Part : A

1. **Title of the Academic Program**
   Master of Science (MS) in Animal Genetics, Breeding and Reproduction

Program Overview	
Degree	Master of Science (MS) in Animal Genetics, Breeding and Reproduction
Abbreviated form of the Degree	M.S. (in Animal Genetics, Breeding and Reproduction)
Discipline/Program Offering Entity (POE)	Department of Genetics and Animal Breeding
Faculty	Faculty of Animal Science and Veterinary Medicine
Awarding Institution	Patuakhali Science and Technology University
Location	Patuakhali, Bangladesh
Bangladesh National Qualifications Framework (BNQF) Level	9
International Standard Classification of Education (ISCED) Code	0811 [Crop and Livestock Production]
Mode of Study	Full Time
Language of Study	English
Applicable Session	July-December, 2023

2. **Name of the University**
   Patuakhali Science and Technology University
3. **Vision of the University**
   Patuakhali Science and Technology University aspires to be a home of excellence for producing competent professionals with improved knowledge and skills to meet national and global challenges
4. **Mission of the University**
   The mission of Patuakhali Science and Technology University is to provide cutting-edge education, research, training and develop entrepreneurship at both undergraduate and postgraduate levels for creating skilled and enlightened personnel to serve the nation.
5. **Name of the Program Offering Entity (Department/Faculty/Institute)**
   Department of Genetics and Animal Breeding
6. **Vision of the Program Offering Entity:**
   The vision is to be a center of learning and research,and producing quality graduates who are competent to respond to the current and future needs of animal improvement through genetic, breeding, and reproductive management in the national and global context.
7. **Mission of the Program Offering Entity:**

The mission is to impartsound knowledge of the students who could develop and implement genetic evaluations, improvement programs, and biotechnologies for sustainable, economic,and eco-friendly breeding of livestock species. Work in a team of faculty, researchers and studentsdedicated to the discovery, development and implementation and collaborate with producers, scientists, and industry personnelwith the latest advances in the field.

8. Objectives of the Program Offering Entity

I) Produce highly trained graduates, skilled in Animal Genetics, Breeding and Reproductionto face the current and upcoming challenges in the field.
II) Conduct research to discover knowledge useful for genetic improvement of animals via appropriate acquisition, and analysis.
III) Interpret research results, reporting of data and integrating them into the existing knowledge in the discipline.
IV) Enhance co-operation, develop partnerships,and collaborate globallyin the related field.
V) Continuous and comprehensive approaches for updating the program as per the current need and future trends assessed in the field.

9. Name of the Degree

Master of Science (MS) in Animal Genetics, Breeding and Reproduction

Description of the Program

MS degree in Animal Genetics, Breeding and Reproductionoffers students the opportunity to investigate livestock populations on either phenotypic or molecular level. It combines different level of genetics, breeding and reproductive biotechnology fields with genetic improvement of livestock to improve the efficiency of production in farm animals. This program focuses mainly on the genetic diversity and evaluation of large and small stock, with an emphasis on traits and sustainable farming.

The study program imparts the most current scientific knowledge in molecular biology, models and algorithms in bioinformatics, genome analysis- methodology, functional genomics, animal breeding plans, theory and application of breeding management and it conveys methodological skills to teach students to work scientifically and systematically.

The Animal Genetics, Breeding and Reproduction Master's degree is intended for students who hold a Bachelor's degree in Animal Husbandry/ Animal Science/ Animal Production. The program includes relevant topics from several disciplines such as Animal Nutrition, Animal Science, and Dairy Science.

The MS program comprises compulsory modules and elective modules during the first two semesters, and a Master's thesis during the third semester. The standard period of study is three

semesters. Courses encompass lectures, seminars presentation, practical exercises, and field trips etc.

10. Graduate Attributes in M.S. in Animal Genetics, Breeding and Reproduction

Disciplinary knowledge

Students are able to demonstrate comprehensive knowledge and understanding of Animal Genetics, Animal Breeding and Animal Reproduction.

Communication Skills

Students are scheduled to prepare various assignments that enable them to develop skills in public speaking, writing and effective's interpersonal skills. Presentation in each paper enhances their confidence, ability to express themselves.

Research-related skills

Students develop a scientific temper and a sense of enquiry through various papers. They have capabilities in asking relevant questions relating to current issues and themes and state hypothesis and rationale for inquiry. Students are capable of using appropriate research methodology especially for understanding current issues in livestock industry and reporting the results in different formats.

Cooperation/Team work

Students are capable of effective working in diverse contexts and teams in class rooms laboratories, student societies, industry and the community.

Self-directed learning

Students are capable of working independently and are able to apply the concepts of "Animal Genetics, Breeding and Reproduction" on the improvement of animals and transfer of knowledge of this area including selection, and breeding of animals for humans' food production and conservation. The courses in this specialization focus on the genetic improvement of farm and companion animals by integrating quantitative, biological and molecular approaches.

Multicultural competence

Students are confident of working in diverse socio-cultural contexts. They are able to effectively engage with multicultural groups and teams. They have sensitivities of cross cultural and ethnic diversity which they can apply to different settings. They are competent to seek higher education in foreign universities.

Moral and ethical awareness/reasoning

Student has awareness of ethical conduct in different situations (academic and personal). They have skills in understanding and avoiding unethical behavior such as misrepresentation, plagiarism and environmental misuse and violence. They are formally taught ethics of research and human interventions.

Leadership readiness/qualities

Students have leadership qualities in organizing teams and their mobilization for effective problem solving in different genetics, breeding and Reproduction aspects. Students apply creative leadership for realization of various goals.

Lifelong learning

Students acquire ability to gain knowledge and skills which are necessary in life for the development for meeting their professional and personal needs in varying environment and changing contexts.

11. Program Educational Objectives (PEOs)

The PEO of the Master of Science (M.S.) in Animal Genetics, Breeding and Reproduction will-

PEO1: Develop knowledge and skills useful for genetic improvement of animals.

PEO2: Guide the students regarding biotechnological and genomic tools applied to animal reproduction and breeding considering the sustainability of livestock.

PEO3: Enhance multidisciplinary teams by contributing genetic expertise to innovative and comprehensive research, teaching, and extension program.

PEO4: Efficient in livestock entrepreneurship to build professional career and contribute ethically to the society through life-long learning.

PEO5: Provide leadership and cooperate with animal industries to develop and enhance economically sound genetic improvement programs.

12. Program Learning Outcomes (PLOs)

After completion of the program graduates will be able to:

PLOs	LO Domains*
PLO1: Understand the basics and principles related to Animal Genetics, Breeding, and Animal Reproduction.	FS, PS, TS
PLO2: Learn how to solve problems based on biomatrices and evaluate an ongoing breeding program using different and available software-based tools.	FS, PS, TS
PLO3: Gain the needful tools and insights to work for the permanent improvement/change of livestock production as deemed from the genetic, breeding and reproductive perspectives.	TS, SS
PLO4: Understand the role of genetic mechanisms in evolution and gain the knowledge required to undertake, plan, design, execute, analyze, and evaluate genetic experimentation in animal model systems as well as in farm field conditions.	FS, TS, SS
PLO5: Familiar with biological principles and modern approaches to the study of stem cells, developmental and regulatory, structural and functional biology.	FS, TS, SS
PLO6: Design, implement and evaluate bioinformatics data using computer-based systems, processes, components or programs in relation to molecular and cellular biology, and genomics research.	

PLO7: Gain knowledge to solve the unidentified genetic, breeding, and reproductive problems in animal and poultry.	FS, PS, TS
PLO8: Apply ethical practice in data collection, analyses, and reporting and an awareness of multiple responsibilities and the impact of their professional conduct.	PS, TS, SS
PLO9: Apply the scientific method and critical scientific thought in the application of a hypothesis formation, and the design and execution of experiments in genetics, breeding and reproduction.	FS, PS
PLO10: Provide national and international leadership with animal industries to develop and enhance economically sound genetic improvement programs.	PS, SS

***Learning Outcome domains:** FS- Fundamental Skills; PS- Personal Skills; TS- Thinking Skills; SS- Social Skills

13. Mapping PLOs with the PEOs

PLO/PEO	PEO1	PEO2	PEO3	PEO4	PEO5
PLO1: Understand the basics and principles related to Animal Genetics, Breeding, and Animal Reproduction.	H	M	-	-	-
PLO2: Learn how to solve problems based on biomatrices and evaluate an ongoing breeding program using different and available software-based tools.	H	H	-	-	-
PLO3: Gain the needful tools and insights to work for the permanent improvement/change of livestock production as deemed from the genetic, breeding and reproductive perspectives.	H	-	L	L	
PLO4: Understand the role of genetic mechanisms in evolution and gain the knowledge required to undertake, plan, design, execute, analyze, and evaluate genetic experimentation in animal model systems as well as in farm field conditions.	M	L	L	-	-
PLO5: Familiar with biological principles and modern approaches to the study of stem cells, developmental and regulatory, structural and functional biology.	M	H	H	L	-
PLO6: Design, implement and evaluate bioinformatics data using computer-based systems, processes, components or programs in relation to molecular and cellular biology, and genomics research.	-	-	-	H	M
PLO7: Gain knowledge to solve the unidentified genetic, breeding, and reproductive problems in animal and poultry.	M	H	H	L	L

PLO8: Apply ethical practice in data collection, analyses, and reporting and an awareness of multiple responsibilities and the impact of their professional conduct.	L	-		H	H
PLO9: Apply the scientific method and critical scientific thought in the application of a hypothesis formation, and the design and execution of experiments in genetics, breeding and reproduction.					
PLO10: Provide national and international leadership with animal industries to develop and enhance economically sound genetic improvement programs.					

*H- high; M- medium; L- low

14. Mapping courses with the PLOs

Course Code and Course Title	PLO1	PLO2	PLO3	PLO4	PLO 5	PLO 6	PLO 7	PLO8	PLO9	PLO10
July-December semester										
ABG 6201 Animal Genetics	X	X	X							
ABG 6202 Animal Breeding	X	X	X				X	X		
ABG 6203 Animal Reproduction	X		X	X	X	X				
ABG 6204 Computer Usage in Animal Genetics, Breeding and Reproduction	X	X	X		X		X			
ABG 6205 Herd fertility and Reproductive Management	X		X	X	X	X				
ABG 6206 Poultry Reproduction	X		X			X	X	X		
ABG 6207 Gene expression, Regulation and Cell Signaling	X					X	X			

ABG 6208 Stem Cells and Reprogramming			X			X	X			
ASC 6201 Goat and Sheep Production			X	X				X		
January-June semester										
ABG 6101 Population and Quantitative Genetics	X	X				X	X	X		
ABG 6102 Poultry Breeding		X	X	X	X		X	X		
ABG 6103 Advances in Semen Technology and Artificial Insemination	X		X	X	X	X				
ABG 6104 Advanced Biometrics in Animal Breeding	X	X			X		X	X		
ABG 6105 Molecular Genetics and Genetic Engineering	X		X	X	X		X	X		
ABG 6106 Advanced Animal Biotechnology			X	X				X		
ABG 6107 Applied Genomics and Bioinformatics	X	X	X				X			
ABG 6108 Developmental and Regulatory Biology	X	X				X	X			
DPS 6101 Dairy Cattle Production			X	X				X		
ANT 6104 Nutrition and Reproduction			X	X				X		
ASC 6101 Beef Cattle Production										

Part: B

15. Structure of the Curriculum

a) Duration of the Program	Year: 01 Year 6 Months	Semester: 03
b) Admission Requirements	The B. Sc. in Animal Husbandry (Honours) or an equivalent degree will be required for entrance to this program for applicants. The proper authority periodically sets or modifies additional terms and conditions.	
c) Graduating Credits / Total Minimum Credit Requirement to Complete the Program	40	
d) Total Class Weeks in a Term*	14	
e) Minimum CGPA Requirements for Graduation	2.50	
f) Maximum Academic Years of Completion	2.5 Years (3+2=5 Consecutive semester)	

16. Level/Semester wise distribution of courses for Master of Science in Animal Genetics, Breeding and Reproduction

Semester	Courses	Credits	Marks
July-December	**A. Compulsory Courses (8 Credits)**		
	ABG 6201 Animal Genetics	2	100
	ABG 6202 Animal Breeding	2	100
	ABG 6203 Animal Reproduction	2	100
	ABG 6204 Computer Usage in Animal Breeding and Genetics	2	100
	B. Elective Courses (any two, 4 Credits)		
	ABG 6205 Herd fertility and Reproductive Management	2	100
	ABG 6206 Poultry Reproduction	2	100
	ABG 6207 Gene expression, Regulation and Cell Signaling	2	100
	ABG 6208 Stem Cells and Reprogramming	2	100
	ASC 6201 Goat and Sheep Production	2	100
	C. Research work (3 Credits)	**3**	**S/U***
	Total	**15**	**600**
January-June	**A. Compulsory Courses (8 Credits)**		
	ABG 6101 Population and Quantitative Genetics	2	100
	ABG 6102 Poultry Breeding	2	100

	ABG 6103 Advances in Semen Technology and Artificial Insemination	2	100
	ABG 6104 Advanced Biometrics in Animal Breeding	2	100
	B. Elective Courses (any two, 4 Credits)		
	ABG 6105 Molecular Genetics and Genetic Engineering	2	100
	ABG 6106 Advanced Animal Biotechnology	2	100
	ABG 6107Applied Genomics and Bioinformatics	2	100
	ABG 6108 Developmental and Regulatory Biology	2	100
	ANT 6104 Nutrition and Reproduction	2	100
	DPS 6101 Dairy Cattle Production	2	100
	ASC 6101 Beef Cattle Production	2	100
	C. Research work (3 Credits)	3	S/U*
	Total	**15**	**600**
Thesis Semester	A. Research Work (2 Credits)	2	S/U*
	B. Evaluation of Thesis (5 Credits)	5	250
	C. Thesis Defense (3 Credits)	3	150
	Total	**10**	**400**
	GRAND TOTAL	**40**	**1600**

*** S = Satisfactory/ U = Unsatisfactory**

Part C

19. Course Description

Course Profiling of Population and Quantitative Genetics

January-June Semester	
Course Code: ABG 6101	
Course Title: Population and Quantitative Genetics	
Course Status: Core	
Credit: 2.0	
Prerequisite(s): Fundamental Genetics	
Rationale	Genetic variations are essential to exploit animal genetic resources by the animal breeding specialists. Understanding the dynamics of genetic variation, transmission, distribution, arrangement, alteration, translation, evolutionary changes is important for animal improvement. The course is designed covering concepts, principles, methods, advances to gain expertise knowledge for the improvement and utilization of animal genetic resources for better production and management of livestock species.
Objectives	1. An understanding of general concepts in population and quantitative genetics. 2. Learn genetic, molecular, and phenotypic evolution of populations. 3. Study polygenic inheritance and understand the evolution of quantitative traits. 4. Acquire knowledge on the dynamics of genetic variation, uses of regression and correlation. 5. Describe the traits of economic importance in livestock species. 6. Describe and estimate the genetic parameters of various economic traits. 7. Genetic management of small populations, interpretation of results from genetic analyses of populations.

Course Learning Outcomes (CLOs)

By the end of the course, the students will be able to:		**Mapping with PLOs**
CLO1	Analyze current genetic characteristics of populations and predict its outcome.	PLO1, PLO3,
CLO2	Evaluate and infer genetic consequences in populations.	PLO1, PLO3,
CLO3	Apply quantitative methods for improvement of desired characteristics of farm animals.	PLO5, PLO10,
CLO4	Design selection strategies and predict the response to selection under differential circumstances.	PLO6, PLO7

CLO5	Understand breeding programs and strategies for planning at differential perspectives.	PLO6, PLO7, PLO8

No.	Topic/Course content	Teaching Strategy	Assessment Strategy
1.	**Introduction:** Relationship among classical genetics, population, and quantitative genetics.	Lectures, multi-media presentation, tutorials (devoted to problem solving), assignment, case studies from literature and group discussions.	Quizzes/MCQ, Short and broad questions, assignment and presentation.
2.	**Genetic constitution of population**: Genetics of a population, Hardy-Weinberg equilibrium, forces changing gene frequency, linkage disequilibrium, idealized population and inbred population, average heterozygosity, and genetic distance.	Lectures, multi-media presentation, tutorials (devoted to problem solving), assignment, case studies from literature and group discussions.	Quizzes/MCQ, Short and broad questions, assignment and presentation.
3.	**Variation, values and means**: Phenotypic and genotypic values, average effect and breeding values, genetic components of variance, environmental variance and repeatability, phenotypic and genetic resemblance between relatives, genetic and environmental covariance, genetic parameters.	Lectures, multi-media presentation, tutorials (devoted to problem solving), assignment, case studies from literature and group discussions.	Quizzes/MCQ, Short and broad questions, assignment and presentation.
4.	**Selection and Breeding**: Predicted response, long term selection effects, efficiency in various methods of selection, quantitative aspects of breeding systems: inbred lines, heterosis, synthetic population, general and specific combining abilities. scale effects, threshold characters, quantitative trait loci (QTL), major genes and fitness related to metric characters.	Lectures, multi-media presentation, tutorials (devoted to problem solving), assignment, case studies from literature and group discussions.	Quizzes/MCQ, Short and broad questions, Assignment and presentation.

Assessment Pattern: Both Formative and Summative.

Books Recommended:

1. **Applications of Linear Models in Animal Breeding,** by CR Henderson, 1984. University of Guelph, Guelph, Ont.
2. **General and Quantitative Genetics,** by AB Chapman, 1985. Elsevier Science Pub. Co., Amsterdam, New York.
3. **Genetics and Analysis of Quantitative Traits,** by M Lynch and B Walsh, 1998. Sinauer, Sunderland, Mass.
4. **Introduction to Quantitative Genetics,** 4th ed. by DS Falconer and TFC Mackay, 1996. Longman, Essex, England.
5. **Manual of Quantitative Genetics,** 4th ed. by WA Becker, 1984. Academic Enterprises, Pullman, Wash. New York.
6. **Population Genetics for Animal Conservation**, by G Bertorelle, 2009. Cambridge University Press, Cambridge, UK; New York.
7. **The Mathematical Theory of Quantitative Genetics**, by MG Bulmer, 1980. Clarendon Press; Oxford University Press, Oxford.

Course Profiling of Poultry Breeding

January-June Semester	
Course Code: ABG 6102	
Course Title: Poultry Breeding	
Course Status: Core	
Credit: 2.0	
Prerequisite(s): Poultry Genetics, Animal Breeding	
Rationale	This course will provide a critical understanding of the theories which underpin quantitative genetics and animal breeding and their application to poultry breeding; including theory of selection, interaction between genotype and environment and strategies to improve progress. The course will overview modern technologies such as genomics and how these have been used to revolutionize modern breeding programs. The background theory will be used to underpin a practical understanding of poultry breeding programs and their importance in modern global poultry production systems.
Objectives	1. To provide students with an understanding of basic principles of poultry breeding, the nature of the poultry industry and explore the poultry genetic resources. 2. To know the methods of mating for increasing the flock or for selecting specific individuals for improvement in one or more characteristics. 3. To become familiar with the different breeding system in poultry. 4. To gain knowledge on the genetic parameters, their scale, methods of estimation and use in breeding strategy decision. 5. To acquire knowledge about the germplasm importation and global threat.

Course Learning Outcomes (CLOs)

By the end of the course, the students will be able to:		**Mapping with PLOs**
CLO1	Identify the breeds of chicken and breed purposes, understand the importance of economic traits in broilers and layers.	PLO1, PLO3,
CLO2	Learn about the breeding principles, breeding systems for improvement and their importance in modern global poultry production systems.	PLO1, PLO3,
CLO3	Know the genetics of biochemical and morpho-logical variants and the immunogenetics and disease resistance.	PLO4, PLO5,
CLO4	Identify and analyze the constraints and opportunities of selection of poultry for breed development.	PLO6

No.	Topic/Course content	Teaching Strategy	Assessment Strategy
1.	Poultry genetic resources, origin and early history of different poultry species, reproductive biology of poultry in relation to genetics and breeding.	Lectures, multi-media presentation, tutorials (devoted to problem solving), assignment, case studies from literature and group discussions.	MCQ, Short and broad questions, assignment and presentation
2.	Genetics of biochemical variants in chickens, genetics of economically important morphological variants in poultry, immunogenetics and disease resistance in poultry.	Lectures, multi-media presentation, tutorials (devoted to problem solving), assignment, case studies from literature and group	MCQ, Short and broad questions, assignment and presentation
3.	Selection and breeding for egg and meat production, breeding strategy for commercial broiler and layer development, poultry germplasm importation and global threat, breeding program in the subsistence level.	Lectures, multi-media presentation, assignment, case studies from literature and group discussions.	MCQ, Short and broad questions, assignment and presentation

Assessment Pattern: Both Formative and Summative.

Books Recommended:

1. **Biometrical Methods in Poultry Breeding,** by RP Singh and J Kumar, 1994. Kalyani, Ludhiana.
2. **Introductory Biostatistics,** by CT Le, 2003. Wiley-Interscience, Hoboken, N.J.
3. **Poultry Breeding and Genetics,** by RD Crawford, 1990. Elsevier, Amsterdam; New York.
4. **Poultry Breeding,** 3d ed. by MA Jull, 1952. Wiley, New York.
5. **Poultry Genetics, Breeding, and Biotechnology,** by WM Muir and SE Aggrey, 2003. CABI Pub., Wallingford, Oxon, UK

Course Profiling of Advances in Semen Technology and Artificial Insemination

January-June Semester	
Course Code: ABG 6103	
Course Title: Advances in Semen Technology and Artificial Insemination	
Course Status: Core	
Credit: 2.0	
Prerequisite(s): Animal Reproduction	
Rationale	Artificial Insemination (AI) was the first great biotechnology applied to improve reproduction and genetics of farm. The discussions include management of liquid and frozen semen production, management of artificial insemination in people's farms and the animal industry. In this course, students are also required to carry out laboratory practices to achieve competence in semen quality testing, the dilution process and the thawing of semen.
Objectives	1. Explain the principles and practical application of genetics to reproduction. 2. Learn methods of handling of semen and artificial insemination techniques in farm animals as well as physiology of male reproduction. 3. Demonstrate appropriate semen collection, and breeding skills. 4. Identify the reproductive anatomy and physiology of domestic farm animals 5. Analyze the duties and responsibilities of a technician. 6. Explain the steps and events during estrus cycle, pregnancy, and parturition. 7. Discuss the various methods used to collect semen from livestock and discuss the methods and techniques of artificial insemination in those species.

Course Learning Outcomes (CLOs)

By the end of the course, the students will be able to:		**Mapping with PLOs**
CLO1	Investigate the factors affecting the coverage of artificial insemination in animals.	PLO3, PLO5
CLO2	Understand the basic theoretical and technical principles of semen storage.	PLO1, PLO4, PLO7
CLO3	Perform semen quality tests, dilution, cooling, and freezing.	PLO4, PLO5
CLO4	Apply AI techniques in various animals and evaluate the success of Artificial Insemination.	PLO4, PLO5

No.	Topic/Course content	Teaching Strategy	Assessment Strategy
1.	**Artificial Insemination in animals**: Definition of artificial insemination, Advantages and disadvantages of artificial insemination, the history of the development of AI in the world and Bangladesh, Institutions and human resources related to and contributing to the success of Artificial Insemination .	Lecture, assignment, video	True-False, MCQ, Essay, Short answer, Presentation
2.	**Male selection management and mating management:** Selection of males to produce spermatozoa and characteristics of good males, raising management of males, Selection of a parent to be used as a recipient, Mating system in extensive and intensive raising, Natural and Artificial Mating Management	Lecture, assignment, video	True-False, MCQ, Essay, Short answer, Presentation
3.	**Storage management and quality testing of semen**: Equipment needed for storage and quality testing of semen, Semen collection techniques for various livestock and animals, Routine quality testing of semen and for studies/research both macroscopic and microscopic including motility, viability, abnormalities.	Lecture, assignment, video	True-False, MCQ, Essay, Short answer, Presentation
4.	**Semen dilution, cooling and freezing techniques:** Facilities and infrastructure required for cooling and freezing cement, Diluent and cryoprotectant requirements, Composition of various cement diluent in various animals (mammals and poultry), Diluent manufacturing techniques, Basic principles of cooling and freezing, semen cooling and freezing techniques, Manufacture of liquid semen, Evaluation of the success of making liquid semen and frozen semen.	Lecture, assignment, video	True-False, MCQ, Essay, Short answer, Presentation

5.	**AI technique in various animals**: AI management using liquid and frozen semen, AI management in cattle, goat, and buffalo, (smallholder and industrial farms).	Lectures, multi-media presentation, assignment, case studies from literature and group discussions.	True-False, MCQ, Essay, Short answer, Presentation
6.	**Factors affecting the success of AI**: Quality of liquid/frozen semen (frozen semen maintenance management), Female physiology (feed, disease, endocrine), Farmer (maintenance system, heat detection, providing information to inseminators), Inseminator (Thawing system, the Accuracy of Deposition, timeliness of AI).	Lectures, multi-media presentation, assignment, case studies from literature and group discussions.	True-False, MCQ, Essay, Short answer, Presentation
7.	**AI strategy for breeding:** Intensification of Natural Mating in the animal industry, AI strategy for animal breeding, Population dynamics in goat and cow breeding businesses, Planning for goat and cow breeding businesses, Application of AI in birds.	Lectures, multi-media presentation, assignment	True-False, MCQ, Essay, Short answer, Presentation

Assessment Pattern: Both Formative and Summative.

Books Recommended:

1. **A Laboratory Guide to the Mammalian Embryo,** by DK Gardner, M Lane and AJ Watson, 2004. Oxford University Press, Oxford; New York.
2. **Handbook of the Assisted Reproduction Laboratory,** by BA Keel, JV May and CJD Jonge, 2000. CRC Press, Boca Raton.
3. **Laboratory Production of Cattle Embryos,** 2nd ed. by I Gordon, 2003. CABI Pub., Oxon, UK; Cambridge, MA.
4. **Principles of Gene Manipulation,** 6th ed. by SB Primrose, RM Twyman and RW Old, 2001. Blackwell Scientific, Oxford; Boston.
5. **Reproduction in Mammals: Manipulating Reproduction,** 2nd ed. by CR Austin and RV Short, 1982. Cambridge University Press, Cambridge; New York.
6. **Reproductive Technologies in Farm Animals,** by I Gordon, 2004. CABI Pub., Wallingford, Oxfordshire, UK; Cambridge, MA.

Course Profiling of Advanced in Biometrics in Animal Breeding

January-June Semester	
Course Code: ABG 6104	
Course Title: Advanced Biometrics in Animal Breeding	
Course Status: Core	
Credit: 2.0	
Prerequisite(s): Biostatistics, Animal Breeding	
Rationale	"Advanced Biometrics in Animal Breeding' is a course for students and researchers of the animal genetics, breeding and reproduction. The primary goal of this course is to give students a deeper understanding of appropriate experimental designs and statistical methods commonly used in animal genetics, breeding and reproduction. Students will be introduced to a number of statistical procedures, and will learn how to apply them to data from laboratory and field experiments using appropriate software. Emphasis will be placed on statistical concepts and principles, design of experiments, error control, testing of hypotheses, and communication of findings to other scientists, as well as data management.
Objectives	1. To know aboutcollection and management of data. 2. To gain knowledge on different variables, hypothesis testing, regression, correlation, and variance analysis. 3. To gain the concept and methods of experimental design. 4. To acquire knowledge about software management.

Course Learning Outcomes (CLOs)

By the end of the course, the students will be able to:		**Mapping with PLOs**
CLO1	Present and summarize data using statistical software.	
CLO2	Understand and apply classical inference using confidence intervals and hypothesis testing.	
CLO3	Explain and apply methods to compare treatments.	
CLO4	Apply and interpret variance partition models.	
CLO5	Perform analyses using statistical software and interpret the output.	
CLO6	Recognize and apply various experimental designs.	
CLO7	Demonstrate the ability to convey statistical results to other researchers.	

No.	Topic/Course content	Teaching Strategy	Assessment Strategy
1.	Concept, collection and management of data, Probability, Random Variables and their Distributions, Discrete Random Variables, Continuous Random Variables, Discrete Dependent Variables.	Lecture, Group discussion, Exercise, Problem based learning.	MCQ, Short question, Broad question, Problem solution.
2.	Population and Sample, Estimation of Parameters, Hypothesis Testing, Simple Linear Regression, Correlation, Multiple Linear Regressions.	Lecture, Group discussion, Exercise, Problem based learning, Computer demonstration	MCQ, Short question, Broad question, Problem solution.
3.	Concepts of Experimental Design, Blocking, Change-Over Designs, Factorial Experiments, Nested Designs, Split-Plot Design.	Lecture, Group discussion, Exercise, Problem based learning, Computer demonstration	MCQ, Short question, Broad question, Problem solution.
4.	One-Way Analysis of Variance, Analysis of Covariance,Analysis of Numerical Treatment Levels.	Lecture, Group discussion, Exercise, Problem Lecture, Group discussion, Computer demonstration	MCQ, Short question, Broad question, Problem solution.

Assessment Pattern: Both Formative and Summative.

Recommended Text Book:

1. **Biometry: the Principles and Practice of Statistics in Biological Research,** 3rd ed. by RR Sokal and FJ Rohlf, 1995. W.H. Freeman, New York.
2. **Biostatistics for Animal Science,** by M Kaps and WR Lamberson, 2004. CABI Pub., Wallingford, Oxfordshire; Cambridge, MA.
3. **Biostatistics,** 1st ed. by B Williams, 1993. Chapman & Hall, London; New York.
4. **Experimental Design, ANOVA, and Regression,** by RA Damon and WR Harvey, 1987. Harper & Row, New York.
5. **Introductory Biostatistics,** by CT Le, 2003. Wiley-Interscience, Hoboken, N.J.
6. **Principles and Procedures of Statistics: A Biometrical Approach,** 2d ed. by RGD Steel and JH Torrie, 1980. McGraw-Hill, New York.
7. **Statistical Methods in Agriculture and Experimental Biology,** 2nd ed. by R Mead, RN Curnow and AM Hasted, 1993. Chapman & Hall, London.

8. **Statistical Methods,** 8th ed. by GW Snedecor and WG Cochran, 1989. Iowa State University Press, Ames.
9. **Statistics for Veterinary and Animal Science,** 2nd ed. by A Petrie and PF Watson, 2006. Blackwell Pub., Oxford; Ames, Iowa.

Course Profiling of Molecular Genetics and Genetic Engineering

January-June Semester	
Course Code: ABG 6105	
Course Title: Molecular Genetics and Genetic Engineering	
Course Status: Core	
Credit: 2.0	
Prerequisite(s): Fundamental Genetics	
Rationale	This course will provide understanding of the use of advanced genetic and technologies and identification of genetic disorders in animal. This course will assist students about principles of gene expression and regulation, and which allow genes to be expressed and be maintained from one generation to the next.
Objectives	1. To clarify the concept, how genetic information is encoded, replicated, and expressed, and explained the chemical basis of variation in expression of traits. 2. To update the students with the principles of modern techniques of genetic analysis, such as PCR, gene sequencing, in situ hybridization, microarray technology, molecular phylogeny and recombinant DNA technology. 3. To acquaint students about the molecular markers and DNA technologies those are implicated in animal production, improvement and health. 4. To acquaint students about the genetic engineering technologies such as CRISPR/CAS, GMOs that are implicated in animal production, improvement and health.

Course Learning Outcomes

By the end of the course, the students will be able to:		**Mapping with PLOs**
CLO1	Explain prokaryotic and eukaryotic gene expression and gene regulation.	PLO1, PLO3
CLO2	Outline gene regulation system in eukaryotes and prokaryotes.	PLO1, PLO3
CLO3	Apply knowledge of Genetic markers, tools and techniques in Animal Breeding.	PLO1, PLO4
CLO4	Inspect genetic code in identifying hereditary/genetic diseases.	PLO5, PLO8
CLO5	Use sequencer and perform genome sequencing.	PLO3, PLO4, PLO7
CLO6	Perform advanced genetic engineering techniques for animal genetic research.	PLO3, PLO4, PLO7
CLO7	Perform bioinformatics analysis using computer based software.	

No.	Topic/Course content	Teaching Strategy	Assessment Strategy
1.	**Introduction:**Concept and application of advanced molecular genetics, genomics and geneticengineering technologies.	Lecture, multimedia projection: video clip, animated object.	Quiz/MCQ, Short and broad question.
2.	**Chemical nature of inheritance and DNA replication:** Composition, structure and types of DNA and RNA,extra-chromosomal inheritance, general feature, DNA replication in prokaryotes and eukaryotes.	Lecture, group discussion, multimedia projection: video clip, animated object.	Quiz/MCQ, short and broad question, assignment and presentation.
3.	**Gene Expression and Regulation:** Genetic code, transcription, translation, transduction, regulation of gene expression,miRNAs and epigenetic process in regulation of gene expression.	Lecture, group discussion, multimedia projection: video clip, animated object.	Quiz/MCQ, short and broad question, assignment and presentation.
4.	**Molecular markers, tools and techniques:**Types and characteristics, application of molecular marker inanimal production and health, PCR, electrophoresis, restriction enzymes, genecloning, genotyping, DNA sequencing, in situ hybridization and microarray technology, Molecular phylogeny.	Lecture, group discussion, multimedia projection: video clip, animated object.	Quiz/MCQ, Short and broad question, assignment and presentation.
5.	**Genetic Engineering:** Recombinant DNA technology, gene manipulation through CRISPR/CAS, genetically modified organisms, transgenic animals.	Lecture, group discussion, multimedia projection: video clip, animated object etc.	Quiz/MCQ, short and broad question, assignment and presentation.
6.	**Programs and software in molecular genetics and bioinformatics**	Multimedia projection, animated object, Computer software.	Quiz/MCQ,broad question, assignment and presentation.

Assessment Pattern: Both Formative and Summative.

Recommended Text Book:

1. **An Introduction to Genetic Engineering,** 3rd ed. by DST Nicholl, 2008. Cambridge University Press, Cambridge; New York.
2. **Gene Cloning and DNA Analysis: An Introduction,** 5th ed. by TA Brown, 2006. Blackwell Pub., Oxford; Malden, MA.
3. **Genetic Engineering: A Reference Handbook,** 2nd ed. by H LeVine, 2006. ABC-CLIO, Santa Barbara, Calif.
4. **Genetics and Molecular Biology,** 2nd ed. by RF Schleif, 1993. Johns Hopkins University Press, Baltimore.
5. **Introduction to Biotechnology and Genetic Engineering,** by AJ Nair, 2008. Infinity Science Press, Hingham, Mass.
6. **Animal Transgenesis and Cloning**, by L-M Houdebine, 2003. John Wiley & Sons, Chichester, UK; Hoboken, NJ.
7. **Molecular Cloning: A Laboratory Manual,** 3rd ed. by J Sambrook and DW Russell, 2001. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y.
8. **Molecular Genetics, Gene Transfer, and Therapy,** by WJ Dodds and JE Womack, 1997. Academic Press, San Diego, Calif.

Course Profiling of Advanced Animal Biotechnology

July-December Semester	
Course Code: ABG 6106	
Course Title: Advanced Animal Biotechnology	
Course Status: Core	
Credit: 2.0	
Prerequisite(s): Animal Breeding and Animal Reproduction	
Rationale	This is a lecture, tutorial-based subject focusing on providing students with a understanding of animal biotechnology. The subject covers animal molecular biology, recombinant DNA technology, production of transgenic animals, reproductive biotechnology, biotechnology in animal breeding and ethics. For livestock breeding an animal breeder needs to know details about animal biotechnology. Furthermore, to simplify livestock breeding he needs to know DNA technology, genetic engineering techniques as well as Assisted Reproductive Technologies (ARTs).
Objectives	1. To make the student understand the tools and techniques required for the animal cell cultures, assisted reproductive technology, development of transgenic animals, and development of animal models. 2. To equip students with culture techniques and scope of animal biotechnology. 3. To provide knowledge on genetic engineering in the improvement of animal for human welfare.

Course Learning Outcomes (CLOs)

By the end of the course, the students will be able to:		**Mapping with PLOs**
CLO1	Describe basic principles and techniques in genetic manipulation and genetic engineering.	PLO3, PLO4,
CLO2	Integrate assisted reproductive biotechnology techniques in livestock improvement.	PLO4, PLO7
CLO3	Utilize animal reproductive technologies for sustainable agriculture and food security.	PLO4, PLO7
CLO4	Learn about structural features of components of immune system as well as their function and development of immune system.	PLO4, PLO7

No.	Topic/Course content	Teaching Strategy	Assessment Strategy
1.	**Introduction**: Definitions and scope of Animal biotechnology, Activities of Animal biotechnology.	Lectures, group discussions and tutorials.	Report, MCQ, Essay, Short questions, Broad questions, Presentation.
2.	**Animal Cell and tissue culture technology:** Overview of animal cell and tissue culture technology; Cell culture laboratory design and basic laboratory equipment; Media preparation, Role of important components of culture media; Common laboratory hazards and safety issues to consider in cell culture laboratory.	Lectures, group discussions and tutorials.	Report, MCQ, Essay, Short questions, Broad questions, Presentation.
3.	**Assisted reproductive biotechnology for livestock improvement:** Reproduction biotechnologies and their use in livestock; Somatic cell nuclear transfer cloning; In Vitro Fertilization, Embryo production, preservation and transfer; Sperm and embryo sexing; Intracytoplasmic sperm injection (ICSI); Cryopreservation and gamete banking.	Lectures, group discussions and tutorials.	Report, MCQ, Essay, Short questions, Broad questions, Presentation.
4.	**Immune and stem cell biotechnology:** Antibody production, immune biotechnology, tissue engineering, stem cell biotechnology, biotechnology in disease diagnosis, evolution and biotechnology, safety in biotechnology.	Lectures, group discussions and tutorials.	Report, MCQ, Essay, Short questions, Broad questions, Presentation.
5.	**Animal Biotechnology & human health:** Recombinant therapeutics and production of pharmaceuticals; Production of tissues and organs for humans and xenotransplantation; Process of gene therapy, Pros and cons in gene therapy; Retrovirus and adenovirus mediated gene therapy.	Lectures, group discussions and tutorials.	Report, MCQ, Essay, Short questions, Broad questions, Presentation.

Assessment Pattern: Both Formative and Summative.

Recommended books:

1. **A Laboratory Guide to the Mammalian Embryo,** by DK Gardner, M Lane and AJ Watson, 2004. Oxford University Press, Oxford; New York.
2. **Laboratory Production of Cattle Embryos,** 2nd ed. by I Gordon, 2003. CABI Pub., Oxon, UK; Cambridge, MA.
3. **Principles of Gene Manipulation,** 6th ed. by SB Primrose, RM Twyman and RW Old, 2001. Blackwell Scientific, Oxford; Boston.
4. **Reproduction in Mammals: Manipulating Reproduction,** 2nd ed. by CR Austin and RV Short, 1982. Cambridge University Press, Cambridge; New York.
5. **Reproductive Technologies in Farm Animals,** by I Gordon, 2004. CABI Pub., Wallingford, Oxfordshire, UK; Cambridge, MA.
6. **Embryonic Stem Cells,** by JRW Masters, B Palsson and JA Thomson, 2007. Springer, Dordrecht.
7. **Essentials of Stem Cell Biology,** by RP Lanza, 2006. Elsevier/Academic Press, Amsterdam; Boston.

Course Profiling of Applied Genomics and Bioinformatics

July-December Semester	
Course Code: ABG 6107	
Course Title: Applied Genomics and Bioinformatics	
Course Status: Core	
Credit: 2.0	
Prerequisite(s): Genetics, Molecular Genetics	
Rationale	This course will provide students with the basics of applied genomics that includes structural and functional genomes, sequencing, gene expression data analysis as well as association and linkage studies. This course will also explore into the basic bioinformatics including sequence data bank, basic sequence tools and sequence database.
Objectives	1. Explain the importance of a genome to an organism. 2. Compare Protein and DNA sequence in different genomes through bioinformatics. 3. Use comparative mapping tools. 4. Identify cell or tissue phenotypes and discover novel genes or pathways involved in particular molecular processes and disease development.

Course Learning Outcomes (CLOs)

By the end of the course, the students will be able to:		**Mapping with PLOs**
CLO1	Understand and describe the basic principles of bioinformatics.	
CLO2	Compare of protein and DNA sequences, and to interpret the results.	
CLO3	Use comparative mapping tools, and in particular be able to explain the concept of genome synteny and orthologous and parologous relationships between genes.	
CLO4	Use biological databases, find and retrieve genomic information using web based genome browsers and databases.	
CLO5	Describe gene (and protein) functions and interactions, compare the complete genome sequences of different species, and identify detailed view of how organisms are related to each other at the genetic level.	
CLO6	Identify cell or tissue phenotypes as well as the discovery of novel genes or pathways involved in particular molecular processes and disease development.	
CLO7	Sequence, map and identify all of the genes present in the DNA sequence.	

No.	**Topic/Course content**	**Teaching Strategy**	**Assessment Strategy**

1.	Concept of genomics; organization and evolution of different prokaryotic and eukaryotic genomes.	Lectures, group discussions and Multimedia Projection	Report, MCQ, Essay, Short questions, Broad questions, Presentation.
2.	Overview of the genome projects, structural and functional genomics, whole genome comparison, genome synteny and annotation of genomic sequences.	Lectures, group discussions and Multimedia Projection	Report, MCQ, Essay, Short questions, Broad questions, Presentation
3.	Gene expression data analysis and identification of biological networks; next-generation sequencing and its use in genomics; protein expression, interaction and modification.	Lectures, group discussions and Multimedia Projection	Report, MCQ, Essay, Short questions, Broad questions, Presentation
4.	DNA sequence polymorphism and association studies, linkage disequilibrium.	Lectures, group discussions and Multimedia Projection	Report, MCQ, Essay, Short questions, Broad questions, Presentation.
5.	General introduction to bioinformatics; sequence databanks (GenBank, EMBL, UCSC, UniProt) and use of servers offering tools for DNA/protein analysis (ExPASy, NCBI, EMBL); database similarity searching for DNA and proteins (FASTA, BLAST, PSI-BLAST).	Lectures, group discussions and Multimedia Projection	Report, MCQ, Essay, Short questions, Broad questions, Presentation
6.	Basic DNA sequence tools: multiple sequence alignments, restriction mapping, detection of silent restriction sites, finding ORFs; tools to design molecular probe and primer.	Lectures, group discussions and Multimedia Projection	Report, MCQ, Essay, Short questions, Broad questions, Presentation

Assessment Pattern: Both Formative and Summative.

Recommended books:

1. **Analysis of Genes and Genomes,** by RJ Reece, 2004. John Wiley & Sons, Chichester, West Sussex, England; Hoboken, NJ.
2. **Applied Bioinformatics: An Introduction,** by PM Selzer, RJ Marhöfer and A Rohwer, 2008. Springer, Berlin.
3. **Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins,** 2nd ed. by AD Baxevanis and BFF Ouellette, 2001. Wiley-Interscience, New York.
4. **Bioinformatics: Genomics and Post-genomics,** by F Dardel and F Képès, 2006. John Wiley & Sons, Chichester, England; Hoboken, NJ.
5. **Bioinformatics for Geneticists,** by MR Barnes and IC Gray, 2003. Wiley, Chichester, West Sussex, England; Hoboken, N.J.
6. **Bioinformatics,** by A Polanski and M Kimmel, 2007. Springer, Berlin; New York.
7. **Essentials of Genomics and Bioinformatics,** by CW Sensen, 2002. Wiley-VCH, Weinheim.
8. **Genomics: Fundamentals and Applications,** by S Choudhuri and DB Carlson, 2009. Informa Healthcare, New York.
9. **Mammalian Genomics,** by ARuvinsky and JAM Graves, 2005. CABI Pub.,Wallingford, Oxfordshire, UK; Cambridge, MA, USA.

Course Developmental and Regulatory Biology

January-June Semester
Course Code:6108
Course Title: Developmental and Regulatory Biology
Course Status: Core
Credit: 2.0
Prerequisite(s): Animal Genetics, Molecular Genetics, Cell Biology

Rationale	The course will focus on the principles of developmental biology and regulatory biology that teaches the cellular and molecular basis of animal embryology and describes the events of development common to many multicellular organisms.
Objectives	1. Understand changes in gene expression and cell-to-cell interaction leading up to particular developmental outcomes. 2. Apply main genetic and molecular tools used in the study of development of principal experimental models. 3. Molecular and cellular understanding of biological processes to identify therapeutic targets relevant to reproductive health, and aging. 4. Integrates evolutionary, ecological and molecular perspectives to investigate how animals develop and interact with their environment.

Course Learning Outcomes (CLOs)

By the end of the course, the students will be able to:		**Mapping with PLOs**
CLO1	Explain the molecular and genetic background of animal.	
CLO2	Describe evolutionary history of complex multi cellular life forms.	
CLO3	Compare environmental influence on development and homeostasis of animals.	
CLO4	Expose to modern techniques used in developmental biology research using animal model systems.	
CLO5	Critically assess and present current scientific literature on topics related to ecological and evolutionary developmental biology.	

No.	**Topic/Course content**	**Teaching Strategy**	**Assessment Strategy**

1.	**Developmental biology:** Basic cellular, molecular, and genetic mechanisms in zygote to organism transformation; maternal and zygotic regulation of development; pattern formation and differentiation in development; cleavage and development to the gastrula; comparative morphology of embryos; development of germ layer derivatives; development of the genital system; anterior–posterior patterning; postembryonic development and regeneration; cell signaling; implications of developmental biology for medicine and evolution. Morphogenesis, maintenance of homeostasis, regeneration, interaction with biotic and abiotic environmental factors.	Lecture,Group discussion, Exercise, Problem based learning.	MCQ, Short question, Broad question, Problem solution
2.	**Regulatory biology:** Hypothalamo-pituitary-gonadal axis; mechanisms of neuro-endocrine regulation in female and male reproduction; cellular and molecular regulation of ovarian, uterine, testicular and prostate function; mechanisms of specific tissues development; embryonic control of transcription; spatial and temporal expression of genes during development; primary intracellular pathways in reproduction and development and their cross –talk.	Lecture, Group discussion, Exercise, Problem based learning.	MCQ, Short question, Broad question, Problem solution

Assessment Pattern: Both Formative and Summative.

Recommended Text Book:

1. **Applied Animal Endocrinology,** by EJ Squires, 2003. CABI Pub., Wallingford, Oxon; Cambridge, Mass.
2. **Developmental Biology,** 6th ed. by SF Gilbert, 2000. Sinauer Associates, Sunderland, Mass.
3. **Embryogenesis,** by K-i Sato, 2012. RominaSkomersic, Rijeka, Croatia.
4. **Essential Developmental Biology,** 2nd ed. by JMW Slack, 2006. Blackwell Pub., Malden, MA.
5. **Principles of Developmental Genetics,** by SA Moody, 2007. Elsevier Academic Press, Amsterdam; Boston.
6. **Reproductive Endocrinology-A Molecular Approach,** by PJ Chedrese, 2009. Springer, New York.

Course Profiling of Animal Genetics

July-December Semester

Course Code: ABG 6201	
Course Title: Animal Genetics	
Course Status: Core	
Credit: 2.0	
Prerequisite(s): Fundamental of genetics	
Rationale	An animal scientist needs advanced knowledge about genetics. So, this module aims to prepare the materials for achieving the knowledge of genetics, and the importance of chromosomal variations, linkage, Mendel's law as well as hereditary materials in the fields of animal breeding, population genetics, evolutionary genetics, taxonomy, and the medical sciences.
Objectives	1. To understand about Medelian Genetics, and its application in the field of the animal agriculture. 2. To identify and characterize chromosomal abnormalities. 3. To know about immunogenetics in relation to blood protein. 4. To perform and interpret molecular diagnostic techniques.

Course Learning Outcomes (CLOs)

By the end of the course, the students will be able to:		**Mapping with PLOs**
CLO1	Explain the principles of governing the inheritance of the trait or characters and its genetic basis.	PLO1, PLO3
CLO2	Describe the chromosome structure, functional properties and abnormalities.	PLO1, PLO3
CLO3	Justify the genetic cause of variation in expression of traits and how perturbations to the genotype result in phenotypic changes in farm animals.	PLO1, PLO3
CLO4	Characterize the genes controlling immunogenetics and associated regulation.	PLO1, PLO3
CLO5	Identify the approaches of genetics that are implicated in animal production and improvement.	PLO6, PLO7
CLO6	Learn DNA marker-based approaches for understanding genome organization and evolution and will provide the students with hands-on experience to do DNA-based work for their MS work.	PLO1, PLO3, PLO4

No.	**Topic/Course content**	**Teaching learning strategy**	**Assessment Strategy**

1.	Recent development in genetics, cytogenetics and its application to domestic animals, the theories of evolution and Darwinism, Mendel's contribution and principles.	Lecture, assignment, video	True-False, MCQ, Essay, Short answer, Presentation
2.	Structure of eukaryotic chromosomes, karyotypes, techniques for banding pattern, chromosomal aberrations and cytoplasmic inheritance.	Lecture, assignment, video	True-False, MCQ, Essay, Short answer, Presentation
3.	Definition, methods and application of Linkage and gene mapping.	Lecture, assignment, video	True-False, MCQ, Essay, Short answer, Presentation
4.	Immune response and its genetic control, components of immune system, Red cell antigen, antibody diversity, major histocompatibility complex (MHC), and inheritance pattern for blood proteins and blood groups in domestic animals and birds.	Lecture, assignment, video	True-False, MCQ, Essay, Short answer, Presentation
5.	DNA structure, composition and configuration, DNA replication, protein synthesis, fluorescence in situ hybridization (FISH), primed in situ hybridization (PRINS), mutation and assays of mutagenesis, sister chromatid exchanges and recombinant DNA technique.	Lecture, assignment, video	True-False, MCQ, Essay, Short answer, Presentation

Books Recommended:

Books Recommended:

1. **Genes IX,** 9th ed. by B Lewin, 2008. Jones and Bartlett Publishers, Sudbury, Mass.
2. **Genetics: from Genes to Genomes,** 4th ed. by L Hartwell**,** 2011. McGraw-Hill, New York.
3. **Genetics and Molecular Biology,** 2nd ed. by RF Schleif, 1993. Johns Hopkins University Press, Baltimore.
4. **Genetics Demystified,** by E Willett, 2006. McGraw-Hill, New York.
5. **Introduction to Veterinary Genetics,** 3rd ed. by FW Nicholas, 2010. Wiley-Blackwell, Chichester, U.K; Ames, Iowa.
6. **Principles of Genetics,** 8th ed. by EJ Gardner, MJ Simmons and DP Snustad, 1991. J. Wiley, New York.
7. **Principles of Genetics,** 7th ed. by RH Tamarin, 2002. McGraw-Hill, Boston.

Course Profiling of Animal Breeding

July-December Semester	
Course Code: ABG 6202	
Course Title: Animal Breeding	
Course Status: Core	
Credit: 2.0	
Prerequisite(s): Animal Genetics	
Rationale	Animal breeding methods are essential for genetic improvement and conservation of genetic diversity. Understanding the principles and practices of animal breeding is important for sustainable improvement of animal productivity. Hence, the course is designed with particular emphasis on animal breeding in the context of selection, mating, heterosis, breeding value, breeding policy and conservation.
Objectives	1. State the importance of breeding in animal production. 2. Describe the animal breed structure and various breeding schemes. 3. Contribute in and evaluate breeding policies based on properties of the production system. 4. Formulate breeding plans in different agro-ecological zones. 5. Explain the importance of conservation of animal genetic resources. 6. Provide adequate animal breeding services and up gradation of local/ indigenous breeds.

Course Learning Outcomes (CLOs)

By the end of the course, the students will be able to:		**Mapping with PLOs**
CLO1	Explain the scope of animal breeding and estimation of genetic parameters.	PLO1, PLO3,
CLO2	Understand and discuss the consequences of different structures of breeding programs.	PLO1, PLO3,
CLO3	Predict the response to selection for different selection strategies.	PLO1, PLO3
CLO4	Estimate breeding values and their accuracy for simple situations.	PLO1, PLO3, PLO6
CLO5	Explain breeding policy and program.	PLO3, PLO6
CLO6	Describe how genetic diversity is maintained in breeding programs.	PLO3, PLO6, PLO7

No.	**Topic/Course content**	**Teaching Strategy**	**Assessment Strategy**

1.	**Introduction**: Scope and nature of animal breeding, statistics, matrix algebra and modeling, genetic parameter estimation.	Lectures, group discussions and tutorials.	Report, MCQ, Essay, Short questions, Broad questions, Presentation
2.	**Genetic Evaluation:** Breeding value, selection index, best linear unbiased prediction (BLUP)**.**	Lectures, group discussions and tutorials.	Report, MCQ, Essay, Short questions, Broad questions, Presentation
3.	**Selection:** Single and multi-trait selection, selection for correlated traits, response to selection, marker assisted selection (MAS).	Lectures, group discussions and tutorials.	Report, MCQ, Essay, Short questions, Broad questions, Presentation
4.	**Mating system:** Inbreeding, crossbreeding-heterosis, breeding for combining ability, synthetic breeds, breed evaluation and development, formulation of breeding design.	Lectures, group discussions and tutorials.	Report, MCQ, Essay, Short questions, Broad questions, Presentation
5.	**Breeding policy and program:** Policy formulation specific to situation - developing vs. developed. Dairy animal breeding- selection within breeds, crossbreeding, genotype - environment interaction. Beef animal breeding, small ruminant breeding. Program - breed structure, nucleus breeding, community-based breeding.Conservation of animal genetic resources: Animal genetic resources- domestic captive, zoo and wild. Perspective, methods of conservation, future utilization.	Lectures, group discussions and tutorials. The tutorials will be devoted to problem solving, data analysis (including ICT), and case studies from the literature.	Report, MCQ, Essay, Short questions, Broad questions, Presentation

Assessment Pattern: Both Formative and Summative.

Books Recommended:

1. **Breeding and Improvement of Farm Animals,** 7th ed. by EJ Warwick, JE Legates and VA Rice, 1979. McGraw-Hill, New York.
2. **Genetic Improvement of Cattle and Sheep,** by G Simm, 2000. Farming Press, Tombridge, U.K.
3. **Genetics and Animal Breeding,** by I Johansson and J Rendel, 1968. W. H. Freeman, San Francisco,.
4. **Genetics for the Animal Sciences,** by LD Van Vleck, EJ Pollak and EAB Oltenacu, 1987. W.H. Freeman, New York.
5. **Genetics of Livestock Improvement,** 3d ed. by JF Lasley, 1978. Prentice-Hall, Englewood Cliffs, N.J.
6. **Population Genetics for Animal Conservation**, by G Bertorelle, 2009. Cambridge University Press, Cambridge, UK; New York.

7. **Understanding Animal Breeding,** 2nd ed. by RM Bourdon, 2000. Prentice Hall, Upper Saddle River, NJ.

Course Profiling of Animal Reproduction

July-December Semester

Course Code: ABG 6203	
Course Title: Animal Reproduction	
Course Status: Core	
Credit: 2.0	
Prerequisite(s): Animal Genetics, Animal Breeding	
Rationale	The animal reproduction course is designed to teach students technical knowledge and skills by developing competencies concerning the physiology of reproduction, fertilization, causes of reproductive failure and gaining knowledge of estimation of reproductive efficiency.
Objectives	1. To provide students with an understanding of principles of animal reproduction and discuss importance of reproduction in animal agriculture. 2. To acquaint students with each stage of fertilization process, pregnancy and parturition. 3. To describe benefits of using genetically superior animals for breeding. 4. To become familiar with factors that affect reproductive efficiency in farm animals and consideration for improvement breeding efficiency. 5. To explain the roles of male and female reproductive hormones.

Course Learning Outcomes (CLOs)

By the end of the course, the students will be able to:		**Mapping with PLOs**
CLO1	Explain the importance of reproduction in animal agriculture.	PLO1, PLO3,
CLO2	Describe the physiology of puberty, gametogenesis, embryogenesis, pregnancy, parturition and lactation.	PLO3, PLO4, PLO5
CLO3	Explain the mechanism and regulation of hormone synthesis, secretion, and transport.	PLO3, PLO5
CLO4	Identify the reasons of reproductive failure and estimating and improving the reproductive efficiency.	PLO3, PLO4,
CLO5	Demonstrate the selection, management and methods of breeding soundness examination of breeding males.	PLO3, PLO5

No.	Topic/Course content	Teaching Strategy	Assessment Strategy
1.	Early history of reproduction, relationship of reproductive biology with Genetics and Animal Breeding, germplasm embryonic development of male and female reproductive organs.	Lecture, assignment, video	True-False, MCQ, Essay, Short answer, Presentation
2.	Spermatogenesis and maturation of spermatozoa, estrous cycles, congenesis, folliculogenesis and fertilization, recovery of embryos.	Lecture, assignment, video	True-False, MCQ, Essay, Short answer, Presentation
3.	Relationship between genetics and endocrinology, endocrine and nervous systems, hormone assays, neuroendocrine control of the pituitary gland, reproductive role of prostaglandins, hormone-like factor and other hormonal mediators, regulation of hormone, secretion, receptor sites, intracellular mechanism of hormone action, use of synthetic hormones in the breeding processes.	Lecture, assignment, video	True-False, MCQ, Essay, Short answer, Presentation
4.	Genetic and environmental causes of infertility and sterility in male and female, physiological, toxicological, and psychological causes of reproductive failure, infectious diseases relating to reproductive failure.	Lecture, group discussion multimedia projection: video clip, animated object.	True-False, MCQ, Essay, Short answer, Presentation
5.	Measures of reproductive efficiency and improvement of reproductive efficiency in relation to life time productivity and profitability of livestock enterprises. Mass selection, family selection, selection index, reciprocal recurrent selection.	Lecture, group discussion multimedia projection: video clip, animated object.	True-False, MCQ, Essay, Short answer, Presentation

Assessment Pattern: Both Formative and Summative.

Books Recommended:

1. **Arthur's Veterinary Reproduction and Obstetrics,** 8th ed. by GH Arthur, DE Noakes, TJ Parkinson and GCW England, 2001. Saunders, London; New York.
2. **Comparative Reproductive Biology,** 1st ed. by H Schatten and GM Constantinescu, 2007. Blackwell Pub, Ames, Iowa.
3. **Dewhurst's Textbook of Obstetrics and Gynaecology,** 7th ed. by DK Edmonds and J Dewhurst, 2007. Blackwell Pub, Malden, Mass.

4. **Knobil and Neill's Physiology of Reproduction,** by JD Neill, 2005. Elsevier-Academic Press, London.
5. **Pathways to Pregnancy and Parturition,** by PL Senger, 2005. Current Conceptions, Pullman.
6. **Reproduction in Farm Animals,** 7th ed. by B Hafez and ESE Hafez, 2000. Lippincott Williams & Wilkins, Philadelphia.
7. **Reproduction in Mammals,** 2nd ed. by CR Austin and RV Short, 1982. Cambridge University Press, Cambridge; New York.

Course Profiling of Computer Usage in Animal Genetics, Breeding and Reproduction.

July-December Semester	
Course Code: ABG 6204	
Course Title: Computer Usage in Animal Genetics, Breeding and Reproduction.	
Course Status: Core	
Credit: 2.0	
Prerequisite(s): Biostatistics, Animal Breeding	
Rationale	An animal scientist needs to know basic concepts about computer applications in livestock breeding. This course will provide adequate knowledge on various software based programs used for genetics and animal breeding.
Objectives	1. To know about basis computer applications in genetics and animal breeding. 2. To know about computer application programs and software used for genetics and animal breeding. 3. To estimate genetic variances and covariance using software.

Course Learning Outcomes (CLOs)

By the end of the course, the students will be able to:		**Mapping with PLOs**
CLO1	Describe basics of computer applications in animal Breeding.	PLO1, PLO2, PLO3,
CLO2	Apply various software in animal breeding and genetics.	PLO2, PLO5, PLO7, PLO3,
CLO3	Estimation and Prediction of breeding result using various software in breeding.	PLO2, PLO5, PLO7
CLO4	Statistical Models and apply these to a large diversity of biological data set	PLO2, PLO7

No.	Topic/Course content	Teaching Strategy	Assessment Strategy
1.	**Introduction:** Basics of computer application in genetics and animal breeding.	Lecture, group discussion multimedia projection: video	Quiz/MCQ, Short and broad question.
2.	**Computer applications in genetics and animal breeding:**Data file and entry of data material, numerical and string variable, creation of directory and sub directory, sorting data and creation ofsecondary data files and database, construction of pedigree files for quantitative analysis.	Lecture, group discussion, multimedia projection: video clip, animated object.	Quiz/MCQ, short and broad question, assignment and presentation.
3.	**Application of programs, models and software:** Statistical Analysis System (SAS), Mixed Model Least Squares and Maximum Likelihood, Derivation free Restricted Maximum Likelihood.	Lecture, group discussion, multimedia projection: video clip, animated object.	Quiz/MCQ, short and broad question, assignment and presentation.
4.	**Estimation of genetic variances and covariance:** Variance Component Estimation, Predictionand Estimation of Breeding Values, Design Crossing System, AlleleFrequencies and genetic distance estimation in Population in ALIELE-DRIFT, DISPAN,GENEPOP, MEGA -7, and R Software etc.	Lecture, group discussion, multimedia projection: video clip, animated object.	Quiz/MCQ, Short and broad question, assignment and presentation.

Assessment Pattern: Both Formative and Summative.

Recommended books

1. **A manual for Use of MTDFREML. A Set of Programs to Obtain Estimates of Variances and Covariances [DRAFT],** by KL Boldman, 1993. U. S. Department of Agriculture, Agricultural Research Service, Clay Center.
2. **PEST, a General Purpose BLUP Package for Multivariate Prediction and Estimation,** by E Groeneveld, M Kovač and T Wang, 1990. Proceedings of the 4th World Congress on Genetics applied to Livestock Production, Edinburgh, UK.Vol. 13 p:488-491.
3. **User's Guide for LSMLMW and MIXMDL,** by WR Harvey, 1990, Columbus, Ohio State University.
4. **VCE- A Multivariate Multimodel REML (Co)variance Component Estimation Package,** by E Groeneveld, 1994. In: Proceedings of the 5th World Congress on Genetics Applied to Livestock Production, Guelph, Canada.Vol. 22 p:47-48.

Course Profiling of Herd Fertility and Reproductive Management

July-December Semester	
Course Code: ABG 6205	
Course Title: Herd Fertility and Reproductive Management	
Course Status: Core	
Credit: 2.0	
Prerequisite(s): Animal Reproduction	
Rationale	As an animal breeder/ reproduction specialist needs to know about the understanding of herd fertility records, service management, pregnancy diagnosis and economics of poor fertility.
Objectives	1. To understanding dairy herd fertility records as well as systems of fertility recording. 2. To improve service management of dairy herd. 3. To measure the economics of poor fertility in a dairy herd. 4. To diagnosis the pregnancy of farm animals. 5. To implement managerial practices for the improvement of reproductive efficiency in farm animals.

Course Learning Outcomes (CLOs)

By the end of the course, the students will be able to:		**Mapping with PLOs**
CLO1	Understand dairy herd fertility records.	PLO1, PLO3,
CLO2	Identify the systems of fertility recording for the dairy herd.	PLO1, PLO3,
CLO3	Explain the relationship between nutrition and fertility.	PLO3, PLO5
CLO4	Understand the oestrus and oestrus detection methods.	PLO5
CLO5	Become familiar with service management.	PLO5
CLO6	Know how to diagnosis pregnancy diagnosis of farm animals.	PLO3, PLO5, PLO7
CLO7	Understand the importance of economics of poor fertility.	PLO5

No.	Topic/Course content	Teaching learning strategy	Assessment Strategy
1.	Components of calving interval, submission rate and pregnancy rate and their measurements, calving index, targets for high performance.	Lecture, assignment, video	MCQ, essay, short question, presentation
2.	Basic structure of a fertility recording system, types and structures of fertility records, choosing a fertility recording system.	Lecture, assignment, group discussion, using computer to practices of recording system	Short question, broad question, use computer for record keeping, presentation

No.	Topic/Course content	Teaching learning strategy	Assessment Strategy
3.	The reproductive cycle and nutrition, body condition scores, energy intake, protein level and fertility, mineral and trace elements.	Lecture, assignment, video	True-False, MCQ, essay, short answer, presentation
4.	Oestrus behaviour, methods and impediments for oestrus detection, improving oestrus detection, oestrus detection aids, recent approaches.	Lecture, assignment, group discussion, practical demonstration, video	True-False, MCQ, essay, short answer, presentation
5.	Pre-breeding management, timing of service, management on the day of service, holding facilities, sweeper bulls.	Lecture, assignment, video	True-False, MCQ, broad question, short answer, presentation
6.	Normal pregnancy rates and limitation of early pregnancy diagnosis, methods of pregnancy diagnosis available, Economics of pregnancy diagnosis.	Lecture, assignment, practical demonstration, video	True-False, MCQ, short answer, broad question, presentation
7.	Effects of poor fertility on the profitability and their calculations.	Lecture, assignment, video	MCQ, essay, short answer

Recommended books

1. **Dairy Herd Fertility,** by Agricultural Development and Advisory Service, Great Britain, 1984. H.M.S.O., London.
2. **Fertility and Infertility in Domestic Animals,** 3d ed. by JA Laing, **1979**. BaillièreTindall, London.
3. **Genetic Disorders and the Fetus: Diagnosis, Prevention, and Treatment,** 6th ed. by A Milunsky and JM Milunsky, 2010. Wiley-Blackwell, Oxford; Hoboken, NJ.
4. **Infections, Infertility, and Assisted Reproduction,** by K Elder, J Ribes and D Baker, 2005. Cambridge, New York.
5. **Male Fertility and Infertility,** by TD Glover and CLR Barratt, 1999. Cambridge University Press, Cambridge, UK; New York, NY.
6. **Reproductive Endocrinology and Infertility,** by V Lewis, 2007. Landes Bioscience, Austin, Tex.
7. **Reproductive Endocrinology and Infertility: The Requisites in Obstetrics and Gynecology,** 1st ed. by R Alvero and WD Schlaff, 2007. Mosby, Philadelphia, Pa.
8. **The Genetics of Male Infertility,** by DT Carrell, 2007. Humana Press, Totowa, N.J.

Course Profiling of Poultry Reproduction

July-December Semester	
Course Code: ABG 6206	
Course Title: Poultry Reproduction	
Course Status: Core	
Credit: 2.0	
Prerequisite(s): Poultry Breeding	
Rationale	Production of eggs for consumption is the principal function of chickens in most regions followed by the use as source of income and meat for home consumption. Through the course the student will gain insight in poultry reproductive physiology, multiplying and hatching, determination of sex, assessing welfare and reproductive health in poultry production, and assessing the quality of poultry.
Objectives	1. Identify and describe the male and female reproductive organs/system of poultry. 2. To acquire knowledge and skill of poultry reproduction process and fertilization. 3. Build competence to raise healthy poultry.

Course Learning Outcomes (CLOs)

By the end of the course, the students will be able to:		**Mapping with PLOs**
CLO1	Acquire knowledge of the poultry reproductive physiology.	PLO1, PLO3
CLO2	Gain knowledge about reproduction, fertilization and Embryonic Development.	PLO1, PLO3
CLO3	Become familiar with the technique and importance of AI in poultry.	PLO5
CLO4	Improve and control reproduction using photo schedules.	PLO1
CLO5	Understand and monitoring reproductive Success.	PLO5, PLO6, PLO7

No.	Topic/Course content	Teaching Strategy	Assessment Strategy
1.	Reproductive organs in the male and female, Avian Endocrine Regulatory system.	Lecture, assignment, video	True-False, MCQ, Essay, Short answer, Presentation
2.	Introduction, Fertilization, Sex determination in the avian embryo Parthenogenesis, embryonic development in different stages of growth of the embryo pre and post incubation.	Lecture, assignment, video	True-False, MCQ, Essay, Short answer,
3.	Artificial Insemination, Introduction, Economics of artificial insemination. Semen collection, Semen evaluation, Volume and number of sperm per insemination, In vitro storage of semen.	Lecture, assignment, video	True-False, MCQ, Essay, Short answer, Presentation
4.	Introduction, controlling the onset and maintenance of lay, Controlling sexual maturation of males, Controlling feed efficiency, Controlling the timing of oviposition, Lighting regimes-Constant illumination, continuous darkness and Ahemeral.	Lecture, assignment, video	True-False, MCQ, Essay, Short answer, Presentation
5.	Introduction, Estimating the rate of ovulation and oviposition, estimating the rate of fertility and hatchability.	Lecture, assignment, video	True-False, MCQ, Essay, Short answer,

Assessment Pattern: Both Formative and Summative.

Books Recommended:

1. **Avian Embryology,** 2 ed. by M Bronner-Fraser, 2008. Methods in cell biology series, Vol. 87. Academic Press, San Diego.
2. **Biology of Breeding Poultry,** by PM Hocking, 2009. CABI North American Office, Cambridge, MA.
3. **Poultry Genetics, Breeding, and Biotechnology,** by WM Muir and SE Aggrey, 2003. CABI Pub., Wallingford, Oxon, UK
4. **Reproduction in Poultry,** by RJ Etches, 1996. CAB International, Wallingford, Oxon.
5. **Reproductive Biology and Phylogeny of Birds,** by BGM Jamieson, 2007. Science Publishers, Enfield, NH.
6. **The Atlas of Chick Development,** 2nd ed. by R Bellairs and M Osmond, 2005. Elsevier, Amsterdam; Boston.

Course Profiling of Gene Expression, Regulation and Cell Signaling

January-June Semester
Course Code:6207
Course Title: Gene Expression, Regulation and Cell Signaling
Course Status: Core
Credit: 2.0
Prerequisite(s): Animal Genetics, Molecular Genetics.

Rationale	Signal transduction pathways coordinate diverse cellular processes such as growth, proliferation, metabolism, adherence, migration, and gene expression.This course covers the molecular mechanisms of gene expression and signal transduction. The fundamental mechanisms underlying transcription, RNA processing, translation, and DNA replication are highlighted, and the integration of these fundamental mechanisms into molecular and cellular regulation of proliferation and signal transduction is discussed.
Objectives	1. Build an understanding of the role of signal transduction in the control of gene expression. 2. Improve written scientific communication skills through engagement in literature searches, data analysis, and writing reports. 3. Develop an awareness of the procedures and protocols for analyzing and making inferences from high-content quantitative molecular biology data.

Course Learning Outcomes (CLOs)

By the end of the course, the students will be able to:		**Mapping with PLOs**
CLO1	Explain the classified organization of signal transduction pathways.	
CLO2	Explain the role of enzymes in signal propagation and amplification.	
CLO3	Recognize the centrality of signaling pathways in cellular processes, such as metabolism, cell division, or cell motility.	
CLO4	Discuss the connection between deranged signaling pathways and disease.	
CLO5	Use software to analyze and interpret gene expression data and an appropriate statistical method for hypotheses testing.	

No.	Topic/Course content	Teaching Strategy	Assessment Strategy
1.	Central dogma; mechanics of transcription; post-transcriptional modification, processing and nuclear export of coding RNA; synthesis of proteins; regulation of protein levels and transcription factors, and receptor's function; Gene expression analysis using northern, southern and western blotting.	Lecture, Group discussion, Exercise, Problem based learning.	MCQ, Short question, Broad question, Problem solution
2.	Regulation of gene expression: gene expression regulation through chromatin remodeling, histone acetylation, histone deacetylation, methylation, telomere length and microRNAs.	Lecture, Group discussion, Exercise, Problem based learning.	MCQ, Short question, Broad question, Problem solution
3.	Origins, components and foundations of signaling: cell signaling and gene transcription; major signaling pathways in eukaryotic cells and their relationship to the activation of transcription factors.	Lecture, Group discussion, Exercise, Problem based learning.	MCQ, Short question, Broad question, Problem solution
4.	Cell to cell signaling; cell to cell and cell to matrix interactions, method of converting signals from extracellular to intracellular level, cell–cell signaling in gonads.	Lecture, Group discussion, Exercise, Problem Lecture, Group discussion.	MCQ, Short question, Broad question, Problem solution
5.	Important signaling pathways regulating differentiation, growth, development, reproduction and diseases.	Lecture, Group discussion, Exercise, Problem based learning.	MCQ, Short question, Broad question, Problem solution

Assessment Pattern: Both Formative and Summative.

Recommended Text Book:

1. **Analysis of Genes and Genomes,** by RJ Reece, 2004. John Wiley & Sons, Chichester, West Sussex, England; Hoboken, NJ.
2. **Gene Expression and Regulation,** by J Ma, 2006. Higher Education Press; Springer, Beijing [New York].
3. **Gene Regulation: A Eukaryotic Perspective,** 5th ed. by DS Latchman, 2005. Taylor & Francis, New York.
4. **Handbook of Cell Signaling,** by RA Bradshaw and EA Dennis, 2004. Academic Press, Amsterdam San Diego, Calif.
5. **Intercellular Signaling in Development and Disease,** by EA Dennis and RA Bradshaw, 2011. Academic Press, Amsterdam; Boston.
6. **Measuring Gene Expression,** by MB Avison, 2007. Taylor & Francis, New York; Abingdon [England].
7. **Molecular and Cellular Signaling,** by M Beckerman, 2005. Springer, New York.
8. **Regulation of Gene Expression: Molecular Mechanisms,** by GH Perdew, JP VandenHeuvel and JM Peters, **2006**. Humana Press, Totowa, N.J.
9. **Regulation of Gene Expression by Small RNAs,** by RK Gaur and JJ Rossi, 2009. CRC Press, Boca Raton.
10. **Structure and Function in Cell Signaling,** by J Nelson, 2008. John Wiley & Sons, Chichester, England; Hoboken, NJ.

11. **The Biochemistry of Cell Signaling,** by EJM Helmreich, 2001. Oxford University Press, OxfordF; New York.

Course Profiling of Stem Cells and Reprogramming

January-June Semester	
Course Code:ABG-6208	
Course Title: Stem Cells and Reprogramming	
Course Status: Core	
Credit: 2.0	
Prerequisite(s): Animal Genetics, Molecular Genetics.	
Rationale	This course will provide students with the necessary for understanding, examining, and dissecting the dynamic field of stem cell research. This course will also explore into the basic research in nuclear reprogramming that uncovers the molecular mechanisms through different reprogramming techniquesincluding Somatic Cell Nuclear Transfer Techniquesby epigenetic or nuclear reprogramming.
Objectives	1. Describe basic concepts in stem cell. 2. Explain uses of stem cell (Pluripotent stem cell) in different area. 3. Apply different nuclear reprogramming techniques.

Course Learning Outcomes (CLOs)

By the end of the course, the students will be able to:		**Mapping with PLOs**
CLO1	Describe the stem cell niche and its role on cell cycle regulation.	
CLO2	Compare different type's stem cells and describe molecular basis of pluripotency.	
CLO3	Isolate, culture, differentiate and manipulate embryonic stem cells in vivo and in vitro.	
CLO4	Apply stem cell in reproduction, therapeutics and extra embryonic lineages.	
CLO5	Define the concepts and principles of nuclear reprogramming.	
CLO6	Apply different techniques in nuclear reprogramming.	

No.	Topic/Course content	Teaching Strategy	Assessment Strategy
1.	**Stem cell biology:** Characteristics, culture and differentiation of embryonic stem cells; molecular basis of pluripotency; stem cell niches; self-renewal of stem cell; cell cycle regulators; differentiation in early development; stem cells in extraembryonic lineages; manipulation of embryonic stem cells; stem cells in reproduction and therapeutic applications.	Lecture, Group discussion, Exercise, Problem based learning.	MCQ, Short question, Broad question, Problem solution
2.	**Nuclear reprogramming:** Concepts of reprogramming, reprogramming somatic cells to pluripotent phenotype, induced pluripotent stem cell (iPS), SCNT and reprogramming, nuclear reprogramming by cell fusion, epigenetic reprogramming of somatic genomes, modulation of cell fate using nuclear and cytoplasmic extracts, transgenic systems in nuclear reprogramming, ethical considerations of cloning and human stem cell research.	Lecture, Group discussion, Exercise, Problem based learning.	MCQ, Short question, Broad question, Problem solution

Assessment Pattern: Both Formative and Summative.

Recommended Text Book:

1. Embryonic Stem Cells, by JRW Masters, B Palsson and JA Thomson, 2007. Springer, Dordrecht.
2. Essentials of Stem Cell Biology, by RP Lanza, 2006. Elsevier/Academic Press, Amsterdam; Boston.
3. Human Embryonic Stem Cells, by JS Odorico, SC Zhang and RA Pedersen, 2005. Garland Science/BIOS Scientific Publishers, Abingdon, Oxon, UK; New York; Independence, KY.
4. Human Embryonic Stem Cells: The Practical Handbook, by S Sullivan, C Cowan and K Eggan, 2007. John Wiley & Sons, Chichester, West Sussex, England; Hoboken, NJ.
5. Nuclear Reprogramming: Methods and Protocols, by S Pells, 2006. Humana Press, Totowa, N.J.
6. Stem Cells in Human Reproduction: Basic Science and Therapeutic potential, by C Simón and A Pellicer, 2007. Informa Healthcare; Taylor & Francis, Abingdon, U.K; Boca Raton.
7. Stem Cells, by AM Wobus and KR Boheler, 2008. Springer, Berlin.

20.Grading and Evaluation (As per PSTU ordinance)

20.1 Grading Scale

a) Letter Grades and corresponding Grade Points will be awarded following provisions shown below:

20.1.1 Evaluation of Theory Courses

a) All theory courses will be evaluated out of 100 marks, the distribution of which is given below:

Sl. No.	Items	Marks
1	Attendance	10
2	Assignment	10
3.	Mid Semester Examination	20
4.	Semester Final Examination	60
	Total	**100**

b) The basis for awarding marks for class attendance and participation will be as follows:

Attendance & Participation	Marks
90% or above	10
85 to below 90%	9
80 to below 85%	8
75 to below 80%	7
70 to below 75%	6
65 to below 70%	5
60 to below 65%	4
Below 60%	0

20. 2. Grades
20. 3. Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA)
20. 4. Course Withdrawal
20. 5. Incomplete (I) courses
20. 6. Retake
20.7. Grade Improvement
20. 8. Dropout

References

BAC 2021. Bangladesh Accreditation Council (BAC) Standards for Accreditation of Academic Program, BAC, Dhaka.pp.1-8.

UGC 2020. Template of Outcome Based Education (OBE) Curriculum (Revised). pp. 1-8.

BAC 2021. Bangladesh National Qualifications Framework (BNQF) Part B: Higher Education (level 7-10). pp. 1-29.