) Odum E. and Barrett G.W. (2005): Fundamentals of Ecology. 5th Ed. Brooks & Cole.
4) Pawlowski L (1982): Physicochemical Methods for Water and Wastewater Treatment. 1st Ed. Elsevier
5) Wetzel R.G. (2001): Limnology: Lake and River Ecosystems. 3rd Ed. Academic Press.
6) Trivedi P.K. and Goyal R.K. (1986): Chemical and biological methods for water pollution studies. Environmental Publ.
7) Welch P.S. (2018): Limnology. Vols. I-II. Franklin Classics.

Practical (2 credits)

1. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.
2. Determine the amount of Turbidity/ transparency, Dissolved Oxygen, Free Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from a nearby lake/ water body.
3. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.
4. A Project Report on a visit to a Sewage treatment plant/ Marine bioreserve/ Fisheries Institutes.

End Semester Examination Pattern: Full marks – 20

1) Identification (3 from item no. 1): 6 marks
2) Estimation (1 from item no. 2): 8 marks
3) Instruments (2 from item no. 3): 4 marks
4) Field report: 2 marks
5) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
6) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.

Suggested Readings:
1) Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
2) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.
3) Trivedi P.K. and Goyal R.K. (1986): Chemical and biological methods for water pollution studies. Environmental Publ.
4) Standard Analytical Procedures for Water Analysis (May, 1999). Hydrology Project. Government of India & Netherlands.

M.Sc.

IBSMSASC701: Animal Bioresources

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Biosystematics and Taxonomy:** 1. Principles of taxonomy as applied to the systematics and classification of the animal kingdom. 2. Concepts about Structural, Numerical, Molecular and Biochemical taxonomy. 3. Basics of Phenetics and Cladistics. 4. Species Concept: Biological, Evolutionary and Phylogenic.	10
	Classification and evolution of different Animal groups: 1. Outline classification and interrelationship amongst the major Invertebrate phyla. 2. Larval forms of Invertebrates and their evolutionary significance. 3. Outline classification of Protochordates and Chordates. 4. Origin and evolution of different chordates groups.	20
II	**Invertebrate Structure and Function:** 1. Biological and medicinal importance of sponges. 2. Evolution of symmetry, coelom and metamerism in Invertebrates. 3. Invertebrate locomotion: *Amoeba*, Earthworm, Butterfly, *Octopus* and Starfish. 4. Excretory organ and excretion: Flame cell, Nephridia, Malpighian tubules and Renal glands. 5. Organization of nervous system: nerve net, central and peripheral nervous system, invertebrate brain. 6. Thermoregulation and Osmoregulation in different invertebrate groups	15
	Chordate Structure and Function: 1. Ultrastructure and role of notochord and endostyle in *Amphioxus* and *Ascidia* with evolutionary significance. 2. Integumentary system and its derivatives. 3. Evolution of vertebrate heart and portal system. 4. Evolution of urinogenital system in vertebrate series. 5. Animal migration and mechanism of navigation. 6. Metamorphosis: progressive and retrogressive, neoteny and paedomorphosis	15
		60

Suggested Readings:

1) Chatterjee, A. & Chakraborty, C. (2015). Text Book of Zoology. Nirmala Library
2) Ganguly, B. B., Sinha, K. S. & Adhikari, S. (2012). Biology of Animals. Vol. I. New Central Book Agency.
3) Jordan, E. L. & Verma, P. S. (2006). Invertebrate Zoology. S. Chand & Company Ltd.
4) Jordan, E. L. & Verma, P. S. (2003). Chordate Zoology. S. Chand & Company Ltd.
5) Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
6) Kent, G. C. & Carr, R.K. (2001). Comparative anatomy of the Vertebrates. 9th Ed. Mc Graw Hill.
7) Kotpal, R.L. (2019). Modern Text Book of Zoology: Invertebrates. 11th Ed. Rastogi Publications.
8) Kotpal, R. L. (2019). Modern Text Book of Zoology: Vertebrates. 4th Ed. Rastogi Publications.
9) Nelson, J. S. (2006): Fishes of the World, 4th Ed. Wiley.
10) Romer, A. S. & Parsons, T. S. (1986).The vertebrate body. 6th Ed. Saunders College Pub.
11) Sinha, K. S., Adhikari, S., Ganguly, B. B. & Goswami B. (2012). Biology of Animals. Vol. II. New Central Book Agency.
12) Young, J. Z. (1981). The Life of Vertebrates. 3rd Ed. Oxford University Press.

IBSMSASC702: Advanced Cellular and Molecular Biology

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Cellular transportation** 1. Diffusion and osmosis across membranes, ion channels, active transport, membrane pumps 2. Mechanism of sorting and regulation of intracellular transport.	5
	Cell-cell communication 1. General principles of cell communication 2. Cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix and its components.	7

	Cell signaling 1. Receptors and their types, Structure and function of cell surface receptors 2. Signal transduction pathways, signaling through G-protein coupled receptors and small intracellular mediators, 3. Enzyme-Coupled Cell-Surface receptors, second messengers, regulation of signaling pathways.	8
	Cell Cycle& Cell Division: 1. Different phases of Cell cycle 2. Cell Cycle checkpoints, Regulation of eukaryotic cell cycle & Role of MPF 3. Mitosis and meiosis; Regulation of cell division 4. Role of cytoskeleton in cell division and control of Spindle fiber synthesis.	10
II	**Structure of DNA, Genes and genomic organization***:* 1. DNA structure, features of the double helix, various forms of DNA. 2. Definition of a gene, organization of genes in viruses, bacteria, eukaryotes. Nucleosome structure and packaging of DNA into higher order structures. 3. Supercoiling of DNA and its importance, topoisomerases – their inhibitors and application in medicine. 4. DNA as the genetic material.	7
	Central Dogma 1. Replication of DNA; DNA polymerases, enzymes and proteins in DNA replication, various modes of replication. 2. Recombination and transposition of DNA, Homologous and site-specific recombination, transposition, different classes of transposable elements, importance of transposable elements in horizontal transfer of genes and evolution. 3. Molecular basis of mutations and Various modes of DNA repair, Replication errors and mismatch repair system, repair of DNA damage, direct repair, base excision repair, nucleotide excision repair, recombination repair, SOS Repair.	8
	Transcription and translation 1. Prokaryotic and eukaryotic promoter, mechanism of transcription, various types of RNA. Control of Transcription, Operon concept. 2. Genetic and its properties, Wobble biochemical reaction involved in amino acylation, mechanism of translation in pro- and eukaryotes.	7
	Molecular biology of Cancer and programmed cell death 1. Properties of benign and malignant tumors, Signaling pathways and mechanism of different oncogene activation in different cancer, anticancer drugs 2. Activation of extrinsic, intrinsic and perforin-granzyme pathway of cell death.	8
		60

Suggested Readings:

1) Alberts, B. et al. (2008). Molecular Biology of the Cell. 5th Ed. Garland Publishing House.
2) Brooker. (2001). Genetics. McGraw-Hill.
3) Brown, T. A. (2002). Genomes 2. Wilely-Liss. Clark, D. P. (2005). Molecular Biology.Elsevier.
4) Clark, D.P. (2009). Understanding the Genetic Revolution. Academic Press.
5) Cooper, G. M. (2004). The Cell. 3rd edn. ASM Press.
6) Hancock, J.T. (2008). Molecular Genetics. Viva Book Private Ltd.
7) Hartl, D.L. & Jones, E.W. (1998). Genetics, Principles and analysis. (4th ed). Blackwell Scientific, Oxford.
8) Hartl, D. L. & Jones, E. W. (2005). Genetics: analysis of genes and genomes. 6th ed. Jones and Bartlett Publ.
9) Hartl, D. L. & Jones, E. W. (2006). Essential Genetics: a genomics perspective (4th ed.). Jones and Bartlett Publ.
10) Hartwell et al. (2001) Genetics: From genes to Genomes. McGraw Hill.
11) Harvey, L. (2004). Molecular cell Biology. 5th ed. W.H.Freeman.
12) Karp, G. (2008). Cell and Molecular Biology: Concepts and experiments. 5th edn., JohnWiley.
13) Cell Biology by Pollard.
14) Molecular Biology of the gene by Watson.

IBSMSASC703: Biochemistry and Immunology

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Biochemistry of Carbohydrates:** 1. Structure, classification and function of mono-, di- and polysaccharides. 2. Open and ring conformations, Concept of maturoration and anomeric effect, glycosidic linkages. 3. Catabolism (glycolysis, pentose phosphate pathaway, TCA cycle, ETC& Oxidative phosphorylation) and anabolism (gluconeogenesis and uronic acid pathway) of glucose.	8

	Biochemistry of Lipids: 1. Structure, classification and function of Lipids. 2. Structure and nomenclature of fatty acids, synthesis and oxidation (beta, alpha and omega) of even and odd chain fatty acids.	6
	Biochemistry of amino acids and proteins: 1. Structure, classification and function of amino acids and Proteins; 2. Ramachandran plot; Concept of post-translational modification, protein folding and trafficking; 3. Classification of Enzymes, Enzyme kinetics and inhibition, 4. Mechanism of action of Lysozyme, Ribonuclease A, Carboxypeptidase and Chymotrypsin. allosteric regulation (MWC and KNF model).	10
	Biochemistry of nucleic acids: 1. Structure, classification and function of DNA and RNA. 2. DNA topology, de novo and salvage synthesis of nucleotides; 3. Degradation of purines and pyrimidines.	6
II	**Innate immunity:** 1. Physicochemical barriers, 2. Mechanism of pathogen recognition and antigen presentation, 3. Toll-like receptors and their signaling pathways.	6
	Adaptive immunity: 1. Structure and function of antibody molecules. 2. Generation of antibody diversity, monoclonal antibodies, MHC molecules, antigen processing and presentation, 3. Activation and differentiation of B and T cells, B and T cell receptors.	12
	1. Complement activation pathways and their regulation, 2. Cell-mediated effector functions, hypersensitivity and autoimmunity.	6
	1. Kinetics of antigen-antibody interactions (agglutination and precipitation), 2. Determination of antigen-antibody interaction using immunofluorescence, western blotting and FACS.	6
		60

Suggested Readings:

1) Lehninger's Principles of Biochemistry by Nelson & Cox; 7th Edition.
2) Biochemistry by Voet & Voet; 3rd Edition
3) Biochemistry by Stryer; 5th Edition
3) Principle of Biochemistry by Horton, Moran, Perry and Rawn, 5th Edition
4) Textbook of Biochemistry by Thomas M. Devlin; 5th Edition
5) Immunology by Kuby (Free man publication), 8th Edition.
6) Immunology and Immunotechnology by Ashim K. Chakravarty (Oxford university Press)
7) Essentials of immunology by Roitt (Blackwell scientific publication), 3rd Edition
8) Cellular & Molecular Immunology by Abbas & Lichtman, 5th Edition.

IBSMSASC704: Advanced Ecology and Conservation Biology

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Factors of the environment :** 1. Concept of limiting factors, Biotic factors: effects of predators, parasites and symbionts. 2. Abiotic factors: effects of temperature, moisture, light and fire.	7
	Habitat and Niche: 1. Concept of habitat and niche; niche width and overlap; fundamental and realized niche. 2. Resource partitioning; character displacement	7
	Population dynamics: 1. Characteristics of a population; population growth curves. 2. Population regulation; life history strategies (r and K selection). 3. Concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.	6
	Ecosystem Ecology : 1. Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition. 2. Structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). 3. Bioremediation.	10

II	**Communities and biodiversity:** 1. Community organization and structure, relative abundance, species diversity, diversity indices and ecosystem development. 2. Ecological succession and climax community.	8
	Species Interactions: 1. Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.	5
	Biogeography: 1. Major terrestrial biomes; theory of island biogeography. 2. Biogeographical zones of India	7
	Conservation Biology: 1. Conservation of natural resources and wildlife, *in situ* and *ex situ* conservations, Red Data Book, IUCN red list categories, Endangered and Endemic species of India. 2. India as a mega-diversity nation; flora & fauna of other Megadiversity countries; hot-spots of biodiversity; wealth of Indian hot-spots. 3. In-situ and Ex-situ Conservation, Biosphere Reserve	10
		60

Suggested Readings:

1) Kormondy, E. J. (2002). Concepts of Ecology. 4th Indian Reprint, Pearson Education.
2) Krebs, C. J. (2001). Ecology. Benjamin Cummings.
3) Krebs, C.J. (2016).Ecology: The Experimental Analysis of Distribution and Abundance. Pearson Education Limited, Noida, India. 13. Molles, Jr. M.C. (2005). Ecology: Concepts and Applications. 3rd Ed. McGraw- Hill.
4) Odum, E. P. & Barret, G. W. (2005). Fundamentals of Ecology. 5th Ed. Thompson Brooks/Cole.
5) Ricklefs, R. E. & Miller, G. L. (2000). Ecology. 4th Ed. W. H. Freeman & Company.
6) Russel, P.J., Wolfe, L. S., Hertz, P.E. Starr, C. & McMillan, B. (2008). Ecology.
7) Brooks/Cole. Saharia, V. B. (1998). Wildlife in India. Natraj Publishers.
8) Smith, R. L. & Smith, T. M. (2001). Ecology and Field Biology. Benjamin Cummings.
9) Pearson Education. Smith, T. M & Smith, R. L. (2006). Elements of Ecology. 6th Ed. Pearson Education.
10) Stiling, P. (2009). Ecology- Theories and Applications. 4th Ed. Prentice Hall of India.
11) Cunningham, W. P. & Cunningham, M. A., (2007). Principles of Environmental Science: Inquiry & Applications. 4th ed. Tata McGraw-Hill Company.

IBSMSASC705: Practical 1

Practical (4 credits)

Animal Bioresources:

1. Identification: From the major animal groups.
2. Dissection: Male and female Reproductive system of Cockroach.
3. Dissection: Afferent branchial System and IXth & Xth Cranial Nerve of Carp, Vth & VIIth Cranial Nerve of Fowl.

Cellular and Miolecular Biology:

4. Preparation of meiotic chromosomes from the Grasshopper testes: Identification of stages with characters.
5. Preparation of polytene chromosomes from Chironomid / *Drosophila* larvae.
6. Identification of mutants of *Drosophila*
7. Preparation of Barr body from human female.
8. Identification of slides on human chromosomal abnormalities and various genetic diseases.
9. Isolation of DNA/ RNA from *Drosophila*/ mosquito /Rat/ Goat (liver tissue) and visualization through gel electrophoresis.

End Semester Examination Pattern: Full marks – 20

1) Identification (3 from item no. 1, 2 & 3): 6 marks
2) Dissection (1 from item no. 4 & 5): 4 marks
3) Slide preparation (from item no. 4, 5, 7)/ Experiment (from item no. 9): 6
4) Identification (item no. 6, 8): 4
4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.

Suggested Readings:

1) Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
2) Lal, S. S. (2016). Practical Zoology- Vertebrate. Rastogi Publication.
3) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.

IBSMSASC706: Practical 2

Practical (4 credits)
Biochemistry and Immunology: 1. Estimation of cellular micromolecules (glucose, amino acid) and macromolecules (DNA, RNA and protein) using spectrophotometric methods. 2. Determination of Km and Vmax of alpha-amylase. 3. Isolation and staining of peritoneal macrophages from mice/ rat. 4. Development of antibody against a given antigen in mice/ rabbit model and study of the antigen-antibody interaction using western blotting. **Advanced Ecology and Conservation Biology:** 5. Quantitative estimation of some Physico-chemical parameters in the aquatic ecosystem: Temperature, pH, dissolved oxygen, carbon dioxide and chloride contents Quantitative estimation of some factors of soil and the sediment: soil moisture, pH, nitrates, phosphates and organic matter. 6. Quadrate analysis and determination of biodiversity. 7. The study of aquatic and terrestrial habitats: Identification and characterization of zooplankton and ecotypes inhabiting terrestrial and aquatic environments. 8. Educational tour to study Biodiversity of animals/ Ecosystem/ Conservation strategy of animals.
End Semester Examination Pattern: Full marks – 20 1) Biochemical estimation or Assay (1 from item no. 1 and 2): 5 marks 2) Experiment (1 from item no. 3 and 4): 5 marks 3) Identification (fro item no. 7): 3 marks 4) Estimation (from item no. 5): 4 4) Field report: 3 marks 4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***. 5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.
Suggested Readings: 1) Practical Biochemistry by David T Plummer, 3rd Edition 2) Biochemical Methods by S. Sadasivan and A. Manikam, 3rd Edition 3) Modern Experimental Biochemistry by Rodney Boyer, 3rd Edition 4) Practical Biotechnology by Vincent. 5) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.

IBSMSASC801: Advanced Animal Physiology and Histotechnology

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Digestive System:** 1. Detailed structure of Gastro intestinal tract, associated digestive glands and their secretions, 2. Digestive enzymes and regulations of their secretion in mammals. 3. Mechanism of digestion and absorption of different food materials.	5
	Respiratory System: 1. Different respiratory organs, 2. Mechanism of breathing and its regulation in mammals, 3. Respiratory pigments, 4. Metabolic pathways - Glycolysis, TCA Cycle, Oxidative phosphorylation.	5
	Blood Vascular System : 1. Various components of circulatory system, 2. Blood: Composition and function of blood, Blood volume, Blood coagulation, Haematopoiesis, Blood pressure, Blood groups, Transport of O2 and CO2 , Oxygen regulation in mammals, 3. Physiological types of hearts, Cardiac cycle and its regulation.	5
	Nervous System: 1. Structure of a typical neuron, 2. Conduction of nerve impulse, Resting potential, 3. Synaptic transmission and Neurotransmitters.	5
	Muscular System: 1. Ultra structure and chemical composition of skeletal muscle, 2. Mechanism of muscle contraction, 3. Energy supply and heat production during muscle contraction.	5

	Excretory System: 1. Different excretory products, 2. Structure of kidney and a nephron, 3. Formation of urine and its regulation and excretion, Acid-base balance, Homeostasis.	5
II	**Animal tissues**: Classification, Nomenclature and characteristics.	4
	Histophysiology: Gastrointestinal tract; Liver; Pancreas; Kidney; Adrenal; Pituitary; Testis; Ovary; Thyroid.	8
	Basic principles of fixation and general account of fixatives for a light and electron microscopic studies.	5
	Basic principles of staining; biological dyes: Chemistry and sources of a. Haematoxylin b. Eosin c. Carmine d. Basic fuchsin e. Acid fuchsin.	5
	Basic principles and theoretical basis: a. PASchiff reaction b. Feulgen reaction c. Metachromasia d. Histochemical techniques for acid and alkaline phosphatase.	6
	Basic principles of immunocytochemistry.	2
		60

Suggested Readings:

1) Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edn. Hercourt Asia PTE Ltd. W.B. Saunders Company.
2) Hill, Wyese and Anderson (2012). Animal Physiology. 3rd Edn. SineuerAssociaes
3) Rastogi, S.C. (2007). Essentials of Animal Physiology4th Edn. New Age Pub., N. Delhi
4) Kent, G.C. and Carr R.K. (2000).Comparative Anatomy of the Vertebrates. IX Edition.
5) Saxena, R.K. & Saxena, S.C. (2008): Comparative Anatomy of Vertebrates, Viva Books Pvt. Ltd.
6) Bloom & Fawcett Textbook of Histology: A Textbook of Histology

IBSMSASC802: Inheritance Biology and Development Biology

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Mendelian principles:** 1. Dominance, segregation, independent assortment.	2
	Concept of gene: 1. Allele, multiple alleles, pseudoallele. 2. Complementation tests	4
	Extensions of Mendelian principles : 1. Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy. 2. Linkage and crossing over, sex linkage. 3. Sex limited and sex influenced characters.	6
	Gene mapping methods : 1. Linkage maps. 2. Tetrad analysis, mapping with molecular markers, mapping using somatic cell hybrids.	8
	Extra chromosomal inheritance: 1. Inheritance of Mitochondrial and chloroplast genes. 2. Maternal inheritance.	4
	Human genetics: 1. Pedigree analysis. 2. Lod score for linkage testing, karyotypes and genetic disorders.	6
II	**Basic concepts of development:** 1. Concepts of Potency, commitment, specification, induction, competence, determination and differentiation.	5
	Gametogenesis: 1. Process of production of sperm and ovum. 2. Basics of hormonal regulation in gametogenesis.	5

	Fertilization and early development: 1. Cell surface molecules in sperm-egg recognition in animals; Process of fertilization in sea archin, amphibians and mammals. 2. Prevention of polyspermy. 3. Gastrulation and formation of germ layers in frog and Chick.	5
	Morphogenesis and organogenesis in animals : 1. Cell aggregation and differentiation in *Dictyostelium*. 2. Axes and pattern formation in *Drosophila*. 3. Vulva formation in *Caenorhabditis elegans*. 4. Eye lens induction in chick, limb development and regeneration in amphibians.	8
	Sex determination: 1. Molecular basis of sex determination in *Drosophila* and Human.	5
		60

Suggested Readings:

1) Arias, A. M. & Stewart, A. (2002). Molecular Priciples of Animal Development. Balinsky (1981).
2) Embryology. Thompson Brooks Cole (India) Pte, Ltd. Browder, L. W. (1984). Developmental Biology. 2nd ed., CBS College Publishing.
3) Carlson, B. M. (1999). Patten's Foundations in Embryology. 6th ed. McGraw Hill.
4) Gilbert S. F. (1999). Embryology. Sinauer Associates, Sunderland, Massachusetts.
5) Gillbert, S.F. (2006). Developmental Biology. 8th ed. Sinauer Associates.
6) Kalthoff, K., (2001). Analysis of Biological Development. 2 ed. McGraw Hill.
7) Snustad, D. P. & Simmons. M. J. (2004). Principles of Genetics. 4th ed. John Wiley and Sons.

IBSMSASC803: Parasitology and Microbiology

Theory (4 credits)		
Unit	**Course content**	**Class**
I	1. Taxonomy, morphology, lifecycle, pathogensis, diagnosis and control of protozoan (*Leishmania spp., Plasmodium spp*., *Entamoeabae histolystica*, *Giardia lamblia, Trypanosoma spp.*), cestode (*Taenia spp*., *Hymenolepis spp*., *Diphyllobothrium latum*), nematode (*Wuchereria bancrofti, Ascaris spp*., *Ancylostoma duodenale, Trichinella spp.)* and trematode *(Fasciola hepatica, Schistosoma mansoni)*.	16
	2. Cellular and molecular mechanism of host-parasite and host-vector interactions in leishmaniasis and malaria.	4
	3. Mechanism of antigenic variation in malaria, trypanosomiasis and giardiasis.	6
	4. Molecular mechanism of immunomodulation in lymphatic filariasis and amoebiasis.	4
II	1. Introduction and history of Microbiology; 2. Classification and nomenclature of bacteria. 3. Structure and morphology of bacteria.	4
	1. Growth and nutritional requirement of aerobic and anaerobic bacteria; 2. Normal, opportunistic and saprophytic bacterial flora: 3. Types and sources of infection, method of transmission of infection.	4
	1. Pathogenicity, virulence, determinants of virulence, Epizootic and enzootic diseases, bacteremia, septicaemia and toxaemia, endotoxins, exotoxins, antitoxins, toxoids. 2. Study of the following bacteria in relation to isolation, growth, cultural, morphological, biochemical and antigenic characteristics: *Staphylococcus; Streptococcus; Bacillus; Mycobacterium; Clostridium*.	12
	1. History of Virology; Introduction to viruses; Structure of Viruses; Classification of Viruses; 2. Viral Replication; Genetic and Non-genetic viral interactions; Virus-Cell Interactions; 3. Viral Pathogenesis, Oncogenesis, latency and immunopathology.	10
		60

Suggested Readings:

1. General parasitology- Thomas C Cheng
2. Human parasitology- Burton J Bogtish.
3. Medical parasitology- Markell and Voges
4. Foundation of parasitology- Roberts and Janovy
5. Molecular Parasitology by Marr
6. S. Peter Borriello, Patrick R. Murray and Guido Funke. Topley andWilson's Microbiology and Microbial Infections, Bacteriology Volumes I & II. Hodder Arnold

7. Glen Sonder J & Karen W Post 2005. *Veterinary Microbiology: Bacterial and Fungal Agents of Animal Diseases.* ColdSpringHarbor Lab. Press.
8. Prescot LM, Harley JP & Klen DA. 2005. *Microbiology*. Wm. C. Brown Publ.

IBSMSASC804: Livestock Management and Animal Breeding

Theory (4 credits)		
Unit	**Course content**	**Class**
I	1. Demographic distribution of livestock and role in Indian economy. 2. Problems and prospects of livestock industry in India.	5
	1. Common animal husbandry terms. (glossary) 2. Body conformation and identification. 3. Transportation of livestock and wild or zoo animals.	6
	1. Common farm management practices including disinfection, isolation, quarantine and disposal of carcass.	7
	1. Introduction to methods of drug administration. 2. Common vices of animals (Cattle, Buffalo, Sheep, Goat,), their prevention and care.	5
	1. Organic livestock production. 2. Judging and BCS for body parts of livestock. 3. Culling of animals. Selection and purchase of livestock.	7
II	1. Domestication of animals. 2. History of Animal Breeding. 3. Type of selection and their genetic consequences.	7
	1. Components of variation, Heritability and Repeatability. 2. Response to selection and its prediction and improvement of response to selection.	8
	1. Theoretical aspects of accuracy and efficiency of different base of selection. 2. Selection of several traits. Bases of selection.	7
	1. Prediction of breeding value using different criteria. 2. Combined Selection. 3. Correlated response to selection and efficiency of indirect selection.	8
		60

Suggested Readings:

1) Livestock production and management. NSR Sastry and CK Thomas.
2) Falconer DS & Mackay TFC. An Introduction to Quantitative Genetics. Longman.
3) Jain JP. 1982. Statistical Techniques in Quantitative Genetics. Tata McGrawHill.
4) Pirchner F. 1981. Population Genetics in Animal Breeding. S. Chand.

IBSMSASC805: Practical 3

Practical (4 Credits)

Advance Animal Physiology and Histochemistry:

1. Determination of Pancreatic protease activity in rats.
2. Identification of stages of an estrous cycle in rat.
3. Hormonal control of pigment dispersion in cat fish.
4. Colorimetric estimation of ovarian ascorbic acid.
5. Collection, Fixation, Dehydration, Infiltration and Paraffin Embedding of Different tissues/ Glands/ Organs of White Rat.
6. Microtomy of Paraffin sections.
7. Haematoxylin-eosin staining of paraffin sections.
8. Identification of tissue sections.
9. Histochemical demonstrations of: a. 1,2 glycol group containing substances in liver, b. Deoxyribonuceic acids in liver, c. Alkaline phosphatase activity in kidney.

Inheritance Biology and Developmental Biology:

10. Preparation of whole mount of Chick embryo of different stages.
11. Identification of chick embryo of 24h, 48h, 72h and 96h stage.

12. Culture and Regeneration of *Hydra.*
13. Morphological studies on the developmental stages of snail, fish, frog, chick and mouse.
14. Dissection of imaginal discs from *Drosophila* larvae.
15. Histological slides of various organs and systems during development using stained serial sections.
16. Identification of whole mounts and histological sections of embryos, larvae, pupae and nymphs.

End Semester Examination Pattern: Full marks – 20

1) Identification (from item no. 2, 8): 4 marks
2) Microtomy/ staining/ histochemistry (from 5, 6, 7, 9): 6 marks
3) Identification (from item no. 11, 13, 15, 16): 4 marks
4) Preparation ((from item no. 10, 14): 6 marks
5) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
6) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.

Suggested Readings:

1) Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
2) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.

IBSMSASC806: Practical 4

Practical (4 Credits)

Parasitology and Microbiology:

1. Collection, histology and staining of goat/ chicken/ fish parasites.
2. Determination of parasite infection (load) in an infected animal.
3. Determination of intestinal and extra-intestinal parasites of laboratory animals.
4. Simple staining, Grams staining, Acid fast staining and Endospore staining.
5. Identification of parasites and microbes from slides.
6. Isolation of Plasmid DNA from Bacterial isolate.

Livestock Management and Animal Breeding:

7. Methods of drug administration in animals
8. Problems on Heritability and Repeatability
9. Problems on Response to selection.
10. Judging and BCS for body parts of livestock
11. Visit to any livestock management or breeding farm.

End Semester Examination Pattern: Full marks – 20

1) Identification (from item no. 5): 4
2) Staining (1 from item no. 4): 6
3) Experiments (1 from item no. 7, 10): 4
4) Problems (1 from item no. 8,9): 6 marks
5) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
6) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.

Suggested Readings:

1) Livestock production and management. NSR Sastry and CK Thomas.
2) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.

IBSMSASMIE801: Environmental Health (Minor Elective)

Theory (4 credits)

Unit	Course content	Class
I	**Ecology and Environment:** 1. Basic ideas on Species, Population, Community and Ecosystem. 2. Nutrient Cycles (Nitrogen, Phosphorus, Magnesium). 3. Environmental Issues.	7
	Environmental Pollution and Health Hazards: 1. Outline of Environmental pollution with special emphasis on bio-waste, medical waste and municipal waste pollution and health hazards.	8

	Environmental Health and Diseases: 2. Basic concept on health and diseases, Principle of communicable and non-communicable diseases and conditions. 3. Food pollution (Additives, Preservatives, Contaminants), Present status, Types and problems. 4. Health programme in India, Hospital waste management in India.	10
II	**Medical Geology:** 1. Concept, Contribution to medical geology from public health and Environmental medicine, Development of Medical Geology, Geological sources of Nutrients, Mineral elements needed for good health. 2. Dietary sources and bioavailability of essential mineral elements, Some case studies.	12
	Medical Microbiology: 1. Concept of Pathogens, Infection and Intoxication. 2. Communicable disease, causative agents, symptoms, mode of transmission, prevention and treatments.	10
	Environmental Laws: 1. Constitutional provisions and Rules and Regulations.	3
		50

Suggested Readings:

1) Conant J and Fadem P. (2008). A Community Guide to Environmental Health. Hesperian Foundation.
2) Finn S. and O'Fallon R.L. (1019). Environmental Health Literacy. Springer.
3) Friis R.H. (2019). Essentials of Environmental Health. 3rd Ed. Jones & Bartlett.
4) Nriagu J.O. (2011). Encyclopaedia of Environmental Health.
5) Resnik D.B. (2012). Environmental Health Ethics. Cambridge.

IBSMSASC901: Animal Biotechnology and Biophysics

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Animal Cell Culture:** 1. Introduction to basic tissue culture techniques; chemically defined and serum free media; 2. Animal cell culture, their maintenance and preservation; 3. Various types of cultures suspension cultures, continuous flow cultures, immobilized cultures; somatic cell fusion; cell cultures as a source of valuable products; organ cultures.	8
	Animal Diseases and their diagnosis: 1. Bacterial and viral diseases in animals; 2. Monoclonal antibodies and their use in diagnosis; 3. Molecular diagnostic techniques like PCR, in-situ hybridization; northern and southern blotting; RFLP.	10
	Micromanipulation of embryo's: 1. Equipment used in micromanipulation; 2. Enrichment of x and y bearing sperms from semen samples of animals; 3. Artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer.	6
	Transgenic animals: 1. Concepts of transgenic animal technology; 2. Strategies for the production of transgenic animals and their importance in biotechnology; 3. Stem cell cultures in the production of transgenic animals.	6
II	**Separation and purification techniques:** 1. Chromatography (paper, TLC and column), gel electrophoresis and centrifugation (ultra and density gradient centrifugation).	8
	Microscopic techniques: 1. Structure, principles and applications of optical, phase-contrast, electron and fluorescence microscopes.	6
	Molecular Spectroscopy: 1. Concept of electromagnetic radiation, Lambert-Beer law and its mathematical expression. 2. nstrumentation and working principle of UV/ visible spectroscopy, IR spectroscopy, Atomic absorption spectroscopy, fluorescence, NMR, circular dichroism and surface plasma resonance spectroscopy and Mass spectrometry (peptide-based finger printing using MALDI-TOF-MS and ESI-MS), 3. Principle and application of XRD,	12
	Diagnostic Biophysics: 1. Radio-isotopic tracer techniques and autoradiography, MRI and ECG.	4
		60

Suggested Readings:

1) Physical Biochemistry by David Freifelder.

2) Molecular Cloning by Sambrook & Russel.
3) Biophysical Chemistry by Cantor and Schimmel
4) Biophysics & Biophysical Chemistry by D. Das
5) Animal Biotechnology. Ranga M.M. Agrobios India Limited, 2002
6) Text Book of Animal Biotechnology. Ramadass P, Meera Rani S. Akshara Printers, 1997.
7) Masters J.R.W. Animal Cell Culture: Practical Approach. Oxford University Press. 2000
8) Molecular Biotechnology by Jones & Bartlett. Primrose SB. 2001.

IBSMSASC902: Animal Health and Pathology

Theory (4 credits)		
Unit	**Course content**	**Class**
I	1. Health and disease. 2. Major intrinsic and extrinsic causes of disease.	4
	1. Haemodynamic disorders (hyperaemia, congestion, haemorrhage, oedema, thrombosis, embolism and infarction).	6
	1. Glycogen overload, amyloidosis and fatty changes. 2. Reversible and irreversible cell injury degenerations, necrosis and its types, apoptosis, differences between post-mortem autolysis and necrosis, gangrene and its types.	10
	1. Photosensitization. 2. Disturbances in growth (Aplasia, hypoplasia, atrophy, hypertrophy, hyperplasia, metaplasia and dysplasia).	10
II	1. Inflammation: Definitions, classification, various cell type and their functions, mediators, cardinal signs and systemic effects. 2. Wound healing by primary and secondary intention including growth factors.	8
	1. Clinical methods for the diagnosis of diseases: Infectious and non-infectious diseases.	8
	1. Benign and Malignant tumors. 2. Terminology, classification and causes of Cancer. 3. Characteristic features of malignancy.	10
	1. Epidemic, Endemic, Pandemic and Sporadic diseases: their causes and precautionary measures.	4
		60

Suggested Readings:

1) McGavin MD & Zachary JF. 2006. Pathologic Basis of Veterinary Diseases. 4th Ed. Elsevier
2) Vegad JL. 2007. Text Book of Veterinary General Pathology. 2nd Ed. International Book Distr.
3) Meuten DJ. 2002. Tumors in Domestic Animals. 4th Ed. Blackwell.
4) Jones TC, Hunt RD & King NW 1997. Veterinary Pathology. Blackwell Publishing.

IBSMSASC903: Entomology and Ichthyology

Theory (4 credits)		
Unit	**Course content**	**Class**
I	1. General characters of Class Insecta. 2. Outline classification up to orders with examples.	8
	External Morphology: 1. General body plane. 2. Head – Generalized structure, types and modifications. Structure and types of antennae and mouthparts. 3. Thorax – Generalized structure; General structure of leg and wing, venation of wing. 4. Abdomen – Generalized structure, Appendages including genitalia.	8
	Insect Physiology: 1. Digestive system - Alimentary canal, Salivary glands, Mechanism of digestion, Micro-organisms and their role in digestion. 2. Excretory system – Major and accessory organs of excretion, Physiology of excretion, Composition of insect urine, Vitamins in Malpighian tubules.	8

	Specialized Organs: 1. Sound production - Structure of the organs, Mechanism of sound production and Significance. 2. Bioluminescence - Structure of organs, Brief mechanism of light production and Significance.	6
II	1. General study of some major fish orders: Cypriniformes, Clupeiformes, Ophiocephaliformes, Perciformes, Mastacembeliformes.	6
	Fish Physiology: 1. Digestive system and digestion. 2. Olfactory organ and chemoreception. 3. Osmoregulatory and Circulatory systems. 4. Endocrine glands (Pituitary and Thyroid). 5. Reproductive organs, Breeding and Parental care.	10
	Specialized Organs: 1. Bioluminescent organ. 2. Electric organs. 3. Poison gland. 4. Acoustico-lateralis system.	4
	Aquaculture: 1. Inland fisheries – Pond management, Composite culture, Induced breeding of Prawn and air-breathing fishes. 2. Marine fisheries – Methods and importance; Hilsha and Pomfret fishery. 3. Importance of edible aquatic animals other than fishes. 4. Fish biotechnology – production of Transgenic fishes. 5. Integrated aquaculture. 6. Common diseases of fish.	10
		60

Suggested Readings:

1) Chapman, R.F. (2013). The Insects: Structure and function. Cambridge University Press.
2) Gullan, P.J. and Cranston, P.S. (2014). The Insects: An Outline of Entomology. Wiley Blackwell.
3) Richards O.W. and Davies R.G. (1977). Imms general text book of Entomology (Vol I) Structure, Physiology & Development. Chapman & Hall.
4) Richards O.W. and Davies R.G. (1977). Imms general text book of Entomology (Vol II) Classification & Biology. Chapman & Hall.
5) Tembhare, D. B. (1997): Modern Entomology. Himalaya Publishing House.
6) Beaumont, A. R. & Hoare, K. (2003). Biotechnology & Genetics in Fisheries and Aquaculture. Blackwell Publishing.
7) Jhingran, V. G. (1991). Fish and Fisheries of India.3rd ed., Hindusthan Pub. Corp. John Wiley & Sons.
8) Lagler, K. F., Bardach, J. E., Miller, R. R. & Passino, D. R. (2003). Ichthyology.
9) Nelson, J. S. (2006): Fishes of the World, 4th Ed. Wiley.
10) Lagler, K. F., Bardach, J. E., Miller, R. R. & Passino, D. R. (2003). Ichthyology.
11) Srivastava, C. B. L. (1999). Fish Biology. Narendra Pub. House.

IBSMSASC904: Bioinformatics, Biostatistics and Bioethics

Theory (4 credits)		
Unit	**Course content**	**Class**
I	1. Data mining and analytical tools of bioinformatic: Sequence and structure databases.	6
	1. Sequence analysis (biomolecular sequence file formats, scoring matrices, sequence alignment approaches, phylogeny) 2. Tools for genomic and proteomic studies.	8
	1. Concept of data mining, analytical tools and techniques of Genomics, transcriptomics, proteomics and metabolomics.	8
	1. Functional and pharmaco genomics including microarrays, 2. Next Generation Sequencing.	8
II	**Biostatistics:** 1. Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); Sampling distribution. 2. Difference between parametric and non-parametric statistics. 3. Confidence Interval; Errors; Levels of significance. 4. Regression and Correlation. 5. t-test; Analysis of variance..	16
	1. Use of statistical software in Biology.	2

	Bioethics: 1. Animal cruelty act and its implications, CPCSEA guidelines. 2. Role of NGO in animal cruelty prevention 3. Animal quarantine act, animal business and its law.	12
		60

Suggested Readings:

1) Bioinformatics: Sequence and Genome Analysis by David W. Mount, D.W. Cold Spring Harbor Laborator Press.
2) Bioinformatics and Functional Genomics by J. Pevsner, John Wiley & Sons, Inc. (New Jersey).
3) Biotechnology: Expanding Horizon by B.D. Singh
4) Biostatistics by K.S Negi
5) Statistical Methods Vol I and II by N. G. Das

IBSMSASC905: Practical 5

Practical (4 Credits)

Animal Biotechnology and Biophysics:

1) Determination of viability of cultured cells using MTT assay.
2) Preparation and amplification of cDNA.
3) Spectroscopic analyses of DNA, RNA and protein and determination of absorption maxima.
4) Experimental validation of Lambert-Beer Law.

Animal Health and Pathology:

5) Preparation and staining of blood smear. Blood smear examination and interpretation.
6) Total leukocyte count
7) Differential leukocyte count
8) Different anticoagulant used in haematology, interpretation of blood tests (haemoglobin, packed cell volume, total erythrocyte count, erythrocytic indices, erythrocytic sedimentation rate
9) Faecal examination for presence of parasitic eggs.
10) Examination of skin scrapings from affected area.

End Semester Examination Pattern: Full marks – 20

1) Experiment (1 from item no 1, 2): 5 marks
2) Experiment (1 from item no 3, 4): 5 marks
3) Preparation (1 from item no 5, 6, 7): 5 marks
4) Experiment (1 from item no 8, 9, 10): 5 marks
5) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
6) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.

Suggested Readings:

1) Physical Biochemistry by David Freifelder.
2) Molecular Cloning by Sambrook & Russel.
3) McGavin MD & Zachary JF. 2006. Pathologic Basis of Veterinary Diseases. 4th Ed. Elsevier
4) Vegad JL. 2007. Text Book of Veterinary General Pathology. 2nd Ed. International Book Distr.
5) Meuten DJ. 2002. Tumors in Domestic Animals. 4th Ed. Blackwell.
6) Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology.

IBSMSASC906: Practical 6

Practical (4 Credits)

Entomology and Ichthyology:

1) Identification: Common Insect and Fish species.
2) Dissection: Digestive system and Nervous system of Grasshopper/ Honey bee.
3) Dissection: Urinogenital system and Efferent branchial system of Teleosta.
4) Mounting: Different types of scales in Fish, Pecten from Fowl.
5) Field visit for study of natural Insect and Fish habitats or culture centres.

Bioinformatics, Biostatistics and Bioethics:

6) BLAST and MSA of given query sequences and construction of a phylogenetic tree.
7) Homology modeling of a protein structure using a given amino acid sequence.

8) Statistical analysis – Chi-square, Student's t test, ANOVA

End Semester Examination Pattern: Full marks – 20

1) Identification (4 from item no. 1): 4 marks
2) Dissection (1from item no. 2, 3) 6 marks
3) One analysis from item no. 6 & 7: 5 marks
4) Statistical analysis: 5 marks
5) Field report: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
6) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
7) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.

Suggested Readings:

1) Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
2) Lal, S. S. (2016). Practical Zoology- Vertebrate. Rastogi Publication.
3) Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology.
4) Bioinformatics: Sequence and Genome Analysis by David W. Mount, D.W. Cold Spring HarborLaborator Press.
5) Bioinformatics and Functional Genomics by J. Pevsner, John Wiley & Sons, Inc. (New Jersey).

IBSMSASMJE1001: Environmental Factors and Rhythm Physiology I

Theory (4 credits)

Unit	Course content	Class
I	1. Origin of life and environment	5
	1. Environmental factors influencing life. 2. The concept of zeitzeber.	5
	1. Milestones in clock research; Chronobiology in 21st century; Evolution of biological timing system; Clocks, genes and evolution. 2. Biological Rhythms - Ultradian, Tidal/ Lunar, Circadian and Circannual rhythms. Temperature effects and compensation; Perception of natural zeitgeber signals. 3. Geophysical environment - Seasons; proximate and ultimate factors.	20
II	1. Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms;	5
	1. Entrainment, masking and zeitgeber cycles; parametric and non-parametric entrainment. 2. Entrainment models; Phase shift, Phase response curves (PRC) and phase transition curves (PTC).	10
	1. Organization of circadian system in multicellular animals. 2. Concept of central and peripheral clock system. 3. Circadian pacemaker system in invertebrates with particular reference to Drosophila. 4. Circadian pacemaker system in vertebrates with particular reference to rodent.	10
	1. Suprachiasmatic nucleus (SCN) as the main vertebrate clock; concept of core and shell.	5
		60

Suggested Readings:

1. Alcock, J. (2001). Animal Behaviour: An Evolutionary Approach. , Sinauer Associate Inc., USA.
2. Chattopadhyay, S. (2012). Life: Evolution, Adaptation, Ethology. 3rd Edn. Books and Allied, Kolkata.
3. Dujatkin, L.A. (2014). Principles of Animal Behaviour. 3rd Edn. W.W.Norton and Co.
4. Dunlap, J.C., Loros, J.J. and De Coursey, J.P. (2004). Chronobiology: Bioloigcal Time keeping. Sinauer Associates, Inc. Publishers, Sunderland, MA, USA

IBSMSASMJE1002: Molecular Parasitology and Immunology I

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Human clinical and veterinary parasitology:** Life cycles, pathogenesis, identification, diagnosis, prophylaxis, treatment,and pharmacology of giardiasis, amoebiasis, malaria, leishmaniasis, filariasis, trypanosomiasis, schistosomiasis and soil-transmitted helminthiases.	6
	Vectors and their importance in transmission of Parasitic diseases: General morphology and life stages of fleas, flies, ticks and mites (*Boophilus sp*. of Babesia, *Trombicula sp*. of Rickettsia, *Xenopsylla cheopis* of-plague vector, *Phlebotomus* sp. of Leishmaniasis, *Glossina* sp. of trypanosomiasis, Mosquitoes of malaria and filariasis.	4
	Host-parasite interaction: 1. Recognition and entry process of different pathogen and parasites in the host cell/ body. 2. Alteration of host cell behavior by pathogens 3. Antigen refractory and immune mimicry.	10
	Molecular biology of parasites: 1. Molecular basis of antigenic variation and diversity of parasites. 2. Molecular organization and gene structure in antigenic variation; Role of RNAi. 3. Strategies of molecular cloning and protection against parasite infections.	10
II	**Cells and organs involved in immune system**: 1. Mononuclear and polymorphonuclear phagocytotic cells; 2. Primary (bone marrow, thymus) and secondary lymphoid organs (spleen, tonsil, CALT, MALT, GALT).	6
	Innate immunity: 1. Anatomical barriers 2. Physiochemical mediators and cell types of innate immunity, Innate receptors (TLR, Scavenger receptor etc.) 3. Signal transduction pathways in activation of innate immunity. Complement activation pathways.	10
	Adaptive immunity: 1. Development, maturation and activation of B- and T- cells. 2. Major histocompatibility complex (genes and antigen presentation). 3. Immunoglobulins - structure classes and subclasses. 4. Generation of antibody diversity and gene rearrangement, class switching, clonal selection and expansion; ADCC.	10
	Immunedysfuntion and therapeutic immunointervention strategies: Immunoglobin-based treatment of infectious, non-infectious diseases and autoimmune diseases.	4
		60

Suggested Readings:

6) Molecular Parasitology by Marr
7) Human parasitology by Burton J Bogtish.
8) General parasitology by Thomas C Cheng
9) Medical parasitology by Markell and Voges
10) Foundation of parasitology by Roberts Janovy
11) Immunology by Kuby (Free man publication)
12) Immunology and immunotechnology by Ashim k. Chakravarty (Oxford university Press)
13) Essentials of immunology by Roitt (Blackwell scientific publication)
14) Cellular & Molecular Immunology by Abbas & Litchman
15) Immunobiology by Janeway

IBSMSASMJE1003: Animal Breeding and Laboratory Animals I

Theory (4 credits)		
Unit	**Course content**	**Class**
I	1. Individual verses population. 2. Genetic Structure of population. 3. Hardy Weinberg Law.	6
	1. Factors affecting changes in gene and genotypic frequencies and their effect on genetic structure of animal populations.	8
	1. Approach to equilibrium under different situations: Viz: Single autosomal locus with two alleles, single sex-linked locus.	8
	1. Small population: random genetic drift, effective population size. 2. Quantitative genetics: gene effects, population mean and variance and its partitioning.	8
II	1. Threshold traits. 2. Genetic and phenotypic parameters - their methods of estimation, uses, possible biases and precision.	6
	1. Inbreeding, different types of inbreeding, its uses and demerits	8
	1. Outbreeding: Different types of outbreeding, heterosis, merits of outbreeding.	10
	1. Crossbreeding and development of crossbreed animals in India and abroad, species hybridization.	6
		60

Suggested Readings:

1) Bulmer MG. 1980. The Mathematical Theory of Quantitative Genetics. Clarendon Press.
2) Crow JF & Kimura M. 1970. An Introduction to Population Genetics. Theory.
3) Harper & Row. Falconer DS & Mackay TFC 1996. An Introduction to Quantitative Genetics. Longman.
4) Jain JP. 1982. Statistical Techniques in Quantitative Genetics. Tata McGrawHill. Pirchner F. 1981. Population Genetics in Animal Breeding. S. Chand.
5) Van Vleck LD, Pollak EJ & Bltenacu EAB. 1987. Genetics for Animal Sciences. WH Freeman.

IBSMSASMJE1004: Cell and Molecular Biology I

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Cellular organization:** 1. Membrane structure and transport of small molecules, electrical properties of membrane. 2. Cytoplasmic organelles: Ultra structure and function. 3. Cytoskeleton and its role in motility. 4. Cell junction, cell adhesion and extracellular matrix.	10
	Protein folding, sorting and trafficking: 1. Chaperones and protein folding. 2. Process of protein sorting and trafficking, vesicular transport, protein import and mitochondrial assembly. 3. Trafficking between nucleus and cytoplasm.	8
	Cell signaling: 1. Hormones and their receptors, cell surface receptor. 2. Signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways. 3. Bacterial two-component signaling systems, bacterial chemotaxis and quorum sensing.	12
II	**Cancer :** 1. Oncogenes, tumor suppressor genes. 2. Cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, therapeutic interventions of uncontrolled cell growth. 3. Tumor angiogenesis. 4. Hybridoma technology and its application in monoclonal antibody production.	7
	Programmed cell death, repair and recombination: 1. Apoptosis and its regulation. 2. Aging and senescence. 3. DNA damage and repair.	7

	4. Homologous and non-homologous recombination.	
	Host cell-pathogen interaction : 1. Recognition and entry process of bacteria and virus in to host cell. 2. Alteration of host cell behaviour by pathogens. 3. Virus induced cell transformation. 4. Cell-cell fusion in both normal and abnormal cells.	6
	Control of gene expression at transcription and translation level: 1. Regulating the expression of phages- Lysogenic and lytic cycles, prokaryotic and eukaryotic genes, role of chromatin in gene expression. 2. Dosage compensation, DNA methylation and acetylation, Imprinting, RNA editing and degradation	10
		60

Suggested Readings:

1) Alberts, B. et al. (2008). Molecular Biology of the Cell. 5th Ed. Garland Publishing House.
2) Brooker. (2001). Genetics. McGraw-Hill.
3) Brown, T. A. (2002). Genomes 2. Wilely-Liss. Clark, D. P. (2005). Molecular Biology. Elsevier.
4) Clark, D.P. (2009). Understanding the Genetic Revolution. Academic Press.
5) Cooper, G. M. (2004). The Cell. 3rd edn. ASM Press.
6) Hancock, J.T. (2008). Molecular Genetics. Viva Book Private Ltd.
7) Hartl, D. L. & Jones, E. W. (1998). Genetics, Principles and analysis. (4th ed). Blackwell Scientific, Oxford.
8) Hartl, D. L. & Jones, E. W. (2005). Genetics: analysis of genes and genomes. 6th ed.
9) Jones and Bartlett Publishers, Sudbury, Mass. Hartl, D. L. & Jones, E. W. (2006).
10) Essential Genetics: a genomics perspective (4th ed.). Jones and Bartlett Publishers, Boston.
11) Hartwell et al. (2001) Genetics: From genes to Genomes. McGraw Hill.
12) Harvey, L. (2004). Molecular cell Biology. 5th ed. W.H.Freeman.
13) Karp, G. (2008). Cell and Molecular Biology: Concepts and experiments.5th edn., John Wiley.

IBSMSASC1005: Entomology I

Theory (4 credits)		
Unit	**Course content**	**Class**
I	***I. Insect Morphology***	
	Morphology and Biology of the orders: Collembola, Orthoptera, Hemiptera, Lepidoptera, Coleoptera, Diptera, Strepsiptera & Hymenoptera.	12
	Integument: Structure, formation and functions of cuticle, Cuticular modifications, Moulting	4
	Head: 1. Modified Mouthparts (Orthopteroid, Hemipteroid and Neuropteroid). 2. Types of eye – Dorsal ocelli, Stemmata, Compound eye; Image formation.	4
	Thorax: 1. Articulation and modification of leg. 2. Morphological variation of wing, wing coupling apparatus and mechanism of flight.	4
	Perception: 1. Chemoreception - structure of cuticular and contact receptors, distribution & functions. 2. Mechanoreception - Structure and functions of cuticular, cellular, proprioceptors, chordotonal and tympanal organs.	4
	Exocrine glands: Important exocrine glands, structure and functions.	2
II	***II. Insect Physiology***	
	Respiratory system: 1. Respiratory organs 2. Physiology of gaseous, gill and plastron respiration.	4
	Nervous system: Central nervous system, Brain, Sympathetic nervous system.	4
	Reproduction: 1. Male and Female reproductive system, Special types of reproduction. 2. Factors controlling fecundity and fertility. 3. Swarming and Oviposition.	5
	Development:	5

	1. Insect eggs, Embryonic development and dynamics. 2. Post-embryonic development and metamorphosis - Types with examples, 3. Larva and pupa - structure and types.	
	Endocrine system: 1. Anatomical organization. 2. Structure and hormones. 3. Endocrine control of metamorphosis, diapause	4
	Insect behaviour: 1. Feeding behaviour - types of feeding and damage, host range and host selection. 2. Reproductive behaviour - mate location, mating frequency and oviposition. 3. Social organization and social behaviour of social insects (Honeybee/ Termites).	6
	Gall formation: Insects involved, mechanism, importance.	2
		60

Suggested Readings:

1) Chapman, R.F. (2013). The Insects: Structure and function. Cambridge University Press.
2) Duntson P.A. (2004). The Insects: Structure, Function and Biodiversity. Kalyani Publ., New Delhi.
3) Gillott, C. (2005). Entomology. 3 ed. Springer Online Book - ISBN-13 978-1-4020-3183-0 (e-book).
4) Gullan, P.J. and Cranston, P.S. (2014). The Insects: An Outline of Entomology. Wiley Blackwell.
5) Kerkut GA & Gilbert LI. 1985. Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vols. I-XIII. Pergamon Press, New York.
6) Klowden. (2002). Physiological Systems in Insects, Academic Press.
7) Patnaik B.D. (2002). Physiology of Insects. Dominant, New Delhi.Gillott, C. (2005). Entomology. 3 ed. Springer
8) Richards O.W. and Davies R.G. (1977). Imms general text book of Entomology (Vol I) Structure, Physiology & Development. Chapman & Hall.
9) Richards O.W. and Davies R.G. (1977). Imms general text book of Entomology (Vol II) Classification & Biology. Chapman & Hall.
10) Snodgrass, R.F. (1935). Principles of Insect Morphology. Tata McGraw-Hill Publishing Company Ltd.
11) Tembhare, D. B. (1997): Modern Entomology. Himalaya Publishing House.
12) Wigglesworth V.B. (1984). Insect Physiology. 8th Ed. Chapman & Hall, New York.

IBSMSASMJE1006: Environmental Factors and Rhythm Physiology II

Theory (4 credits)		
Unit	**Course content**	**Class**
I	1. Diversity and complexity of the clock system. 2. Melatonin: Input or output signal of the clock system;	8
	1. Molecular Biology of the circadian pacemaker system: Experiments in the generation of models for the feedback loop comprising the clock, Pre-molecular genetics era, Generic core circadian feedback loop.	10
	1. Molecular clockworks in Cyanobacteria, Neurospora, Drosophila and mammals. 2. Cellular and molecular bases of Entrainment.	6
	1. Experiments in the generation of models for the feedback loop comprising the clock, Pre-molecular genetics era, Generic core circadian feedback loop. 2. Molecular clock works in Fish and Mammal.	6
II	1. Photoreception and photo-transduction. 2. The physiological clock and measurement of day length.	6
	1. Role of photic and non-photic cues in seasonality. 2. Reversal of roles of principal and supplementary cues.	6
	1. Evolution of photoperiodism: comparative studies; Circannual rhythms and seasonality; Molecular bases of seasonality;	8
	1. The relevance of biological clocks for human welfare - Clock function (dysfunction). 2. Human health and diseases - Chronopharmacology, chronomedicine, chronotherapy.	10
		60

Suggested Readings:

1. Alcock, J. (2001). Animal Behaviour: An Evolutionary Approach. , Sinauer Associate Inc., USA.
2. Chattopadhyay, S. (2012). Life: Evolution, Adaptation, Ethology. 3rd Edn. Books and Allied, Kolkata.
3. Dujatkin, L.A. (2014). Principles of Animal Behaviour. 3rd Edn. W.W.Norton and Co.
4. Dunlap, J.C., Loros, J.J. and De Coursey, J.P. (2004). Chronobiology: Bioloigcal Time keeping. Sinauer Associates, Inc. Publishers, Sunderland, MA, USA

IBSMSASMJE1007: Molecular Parasitology and Immunology II

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Immunomodulation and immune-evasion by parasites**: 1. Mechanism of host-parasite and host-vector interactions in leishmaniasis and malaria. 2. Mechanism of antigenic variation in malaria, trypanosomiasis and giardiasis. 3. Immunomodulation in lymphatic filariasis and amoebiasis.	10
	Drug resistance and its molecular mechanism: 1. Emergence of drug resistance in medically important parasites. 2. Mechanism of drug resistance, identification of resistant strain, Role of SNPs.	6
	Antiparasitic drug development approaches: 1. Classical medicical chemistry approach. 2. Rational drug design, high-throughput screening, Pharmacokinetics, pharmacodynamics, biotransformation and bioavailability.	6
	Techniques of molecular parasites and recent trends in molecular parasitology research: 1. Whole genome sequencing; cDNA mapping, Worm base, Polymorphism analysis. 2. Altered pathogenicity of parasites.	8
II	**Antiparasitic vaccine development**: 1. Immunization techniques. 2. Types of vaccines, antibody engineering and generation of antibody using recombinant DNA technology.	6
	Immunotherapy of animal diseases: 1. Recombinant cytokines and their use in the treatment of animal infections. 2. Monoclonal antibodies in therapy; vaccines and their applications in animal infections 3. Gene therapies immunotherapy for treating animal diseases.	6
	Immunological techniques: 1. Flow cytometry (FACS and MACS) based sorting of immune cells, cytokines and chemokines and analysis of signalling pathways. 2. Different types of serological tests (Precipitation, Agglutination, Immunofluorescence, RIA, ELISA, Flowcytometry). 3. Vaccines for bacterial, viral, protozoal and parasitic infections.	8
	Recent trends in immunology: 1. Analysis of immune regulatory circuits, Polymorphisms in innate immune receptors. 2. Development of polyreactive antibodies 3. Use of immunoglobin enriched plasma for treating complex infectious and autoimmune diseases, Abzymes 4. Antibodies as anticancer agents.	10
		60

Suggested Readings:

1) Molecular Parasitology by Marr
2) Human parasitology by Burton J Bogtish.
3) General parasitology by Thomas C Cheng
4) Medical parasitology by Markell and Voges
5) Foundation of parasitology by Roberts Janovy
6) Immunology by Kuby (Free man publication)
7) Immunology and immunotechnology by Ashim k. Chakravarty (Oxford university Press)
8) Essentials of immunology by Roitt (Blackwell scientific publication)
9) Cellular & Molecular Immunology by Abbas & Litchman
10) Immunobiology by Janeway

IBSMSASMJE1008: Animal Breeding and Laboratory Animals II

Theory (4 credits)		
Unit	**Course content**	**Class**
I	1. Heritability, types of heritability, its significance and uses. 2. Repeatability: Significance and uses.	6
	1. Selection, natural verses artificial selection. 2. Selection on the basis of single trait and multi-trait selection.	2
	1. Bases of selection: individual selection, sib selection, family selection, pedigree selection, combined selection and progeny testing.	12
	1. Selection for general and specific combining ability. 2. Genetic polymorphism and its application in genetic improvement.	6
	1. Quantitative trait loci 2. Marker-assisted selection 3. Genomic selection.	4
II	1. Introduction to laboratory animal genetics – Breeding colonies of mice, rats, hamsters, guinea pigs and rabbits.	8
	1. Selection and Mating methods/ systems – monogamous, polygamous and others.	6
	1. Development of genetically controlled laboratory animals – Rules for nomenclature 2. Inbred strains, outbreed stocks, mutant stocks, recombinant inbred strains. 3. Transgenic strains, gene targeting and production of 'gene knock-out' animals.	8
	1. Genetic control and monitoring – Record keeping – Ethics of laboratory animal use.	8
		60

Suggested Readings:

1) Bulmer MG. 1980. The Mathematical Theory of Quantitative Genetics. Clarendon Press.
2) Crow JF & Kimura M. 1970. An Introduction to Population Genetics. Theory.
3) Harper & Row. Falconer DS & Mackay TFC 1996. An Introduction to Quantitative Genetics. Longman.
4) Jain JP. 1982. Statistical Techniques in Quantitative Genetics. Tata McGrawHill. Pirchner F. 1981. Population Genetics in Animal Breeding. S. Chand.
5) Van Vleck LD, Pollak EJ & Bltenacu EAB. 1987. Genetics for Animal Sciences. WH Freeman.

BSMSASMJE1009: Cell and Molecular Biology II

Theory (4 credits)		
Unit	**Course content**	**Class**
I	**Concepts on Inheritance Biology:** 1. Mendelian principles and its deviation, extension of Mendelian principles – co dominance, incomplete dominance, gene interactions, pleitropy, penetrance and expressivity, phenocopy. 2. Linkage and crossing over, sex linked, sex-limited and sex influenced character. 3. Sex determination, dosage compensation in *Drosophila*, *Caenorhabditis elegans* and mammals, 4. Genetic disorders, polygenic inheritance, heritability and its measurements, QTL. linkage mapping, microbial genetics.	12
	RNA interference and antisense technology : 1. siRNA, shRNA, miRNA, therapeutic use of RNA interference.	8
	Transcriptome and Proteome: 1. Concepts of transcriptome and proteome, gene families, interrupted gene, pseudogenes, and transposable genetic element. 2. Random mutagenesis, mutation screens, complementation & suppression, Manipulation of genes, site-specific mutagenesis, reporter genes expression, genomic expression profiling.	10
II	**Recombinant DNA technology :** 1. Molecular techniques in gene cloning, DNA modifying enzymes (restriction endo Nuclease, kinase, polymerases, ligases). 2. Gene transfer and transfection methods, transgenic animal production- DNA integration. Use of cre/loxp in transgenic animal production.	10

	3. Somatic cloning, use of plasmids and vectors in recombinant DNA technology.	
	Techniques in Molecular Biology : 1. PCR, RT-PCR, Real time PCR, Restriction mapping, RAPD, RFLP. AFLP, Chromosome walking, site directed mutagenesis. Gel retardation assay, RNase protection assay. 2. Protein sequencing techniques, in situ localization - FISH and GISH, Microarray technique, DNA sequencing methods, RIA, ELISA, 3. Gene knock out techniques in bacterial and eukaryotic organisms.	12
	Methods of cell and tissue culture: 1. Monolayer and Suspension culture, co-culture, Cell Freezing. Embryonic stem cell Culture.	8
		60

Suggested Readings:

1) Alberts, B. et al. (2008). Molecular Biology of the Cell. 5th Ed. Garland Publishing House.
2) Brooker. (2001). Genetics. McGraw-Hill.
3) Brown, T. A. (2002). Genomes 2. Wilely-Liss. Clark, D. P. (2005). Molecular Biology. Elsevier.
4) Clark, D.P. (2009). Understanding the Genetic Revolution. Academic Press.
5) Cooper, G. M. (2004). The Cell. 3rd edn. ASM Press.
6) Hancock, J.T. (2008). Molecular Genetics. Viva Book Private Ltd.
7) Hartl, D. L. & Jones, E. W. (1998). Genetics, Principles and analysis. (4th ed). Blackwell Scientific, Oxford.
8) Hartl, D. L. & Jones, E. W. (2005). Genetics: analysis of genes and genomes. 6th ed.
9) Jones and Bartlett Publishers, Sudbury, Mass. Hartl, D. L. & Jones, E. W. (2006).
10) Essential Genetics: a genomics perspective (4th ed.). Jones and Bartlett Publishers, Boston.
11) Hartwell et al. (2001) Genetics: From genes to Genomes. McGraw Hill.
12) Harvey, L. (2004). Molecular cell Biology. 5th ed. W.H.Freeman.
13) Karp, G. (2008). Cell and Molecular Biology: Concepts and experiments.5th edn., John Wiley.

IBSMSASC1010: Entomology II

Theory (4 credits)		
Unit	**Course content**	**Class**
I	***I. Applied Entomology***	
	Crop Husbandry: 1. Bionomics and Management of pests of Paddy, Wheat, Jute, Sugarcane, Mango, Oil-seed crops, Vegetables and Stored grains. 2. Polyphagous pest. 3. Concept of injury level, Economic level of injury, Economic threshold level.	10
	Management of insect pests: 1. Integrated pest Management (IPM). 2. Chemical control: Organochemicals, Inorganic chemicals and Phytochemicals. Mode of action of toxicants. 3. Physical, Mechanical and Cultural control. 4. Biological Control: Predators, Parasitoids, Nematodes and other animals. 5. Hormonal control: Concept and use of Juvenoids, Ecdysoids and Insect growth regulators (IGRs). 6. Genetic control: Methods of genetic manipulation and field trials. 7. Biotechnological control: Transgenic plants and Transgenic agents. 8. Insect Fumigants, Attractants, Repellents and Antifeedants. 9. Impact of different management methods on environment. Pest control equipments.	20
II	***II. Applied Entomology***	
	Veterinary Entomology: 1. General biology, Vector potentiality, Pathogenesis and control of Arthropods affecting Animals: Biting midges (*Culicoides*), Black flies (*Simulium*), Warbles (*Hypoderma*), Nasal bots (*Oestrus ovis*), Stomach bots (*Gasterophilus*), Bottle flies (*Calliphora, Lucilia, Chrysomya*), Sand flies (*Phlebotomus*), Mosquitoes (*Culex, Anophele, Aedes*), Horse flies (*Tabanus*). 2. Fleas (*Ctenocephalides, Xenopsylla*). 3. Soft ticks (*Argas, Ornithodoros, Otobius*). 4. Hard ticks [*Hyalomma, Haemaphysalis, Rhipicephalus, (Boophilus), Dermacentor, Ixodes, Amblyomma*]. 5. Mites (*Demodex, Sarcoptes, Psoroptes*).	12
	Medical Entomology:	5

	1. Biology of Mosquitoes, Sand flies, House flies, Human lice and Rat fleas with role in disease transmission in Humans and their control. 2. Promise of Pharmaceutical Entomology.	
	Industrial Entomology: Recent trends in Sericulture (Mulberry, Tasar, Muga and Eri), Lac culture and Apiculture.	5
	Forest Entomology: Insects causing damage to the forests - Defoliators, Borers and Sapsuckers.	4
	Forensic Entomology: Insects associated with the corpses and carrions, Techniques in forensic entomology.	4
		60

Suggested Readings:

Atwal, A.S. and Dhaliwal, G.S. (2002). Agricultural pests of South Asia and their management. Kalyani Publ., NewDelhi.
Bhati,aB.B., Pathak, K.M.L. and Juyal, P.D. (2016). Textbook of Veterinary parasitology. Kalyani Publ., NewDelhi.
Bruin, J. and Geest, L.P.S. (2009). Diseases of Mites and Ticks. Springer.
Cameron, M. and Lorenz, L. (2013). Biological and Environmental Control of Disease Vectors. CABI.
Chandra, G. (2000). Mosquito. Sribhumi Pub. Co., Kolkata.
Dhaliwal, G.S. & Koul O. (2007). Biopesticides and Pest Management. Kalyani Publ., NewDelhi.
Fenemore P.G. and Prakash A. (2015). Applied Entomology. New Age International (P) Ltd.
Ghosh M.R. (2008). Concepts of Insect Control. New Age International (P) Ltd.
Hati, A. K. (2001). Medical Entomology. Allied Book Agency, Kolkata.
Mullen, G.R. and Durden, L.A. (2019). Medical and Veterinary Entomology. 3rd Ed. Academic Press.
Norris R.F., Caswell-Chen E.P. and Kogan M. (2002). Concept in Integrated Pest Management. Prentice Hall, NewDelhi.
Shukla, G. S. and Upadhyay, V. B. (2005). Economic Zoology. 4th Ed. Rastogi Publication.
Singh R. (2018). Elements of Entomology. Rastogi Publications.
Soulsby (2012). Helminths, arthropods and Protozoa of Domesticated Animals. 7th Ed. EWP
Srivastava, K. P. (1988). A textbook of Applied Entomology. Vol. II. 2nd Ed. Kalyani Publishers, NewDelhi.
Wall R. and Shearer D. (1997). Veterinary Entomology. 1st Ed. Chapman & Hall.
Williams R.E. (2009). Veterinary Entomology, Livestock & Companion Animals. 1st Ed. CRC Press.

IBSMSASMJE1011: Environmental Factors and Rhythm Physiology III PRACTICAL

Practical (4 credits)
1. Assay of circadian rhythms using animal model systems. 2. Assay of circadian activity rhythms in human. 3. Ambulatory blood pressure monitoring and circadian analysis. 4. Quantifying oscillations: phase, period and amplitude. 5. Dry lab exercises on the previously recorded data. 6. Recording of body temperature (Tb) of human. 7. Experiments demonstrating the photoperiodic clock.
End Semester Examination Pattern: Full marks – 20 1) One performance from item no. 1 to 5: Marks 8 2) Performance item no. 6,7 and 8: Marks 8 3) Laboratory note book: 4 marks 4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***. 5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.
Suggested Readings: 1. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA 2. Insect Clocks D.S. Saunders, C.G.H. Steel, X., afopoulou (ed.) R.D. Lewis. (3rd Ed) 2002 Barens and Noble Inc. New York. 3. Biological Rhythms: Vinod Kumar (ed 2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

IBSMSASMJE1012: Molecular Parasitology and Immunology III PRACTICAL

Practical (4 credits)
1. Determination of the efficacy (LD50; IC50) of antiparasitic drugs (praziquantel, ivermectin, DEC, albendazole) on different parasites of rat/human/chicken and investigation of the effect of the drug at molecular level (DNA, RNA, protein and oxidative parameters). 2. Isolation of total protein from helminth parasite and determination of protein profile using SDS-PAGE & Native PAGE. 3. Assessment of parasite mediated activation of immune cells and determination of TLR4 signaling pathway. 4. Isolation and characterization (Giemsa staining) of peritoneal macrophages. 5. Isolation PBMC using phycoll-density gradient centrifugation using human/animal blood. 6. Isolation of monocytes from PBMC, differentiation to macrophages/dendritic cells and characterization using flow cytometry. Assessment of macrophage migration. 7. Co-culture and transculture of macrophage/dendritic cells &naïve T- cellsof immune cells. 8. ELISA and immunofluorescence of cytokines and chemokines.
End Semester Examination Pattern: Full marks – 20 1)Experiment from item no. 1 to 3: 7 marks 2) Experiment from item no. 4 to 6: 7 marks 3) Experiment from item no. 7 & 8: 6 marks 4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***. 5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.
Suggested Readings: 1) Molecular Cloning by Sambrok and Russel 2) Practical Biochemistry by David T Plummer, 3rd Edition 2) Biochemical Methods by S. Sadasivan and A. Manikam, 3rd Edition 3) Modern Experimental Biochemistry by Rodney Boyer, 3rd Edition

IBSMSASMJE1013: Animal Breeding and Laboratory Animals III PRACTICAL

Practical (4 credits)	
Unit	**Course content**
I	1. Problems on Hardy Weinberg Law. 2. Correlation, properties of correlation, types of correlation, problems on correlation. 3. Regression, difference between correlation and regression, problems on regression. 4. Concepts of Heritability and Repeatability, types of heritability. Problems based on heritability and repeatability. 5. Problems on Inbreeding, inbreeding coefficient and coefficient of relationship. 6. Problems on Heterosis. 7. Visit to a laboratory animal house 8. Handling of laboratory animals 9. Nutritional requirements of laboratory animals 10. Breeding and Reproductive management in laboratory animals
End Semester Examination Pattern: Full marks – 20 1) Problems from item no. 1: 7 marks 2) Problems from item no. 2 to 4: 7 marks 3) Problems from item no. 5 & 6: 6 marks 4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***. 5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.	
Suggested Readings: 1) Bulmer MG. 1980. The Mathematical Theory of Quantitative Genetics. Clarendon Press. 2) Crow JF & Kimura M. 1970. An Introduction to Population Genetics. Theory. 3) Harper & Row. Falconer DS & Mackay TFC 1996. An Introduction to Quantitative Genetics. Longman. 4) Jain JP. 1982. Statistical Techniques in Quantitative Genetics. Tata McGrawHill. Pirchner F. 1981. Population Genetics in Animal Breeding. S. Chand. 5) Van Vleck LD, Pollak EJ & Bltenacu EAB. 1987. Genetics for Animal Sciences. WH Freeman.	

IBSMSASMJE1014 Cell and Molecular Biology III PRACTICAL

Theory (4 credits)		
	Course content	**Class**
	1) Basic principle of experimental animal handling and ethical issues and biosafety for molecular biology work. 2) Identification of different embryonic stages and mutants of *Drosophila*, Preparation of *Drosophila* food. 3) Slide preparation for Polytene chromosome from Salivary gland of *Drosophila* larvae. 4) Cell viability test using vital dye. 5) Identification of Mitotic and meiotic cell division stages using onion root tip and grass hopper testis respectively. 6) Slide preparation for metaphase chromosome from rat bone marrow/blood. 7) Karyotype and idiogram preparation (G, C banding), human lymphocyte culture. 8) Single cell gel electrophoresis assay. 9) Reporter gene assay using transgenic insect model. 10) Extraction of DNA from animal tissue/blood. 11) Extraction of RNA from animal tissue. 12) Preparation of culture media, *E. coli* culture preparation and plasmid isolation. 13) Agarose gel electrophoresis for plasmid, genomic DNA and RNA. 14) PCR and RT-PCR. 15) Separation of protein from mouse/rat tissue on native and/ denaturation gel (PAGE) and western blotting.	

End Semester Examination Pattern: Full marks – 20

1) Identification of *Drosophila* mutants (any two): 4
2) Cytological preparations from item number 3/4/5/6/7: 8
3) Practical from item number 8/9/10/11/12/13/14/15 : 8
4) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
5) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.

Suggested Readings:

1) Alberts, B. et al. (2008). Molecular Biology of the Cell. 5th Ed. Garland Publishing House.
2) Brooker. (2001). Genetics. McGraw-Hill.
3) Brown, T. A. (2002). Genomes 2. Wilely-Liss. Clark, D. P. (2005). Molecular Biology. Elsevier.
4) Clark, D.P. (2009). Understanding the Genetic Revolution. Academic Press.
5) Cooper, G. M. (2004). The Cell. 3rd edn. ASM Press.
6) Hancock, J.T. (2008). Molecular Genetics. Viva Book Private Ltd.
7) Hartl, D. L. & Jones, E. W. (1998). Genetics, Principles and analysis. (4th ed). Blackwell Scientific, Oxford.
8) Hartl, D. L. & Jones, E. W. (2005). Genetics: analysis of genes and genomes. 6th ed.
9) Jones and Bartlett Publishers, Sudbury, Mass. Hartl, D. L. & Jones, E. W. (2006).
10) Essential Genetics: a genomics perspective (4th ed.). Jones and Bartlett Publishers, Boston.
11) Hartwell et al. (2001) Genetics: From genes to Genomes. McGraw Hill.
12) Harvey, L. (2004). Molecular cell Biology. 5th ed. W.H.Freeman.
13) Karp, G. (2008). Cell and Molecular Biology: Concepts and experiments.5th edn., John Wiley.

IBSMSASMJE1015: Entomology III PRACTICAL

Practical (4 credits)
1. Identification with reasons (up to family) of Exopterygote and Endopterygote insects. 2. Identification of common Insect Pests, Vectors, Parasites and economically important Insects. 3. Dissection: Digestive system, Reproductive system and Nervous system of Blue bottle fly/ Wasp/ Cockroach. 4. Mounting: Different types of Antennae, Mouthparts, Legs and wings; Tympanum. 5. Equipments and Methods of insect collection and preservation/ mounting. 6. Preparation of Insect blood smear, staining and identification. Chitosan test of cuticle. 7. Determination of LC_{50}/ LD_{50} 8. Visit to any biodiversity reach place to study Entomofauna or Sericulture/ Lac culture/ Apiculture farm.
End Semester Examination Pattern: Full marks – 20 1) Identification (3 from item no. 1, & 2 from item no. 2): 10 marks 2) Dissection (1 from item no. 3): 6 marks 3) Physiological test (from item no. 6): 2 marks

4) Submission of collected preserved and mounted insects: 2 marks
5) Field report: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
6) Laboratory note book: ***mandatory to produce during the examination but marks will be allotted from internal assessment***.
7) Viva-voce: ***mandatory in the examination but marks will be allotted from internal assessment***.

Suggested Readings:

1) Devasahayam H.L. (2011). Practical Manual of Entomology (Insects and Non-insects Pests). New India Publ. Agency.
2) Fenemore P.G. and Prakash A. (2015). Applied Entomology. New Age International (P) Ltd.
3) Mullen, G.R. and Durden, L.A. (2019). Medical and Veterinary Entomology. 3rd Ed. Academic Press.
4) Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015). Advanced Practical Zoology. Books and Allied (P) Ltd.
5) Trigunayat M.M. (2001). A Manual of Practical Entomology. Scientific Publishers Journals Dept

IBSMSASC1001: Project Work/ Term Paper

Related to MJE (Credit 4)

[**End Semester Evaluation:** Thesis submission – 25, Presentation – 15 & Viva-voce – 10]

KAZI NAZRUL UNIVERSITY

Ph.D. in Animal Science (W.E.F. 2019-2020)

Course of Study Code	Discipline Code	Discipline	Semester*	Course Name	Course Type	Course Code	Course Details	L - T - P	Course Credit	Semister Credit
Ph.D.	PHDAS	Animal Science	I	**Research Methodology**	CC	PHDAS-101	CC-1	4 - 0 - 0	4	4
			I	**Elective Paper (Any One)** Endocrinology and Chronobiology Molecular Parasitology & Immunology Animal Breeding & Genetics Molecular & Clinical Toxicology Vector Biology and Vector Borne Disease of Animals Animal Biotechnology	CC	PHDAS-102	CC-2	4- 0 - 0	4	4
			II	**Review of Research Work**	CC	PHDAS-201	CC-3	0 - 0 -8	4	4
						Total Credit / Marks				**12**

Abbreviations: PHD = Doctor of Philosophy; PHDAS= Doctor of Philosophy in Animal Science; CC=Core Course; L= Lecture Hour; T= Tuto

CA Marks		Total Marks	Sem Marks
Report Submission and Presentation	Theoretical		
	50 (10+40)	50	50
		50	50
50 (30+20)		50	50
		150	150

rial Hour; P= Practical Hour; C= Core; CA Marks= Continuous Assessment Mark

Ph.D. Programme in Animal Science

(W.E.F. 2019-2020)

Department of Animal Science

Kazi Nazrul University

Asansol-713340, West Bengal

India

DOCTOR OF PHILOSOPHY (Ph.D.) IN ANIMAL SCIENCE

Summary of the Ph.D. coursework

	SEMESTER CREDITS		Total credits
	Theory	Practical	
Semester – I	8		8
Semester – II		4	4
Total	8	4	12

SEMESTER – I (CREDITS – 8)					
COURSE CODE	**COURSE**	**DIVISION**	**CREDIT POINT**	**EXAM HOURS**	**FULL MARKS**
PHDAS-101	Research Methodology	Theory	4	10+40	50
PHDAS-102	Elective Paper (Any One) 1. Endocrinology & Chronobiology 2. Molecular Parasitology & Immunology 3. Animal Genetics & Breeding 4. Molecular & Clinical Toxicology 5. Vector Biology & Vector Borne Diseases of Animals 6. Animal Biotechnology	Theory	4	10+40	50

SEMESTER – II (CREDITS – 4)					
COURSE CODE	**COURSE**	**DIVISION**	**CREDIT POINT**	**EXAM HOURS**	**FULL MARKS**
PHDAS-201	Review of Research Work	Practical	4	30+20	50

NOTES ON MARKS DISTRIBUTION:

1. In each course, 20% marks is allotted for Internal Assessment, i.e., 10 marks for a paper of 50 marks.
2. Marks distribution for each paper will be as follows: **Eight** *questions (out of ten) of* **1** *mark each, Eight questions (out of ten) of* **2***marks each and two question (out of four) of* **8** *marks are to be answered.*

SEMESTER – I (CREDITS – 8)

PHDAS-101 (Research Methodology) *Total credit: 4*

1. **Microscopy and its Applications in Biology**
   Microscopy: Basic principles and applications of light and fluorescence microscopy, *in situ* hybridization and histology, confocal microscopy and applications of a confocal microscope, Electron microscopy.
2. **Biophysical techniques**
   Spectroscopic techniques including UV-Visible, IR, Fluorescence Spectrophotometer, SPR, CD spectra etc. Mass spectrometry: Basic principles, MALDI-TOF, LC-MS. Chromatography and ultracentrifugation: Principle and applications in analytical and preparative separation, X-ray crystallography, Proteins crystallization and methods for determination of protein structure.
3. **Basic Molecular Biology Techniques**
   Molecular cloning; PCR; Recombinant protein expression and purification; Western blotting; qRT-PCR; gene silencing by siRNA/shRNA; Gene knockout technologies.
4. **Immunological Techniques**
   Immunoblots, ELISA, Flow cytometry analysis and sorting (demo included), Raising of antibodies against a protein/ peptide in rabbit/ mouse/ rat.
5. **Bioinformatics and Biostatistics**
   Basics of sequence alignment, Phylogenetic analysis, Functional genomics including microarrays, Marker analysis, Single Nucleotide Polymorphisms, Next Generation Sequencing; Biostatistics.
6. **Animal handling techniques**
   CPCSEA guidelines, Anaesthesia, Handling of *Drosophila*, Arthropod Pests & Parasites, Zebra-fish, Mice, Rat, Rabbit and Cattle.

PHDAS-102 (Any one Elective) *Total credit: 4*

Elective 1: Endocrinology & Chronobiology

1. Comparative aspects of endocrine physiology in vertebrates. Evolution of pituitary gland; Physiological actions of hormones secreted from pituitary, adrenal and thyroid gland.
2. Milestones in clock research; Chronobiology in 21st century; Evolution of biological timing system; Clocks, genes and evolution. Biological Rhythms - Ultradian, Tidal/ Lunar, Circadian and Circannual rhythms.

3. Melatonin: Input or output signal of the clock system; Molecular Biology of the circadian pacemaker system: Experiments in the generation of models for the feedback loop comprising the clock, Pre-molecular genetics era, Generic core circadian feedback loop; Molecular clockworks in Fish and Mammal.

4. Photoreception and photo-transduction; The physiological clock and measurement of day length; Role of photic and non-photic cues in seasonality. Human health and diseases - Chronodisruption.

Suggested readings:

1. *Comparative Vertebrate Endocrinology, Bentley, P. J., Cambridge University Press, UK*
2. *Vertebrate Endocrinology, Norris D.O., Elsevier Academic Press,*
3. *Hand Book of Physiology, American Physiological Society, Oxford University Press, Section 7: Multiple volumes set*
4. *Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA*
5. *Biological Rhythms: Vinod Kumar (ed 2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany*

Elective 2: Molecular Parasitology & Immunology

1. Parasitic association, Host-parasite interactions, Effect of parasitism on the host, Sources of parasitic infections.

2. Life cycle, mechanism of pathogenesis and drug development against protozoa (*Entamoeba*, *Plasmodium*, *Leishmania)*, *Schistosoma,* Intestinal Tapeworms and Extra-intestinal Tapeworm, Filarial nematodes.

3. Cells and organs involved in immune system, Innate immunity, Anatomical barriers, Physiochemical mediators and cell types of innate immunity, Innate receptors (TLR, Scavenger receptor etc.), Signal transduction pathways in activation of innate immunity. Immunoglobulins- structure classes and subclasses. Generation of Antibody Diversity and Gene rearrangement class switching.

4. Different types of serological tests (Precipitation, Agglutination, Immunofluorescence, RIA, ELISA, Flowcytometry). Vaccines for bacterial, viral, protozoal and parasitic infections.

Suggested readings:

1. *Human parasitology - Burton J Bogtish.*
2. *General parasitology - Thomas C Cheng*
3. *Medical parasitology - Markell and Voges*
4. *Foundation of parasitology - Roberts Janovy*

5. *Immunology - Kuby (Free man publication)*
6. *Immunology and immunotechnology - Ashim k. Chakravarty (Oxford university Press)*
7. *Essentials of immunology by Roitt (Blackwell scientific publication)*
8. ***Online resources:*** *Worm base, Pubmed, International Journal of Parasitology, Journal of Parasitology, Molecular and Biochemical Parasitology, Journal of Infectious diseases, Trends in Parasitology, Journal of Immunology, Immunity, Nature, Cell, Science etc.*

Elective 3: Animal Breeding & Genetics

1. Molecular markers and their application; RFLP, RAPD, Microsatellite/ Minisatellite markers, SNP marker, DNA fingerprinting. Genomic selection.
2. DNA sequencing, Genome sequencing, Genomic Library, Polymerase Chain Reaction (PCR), its types (PCR-RFLP, AS-PCR etc.) and applications; Transgenesis and methods of gene transfer.
3. Fundamental theorem of natural selection. Artificial selection/ Selective breeding: Multistage, Restricted and retrospective selection indices. Development of specialized sire and dam lines; inbred lines and their maintenance; inbreeding and hybridization.
4. Heterosis. General combining ability, Specific combining ability and reciprocal effects; Utilization of non-additive genetic variance. Crossbreeding systems – crossbreeding effects; recurrent and reciprocal recurrent selection and their forms.

Suggested readings:

1. *Akano IE 1992. DNA Technology. IAP Academic Press.*
2. *Micklos DA, Fryer GA & Crotty DA. 2003. DNA Science. Cold Spring Harbour.*
3. *Setlow JK. 2006. Genetic Engineering – Principles and Methods. Springer.*
4. *Falconer DS & Mackay TFC. 1996. An Introduction to Quantitative Genetics. Longman.*
5. *Jain JP. 1982. Statistical Techniques in Quantitative Genetics. Tata McGrawHill.*
6. *Tomar SS 1996. Text Book of Population Genetics. Vol. I. Qualitative Inheritance; Vol. II. Quantitative Inheritance. Universal Publ.*

Elective 4: Molecular & Clinical Toxicology

1. Toxicity tests, Dose, dosage and dose response, Methods of toxicity testing: Bioassays, Acute and Chronic toxicity tests and their importance, Lethal dose and lethal concentration, Threshold limitations: Hormesis, Lower dose extrapolation.
2. Pesticides - Classification and mode of action, Effects in Non-targets and environment, Mechanism of action and metabolism of common groups of pesticides: Organophosphate, Organochlorine, Carbamates and Pyrethroids.

3. Study of toxic impacts of common drugs: Paracetamol, Aspirin, Acetaminophen, Thalidomide. Biotransformation and Metabolism of drugs. Factors affecting toxicity and metabolism of drugs. Impacts of drug toxicity on Lungs, Liver and Kidneys.

4. Case history and Toxicity of Lead, Arsenic and Cadmium, Metal chelation, Importance and scopes of Toxicology in Forensic and Clinical science.

***Suggested readings**:*

1. *Timbrell, J. (2002*). Introduction to Toxicology*, 3rd Ed., Taylor & Francis, London.*
2. *Walker, C. H., Hopkin, S. P., Sibly, R. M. & Peakall, D. B. (2000)*. Principles of Ecotoxicology*, 2nd Ed. Taylor & Francis, London.*
3. *Duffus, J.H. & Worth H.G.J. (Ed.) (2006)*. Fundamental Toxicology. *RSC publishing.*
   Klaassen, C. D. (Ed.) (1996). Casarett & Daul's Toxicology: The Basic Science of Poisons. *5th ed. McGraw-Hill, New York.*
4. *Plant, N. (2003)*. Molecular Toxicology*, 1st Ed. Bios Scientific Publishers.*
   Stine, K. E. & Brown, T. M. (2006). Principles of Toxicology. *2nd Ed. CRC, Taylor & Francis Group, New York.*
5. *Lu, F. C. (1996)*. Basic Toxicology: Fundamentals, Target organs and Risk Assessment. *3rd ed. Taylor & Francis.*
6. *Pandey, K., Shukla, J. P. & Trivedi, S. P. (2005)*. Fundamentals of Toxicology*, New Central Book Agency (P) Ltd. Kolkata.*
7. *De, A. K. (2000)*. Environmental chemisrtry. *4th ed. New Age International (P) Ltd. Publishers.*

Elective 5: Vector Biology and Vector Borne Disease of Animals

1. Equipments, Methods and Parameters to Study Vectors, Pests and Parasites; Arthropod Classification and Identification - Source and Methods; Molecular Phylogenetics/ DNA fingerprinting for Taxonomy and Phylogeny.

2. Management Strategies: Entomopathogenic Bacteria, Fungus and Nematode; Selection and Establishment of Predators in Biocontrol; Development of Phytochemicals for Biocontrol; Sterile Insect Technique; Insect Growth Regulator; Nanotechnology in Insect control; Insecticide Resistance and Strategies for its Management; Evaluation of Management Strategies.

3. Epidemiology and Threat of Vector Born Diseases – Globally and in India; Vector Born Diseases in Economically Important Animals; An Account of the Arthropods affecting Animals; Biology and Management of Some Important Vectors and Parasites; Insect Vectors of Plant Pathogens.

4. Major Parasite and Pathogen Groups Causing Diseases to Animals; Culture, Maintenance and Preservation of Microbes in Laboratory; Preliminary Tests for Developing New Drugs in Microbiology; Biotechnology in Entomology, Parasitology and Microbiology.

***Suggested readings**:*

1. *Imm's general textbook of Entomology (Vol II): Richards & Davies, 1977.*
2. *Medical Entomology: Hati, 1979.*
3. *Biological and Environmental Control of Disease Vectors: Cameron & Lorenz (Eds.), 2013.*
4. *Medical and Veterinary Entomology: Mullen & Durden (Eds.), 2019.*
5. Diseases of Mites and Ticks: Bruin & Geest, 2009.
6. *General Parasitology: Cheng, 2005*
7. *Veterinary Parasitology: Taylor, Coop & Wall, 2016.*
8. *Microbiology – Principles and Explorations: Black & Black, 2015.*
9. *Helminths, arthropods and Protozoa of Domesticated Animals: Soulsby, 2012.*
10. *Veterinary Parasitology: Taylor, Coop & Wall, 2016*
11. *Textbook of Veterinary parasitology: Bhatia, Pathak & Juyal, 2016*

Elective 6: Animal Biotechnology

1. **Animal Cell Culture:** Introduction to basic tissue culture techniques; chemically defined and serum free media; animal cell culture, their maintenance and preservation; various types of cultures suspension cultures, continuous flow cultures, immobilized cultures; somatic cell fusion; cell cultures as a source of valuable products; organ cultures.

2. **Animal Diseases and their diagnosis:** Bacterial and viral diseases in animals; monoclonal antibodies and their use in diagnosis; molecular diagnostic techniques like PCR, in-situ hybridization; northern and southern blotting; RFLP.

3. **Therapy of animal diseases:** Recombinant cytokines and their use in the treatment of animal infections; monoclonal antibodies in therapy; vaccines and their applications in animal infections; gene therapy for animal diseases.

4. **Micromanipulation of embryo's:** What is micromanipulation technology; equipments used in micromanipulation; enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer; micromanipulation technology and breeding of farm animals.

5. **Transgenic animals:** Concepts of transgenic animal technology; strategies for the production of transgenic animals and their importance in biotechnology; stem cell cultures in the production of transgenic animals.

Suggested readings:

1. *Animal Biotechnology. Ranga M.M. Agrobios India Limited, 2002*
2. *Text Book of Animal Biotechnology. Ramadass P, Meera Rani S. Akshara Printers, 1997.*
3. *Masters J.R.W. Animal Cell Culture: Practical Approach. Oxford University Press. 2000*
4. *Suggested Readings Lewin B. 2008. Gene IX.*
5. *Jones & Bartlett. Primrose SB. 2001. Molecular Biotechnology. Panima.*
6. *Twyman RM. 2003. Advanced Molecular Biology. Bios Scientific.*

SEMESTER – II (CREDITS – 4)

PHDAS-201 (Review of Research Work)

Students have to work on any of their topic of research interest on which they are required to make a comprehensive review and submit to the department. The review work will be evaluated by the members of BRS, Department of Animal Science.