Academic:

1. **Degree Offered:B.V.Sc.&A.H., M.V.Sc and Ph.D.**

Title of degree	: Bachelor of Veterinary Science and Animal Husbandry
Duration	: Five and Half Year
Eligibility Criteria	: NEET Qualified
Intake Capacity	: 115
Opportunities	: Placement as LDO, Organized Livestock farms, Feed Industry, veterinary Clinics etc.

Degree Offered	: M.V.Sc.
Title of degree	: Master of Veterinary Science in Animal Genetics and Breeding
Duration	: 2 years
Eligibility Criteria	: ICAR -Entrance Exam Qualified
Intake Capacity	: 03
Opportunities	: Placement as Academician, National Veterinary Research Institutes, Poultry Breeding, etc.

Degree Offered	: Ph.D.
Title of degree	: Doctor of Philosophy in Animal Genetics and Breeding
Duration	: 3/4 years
Eligibility Criteria	: ICAR -Entrance Exam Qualified
Intake Capacity	: 02
Opportunities	: Placement as Academician, National Veterinary Research Institutes, Poultry Breeding, etc.

2. Academic Regulations:
   UG , PG, PhD (VCI, ICAR, IV, V Dean's and Corrigendum)
3. Admissions:

UG, PG, PhD

List of Admitted Students – First Year to Final Year (Veterinary Year-wise / Fishery and Dairy Semester-wise) :

M.V.Sc Semester: V

Sr. No.	Name of Student	Enrl. No.	Email Address	Name of Advisor
1	Mahesh Kumar Prajapat	V/22/424	mkp008653@gmail.com	Dr.V.D.Pawar
2.	Byale Sudhanshu Madhav	V/17/046	byalesudhanshu@gmail.com	Dr.S.J.Komarwar
M.V.Sc Semester:III				
1	Yewale Rushikesh Vijayrao	V/18/398	rushikeshyeole21@gmail.com	Dr.M.P.Sawane
2	Thorat Ganesh Chandrakant	V/18/369	ganeshthorat7070@gmail.com	Dr.S.J.Komatwar
M.V.Sc Semester:I				
1.	Ms.Nikam Siddhi	V/19/250	siddhinikam2001@gmail.com	Dr.M.P.Sawane
2.	Funde Nagesh Sukhdeo	V/19/099	nageshf10@gmail.com	Dr.M.P.Sawane
Ph.D Semester I				
1	Shashank Wamanrao Kamble		shashankkamble@yahoo.com	Dr.M.P.Sawane

- **Course offered: UG, PG, PhD - Semester / Year wise**

List of UG Courses (B.V.Sc & AH) As per latest MSVE-2016 Guidelines)

Sr No	Course No.	Title	Credit	Course offered in the Year
1	UNIT-I,UNIT-II &UNIT-III	Animal Genetics and Breeding with Biostatistics	3+1	II nd year

- List of PG Courses (MVSc) and M.Tech. (Dairy Technology)

Sr No	Course No .	Title	Credit	Semester
1	AGB 601	Animal Cytogenetics and Immunogenetics	2 + 1 = 3	I
2	AGB 602	Molecular Genetics I	2 + 1 = 3	I
3	AGB 603	Population and Quantitative Genetics	2 + 1 = 3	I

4	AGB 604	Selection Method and Breeding System	2 + 1 = 3	I
5	AGB 605	Biometrical Genetics	2 + 1 = 3	II
6	AGB 606	Conservation of Animal Genetics Resources	2 + 0 = 2	II
7	AGB 607 Optional	Cattle and Buffalo Breeding	2 + 1 = 3	II
8	AGB 608 Optional	Sheep and Goat Breeding	2 + 0 = 2	II
9	AGB 609 Optional	Poultry Breeding	2 + 1 = 3	II
10	AGB 610 Optional	Laboratory Animal and Rabbit Breeding	2 + 0 = 2	II
11	AGB 611 Optional	Swine Breeding	1 + 0 = 1	II
12	AGB 612	Pet Animal Breeding (Dogs and Cats)	1 + 0 = 1	II
13	AGB 613 Optional	Wild Animal Genetics and Breeding	1 + 0 = 1	II
14	AGB 614 Optional	Equine Breeding	1 + 0 = 1	II
15	AGB 615 Optional	Camel Breeding	1 + 0 = 1	II
16	AGB 616 Optional	Yak and Mithun Breeding	1 + 0 = 1	II
17	AGB 617 Optional	Statistical Methods in Animal Breeding	2 + 1 = 3	II
18	AGB 691	Masters Seminar	1 + 0 = 1	III
19	AGB 699	Masters Research	0 + 10=10	III
20	AGB 699	Masters Research	0 + 20 = 20	IV

Ph. D. Semester-wise Course Programme (Regular)

Sr. No	Course No.	Title of the course	Credits	Compulsory/ Optional
	Semester-I			
1.	AGB 701	Molecular Genetics II	2+0	Compulsory
2.	AGB 702	Trends in Animal Breeding	2+0	Compulsory
3.	AGB 703	Biometrical Genetics II	2+1	Compulsory
4.	AGB 704	Advances in Selection Methodology	2+1	Compulsory
		Total	**10**	
Semester-II				
1.	AGB 705	Bioinformatics in Animal Breeding	1+1	Optional

2.	AGB 706	Animal Cytogenetics and Immunogenetics II	2+0	Optional
3.	AGB 707	Statistical Software in Animal Breeding	1+1	Optional
4.	RPE 700	Research and Publication Ethics	1+1	Compulsory
		Total	**8**	
Semester-III				
1.	AGB 791	Seminar I	1+0	Compulsory
2.	AGB 792	Seminar II	1+0	Compulsory
3.	AGB 799	Research	15	Compulsory
		Total	**17**	
	Semester-IV			
1.	AGB 799	Research	20	Compulsory
	Semester-V			
		Total	**20**	
1.	AGB 799	Research	20	Compulsory
		Total	**20**	
	Semester-VI			
1.	AGB 799	Research	20	Compulsory
		Total	**20**	

Ph.D. Semester-wise Course Programme (In-service)

Sr. No	Course No.	Title of the course	Credits	Compulsory/ Optional	
Semester – I					
1.	AGB 701	Molecular Genetics II	2+0	Compulsory	
2.	AGB 702	Trends in Animal Breeding	2+0	Compulsory	
		Total	**4**		
Semester – II					
1.	AGB 703	Biometrical Genetics II	2+1	Compulsory	
2.	RPE 700	Research and Publication Ethics	1+1	Compulsory	
		Total	**5**		
Semester – III					
1.	AGB 704	Advances in Selection Methodology	2+1	Compulsory	
2.	AGB 705	Bioinformatics in Animal	1+1	Optional	

		Breeding			
3.	AGB 706	Animal Cytogenetics and Immunogenetics II	2+0	Optional	
4	AGB 707	Statistical Software in Animal Breeding	1+1	Optional	
5	AGB 791	Seminar I	1+0	Compulsory	
6	AGB 792	Seminar II	1+0	Compulsory	
		Total	**11**		
Semester – IV					
1.	AGB 799	Research	15	Compulsory	
		Total	**15**		
Semester – V					
1.	AGB 799	Research	15	Compulsory	
		Total	**15**		
Semester – VI					
1.	AGB 799	Research	15	Compulsory	
		Total	**15**		
Semester – VII					
1.	AGB 799	Research	15	Compulsory	
		Total	**15**		
Semester – VIII					
1.	AGB 799	Research	15	Compulsory	
		Total	**15**		

COURSES OFFERED IN UNDERGRADUATE (B.V.SC AND A.H) DEGREE PROGRAAME

ANIMAL GENETICS AND BREEDING **Credit Hours: 3+1**

THEORY

UNIT-1 (BIOSTATISTICS AND COMPUTER APPLICATION)

Biostatistics: Introduction and importance of statistics and biostatistics, Classification and tabulation of data. Parameters, observation, recording and graphical and diagrammatic representation of data. Measures of Central tendency (simple and grouped data). Measures of Dispersion (simple and grouped data). Probability and probability distributions: binomial, Poisson and normal, moments and skewness to kurtosis. Correlation and regression. Introduction of sampling methods. Tests of hypothesis and t, Z- tests of significance. Chi-square and F-test of significance. Design of experiment, Analysis of variance. Completely randomized design (CRD). Randomized block design (RBD).

Computer Application: Basics of computer. Introduction to computer languages. Data management using spread sheet (MS-Excel). Introduction of MS-Office, MS-Word, MS-PowerPoint. Concepts of computer networks, internet & e-mail.

UNIT-2 (PRINCIPLES OF ANIMAL AND POPULATION GENETICS)

Animal Genetics: History of Genetics. Mitosis v/s Meiosis. Chromosome numbers and types in livestock and poultry. Overview of Mendelian principles. Modified Mendelian inheritance, Pleiotropy, Penetrance and expressivity. Multiple alleles; lethals; sex-linked, sex limited and sex influenced inheritance. Sex determination. Linkage, crossing over and construction of linkage map. Mutation, Chromosomal aberrations. Cytogenetics, Extra-chromosomal inheritance. Molecular genetics, nucleic acids-structure and function. Gene concept, DNA and its replication. Introduction to molecular techniques.

Population Genetics: Introduction to population genetics; individual v/s population. Genetic structure of population: Gene and genotypic frequency. Hardy - Weinberg law and its application. Forces changing gene and genotypic frequencies (eg Mutation, migration, selection and drift). Quantitative v/s qualitative genetics; concept of average effect and breeding value. Components of Variance. Concept of correlation and interaction between Genotype and Environment. Heritability and Repeatability. Genetic and Phenotypic Correlations.

UNIT-3 (PRINCIPLES OF ANIMAL BREEDING)

Livestock and Poultry Breeding: History of Animal Breeding. Classification of breeds. Economic characters of livestock and poultry and their importance. Selection, types of selection, response to selection and factors affecting it. Bases of selection: individual, pedigree, family, sib, progeny and combined, indirect selection. Method of selection, Single and Multi trait. Classification of mating systems. Inbreeding coefficient and coefficient of relationship. Genetic and phenotypic consequences of inbreeding, inbreeding depression, application of inbreeding. Out breeding and its different forms. Genetic and phenotypic consequences of outbreeding, application of outbreeding, heterosis. Systems of utilization of heterosis; Selection for combining ability (RS & RRS). Breeding strategies for the improvement of dairy cattle and buffalo. Breeding strategies for the improvement of sheep, goat, swine and poultry. Sire evaluation. Open nucleus breeding system (ONBS). Development of new breeds/strains. Current livestock and poultry breeding policies and programmes in the state and country. Methods of conservation- livestock and poultry conservation programmes in the state and country. Application of reproductive and biotechnological tools for genetic improvement of livestock and poultry. Breeding for disease resistance.

Breeding of pet, zoo and wild animals: Classification of dog and cat breeds. Pedigree sheet, selection of breeds and major breed traits. Breeding management of dogs and cats. Common pet birds seen in India and their breeding management.

Population dynamics and effective population size of wild animals in captivity/zoo/natural habitats. Planned breeding of wild animals. Controlled breeding and assisted reproduction. Breeding for conservation of wild animals.

PRACTICAL

UNIT-1 (BIOSTATISTICS AND COMPUTER APPLICATION)

Collection, compilation and tabulation of data. Estimation of measures of central tendency (mean, median, mode) for simple and grouped data. Estimation of measures of dispersion (Range, standard deviation, standard error, variance, and coefficient of variation) for simple and grouped data. Graphical and diagrammatic representation of data. Estimation of correlation and regression. Simple probability problems, Normal distribution. Tests of significance: t-test, Z – test, Chi-square, F- tests. Completely randomized design (CRD). Randomized block design (RBD). Computer basics and components of computer. Simple operations: internet and e-mail, Entering and saving biological data through MS-Office (MS-Excel)

UNIT-2 (PRINCIPLES OF ANIMAL AND POPULATION GENETICS)

Monohybrid, Dihybrid cross and Multiple alleles. Modified Mendelian inheritance and sex linked inheritance. Linkage and crossing over. Demonstration of Karyotyping in farm animals. Demonstration of molecular techniques. Calculation of gene and genotypic frequencies, Testing a population for Hardy-Weinberg equilibrium. Calculation of effects of various forces that change gene frequencies. Computation of population mean, average effect of gene and gene substitution and breeding value. Estimation of repeatability, heritability, genetic and phenotypic correlations.

UNIT-3: (PRINCIPLES OF ANIMAL BREEDING)

Computation of selection differential and intensity of selection, Generation interval, expected genetic gain, correlated response, EPA and Most probable producing ability (MPPA). Estimation of inbreeding and relationship coefficient. Estimation of heterosis. Computation of sire indices. Computation of selection index.\

COURSES OFFERED IN POSTGRADUATE (M.V.Sc.) EGREE PROGRAAME

M.V.Sc Syllabus

Course Title : Animal Cytogenetics and Immunogenetics I
Course Code : AGB 601
Credit Hours : 2+1

I. Why this course?

To provide basic and advanced theoretical and practical training in animal cytogenetics and immunogenetics with an ulterior aim of enhancing animal production.

II. Aim of the course

This course is aimed to train students in identifying genetic/ chromosomal abnormalities and reviewing genetic mechanisms responsible for the generation of diversity in genes for immunoglobulin, TLR and MHC, etc., facilitating the better application of both classical and molecular cytogenetics and immunogenetics for animal improvement.

III. Theory

Unit I (7 Lectures)

Physical and chemical basis of heredity; Development in animal cytogenetics and immunogenetics of farm animals; Inborn errors of metabolism and inherited disorders; immunoglobulin and their types; Antigen-antibody interactions; Immune response; ELISA.

Unit II (10 Lectures)

Chromatin structure of eukaryotes; Chromosome number and morphology in farm animals; Karyotyping and banding; Chromosomal abnormalities and genetic syndromes; DNA packing in chromosomes; Types of DNA; FISH chromosome painting and PRINS; SCH and RH panel mapping.

Unit III (10 Lectures)

Genetic variants in blood group systems of farm animals; Major histocompatibility complex: BoLA, BuLA; Genetics of biochemical variants and their applications; Immune response genes and concepts of disease resistance including major genes; Hybridoma and its significance; Concept of immunofertility; TLRs and interleukins.

Unit IV (3 Lectures)

Mutation and assays of mutagenesis; Sister chromatid exchanges.

IV. Practical (15 Classes)

Identification of Barr bodies; *In-vitro* and *in vivo* preparation of somatic metaphase chromosomes; Screening of chromosomal abnormalities; Microphotography and karyotyping; Banding procedures for comparing the chromosomal complement; FISH and PRINS; ELISA; Immunocompetence tests.

V. Teaching methods

Blackboard; PPT-animations; Hands-on practical training; application-based practical approach; Visit labs specialising in animal cytogenetics and immunogenetics; Research article discussion in the classroom.

VI. Learning outcome

Upon successful completion, the students will be able to understand the immune response (IR) and its role in disease resistance along with the role of allelic variations in IR genes in animal production in addition to the advances in the field of animal cytogenetics and immunogenetics.

VII. Suggested Reading

- Gersen SL and Keagle MB. 2013. *The Principles of Clinical Cytogenetics*. Springer.
- Hare WCD and Singh EL. 1999. *Cytogenetics in Animal Reproduction.* CABI.
- Panayi GS and David CS. 1984. *Immunogenetics*. Elsevier.
- Roitt I. 1997. *Essential Immunology.* Blackwell.
- Summer AT and Chandley AC. 1993. *Chromosome Today*. Chapman and Hall.

Course Title : Molecular Genetics in Animal Breeding
Course Code : AGB 602
Credit Hours : 2+1

I. **Why this course?**

To provide basic and advanced concepts of molecular genetics and their application to different species of animals

II. **Aim of the course**

This aim of this course is to study genes and their functions to understand their role in animal breeding and selection. Also aimed at the genetics of populations including quantitative genetics and its applications in animal breeding.

III. **Theory**

Unit I (8 Lectures)

Basic concepts in molecular genetics; Concepts of proteomics and genomics; Genesis and importance of molecular techniques; Genome organization: physical and genetic map, current status of genome maps of livestock; Gene expression and control.

Unit II (8 Lectures)

Molecular markers and their applications; RFLP, RAPD, Microsatellite/ Minisatellite markers, SNP marker, DNA fingerprinting.

Unit III (7 Lectures)

DNA sequencing; Genome sequencing; Genomic Library; Polymerase Chain Reaction (PCR) and its types (PCR-RFLP, AS-PCR, etc.) and applications; Transgenesis and methods of gene transfer; Recombinant DNA technology and applications.

Unit IV (7 Lectures)

Analysis of molecular genetic data; Quantitative Trait Loci (QTL) mapping and its application in animal breeding: Genome scan, candidate gene approach.

IV. **Practical (15 Classes)**

Extraction and purification of genomic DNA; Gel electrophoresis; Restriction enzyme digestion of DNA and analysis; PCR-RFLP; PCR-SSCP; Bioinformatics tool for DNA sequence analysis; Isolation of RNA; cDNA synthesis; Statistical methods for analyzing molecular genetic data.

Blackboard; PPT-animations; Web-courses (if available); Hands-on practical training; Application-based practical skills; Visit labs specialising in molecular genetics critical discussion of articles in the area.

I. **Learning outcome**

Upon successful completion, the students will have an understanding of how genes control biological functions from cellular activities to development, techniques used to

manipulate gene functions in addition to genomics, proteomics and their applications in livestock improvement.

II. **Suggested Reading**

- Akano IE. 1992. *DNA Technology.* IAP Academic Press.
- Brown TA. 2006. *Genome 3*. Garland Science Publishers.
- Clark D and Pazdernik N. 2012. *Molecular Biology*, 2nd ed. Elsevier.
- Micklos DA, Fryer GA and Crotty DA. 2003. *DNA Science.* Cold Spring Harbor.
- Setlow JK. 2006. *Genetic Engineering – Principles and Methods,* Springer.

Title : Population and Quantitative Genetics

Course Code : AGB 603

Credit Hours : 2+1

I. **Why this course?**

To study the genetic structure of the animal population and the importance of genetic variation and covariation among quantitative traits.

II. **Aim of the course**

To impart knowledge on the general structure of animal population and factors affecting it and estimation of genetic and phenotypic parameters of different quantitative traits.

III. **Theory**

Unit I (15 Lectures)

Genetic structure of population; Hardy Weinberg Law; Idealized population; Factors affecting changes in gene and genotypic frequencies; Systematic processes; Approach to equilibrium under different situations: Single autosomal locus with two alleles, single sex-linked locus, two pairs of autosomal linked and unlinked loci; Linkage equilibrium and disequilibrium; Combined effect of all forces changing gene frequency.

Unit II (10 Lectures)

Dispersive process - small population: random genetic drift; Effective population size; Regular and irregular inbreeding systems; Founder effect and bottleneck; Effective number of founders and ancestors.

Unit III (10 Lectures)

Quantitative genetics: Gene effects, population mean, breeding value; Variance and its partitioning; Genotype-environment interaction and correlation; Resemblance between relatives.

Genetic and phenotypic parameters (heritability, repeatability, correlations): Methods of estimation, uses, possible biases, precision, optimal designs; Scale effects and threshold traits.

IV. Practical (15 Classes)

Estimation of gene and genotypic frequencies under different conditions; Estimation of inbreeding in regular and irregular systems; Estimation of effective population size; Computation of quantitative genetic effects; Estimation of variance components; Computation of heritability, repeatability, genetic, phenotypic and environmental correlations and their standard errors.

V. Teaching methods

Lectures; PPT-Presentations; MS-Excel for estimation of data.

VI. Learning outcome

Understanding the effect of gene and genotype frequencies on the genetic structure of populations, and estimation of genetic variation and covariation among different quantitative traits.

VII. Suggested Reading

- Bulmer MG. 1980. *The Mathematical Theory of Quantitative Genetics.* Clarendon Press.
- Crow JF and Kimura M. 2009. *An Introduction to Population Genetics.* Harper and Row.
- Falconer DS and Mackay TFC. 1996. *An Introduction to Quantitative Genetics.* Longman.
- Jain JP. 1982. *Statistical Techniques in Quantitative Genetics.* Tata McGraw-Hill.
- Pirchner F. 1983. *Population Genetics in Animal Breeding*. Springer.

Course Title : Selection Method and Breeding System
Course Code : AGB 604
Credit Hours : 2+1

I. Why this course?

To explain the methodology of selection and breeding systems for improvement of livestock and poultry.

II. Aim of the course

To study different methods of selection and factors affecting it, various mating systems and their use in animal genetics and the concepts of recent selection techniques.

III. Theory

Unit I (6 Lectures)

Types of selection and their genetic consequences; Response to selection: Prediction and improvement.

Unit II (12 Lectures)

Theoretical aspects of accuracy and efficiency of selection bases; Prediction of breeding value using different criteria; Combined selection; Correlated response and efficiency of indirect selection.

Unit III (12 Lectures)

Selection for several traits; Different types of selection indices; Evaluation of short term and long term selection experiments: bidirectional selection, asymmetry of response, selection limit.

Unit IV (15 Lectures)

Different mating systems: assortative mating, inbreeding, out-breeding; Genetic and phenotypic consequences and applications of various mating systems in animal improvement; Heterosis; Selection for general and specific combining abilities; Genetic polymorphism and its application in genetic improvement: Basic concepts of marker-assisted selection (MAS) and genomic selection.

IV. Practical (15 Classes)

Prediction of direct and correlated response; Computation of realized heritability and genetic correlation; Computation of selection index; Estimation of breeding values from different sources of information; Determining the accuracy of selection; Estimation of heterosis for different types of crosses; Estimation of GCA and SCA.

V. Teaching methods

Blackboard; PPT-animations; Hands-on practical training; application based practical approach; Visit labs specialising in animal cytogenetics and immunogenetics; Research article discussion in the classroom.

VI. Learning outcome

Good knowledge of the application of selection methods and mating systems in animal improvement, and application of selection for combining abilities.

VII. Suggested Reading

- Falconer DS and Mackay TFC. 1996. *An Introduction to Quantitative Genetics.* Longman.
- Jain JP. 1982. *Statistical Techniques in Quantitative Genetics.* Tata McGraw-Hill.
- Tomar SS. 1996. *Text Book of Population Genetics,* vol. I. *Qualitative Inheritance.* Universal Publishers.
- Tomar SS. 2010. *Text Book of Animal Breeding.* Universal Publishers.
- Tomar SS. 2014. *Text Book of Population Genetics,* vol II. *Quantitative Inheritance.* Universal Publishers.

Course Title : Biometrical Genetics I
Course Code : AGB 605
Credit Hours : 2+1

I. Why this course?

To educate about the various biometrical techniques for data analysis and their applications

II. Aim of the course

To impart knowledge about common diseases and disorders of poultry, diagnosis, vaccination, prevention, control and treatment.

III. Theory

Unit I (8 Lectures)

Nature and structure of animal breeding data; Source of variation; Adjustment of data; Outliers and their removal; Basic concepts in statistical inference and experimental designs.

Introduction to matrix algebra; Types of matrices and their operations; Determinants and their properties; Matrix inversion and its applications.

Unit III (15 Lectures)

Multiple regression and correlations; Fisher's discriminant function and its application; D2 statistics in divergent analysis; Cluster analysis; Fixation index; Genetic distance estimation and phylogeny construction; Linear models and their types; Least-squares (LS) analysis; Generalized LS and weighted LS; BLUE, BLUP; Methods of estimation of variance components: ANOVA, ML, REML, MINQUE, MIVQUE; Bayesian approach.

Unit IV (15 Lectures)

Animal model; Reduced animal model; Sire model; Maternal grandsire model; Maternal effects model; Repeatability model; Random regression model; Threshold model; Multidimensional scaling (MDS) and principal component analysis (PCA); Database management and use of software in animal breeding.

IV. Practical (15 Classes)

Collection, compilation, coding and transformation of animal breeding data; Matrix applications, determinant and inverse of matrices; Building of models for various types of data; Least-squares analysis of data; Estimation of BLUE and BLUP solutions; Formation of numerator relationship, dominance and identical by descent matrix; Estimation of variance components.

V. Teaching methods

Blackboard; PPT-Presentations; Application based practical approach; Research article discussion in the classroom.

VI. Learning outcome

Students will develop skills in analyzing breeding data using different biometrical techniques.

VII. Suggested Reading

- Henderson CR. 1984. *Application of Linear Models in Animal Breeding.* University of Guelph Press.
- Mather K and Jinks JL. 1977. *Introduction to Biometrical Genetics.* Chapman and Hall.
- Searle SR. 2014. *Linear Models.* John Wiley and Sons.
- Singh RK and Chaudhary BD. 2012. *Biometrical Methods in Quantitative Genetic Analysis*. Kalyani Publishers.

Course Title : Conservation of Animal Genetics Resources

Course Code : AGB 606

Credit Hours : 2+0

I. Why this course?

To study the concepts of conservation of animal genetic resources (AnGR)

II. Aim of the course

To impart knowledge on AnGR in India and their characterization, concepts and methods of conservation and national and international strategies for conservation of AnGR.

III. Theory

Unit I (12 Lectures)

Domestic animal diversity in India: Origin, history and utilization; Present status and flow of AnGR and its contribution to livelihood security; Methodology for phenotypic and genotypic characterization of livestock and poultry breeds through systematic surveys; Management of breed; Physical, biochemical and performance traits and uniqueness of animals of a breed; Social, cultural and economic aspects of their owners/ communities rearing the breed.

Unit II (12 Lectures)

Methods for increasing effective population size of endangered breed/ species: Effective number of alleles, inbreeding effective size, variance effective size, minimum viable population size; Methodology for characterization of AnGR; nuDNA and mtDNA based diversity analysis and relationship among the breeds; Concept of conservation: *In-situ*

and *ex-situ* (in-*vivo* and *in-vitro*); Models of conservation; Prioritization of breeds for conservation; Strategies for conservation of livestock and poultry genetics resources; Gene bank concept; Preservation of ecosystem.

Unit III (6 Lectures)

Status, opportunities and challenges in the conservation of AnGR; IPR issues on animal genetic resources/ animal products or by-products; Registration of livestock breeds and protection of livestock owner's rights in India; Breed societies and their role in conservation.

IV. Practical -

V. Teaching methods

Blackboard; PPT-Presentations; Application based practical approach; Research article discussion in the classroom

VI. Learning outcome

Conservation strategies of AnGR, their characterization and methods of conservation to protect biodiversity

VII. Suggested Reading

- Nivsarkar AE, Vij RK and Tantia MS. 2000. *Animal Genetic Resources of Indian Cattle and Buffaloes.* ICAR.
- Oldenbroek K. 2007. *Utilisation and Conservation of Farm Animal Genetic Resources.* WA

Publishers.
- Sahai R and Vij RK. 1997. *Domestic Animal Diversity, Conservation and Sustainable Development.* SI Publishers.
- Van Vleck LD, Pollak E and Bltenacu EAB. 1987. *Genetics for Animal Sciences.* WH Freeman.

Course Title : Cattle and Buffalo Breeding

Course Code : AGB 607

Credit Hours : 2+1

I. Why this course?

To educate the concept of cattle and buffalo breeding and improvement in dairy production

II. Aim of the course

To impart knowledge on different breeds of cattle and buffalo and their economic traits, sire evaluation methods and breeding systems and different cattle and buffalo breeding programmes.

III. Theory

Unit I (15 Lectures)

History of dairy cattle and buffalo breeding; Evolution of cattle and buffalo breeds and their characteristics; Population dynamics and production systems; Inheritance of important economic traits; Recording and handling of breeding data; Standardization of records; Computation of correction factors for the adjustment of the data; International Committee on Animal Recording (ICAR) and INAPH.

Unit II (12 Lectures)

Progeny testing under farm and field conditions; Evaluation of bulls by different models; Estimation of breeding values of the cows; Nucleus breeding system; Marker- assisted selection and genomic selection.

Unit III (12 Lectures)

Crossbreeding in cattle in India and abroad; Development of new breeds; Conservation of threatened breeds of cattle and buffaloes; Role of breed associations in dairy improvement; Breeding policy: national and state.

Unit IV (6 Lectures)

Import of exotic germplasm for breeding cattle in the tropics; Appraisal of buffalo and cattle breeding programme; Role of breed associations in dairy improvement.

IV. Practical (15 Classes)

Performance recording; Standardization of records; Estimation of economic traits; Computation of genetic parameters; Genetic gain; Sire evaluation methods; Estimation of heterosis; Culling and replacement.

V. Teaching methods

Blackboard; PPT-Presentations; Application based practical approach; Research article discussion in the classroom

VI. Learning outcome

After completion of the course, the students get good knowledge of different breeds of cattle and buffalo and breeding programmes

VII. Suggested Reading

- Chakravarty AK and Vohra V. 2011. *Sustainable Breeding in Cattle and Buffalo. Satish Serial Publications.*
- Lasley JF. 1972. *Genetics of Livestock Improvement*. IBH.
- Oldenbroek K and van der Waaij L. 2014. *Text book of Animal Breeding and Genetics*. Wageningen University and Research Centre (Free Online).
- Schmidt GM, Van Vleck LD and Hutjens MF. 1988. *Principles of Dairy Science.* WH Freeman.

- Van Vleck LD, Pollak EJ and Bltenacu EAB. 1987. *Genetics for Animal Sciences.* WH Freeman.

Course Title : Sheep and Goat Breeding
Course Code : AGB 608
Credit Hours : 2+0

I. Why this course?

To educate about sheep and goat breeding concepts and development in small ruminants
To impart knowledge on different breeds of sheep and goat and their economic traits, breeding systems and selection strategies, and different sheep and goat breeding policies.

VI. Theory

Unit I (8 Lectures)

Breeds; Economic traits; Population dynamics and production systems; Prolificacy; Breeding records and standardization; Computation of correction factors.

Unit II (12 Lectures)

Genetic parameters; Selection of males and female; Selection indices for sheep and goat; Breeding systems; Breeding strategies for improvement of production (meat, milk and wool) and reproduction (fertility and fecundity); Inbreeding and its effects on production traits; Group breeding schemes; Development of new breeds; Strategies for introgression of genes (fecundity and growth).

Unit III (10 Lectures)

Breeding policy; Sheep and goat improvement programme in India; Conservation of breeds; Culling and replacement; Equivalent Animal Death Rate (EADR).

VII. Teaching methods

Blackboard; PPT-presentations

VIII. Learning outcome

After completion of the course, the students get a good knowledge of different breeds of sheep and goat and their breeding policies

IX. Suggested Reading

- Jindal SK. 2013. *Goat Production and Health Management*. New India Publishers.
- Karim SA. 2010. *Climate Change and Stress Management: Sheep and Goat Production*. Satish Serial Publications.
- Mulugeta A. 2016. *Sheep and Goat Production Text Book*. Lambert Academic Publishers.
- Prasad J. 2018. *Goat, Sheep and Pig, Production and Management*. Kalyani Publishers.

- Ross CV. 1988. *Sheep Production and Management*. Prentice-Hall.

Course Title : Poultry Breeding
Course Code : AGB 609
Credit Hours : 2+1

I. Why this course?

To educate about advances in poultry breeding practices

II. Aim of the course

To impart knowledge on different species of poultry and their economic traits, selection criteria and selection indices, and conservation of poultry genetic resources.

III. Theory

Unit I (10 Lectures)

Origin and history of poultry species: Chicken, turkey, duck and quail; Poultry classes and breeds; Important qualitative traits in poultry including lethal; Economic traits of egg and meat-type chicken and their standardization; Different mating systems.
Selection criteria and selection indices; Response to selection; Genetic controls; Genotype and environment interaction; Inbreeding and its effects on production traits in egg and meat-type chickens; Development of inbred lines and strains; Strain and line crosses; Introduction to diallel cross; Utilisation of heterosis and reciprocal effect; Recurrent selection, reciprocal recurrent selection and modified RRS; Specialized sire and dam lines; Genetic improvement programs in poultry; Selection strategies for the improvement of layers and broilers; Performance testing of commercial strains; Backyard poultry.

Unit III (4 Lectures)

Industrial breeding; Artificial insemination in chicken; Auto-sexing; Random Sample Test.

Unit IV (6 Lectures)

Biochemical variants and immunogenetics of poultry; Use of molecular genetics in poultry breeding; Quantitative trait loci; Marker-assisted selection and genomic selection; Conservation of poultry genetic resources.

IV. Practical (15 Classes)

Inheritance of qualitative traits; Economic traits of egg-type and meat-type chicken; Procedures of standardization; Estimations of heritability, the correlation between various production traits; Inbreeding co-efficient and heterosis; Selection of sires and dams; Osborne index; Restricted selection index; Collection and evaluation of semen and insemination; Estimation of GCA and SCA.

V. Teaching methods

Blackboard; PPT-presentations

VI. Learning outcome

Students get acquainted with different poultry species, applications of selection methodology and molecular genetics in poultry for higher productivity.

VII. Suggested Reading

- Brereton G and Roadnight S. 2000. *21st Century Poultry Breeding*. Gold Cockerel Books.
- Crawford RD. 1990. *Poultry Breeding and Genetics.* Elsevier.
- Hutt FB. 2003. *Genetics of Fowl.* Norton Greek Press.
- Muir WM and Aggrey SE. 2003. *Poultry Genetics, Breeding and Biotechnology.* CABI.
- Singh RP and Kumar J. 1994. *Biometrical Methods in Poultry Breeding.* Kalyani Publishers.

Course Title : Laboratory Animal and Rabbit Breeding

Course Code : AGB 610

Credit Hours : 2+0

I. Why this course?

To educate about laboratory animal breeding principles and commercial rabbit breeding.

II. Aim of the course

To impart knowledge on different laboratory animals and their importance, selection and mating methods, and commercial rabbit production and management.

Theory

Unit I (6 Lectures)

Introduction to laboratory animal genetics; Breeding colonies of mice, rats, hamsters, guinea pigs and rabbits and their maintenance; Use of primates in animal research.

Unit II (4 Lectures)

Selection methods and mating systems: Monogamous, polygamous and others.

Unit III (12 Lectures)

Development of genetically controlled laboratory animals; Rules for nomenclature: Inbred strains, outbred stocks, mutant stocks, recombinant inbred strains, transgenic strains; Gene targeting and production of ‘gene knock-out’ animals; Production and use of specific pathogen-free animals; Guidelines and SOPs for the establishment of lab animal house; Genetic control and monitoring; Record-keeping; Ethics of laboratory animal research: FELASA, CPCSEA and IAEA regulations.

Unit IV (8 Lectures)

Rabbit production and management systems; Rabbit breeds for meat and wool; Economic traits and their inheritance; Breeding records and standardisation; Selection methods and breeding systems.

VII. Teaching methods

Blackboard; PPT-presentations

VIII. Learning outcome

Students get a view on breeding importance of laboratory animals and their applications in animal genetics. Additionally, knowledge of commercial rabbit production will also be developed

IX. Suggested Reading

- Hafez ESE. 1970. *Reproduction and Breeding Techniques for Laboratory Animals.*

Philadelphia.

- Peter RC, Nephi MP, Steven DL and James IM. 1987. Rabbit Production, 6th ed. Vero Media Inc.
- Shinde AK, Swarnkar CP and Naqvi SMK. 2013. *Sheep and Rabbit Production and Utilization*

Technologies. CSWRI Publications.

- Sirosis M. 2004. *Laboratory Animal Breeding: Principles and Procedures.* Elsevier.
- Tuffery AA. 1995. *Laboratory Animals: An Introduction for Animal Experimenters.* J Wiley and Sons.
- USDA. 2014. *A Complete Hand Book of Backyard and Commercial Rabbit Production*. Peace

Corps (Free Online).

- Van Vleck LD, Pollak EJ and Bltenacu EAB. 1987. *Genetics for Animal Sciences.* WH Freeman.
- Weichbrod RH, Thompson GAH and Norton JN. 2018. *Management of Animal Care and Use*

Programs in Research, Education, and Testing, 2nd ed. CRC Press.

Course Title : Swine Breeding
Course Code : AGB 611
Credit Hours : 1+0

I. Why this course?

To educate about swine breeding principles and swine improvement programme in India
To impart knowledge on different breeds of swine and their economic traits, breeding systems and selection methods, and breeding policies and conservation methods.

VI. Theory

Unit I (7 Lectures)

History and development of swine industry; Different breeds of pigs; Economic traits; Breeding records and standardization; Computation of correction factors; Culling and replacement; Equivalent Animal Death Rate (EADR).

Unit II (6 Lectures)

Genetic parameters; Bases and methods of selection; Selection of boars and sows; Breeding systems; Breeding strategies for improvement of indigenous and pure exotic breeds; Inbreeding and its effects on performance traits; Exploitation of heterosis; Development of synthetic varieties/ breeds.

Unit III (2 Lectures)

Swine breeding policy; National swine improvement programme; Conservation of breeds.

VII. Teaching methods

Blackboard: PPT-presentations: Research article discussion in the classroom

VIII. Learning outcome

Get acquainted with different breeds of swine, breeding methods and swine improvement programmes in India

IX. Suggested Reading

- ATARI. 2019. *Pig Farming: Promising Agri-business in Punjab.* ATARI-I Publication (Free Online).
- Board E. 2008. *Handbook of Pig Farming*, Engineers India Research Institute Publications.
- Das A, Tamuli AK, Mohan NH and Thomas R. 2013. *Handbook of Pig Husbandry,* Today and Tomorrow Printers.
- Das A, Tamuli, MK, Thomas R and Banik S. 2012. *Scientific Pig Production Practices*, NRC

on Pig Publication.

- FAO. 2009. *Farmer's Hand Book on Pig Production.* FAO Publication.

- Oldenbroek K and van der Waaij L. 2014. *Text Book of Animal Breeding and Genetics*. Wageningen University and Research Centre (Free Online).

Course Title : Pet Animal Breeding (Dogs and Cats)
Course Code : AGB 612
Credit Hours : 1+0

I. Why this course?

To educate about pet animal breeding principles which are contemporary in the defence establishment and affluent civic society

II. Aim of the course

To impart knowledge on different breeds of cats and dogs besides the principles of breeding management.

Theory

Unit I (9 Lectures)

Breeds of dogs: Classification of breeds, important Indian and exotic breeds; Pedigree breeding and maintenance of breeding records; Kennel Club; Breed associations; Breeding management of dog.

Unit II (6 Lectures)

Breeds of cats: Classification of breeds, important Indian and exotic breeds; Pedigree breeding and maintenance of breeding records; Breeding management of cat.

VII. Teaching methods

Blackboard; PPT-animations; research article discussion in the classroom

VIII. Learning outcome

Different breeds of cats and dogs and their breeding management

IX. Suggested Reading

- Battaglia CL. 1990. *Dog Genetics: How to Breed Better Dogs*. TFH Publications.
- Harmer H. 1974. *Dogs and How to Breed Them*, 2nd ed. Gifford Publications.
- Hedberg K. 1992. *The Dog Owner's Manual on Selecting, Raising and Breeding Dogs*. Watermark Press.
- Moore AS. 1981. *Breeding Purebred Cats: A Guide for the Novice and Small Breeder*. Abraxes

Publication.

- Robinson R. 1997. *Genetics of Cat Breeders*. Science Direct Publications.
- Vella CM and McGonagle JJ. 1997. *Breeding Pedigreed Cats*. Howell Book House.
- Vella C and Shelton L. 1999. *Genetics for Cat Breeders and Veterinarians*. Elsevier.

- Vine LL. 1977. *Breeding, Whelping and Natal Care of Dogs*. Acro Publication, NY.
- White K. 1980. *Dog Breeding: A Guide to Mating and Whelping*. Bartholomew Publications.

Course Title : Wild Animal Genetics and Breeding
Course Code : AGB 613
Credit Hours : 1+0

I. Why this course?

To educate about wild animal breeding

II. Aim of the course

To impart knowledge on wildlife biodiversity in India, wild animal breeding in nature and captivity, and conservation of wild animals.

III. Theory

Unit I (4 Lectures)

Wildlife biodiversity of India; Adaptation and natural selection; Species and speciation; Population dynamics; Variation; Loss of genetic variation; Hardy- Weinberg equilibrium.

Unit II (6 Lectures)

Inbreeding: Inbreeding depression, effective population size, demographic bottleneck; Genetic considerations in the translocation of wild animals; Wild animal breeding in nature and captivity; Captive breeding projects and principles; Concept of landscape genetics. Conservation of wild animals; Cryopreservation of semen and embryos of endangered species; Frozen zoo concept; Genetic markers; Application of molecular and cytogenetic techniques in wildlife breeding; Genetic defects in wild animals; Wildlife Protection Act.

IV. Teaching methods

Blackboard; PPT-animations; research article discussion in the classroom

V.Learning outcome

Breeding and conservation methods of wild animals

VI. Suggested Reading

- Devera GK, Katerina VT and Charlotte KB. 2012. *Wild Animals in Captivity: Principles and Techniques of Zoo Management*. University of Chicago Press.
- Kleiman DG, Allen ME, Thompson KV and Lumpkin S. 1997. *Wild Mammals in Captivity-Principles and Techniques.* Chicago Press.
- Linda JS. 2017. *A Field Guide of Tracking Mammals in North East*. Countryman Press.

- Nicholas FW. 1987. *Veterinary Genetics.* Oxford Science Publication.
- Parragon. 2006. *The Encyclopaedia of Wildlife*. Parragon Books Service Ltd.
- Ranjitsinh MK. 2017. *A Life with Wildlife: From Princely India to the Present*, Harper Collins Publications.
- Saha GK and Mazumdar S. 2017. *Wildlife Biology: An Indian Perspective*. PHI Learning Pvt Ltd.

Course Title : Equine Breeding
Course Code : AGB 614
Credit Hours : 1+0

I. Why this course?

To educate about breeding practices in equines

II. Aim of the course

To impart knowledge on classification of light and work-horses, breeding management and selection strategies in equines, and biotechnology in equine breeding programmes requirements of poultry and factors influencing the same.

III. Theory

Unit I (4 Lectures)

Equine population in India; Domestic diversity, its origin, history and utilization; Breeds of native and exotic horses; Types and classes of light and work-horses.

Unit II (6 Lectures)

Cytogenetics of horses and donkeys; Breeding of horses and donkeys and production of mules; Foaling and care of foal; Important quantitative and qualitative traits and their inheritance; Recording and handling of breeding data; Standardization of records.

Unit III (5 Lectures)

Stallion and mare complementation; Judging criteria for elite animals; Conservation strategies; Selecting the mare and the stallion for breeding; Ongoing breed improvement programmes; Biotechnology in equine breeding programmes. Blackboard; PPT-presentations

VIII. Learning outcome

Breeding and conservation methods of equines

IX. Suggested Reading

- McKinnon AO, Squres EL, Vaala WE and Varner DD. 2011. *Equine Reproduction.* Wiley Blackwell.
- Morel MCGD. 2008. *Equine Reproductive Physiology, Breeding and Stud Management.* CABI.

- Samper JC. 2008. *Equine Breeding Management and Artificial Insemination*. Science Direct Publications.

Course Title : Camel Breeding
Course Code : AGB 615
Credit Hours : 1+0

I. Why this course?

To educate about camel breeding, an emerging economically important species of livestock

II. Aim of the course

To impart knowledge on breeding management of camels, breed improvement programmes, and application of molecular genetic methods in camel breeding.

III. Theory

Unit I (7 Lectures)

Population dynamics and economic importance; Breeds of the camel; Production systems and herd structure; Inheritance of important economic traits; Recording and handling of breeding data; Standardization of records; Cytogenetics of the camel; Behaviour and breeding management.

Unit II (5 Lectures)

Judging criteria for elite animals; Selection of breeding stock; Breeding seasons; Methods for detection of heat; Natural service and artificial insemination; Breed improvement programmes.

Unit III (3 Lectures)

Conservation strategies; Immune status of camel; Molecular genetics in camel breeding.

IV. Teaching methods

Blackboard; PPT-presentations; Research article discussion in the classroom

V.Learning outcome

Breeding and conservation methods of camels

VI. Suggested Reading

- Dmitriez NG and Ernst LK. 1989. *Animal Genetic Resources of the USSR*. FAO.
- Wilson RT. 1984. *The Camel*. Longman.
- Selected Research Articles

Course Title : Yak and Mithun Breeding
Course Code : AGB 616
Credit Hours : 1+0

I. Why this course?

To educate about Yak and Mithun breeding

II. Aim of the course

To impart knowledge on breeds/ types of Yak and Mithun, production systems in Yaks and Mithun, their behaviour and breeding management including conservation strategies and molecular genetics in Yak and Mithun breeding.

III. Theory

Unit I (7 Lectures)

Population dynamics and economic importance; Breeds/ types of yak and mithun; Production systems; Inheritance of important economic traits; Recording and handling of breeding data; Standardization of records; Cytogenetics of yak and mithun; Behaviour and breeding management.

Unit II (5 Lectures)

Judging criteria for elite animals; Selection of breeding stock; Breeding seasons; Methods for detection of heat; Natural service and artificial insemination; Breed improvement. programmes

Unit III (3 Lectures)

Conservation strategies; Molecular genetics in yak and mithun breeding.

IV. Teaching methods

Blackboard; PPT-presentations; Research article discussion in classroom

V. Learning outcome

Breeding and conservation methods of yak and mithun

VI. Suggested Reading

- Das PJ, Deori S and Deb SM. 2017. *Arunachali Yak.* NRC on Yak, Dirang, India.
- Gupta SC, Gupta N and Nivsarkar AE. 1996. *Mithun - A Bovine of Indian Origin*.
- Nivsarkar AE, Gupta SC and Gupta N. 1997. *Yak Production*. ICAR Publication.
- Pal RN. 2003. *The Yak,* 2nd ed. FAO; RAP Publication.
- *Selected Research Articles*

Course Title : Statistical Methods in Animal Breeding
Course Code : AGB 617
Credit Hours : 2+1

I. Why this course?

To educate about Statistical Methods in Animal breeding

II. Aim of the course

To impart knowledge on the transformation of data, sampling, standard error and importance, basics of statistical inferences, and analysis of variance.

Unit I (12 Lectures)

Measures of central tendency; Measures of dispersion; Correlation and regression; Probability; Theory of distributions; Transformation of data; Sampling: Theory, need and properties; Estimators: Concept, standard error and importance.

Unit II (8 Lectures)

Basics of statistical inferences; Parametric tests: *Z*, *t* and *F* distribution; Non- parametric test: c2 sign test, run test and rank test; Confidence interval.

Unit III (10 Lectures)

Analysis of variance: One and two way; Experimental designs: CRD, RBD and LSD; Missing plot techniques; Analysis of covariance.

IV. Practical (15 Classes)

Measures of central tendency; Measures of dispersion; Correlation and regression; Transformation of data; Probability; Z, t, F and c2 tests; CRD, RBD and LSD; Analysis of covariance

V. Teaching methods

Blackboard; PPT-presentations

VI. Learning outcome

Application of statistical methods in animal breeding

VII. Suggested Reading

- Gianola D and Hammond K. 1990. *Advances in Statistical Methods for Genetic Improvement of Livestock*. Springer.
- Gupta SC and Kapur VK. 2014. *Fundamentals of applied statistics.* Sultan Chand and Sons.
- Gupta SC. 2016. *Fundamentals of Statistics.* Himalaya Publishing House Pvt Ltd.
- Pillai SK and Sinha HC. 1968. *Statistical Methods for Biological Workers*. Ram Prasad and Sons.
- Snedecor GW and Cochran WG. 1989. *Statistical Methods.* Wiley India Publications.

COURSES OFFERED IN DOCTORAL (Ph.D) DEGREE PROGRAAME

Ph.D Syllabus

Course Title : Molecular Genetics II
Course Code : AGB 701
Credit Hours : 2+0

I. Why this course?

To educate about the latest tools and techniques of animal genetics and their uses in animal sciences

II. Aim of the course

To impart knowledge on the eukaryotic genome, gene editing, gene knock-out and silencing, transgenic animals their benefits in livestock production, and genomic selection.

III. Theory

Unit I (10 Lectures)

Eukaryotic genome: Gene families, pseudogenes, SnRNPs; Types of RNA including miRNA; Gene conversion; Tandem repeats; Minisatellites and microsatellites; Sequencing of EST.

Unit II (10 Lectures)

Transposable elements; Transcription and RNA processing; Translation; Regulation of gene expression; Differential expression analysis; Serial analysis of gene expression; Selective gene amplification; The proteasome and longevity of proteins; Gene editing; Gene targeting; Gene knock-out and silencing.

Unit III (10 Lectures)

Transgenic animals: Application, ethical issues; Gene therapy; Bio-pharming; Cloning; Genome imprinting; Epigenetic modification; Creation of SNP chips and microarray technology; Next-generation sequencing; Genomic selection.

IV. Teaching methods

Blackboard; PPT-animations; Research article discussion in classroom

V. Learning outcome

Epigenetic Modification and transgenic animal production

VI. Suggested Reading

- Brown TA. 2006. *Genome 3*. Garland Science Publishers
- Clark DP. 2012. *Molecular Biology*. Academic Cell
- Hugo van den Berg. 2015. *Cell Biology and Molecular Genetics*. IPO Publishers

- Pasternak JJ. 2005. An Introduction to Human Molecular Genetics*: Mechanisms of Inherited Diseases*. Wiley
- Puehler A and Timmis KN. 1984. *Advanced Molecular Genetics*. Springer
- Watson, JD, Tania AB, Bell SP, Gann A, Levine A and Losick R. 2017. *Molecular Biology of the Gene*. Pearson Education Publication

Course Title : Trends in Animal Breeding
Course Code : AGB 702
Credit Hours : 2+0

I. Why this course?

To acquaint with recent trends in animal breeding and designing of need-based breeding strategies

II. Aim of the course

To impart knowledge on identification of novel traits and their role in breed improvement programme, development of mixed model equations, formulation of detailed breeding plans and advanced techniques in genetic manipulation for multiplication and improvement of livestock species.

III. Theory

Unit I (12 Lectures)

Identification of novel traits and their role in breed improvement programme; Development of mixed model equations; Advancement in biometrical methods including artificial neural network and Bayesian approach; Detection of QTL; Ancestry informative markers for admixture analysis.

Unit II (10 Lectures)

Formulation of detailed breeding plans; Breeding for disease resistance and functional traits; Breeding for climate resilience; Inheritance of animal behavior traits; Breeding for animal welfare; Impact analysis of different breed improvement programme in various livestock species.

Unit III (8 Lectures)

Advanced techniques in genetic manipulation for multiplication and improvement of livestock species: Use of sexed semen, gene introgression, and cloning, etc.

IV. Teaching methods

Blackboard; PPTs; Research article discussion in the classroom

V.Learning outcome

Breeding for disease resistance and functional traits; Breeding for climate resilience

VI. Suggested Reading

- Brah GS. 2016. *Animal Breeding: Principles and Applications. Kalyani Publishers.*
- Lynch M and Walsh B. 1998. *Genetics and Analysis of Quantitative Traits.* Oxford University Press.
- Morde RA and Thompson R. 2014. *Linear Models for the Prediction of Animal Breeding Values*. CABI.
- Oldenbroek K and van der Waaij L. 2014. *Text book of Animal Breeding and Genetics*. Wageningen University and Research Centre (Free Online).
- Tomar SS. 2010. *Textbook of Animal Breeding*. Universal Publishers.
- Zeggini E and Morris A. 2010. *Analysis of Complex Disease Association Studies.* Academic Press.

Course Title : Biometrical Genetics II
Course Code : AGB 703
Credit Hours : 2+1

I. Why this course?

To impart knowledge about recent advances in population genetic theory and application in animal breeding.

II. Aim of the course

To impart knowledge on multivariate analysis, QTL gene mapping, mating designs and other advanced biometrical techniques pertaining to animal breeding.

III. Theory

Unit I (8 Lectures)

Multivariate analysis; Discriminant function; D2 analysis; Principal component analysis; Path analysis.

Unit II (8 Lectures)

Mating designs: Basis, diallel, partial diallel, NCD-1, 2, 3 for reciprocal and maternal effects.

Unit III (5 Lectures)

Prediction of recombinant inbred lines using genetic parameters; Advances in genotype-environment interaction and selection indices.

Unit IV (9 Lectures)

QTL mapping; Analysis of SNP data for genomic selection; Advances in the estimation of variance component and prediction of breeding value: Threshold, dominance, random regression and survival models.

IV. Practical (15 Classes)

Discriminant function; D2 analysis; Principal component analysis; Path analysis; Estimation of GCA and SCA through diallel, partial diallel, NCD-1, 2, 3; Advances in construction of selection indices; QTL mapping; Analysis of SNP data for genomic selection; Advances in estimation of variance components.

V. Teaching methods

Blackboard; PPTs; Research article discussion in the classroom

VI. Learning outcome

Students can analyze data on Animal Genetics using different Biometrical Techniques

VII. Suggested Reading

- Choudhuri S. 2014. *Bioinformatics for Beginners.* Academic Press.
- Daniel S and Daniel G. 2012. *Likelihood, Bayesian, and MCMC Methods in Quantitative Genetics.* Springer.
- Kute N and Shinde G. 2016. *Principles of Biometrical Genetics*. Daya Publications.
- Marther K. 1997. *Biometrical Genetics*. Springer.
- Michael JK and Harpal SP. 1996. *The Genetical Analysis of Quantitative Traits*. Springer.
- Pawar IS and Singh S. 2010. *Theory and Application of Biometrical Genetics*. CBS Publications.
- Weller JI. 2016. *Genomic Selection in Animals*. John Wiley and Sons.
- Womack JE. 2012. *Bovine Genomics*. John Wiley and Sons.

Course Title : Advances in Selection Methodology

Course Code : AGB 704

Credit Hours : 2+1

I. Why this course?

To educate about the latest advances in selection theory and their application in animal breeding

II. Aim of the course

To impart knowledge on design of selection experiments, information on single and multiple trait animal models, construction of various selection indices and their relationship with BLUP including the fundamentals of MAS and gBLUP.

III. Theory

Unit I (8 Lectures)

Fundamental theorem of natural selection; Selection in finite populations; Effect on genetic structure and variance; Design of selection experiments for testing selection theory.

Unit II (6 Lectures)

Measurement of genetic and environmental trends; Advances in selection indices: Multistage, restricted and retrospective selection indices.

Unit III (6 Lectures)

Empirical evaluation of selection theory: genetic slippage, limits to the selection, asymmetry of response, selection experiments, the effect of selection on variance.

Unit IV (10 Lectures)

Selection for threshold traits; Selection under single and multiple trait animal models; Direct and correlated response through various selection indices; Relationship between BLUP and selection index; Selection using markers and entire genome; Methods for analysing GS data like RR-BLUP, Bayes-1, 2 and 3, etc.

IV. Practical (15 Classes)

Determination of culling levels and selection intensity; Estimation of direct and correlated response; Estimation of relative economic values; Construction of various selection indices; Prediction of breeding value using advance methods; QTL analysis using LDMAS and LEMAS.

V. Teaching methods

Blackboard; PPT; Research article discussion in classroom

VI. Learning outcome

They will be acquainted with all the theoretical techniques of the advanced selection methodology

VII. Suggested Reading

- Balakrishnan N, Nagaraja HN and Kannan N. 2007. *Advances in Ranking, Multiple Comparisons and Reliability*. Springer.
- Cameron ND. 1997. *Selection Indices and Prediction of Genetic Merit in Animal Breeding*.CABI.
- Daniel S and Daniel G. 2012. Likelihood, Bayesian and MCMC *M*ethods in *Quantitative Genetics*. Springer.
- Draper NR and Smith H. 1998. Applied *R*egression *A*nalysis. J Wiley and Sons.
- Henderson CR. 1984. *Applications of Linear Models in Animal Breeding*. CABI.
- Legarra A, Lourenco DAL and Vitezica ZG. 2018. *Bases for Genomic Prediction*. INRA (Free Online).
- Morde RA and Thompson R. 2014. *Linear Models for the Prediction of Animal Breeding Values*, CABI.

Course Title : Bioinformatics in Animal Breeding
Course Code : AGB 705
Credit Hours : 1+1

I. Why this course?

To educate about basic concepts of bioinformatics and their applications in animal breeding

II. Aim of the course

To impart knowledge on the concepts of bioinformatics, information resources for protein and genome databases, genetic characterization and selection using bioinformatic tools, and modern bioinformatic tools like GWAS.

III. Theory

Unit I (4 Lectures)

Overview of bioinformatics; Database concepts; Algorithms; Information resources for protein and genome databases: GenBank, EMBL, SWISSPROT, PROSITE.

Unit II (5 Lectures)

Nucleotide and protein sequence analysis; Pair-wise and multiple sequence alignments; Phylogeny; Big SNP data analysis methods; Micro-array processing; Clustering; Software for secondary database search and analysis.

Unit III (6 Lectures)

Genetic characterization; Use of bioinformatics tools for identifying QTL and selection of elite germplasm; GWAS; Development of DNA chips; NGS data analysis.

IV. Practical (15 Classes)

Database development; Algorithms; Nucleotide and protein sequence analysis; Pair-wise and multiple sequence alignments; Phylogeny and dendrogram; Micro-array processing; Clustering; Secondary database search and analysis; Genetic characterization; Identification of QTL; GWAS; NGS data analysis.

V. Teaching methods

Blackboard; PPT-animations; Research article discussion in the classroom

VI. Learning outcome

Nucleotide and protein sequence analysis and phylogenetic analysis

VII. Suggested Reading

- Attwood TK and Parry-Smith DJ. 2001. *Introduction to Bioinformatics*. Benjamin-Cummings Publishing Company.
- Bishop M. 1999. *Genetics Databases.* Elsevier.
- Jiang R, Zhang X and Zhang MQ. 2013. *Basics of Bioinformatics.* Springer. Scientific Publishers.

- Ramsden J. 2009. *Bioinformatics: An Introduction*. Springer.
- Stekel D. 2003. *Microarray Bioinformatics.* Cambridge University Press.
- Wu CH and McLarty JW. 2000. *Neural Networks and Genome Informatics*. Elsevier Science.
- Xiong J. 2006. *Essential Bioinformatics*. Cambridge University Press.

Course Title : Animal Cytogenetics and Immunogenetics II
Course Code : AGB 706
Credit Hours : 1+1

I. Why this course?

To educate about the advances in cytogenetics and their application in animal genetics and breeding

II. Aim of the course

To impart knowledge on somatic cell genetics, stem cell genetics, image analysis of advanced karyotyping techniques, and molecular cytogenetics and gene mapping techniques.

III. Theory

Unit I (8 Lectures)

Structure of eukaryotic chromosomes; Evolution of karyotype; Various *in- vitro* cell culture techniques; Cell lines and utility; Genotoxicity

Unit II (10 Lectures)

Somatic cell genetics; Stem cell genetics; Molecular cytogenetics and gene mapping; Linkage mapping; ISH; FISH; Radiation hybrid mapping; Fibre-FISH; PRINS; Positional cloning; Spectral karyotyping

Unit III (12 Lectures)

Image analysis; Chromosome painting; Chromosome walking; Micro-dissection of chromosomes; Structure and functions of major histocompatibility complex; T Cell receptor; CD4; Interleukins; Toll-like receptors and their functions

IV. Teaching methods

Blackboard; PPT-animations; Research article discussion in the classroom

V.Learning outcome

Students get a good grip on different gene mapping techniques and image analysis

X. Suggested Reading

- Agarwal S and Naik S. 2008. *Fundamentals of Immunogenetics Principles and Practices.*IBD Publisher.
- Christiansen FT and Tait BD. 2012. *Immunogenetics: Methods and Applications in Clinical Practice.* Springer.

- Gersen SL and Keagle MB. 2013. *The Principles of Clinical Cytogenetics.* Springer.
- Litwin SD. 1989. *Human Immunogenetics.* CRC Press.
- Tyagi R. 2009. *Textbook of Cytogenetics.* Discovery Publishers.

Course Title : Statistical Software in Animal Breeding
Course Code : AGB 707
Credit Hours : 1+1

I. Why this course?

To educate about the standard statistical software packages in animal breeding

II. Aim of the course

To impart knowledge on the use of software for computation of different statistical data

III. Theory

Unit I (4 Lectures)

Data preparation and job control commands for statistical analysis of data; Introduction to statistical and standard software packages.

Unit II (6 Lectures)

Use of software for t-test, Chi-squares test, F-test, ANOVA (CRD, RBD and LSD), correlation and regression (simple, multiple, curvilinear, stepwise) and discriminant analysis.

Unit III (5 Lectures)

Graphic features of the software packages; Linear programming using appropriate software package; Least-squares analysis; Data mining techniques such as neural networks, genetic algorithms and fuzzy logic for predictive modelling.

IV. Practical (15 Classes)

Data preparation and generation; Import and export of data from spreadsheet and database packages; Use of software for t-test, Chi-squares test, F-test, ANOVA (CRD, RBD and LSD), correlation and regression (simple, multiple, curvilinear, stepwise) and discriminant analysis; Graphic features of the software packages; Use of software for linear programming problem; Least-squares analysis; Use of software for neural networks and fuzzy logic models for prediction.

V. Teaching methods

Blackboard; PPTs; Research article discussion in the classroom

VI. Learning outcome

Students get an idea on the availability of different statistical and standard software packages and their application in Animal Breeding.

VII. Suggested Reading

- Balding DJ, Bishop M and Cannings C. 2001. *Handbook of Statistical Genetics*. J Wiley and Sons.
- Boldman K, Kriese LA, Van Vleck LD, Van Tassell CP and Kachman SD. 1995. *Manual for Use of MTDFREML*. ARS, USDA (Free online).
- Dempfle L. 1990. *Statistical Aspects of Design of Animal Breeding Programs*. Springer.
- Freund RJ, Mohr D and William WJ. 2010. *Statistical Methods*. Academic Press.
- Henderson CR. 1984. *Applications of Linear Models in Animal Breeding.* University Guelph Press.
- Isik F, Holland J and Maltecca C. 2017. Genetic *Data Analysis for Plant and Animal Breeding*. Springer.
- Lynch M and Walsh B. 1990. *Genetics and Analysis of Quantitative Traits.* Oxford.

UG lecture schedule

Sr.No.	Unit No.	Lecture/No.	Topic to be covered
1.	I	1	Introduction and Importance of statistics and biostatistics: Elementary statistical definitions
2.		2	Classification and Tabulation of Data, Parameter, Statistic and Observation.
3.		3	Graphical (Histogram, Frequency polygon, Ogive)and diagrammatic (Bar diagram, Pie diagram) representation of data.
4.		4-5	Measure of central tendency(simple and grouped data) Concept: Mean, Median, Mode Weighted mean, Geometric mean, Harmonic mean.
5.		6	Measure of dispersion(Simple and grouped data)Concept: Range, Inter quartile range, Mean deviation
6.		7	Standard deviation, Variance, Standard Error, Coefficient of Variance
7.		8	Elements of Probability : definition and its laws
8.		9-10-11-	Probability distribution: Binomial, Poisson, Normal
9.		12	Moments, Skewness, Kurtosis
10.		13-14	Correlation: Introduction, Concept, types, Properties and its uses.Rank Correlation
11.		15	Regression : Introduction, Concept, Properties and its uses
12.		16-17	Introduction to sample methods: Simple Random Sampling (SRS), Stratified sampling, Systematic sampling, Cluster sampling, etc.
13.		18	Testing of hypothesis: Simple and composite hypothesis, Null hypothesis, types of error, one tailed and two tailed, test, confidence interval, Power test.
14.		19-20	Test of hypothesis: t – test for single mean, difference of mean and paired t – test, testing of correlation coefficient
15.		21-22	Z-test, Chi - Square test for goodness of fit and test of attributes.
16.		23	Analysis of variance : One way classification
17.		24	Analysis of variance : Two way classification
18.		25	Design of Experiments: Concept and Principles (Replication, Randomization, Local control)
19.		26	Complete Randomized Design (CRD)
20.		27	Randomized Block Design (RBD) ,F- TEST OF Significance
21.		28	Introduction to Non-parametric tests (Rank test, Median, Mann-Whitney)
22.		29	Computer Application : Introduction to Computer languages,
23.		30	Data Base Management
24.		31-32	Review of MS-Office and its components (Ms-Word, Excel, Power Point and Access)
After 30% course completion – FIRST INTERNAL ASSESSMENT			
25.	I	33.	Analysis of data using MS-Excel
26.		34.	Concept of computer networks, Internet and e-mail.
27.		35.	History of Genetics

28.	II	36.	Mitosis v/s Meiosis
29.		37.	Chromosome numbers and types in livestock and poultry
30.		38.	Overview of Mendelian principles
31.		39.	Overview of Mendelian principles
32.		40.	Modified Mendelian inheritance
33.		41.	Modified Mendelian inheritance
34.		42.	Pleiotropy, Penetrance and expressivity
35.		43.	Multiple alleles
36.		44.	lethals
37.		45.	sex-linked inheritance
38.		46.	sex limited inheritance and sex influenced inheritance
39.		47.	Sex determination
40.		48.	Linkage and construction of linkage map
41.		49.	Crossing over
42.		50.	Mutation
43.		51.	Cytogenetics
44.		52.	Chromosomal aberrations
45.		53.	Extra-chromosomal inheritance
46.		54.	Gene concept, Molecular genetics
47.		55.	Nucleic acids-structure and function
48.		56.	DNA and its replication
49.		57.	Introduction to molecular techniques
50.		58.	Introduction to population genetics
51.		59.	Individual v/s population
52.		60.	Genetic structure of population: Gene and genotypic frequency
53.		61.	Hardy - Weinberg law and its application
54.		62.	Forces changing gene and genotypic frequencies (eg. Mutation, migration)
55.		63.	Forces changing gene and genotypic frequencies (eg.Selection and drift)
After 60% course completion – SECOND INTERNAL ASSESSMENT			
56.	II	64.	Quantitative v/s qualitative genetics
57.		65.	Concept of average effect and breeding value
58.		66.	Components of Variance
59.		67.	Concept of correlation and interaction between Genotype and Environment
60.		68.	Heritability
61.		69.	Repeatability
62.		70.	Genetic and Phenotypic Correlations
63.	III	71.	History of Animal Breeding
64.		72.	Classification of breeds
65.		73.	Economic characters of cattle,buffalo,sheep,goat and their importance
66.		74.	Economic characters of pig, poultry and their importance
67.		75.	Selection, types of selection
68.		76.	response to selection and factors affecting it
69.		77.	Bases of selection: individual, pedigree
70.		78.	Bases of selection: family, sib,

71.		79.	Bases of selection: progeny and combined, indirect selection
72.		80.	Method of selection, Single and Multi trait
73.		81.	Classification of mating systems
74.		82.	Inbreeding coefficient
75.		83.	Coefficient of relationship
76.		84.	Genetic and phenotypic consequences of inbreeding, inbreeding depression, application of inbreeding
77.		85.	Out breeding and its different forms
78.		86.	Genetic and phenotypic consequences of outbreeding, application of outbreeding,
79.		87.	Heterosis
80.		88.	Systems of utilization of heterosis; Selection for combining ability (RS and RRS)
81.		89.	Breeding strategies for the improvement of dairy cattle and buffalo
82.		90.	Breeding strategies for the improvement of sheep, goat, swine and poultry
83.		91.	Sire evaluation
84.		92.	Open nucleus breeding system (ONBS)
85.		93.	Development of new breeds or strains
86.		94.	Current livestock and poultry breeding policies and programmes in the state and country
87.		95.	Methods of conservation- livestock and poultry conservation programmes in the state and country
After 90% course completion- THIRD INTERNAL ASSESSMENT			
88.		96.	Application of reproductive and biotechnological tools for genetic improvement of livestock and poultry
89.	III	97.	Breeding for disease resistance
90.		98.	Classification of dog and cat breeds
91.		99.	Pedigree sheet, selection of breeds and major breed traits
92.		100.	Breeding management of dogs and cats
93.		101.	Common pet birds seen in India and their breeding management
94.		102.	Population dynamics and effective population size of wild animals in captivity or zoo or natural habitats
95.		103.	Planned breeding of wild animals
96.		104.	Controlled breeding and assisted reproduction
97.		105.	Breeding for conservation of wild animals

Lecture Schedule of M. V. Sc. (Animal Genetics and Breeding) courses

Course Title : Animal Cytogenetics and Immunogenetics
Course Code : AGB 601
Credit Hours : 2+1=3

Theory

Unit No.	Lecture No.	Name of Topic
I	1	Physical and chemical basis of heredity
	2	Development of animal cytogenetics and animal immunogenetics in farm animals.
	3	Inborn errors of metabolism and inherited disorders
	4	Immunoglobulin and their types
	5	Antigen – Antibody interactions
	6	Immune response
	7	ELISA
II	8	Chromatin structure of eukaryotes
	9	Chromosome number and morphology in farm animals
	10	Karyotyping
	11	Chromosomal and genetic syndromes
	12	DNA packing in chromosomes
	13	Types of DNA
	14	FISH chromosome panting and PRINS
	15	FISH chromosome panting and PRINS
	16	SCH and RH Panel mapping
	17	SCH and RH Panel mapping
III	18	Genetic variants in blood group systems of farm animals
	19	Major Histocompatability Complex
	20	Major Histocompatability Complex
	21	BoLA, BuLA,
	22	Genetics of Biochemical variants and their applications
	23	Genetics of Biochemical variants and their applications
	24	Immune response genes and concepts of disease resistance including major genes
	25	Hybridoma and its significance
	26	Concept of immuno-fertility
	27	TLRs and interleukins
IV	28	Mutation and assays of mutagenesis
	29	Mutation and assays of mutagenesis
	30	Sister chromatid exchanges

Practical

Practical No.	Name of Topic
1	Identification of Barr bodies
2	Identification of Barr bodies
3	In-vitro and in-vivo preparation of somatic metaphase chromosome
4	In-vitro and in-vivo preparation of somatic metaphase chromosome
5	Screening of chromosomal abnormalities
6	Screening of chromosomal abnormalities
7	Microphotography and Karyotyping

8	Microphotography and Karyotyping
9	Banding procedures for comparing the chromosomal complement
10	Banding procedures for comparing the chromosomal complement
11	FISH and PRINS
12	FISH and PRINS
13	ELISA
14	ELISA
15	Immunocompetence tests

Teaching methods:
Blackboard; PPT-animations; Hands-on practical training; application based practical approach; Visit labs specialising in animal cytogenetics and immunogenetics; Research article discussion in the classroom.

Learning outcome:
Upon successful completion, the students will be able to understand the immune response (IR) and its role in disease resistance along with the role of allelic variations in IR genes in animal production in addition to the advances in the field of animal cytogenetics and immunogenetics

Suggested Reading:

- Gersen SL and Keagle MB. 2013. The Principles of Clinical Cytogenetics. Springer.
- Hare WCD and Singh EL. 1999. Cytogenetics in Animal Reproduction.CABI.
- Panayi GS and David CS. 1984.Immunogenetics.Elsevier.
- Roitt I. 1997.Essential Immunology. Blackwell.
- Summer AT and Chandley AC. 1993.Chromosome Today.Chapman and Hall.

Course Title : Molecular Genetics I
Course Code : AGB 602
Credit Hours : 2+1=3

Theory

Unit No.	Lecture No.	Name of Topic
I	1	Basic concept of Molecular genetics
	2	Concepts of proteomics and genomics
	3	Genesis and importance of molecular techniques
	4	Genesis and importance of molecular techniques
	5	Genome organization-Physical and genetic map
	6	Genome organization-Physical and genetic map
	7	Current status of genome map in livestock
	8	Gene expression and control
II	9	Molecular markers and their applications
	10	Molecular markers and their applications
	11	RFLP Marker
	12	RAPD Marker
	13	Microsatellite marker
	14	Minisatellite marker
	15	SNP Marker
	16	DNA Fingerprinting
III	17	DNA Sequencing
	18	Genome sequencing
	19	Genomic Library
	20	Polymerase Chain Reaction (PCR) and its types (PCR-RFLP, AS-PCR, etc.)
	21	Applications of PCR
	22	Transgenesis and methods of gene transfer
	23	Recombinant DNA technology and application
IV	24	Analysis of molecular genetic data
	25	Analysis of molecular genetic data
	26	Quantitative Trait Loci (QTL)
	27	QTL mapping and its application in animal breeding
	28	QTL mapping and its application in animal breeding
	29	Genome scan
	30	Candidate gene approach

Practical

Practical No.	Name of Topic
1	EXtraction and purification of genomic DNA
2	EXtraction and purification of genomic DNA
3	Gel electrophoresis
4	Restriction enzyme digestion of DNA and analysis
5	PCR-RFLP
6	PCR-RFLP
7	PCR-SSCP
8	Bioinformatics tool for DNA sequence analysis
9	Bioinformatics tool for DNA sequence analysis
10	Isolation of RNA
11	Isolation of RNA

12	cDNA synthesis
13	cDNA synthesis
14	Statistical methods for analyzing molecular genetic data
15	Statistical methods for analyzing molecular genetic data

Teaching methods:
Blackboard; PPT-animations; Web-courses(if available); Hands-on practical training; Application based practica
of articles in th earea.

Learning outcome:
Upon successful completion, the students will ha
genescontrolbiologicalfunctionsfromcellularactivitiestodevelopment,techniquesusedtomanipulategenefunctionsinadd

Suggested Reading

- Akano IE. 1992. DNA Technology. IAP Academic Press.
- Brown TA. 2006. Genome 3. Garland Science Publishers.
- Clark D and Pazdernik N. 2012.Molecular Biology, 2nd ed. Elsevier.
- Micklos DA, Fryer GA and Crotty DA. 2003. DNA Science. Cold Spring Harbor.
- Setlow JK. 2006. Genetic Engineering – Principles and Methods, Springer.

Course Title : Population and Quantitative Genetics
Course Code : AGB 603
Credit Hours : 2+1

Theory

Unit No.	Lecture No.	Name of Topic
I	1.	Genetic structure of population
	2.	Hardy Weinberg Law
	3.	Hardy Weinberg Law
	4.	Idealized population
	5.	Factors affecting changes in gene and genotypic frequencies
	6.	Factors affecting changes in gene and genotypic frequencies
	7.	Systematic processes
	8.	Approach to equilibrium under different situations
	9.	Single autosomal locus with two alleles
	10.	Single X-linked locus
	11.	Two pairs of autosomal linked and unlinked loci
	12.	Linkage equilibrium and disequilibrium
	13.	Linkage equilibrium and disequilibrium
	14.	Combined effect of all forces changing gene frequency
	15.	Combined effect of all forces changing gene frequency
II	16.	Dispersive process: Small population
	17.	Dispersive process: Small population
	18.	Random genetic drift
	19.	Effective population size
	20.	Regular and irregular inbreeding systems
	21.	Regular and irregular inbreeding systems
	22.	Founder effect and bottleneck
	23.	Founder effect and bottleneck
	24.	Effective number of founders and ancestors
	25.	Effective number of founders and ancestors
III	26.	Quantitative genetics: Gene effects
	27.	Population mean
	28.	Breeding value
	29.	Breeding value
	30.	Breeding value
	31.	Variance and its partitioning
	32.	Genotype-environment interaction and correlation
	33.	Genotype-environment interaction and correlation
	34.	Resemblance between relatives
	35.	Resemblance between relatives
IV	36.	Genetic and phenotypic parameters- heritability
	37.	Genetic and phenotypic parameters- repeatability
	38.	Genetic and phenotypic parameters- correlations
	39.	Methods of estimation heritability
	40.	Methods of estimation heritability
	41.	Methods of estimation repeatability
	42.	Methods of estimation – correlations

	43.	Uses, possible biases, precision
	44.	Optimal designs
	45.	Scale effects and threshold traits

Practical

Practical No.	Name of Topic
1.	Estimation of gene and genotypic frequencies under different conditions
2.	Estimation of gene and genotypic frequencies under different conditions
3.	Estimation of inbreeding in regular and irregular systems
4.	Estimation of effective population size
5.	Computation of quantitative genetic effects
6.	Estimation of variance components
7.	Estimation of variance components
8.	Computation of heritability
9.	Computation of heritability
10.	Computation repeatability
11.	Computation genetic, phenotypic and environmental correlations and their standard errors
12.	Computation genetic, phenotypic and environmental correlations and their standard errors
13.	Computation genetic, phenotypic and environmental correlations and their standard errors
14.	Computation genetic, phenotypic and environmental correlations and their standard errors
15.	Computation genetic, phenotypic and environmental correlations and their standard errors

Teaching methods:
Blackboard; Lectures; PPT-Presentations; MS-EXcel for estimation of data.

Learning outcome:
Understanding the effect of gene and genotype frequencies on the genetic structure of populations, and estimation of genetic variation and covariation among different quantitative traits.

Suggested Reading:

- Bulmer MG. 1980. The Mathematical Theory of Quantitative Genetics. Clarendon Press.
- Crow JF and Kimura M. 2009. An Introduction to Population Genetics. Harper and Row.
- Falconer DS and Mackay TFC. 1996. An Introduction to Quantitative Genetics. Longman.
- Jain JP. 1982. Statistical Techniques in Quantitative Genetics. Tata McGraw-Hill.
- Pirchner F. 1983. Population Genetics in Animal Breeding. Springer.

Course Title : Selection Methods and Breeding System
Course No : AGB 604
Credit Hours : 2+1

Theory

Unit No.	Lecture No.	Name of Topic
I	1	Selection, its concept and different types of selection
	2	Genetic consequences of selection
	3	Response to selection
	4	Response to selection
	5	Prediction of selection response
	6	Improvement of selection response
II	7	Accuracy of selection
	8	Efficiency different bases of selection
	9	Prediction of Breeding value- Individual selection
	10	Prediction of Breeding value- Individual selection
	11	Prediction of Breeding value- Pedigree selection
	12	Prediction of Breeding value- Family selection
	13	Progeny testing
	14	Progeny testing
	15	Combined selection
	16	Combined selection
	17	Correlated response and efficiency of indirect selection
	18	Correlated response and efficiency of indirect selection
III	19	Selection for several traits
	20	Different types of selection indices
	21	Different types of selection indices
	22	Evaluation of short term selection experiments
	23	Evaluation of long term selection experiments
	24	Evaluation of long term selection experiments
	25	Bidirectional selection
	26	Bidirectional selection
	27	Asymmetry of response
	28	Asymmetry of response
	29	Selection limit
	30	Selection limit
IV	31	Importance and classification of mating system
	32	Assortative mating
	33	Inbreeding and its genetic and phenotypic consequences
	34	Application of inbreeding for genetic improvement of animals
	35	Out breeding and its genetic and phenotypic consequences
	36	Application of out breeding for genetic improvement of animals
	37	Heterosis: Definition and concept along with its applications
	38	Specific Combining Ability
	39	General Combining Ability
	40	Genetic polymorphism and its applications
	41	Marker Assisted Selection
	42	Marker Assisted Selection
	43	Marker Assisted Selection
	44	Genomic selection
	45	Genomic selection

Practical

Practical No.	Name of Topic
1	Prediction of direct response to selection
2	Prediction of correlated response to selection
3	Estimation of realized heritability
4	Estimation of genetic correlation
5	Estimation of genetic correlation
6	Computation of selection index
7	Estimation of breeding value – Individual selection
8	Estimation of breeding value – pedigree selection
9	Estimation of breeding value – Family selection
10	Determination of accuracy of selection
11	Estimation of heterosis for different types of crosses
12	Estimation of heterosis for different types of crosses
13	Estimation of GCA
14	Estimation of SCA
15	Estimation of SCA

Teaching methods:
Blackboard; PPT-animations; Hands-on practical training; application based practical approach; Visit labs specialising in animal cytogenetics and immunogenetics; Research article discussion in the classroom

Learning outcome:
Good knowledge of the application of selection methods and mating systems in animal improvement, and application of selection for combining abilities.

Suggested Reading:

- Falconer DS and Mackay TFC. 1996. An Introduction to Quantitative Genetics. Longman.
- Jain JP. 1982. Statistical Techniques in Quantitative Genetics. Tata McGraw-Hill.
- Tomar SS. 1996. Text Book of Population Genetics, vol. I. Qualitative Inheritance. Universal Publishers.
- Tomar SS. 2010. Text Book of Animal Breeding. Universal Publishers.
- Tomar SS. 2014. Text Book of Population Genetics, vol II. Quantitative Inheritance. Universal Publishers.

ourse Title : Biometrical Genetics I
Course Code : AGB 605
Course credits : 2+1

Theory

Unit No.	Lecture No.	Name of Topic
I	1	Nature and structure of animal breeding data
	2	Nature and structure of animal breeding data
	3	Source of variation
	4	Source of variation
	5	Adjustment of data
	6	Outliers and their removal
	7	Basic concepts in statistical inference
	8	Basic concepts in experimental designs
II	9	Introduction to matrix algebra
	10	Types of matrices and their operations
	11	Types of matrices and their operations
	12	Determinants and their properties

	13	Determinants and their properties
	14	Matrix inversion and its applications
	15	Matrix inversion and its applications
III	16	Multiple regression
	17	Correlations
	18	Fisher's discriminate function and its application
	19	D^2 statistics in divergent analysis
	20	Cluster analysis
	21	Fixation index
	22	Genetic distance estimation and phylogeny construction
	23	Linear models and their types
	24	Least-squares (LS) analysis
	25	Generalized LS and weighted LS
	26	BLUE, BLUP
	27	Methods of estimation of variance components: ANOVA
	28	Methods of estimation of variance components: ML, REML
	29	Methods of estimation of variance components: MINQUE,MIVQUE
	30	Bayesian approach
IV	31	Animal model
	32	Animal model
	33	Reduced animal model
	34	Sire model
	35	Maternal grand sire model
	36	Maternal effects model
	37	Repeatability model
	38	Random regression model
	39	Threshold model
	40	Multidimensional scaling(MDS)
	41	Principal component analysis(PCA)
	42	Principal component analysis(PCA)
	43	Data base management and use of software in animal breeding
	44	Data base management and use of software in animal breeding
	45	Data base management and use of software in animal breeding

Practical

Practical No.	**Name of Topic**
1	Collection, compilation, coding and transformation of animal breeding data
2	Collection, compilation, coding and transformation of animal breeding data
3	Matrix applications
4	Determinant of matrices
5	Inverse of matrices
6	Dominance and identical by descent matrix
7	Building of models for various types of data
8	Least-squares analysis of data
9	Least-squares analysis of data
10	Least-squares analysis of data
11	Estimation of BLUE solutions
12	Estimation of BLUP solutions
13	Formation of numerator relationship
14	Estimation of variance components
15	Estimation of variance components

Teaching methods Blackboard; PPT-Presentations; Application based practical approach; Research article discussion in the classroom.
Learning outcome Students will develop skills in analyzing breeding data using different biometrical techniques.
Suggested Reading: • Henderson CR. 1984.Application of Linear Models in Animal Breeding.University of Guelph Press. • Mather K and Jinks JL. 1977. Introduction to Biometrical Genetics. Chapman and Hall. • Searle SR. 2014.Linear Models.John Wiley and Sons. • Singh RK and Chaudhary BD. 2012.Biometrical Methods in Quantitative Genetic Analysis.Kalyani Publishers.

Course Title : Conservation of Animal Genetics Resources
Course Code : AGB-606
Credit Hours :2+0

Theory

Unit No.	Lecture No	Name of Topic
I	1	Domestic animal diversity in India: Origin, history and Utilization
	2	Domestic animal diversity in India: Origin, history and Utilization
	3	Present status and flow of AnGR and It's contribution to livelihood security
	4	Present status and flow of AnGR and It's contribution to livelihood security
	5	Methodology for Phenotypic and genotypic characterization of livestock and poultry breeds through systematic survey
	6	Methodology for Phenotypic and genotypic characterization of livestock and poultry breeds through systematic survey
	7	Management of breed
	8	Physical, biochemical and performance traits and uniqueness of animal breed
	9	Physical, biochemical and performance traits and uniqueness of animal breed
	10	Physical, biochemical and performance traits and uniqueness of animal breed
	11	Social, cultural and economic aspects of owners/communities rearing the breed
	12	Social, cultural and economic aspects of owners/communities rearing the breed
II	13	Methods for increasing effective population size of endangered breed/species
	14	Effective number of alleles, inbreeding effective size, variance effective size, minimal viable population size.
	15	Methodology of characterization of AnGR
	16	nuDNA and mtDNA based diversity analysis and relationship among the breeds
	17	Concept of conservation *in-situ (in-vivo)*
	18	Concept of conservation e*x-situ (in-vitro)*
	19	Models of conservation
	20	Prioritization of breeds for conservation
	21	National and international strategies for conservation of livestock and poultry genetic resources
	22	National and international strategies for conservation of livestock and poultry genetic resources
	23	Gene bank concept
	24	Preservation of ecosystem
III	25	Status, opportunities and challenges in the conservation of AnGR
	26	IPR issues on animal genetic resources/animal products or by-products

	27	IPR issues on animal genetic resources/animal products or by-products
	28	IPR issues on animal genetic resources/animal products or by-products
	29	Registration of livestock breeds and protection of livestock owner's right in India
	30	Breed societies and their role in conservation

Teaching methods
Blackboard; PPT presentations; Application based practical approach; Research article discussion in the classroom

Learning outcome
Conservation strategies of AnGR, their characterization and methods of conservation to protect biodiversity

Suggested Reading

- Nivsarkar AE, Vij RK and Tantia MS. 2000.Animal Genetic Resources of Indian Cattle and Buffaloes. ICAR.
- Oldenbroek K. 2007. Utilisation and Conservation of Farm Animal Genetic Resources.WA Publishers.
- Sahai R and Vij RK. 1997. Domestic Animal Diversity, Conservation and Sustainable Development. SI Publishers.
- Van Vleck LD, Pollak E and Bltenacu EAB. 1987. Genetics for Animal Sciences. WH Freeman.

Course Title : Cattle and Buffalo Breeding
Course Code : AGB 607
Credit Hours : 2+1=3

Theory

Unit No.	Lecture No.	Name of Topic
I	1	History of dairy cattle and buffalo breeding
	2	Evolution of cattle and buffalo breedsand their characteristics
	3	Evolution of cattle and buffalo breedsand their characteristics
	4	Evolution of cattle and buffalo breedsand their characteristics
	5	Population dynamics and production systems
	6	Population dynamics and production systems
	7	Inheritance of important economic traits
	8	Inheritance of important economic traits
	9	Inheritance of important economic traits
	10	Recording and handling of breeding data
	11	Standardization of records
	12	Computation of correction factors for the adjustment of the data.
	13	Computation of correction factors for the adjustment of the data.
	14	International Committee on Animal Recording (ICAR) and INAPH
	15	International Committee on Animal Recording (ICAR) and INAPH
II	16	Progeny testing under farm and field conditions
	17	Progeny testing under farm and field conditions
	18	Evaluation of bulls by different models
	19	Evaluation of bulls by different models
	20	Estimation of breeding values of the cows
	21	Estimation of breeding values of the cows
	22	Nucleus breeding system
	23	Nucleus breeding system
	24	Marker- assisted selection
	25	Marker- assisted selection

	26	Genomic selection
	27	Genomic selection
III	28	Crossbreeding in cattle in India and abroad
	29	Crossbreeding in cattle in India and abroad
	30	Crossbreeding in cattle in India and abroad
	31	Development of new breeds
	32	Development of new breeds
	33	Conservation of threatened breeds of cattle and buffaloes
	34	Conservation of threatened breeds of cattle and buffaloes
	35	Role of breed associations indairy improvement
	36	Role of breed associations indairy improvement
	37	Breeding policy : National and State
	38	Breeding policy : National and State
	39	Breeding policy : National and State
IV	40	Import of exotic germplasm for breeding cattle in the tropics
	41	Import of exotic germplasm for breeding cattle in the tropics
	42	Appraisal of buffalo and cattle breeding programme
	43	Appraisal of buffalo and cattle breeding programme
	44	Role of breed associations in dairy improvement
	45	Role of breed associations in dairy improvement

Practical

Practical No.	Name of Topic
1	Performance recording
2	Performance recording
3	Standardization of records
4	Standardization of records
5	Estimation of economic traits
6	Estimation of economic traits
7	Computation of genetic parameters
8	Computation of genetic parameters
9	Computation of genetic parameters
10	Genetic gain
11	Sire evaluation methods
12	Sire evaluation methods
13	Estimation of heterosis
14	Estimation of heterosis
15	Culling and replacement

Teaching methods

Blackboard; PPT presentations; Application based practical approach; Research article discussion in the classroom

Learning outcome

After completion of the course, the students get good knowledge of different breeds of cattle and buffalo and breeding programmes

SuggestedReading

- Chakravarty AK and Vohra V. 2011.Sustainable Breeding in Cattle and Buffalo.Satish Serial Publications.
- Lasley JF. 1972. Genetics of Livestock Improvement. IBH.
- Oldenbroek K and van der Waaij L. 2014.Text book of Animal Breeding and Genetics.Wageningen University and Research Centre (Free Online).
- Schmidt GM, Van Vleck LD and Hutjens MF. 1988. Principles of Dairy Science. WH

Freeman.
- Van Vleck LD, Pollak EJ and Bltenacu EAB. 1987. Genetics for Animal Sciences. WH Freeman.

Course Title : Sheep and Goat Breeding
Course Code : AGB 608
Credit Hours : 2+0=2

Theory

Unit No.	Lecture No.	Name of Topic
I	1	Breeds-Sheep
	2	Breeds-Goat
	3	Economic traits-Sheep
	4	Economic traits-Goat
	5	Population dynamics and production systems
	6	Prolificacy
	7	Breeding records and standardization
	8	Computation of correction factors
II	9	Genetic parameters
	10	Selection of males and females of Sheep
	11	Selection of males and females of Goat
	12	Selection indices for sheep and goat
	13	Breeding systems
	14	Breeding strategies for improvement of production (meat, milk and wool) and reproduction (fertility and fecundity)-Sheep
	15	Breeding strategies for improvement of production (meat, milk and wool) and reproduction (fertility and fecundity)-Goat
	16	Inbreeding and its effects on production traits
	17	Group Breeding schemes
	18	Development of new breeds
	19	Strategies for introgression of genes (fecundity & growth)-Sheep
	20	Strategies for introgression of genes (fecundity & growth)-Goat
III	21	Breeding policy
	22	Breeding policy
	23	Sheep and goat improvement programme in India
	24	Sheep and goat improvement programme in India
	25	Conservation of breeds
	26	Conservation of breeds
	27	Culling and replacement
	28	Culling and replacement
	29	Equivalent Animal Death Rate (EADR).
	30	Equivalent Animal Death Rate (EADR).

Teaching methods
Blackboard; PPT-presentations; Research article discussion in the classroom

Learning outcome
After completion of the course, the students get a good knowledge of different breeds of sheep and goat and their breeding policies

Suggested Reading

- Jindal SK. 2013. Goat Production and Health Management. New India Publishers.
- Karim SA. 2010. Climate Change and Stress Management: Sheep and Goat Production. Satish Serial Publications.

- Mulugeta A. 2016. Sheep and Goat Production Text Book. Lambert Academic Publishers.
- Prasad J. 2018. Goat, Sheep and Pig, Production and Management. Kalyani Publishers.
- Ross CV. 1988. Sheep Production and Management. Prentice-Hall.

Course Title : Poultry Breeding
Course Code : AGB 609
Credit Hours :- 2+1=3

Theory

Unit No.	Lecture No.	Name of Topic
I	1	Origin and history of poultry species: Chicken, turkey, duck and quail
	2	Origin and history of poultry species: Chicken, turkey, duck and quail
	3	Important qualitative traits in poultry including lethal
	4	Important qualitative traits in poultry including lethal
	5	Economic traits of egg type chicken and their standardization
	6	Economic traits of egg type chicken and their standardization
	7	Economic traits of meat-type chicken and their standardization
	8	Different mating systems
	9	Different mating systems
	10	Different mating systems
II	11	Selection criteria and selection indices
	12	Response to selection
	13	Genetic controls; Genotype and environment interaction;
	14	Inbreeding and its effects on production traits in egg and meat-type chickens; Development of inbred lines and strains; Strain and line crosses
	15	Introduction to diallel cross; Specialized sire and dam lines
	16	Utilisation of heterosis and reciprocal effect; Recurrent selection; reciprocal recurrent selection and modified RRS
	17	Genetic improvement programs in poultry
	18	Selection strategies for the improvement of layers and broilers
	19	Performance testing of commercial strains
	20	Backyard poultry
III	21	Industrial breeding
	22	Artificial insemination in chicken;
	23	Auto-sexing in chicken
	24	Random Sample Test
IV	25	Biochemical variants and immunogenetics of poultry;
	26	Biochemical variants and immunogenetics of poultry;
	27	Use of molecular genetics in poultry breeding;
	28	Quantitative trait loci;
	29	Marker-assisted selection and genomic selection;
	30	Conservation of poultry genetic resources

Practical

Practical No.	Name of Topic
1	Inheritance of qualitative traits
2	Economic traits of egg-type and meat-type chicken
3	Procedures of standardization
4	Procedures of standardization
5	Estimations of heritability
6	Estimations of heritability

7	the correlation between various production traits
8	Inbreeding co-efficient
9	Heterosis
10	Selection of sires and dams
11	Osborne index
12	Restricted selection index
13	Collection and evaluation of semen and insemination
14	Estimation of GCA and SCA
15	Estimation of GCA and SCA

Teaching methods
Blackboard; PPT-presentations; Research article discussion in the classroom

Learning outcome
Students get acquainted with different poultry species, applications of selection methodology and molecular genetics in poultry for higher productivity.

SuggestedReading

- Brereton G and Roadnight S. 2000. 21st Century Poultry Breeding. Gold Cockerel Books.
- Crawford RD. 1990. Poultry Breeding and Genetics.Elsevier.
- Hutt FB. 2003. Genetics of Fowl. Norton Greek Press.
- Muir WM and Aggrey SE. 2003.Poultry Genetics, Breeding and Biotechnology.CABI.
- Singh RP and Kumar J. 1994.Biometrical Methods in Poultry Breeding.Kalyani Publishers.

Course Title : Laboratory Animal and Rabbit Breeding
Course Code : AGB 610
Credit Hours : 2+0

Theory

Unit No.	Lecture No.	Name of Topic
I	1.	Introduction to laboratory animal genetics
	2.	Breeding and Management of mice colonies
	3.	Breeding and Management of rats colonies
	4.	Breeding and Management of hamsters & guinea pigs
	5.	Breeding and Management of rabbits
	6.	Use of primates in animal research.
II	7.	Selection methods and mating systems in Monogamous
	8.	Selection methods and mating systems in polygamous
	9.	Selection methods and mating systems in other species
III	10.	Development of genetically controlled laboratory animals
	11.	Rules for nomenclature: Inbred strains & outbred stocks,
	12.	Mutant stocks & recombinant inbred strains
	13.	Transgenic strains
	14.	Gene targeting and production of ‘gene knock-out’ animals
	15.	Production and use of specific pathogen-free animals
	16.	Guidelines and SOPs for the establishment of lab animal house
	17.	Genetic control and monitoring of lab animals
	18.	Record-keeping in Lab Animal House
	19.	FELASA role in ethics of laboratory animal research
	20.	CPCSEA role in ethics of laboratory animal research
	21.	Ethics of laboratory animal research: IAEA regulations
	22.	Rabbit breeds for meat and wool
IV	23.	Economic traits and their inheritance in Rabbit

	24.	Breeding and Management of Rabbits
	25.	Breeding records in Rabbit
	26.	Standardization in Rabbit
	27.	Selection methods in Rabbits
	28.	Breeding systems in Rabbits
	29.	Breeding importance of laboratory animals and their applications in animal genetics
	30.	Importance of Lab Animals in Research

Teaching methods
Blackboard; PPT-presentations; Research article discussion in the classroom

Learning outcome
Students get a view on breeding importance of laboratory animals and their applications in animal genetics. Additionally, knowledge of commercial rabbit production will also be developed

Suggested Reading

- Hafez ESE. 1970. Reproduction and Breeding Techniques for Laboratory Animals. Philadelphia.
- Peter RC, Nephi MP, Steven DL and James IM. 1987. Rabbit Production, 6th ed. Vero Media Inc.
- Shinde AK, Swarnkar CP and Naqvi SMK. 2013. Sheep and Rabbit Production and Utilization Technologies. CSWRI Publications.
- Sirosis M. 2004. Laboratory Animal Breeding: Principles and Procedures. Elsevier.
- Tuffery AA. 1995. Laboratory Animals: An Introduction for Animal Experimenters. J Wiley and Sons.
- USDA. 2014. A Complete Hand Book of Backyard and Commercial Rabbit Production. PeaceCorps (Free Online).
- Van Vleck LD, Pollak EJ and Bltenacu EAB. 1987. Genetics for Animal Sciences. WH Freeman.
- Weichbrod RH, Thompson GAH and Norton JN. 2018. Management of Animal Care and UsePrograms in Research, Education, and Testing, 2nd ed. CRC Press.

Course Title :Swine Breeding
Course Code : AGB 611
Credit Hours : 1+0

Theory

Unit No.	Lecture No.	Name of topic
I	1	History and development of swine industry
	2	Different breeds of pigs
	3	Economic traits of swine
	4	Breeding records and standardization of records in pig.
	5	Computation of correction factors in data
	6	Culling and replacement of pig
	7	Equivalent Animal Death Rate (EADR) in pig
II	8	Genetic parameters; Bases and methods of selection in pig
	9	Selection of boars and sows in pig.
	10	Breeding systems; Breeding strategies for improvement of indigenous and pure exotic breeds.
	11	Inbreeding and its effects on performance traits of pig

	12	Exploitation of heterosis in pig
	13	Development of synthetic varieties/ breeds in swine
III	14	Swine breeding policy; National swine improvement programme in India.
	15	Conservation of native breeds of pig

Teaching methods
Blackboard; PPT-presentations; Research article discussion in the classroom

Learning outcome
Get acquainted with different breeds of swine, breeding methods and swine improvement programmes in India

Suggested Reading

- ATARI. 2019. Pig Farming: Promising Agri-business in Punjab. ATARI-I Publication (Free Online).
- Board E. 2008. Handbook of Pig Farming, Engineers India Research Institute Publications.
- Das A, Tamuli AK, Mohan NH and Thomas R. 2013.Handbook of Pig Husbandry, Today and Tomorrow Printers.
- Das A, Tamuli, MK, Thomas R and Banik S. 2012. Scientific Pig Production Practices, NRC
- on Pig Publication.
- FAO. 2009. Farmer's Hand Book on Pig Production. FAO Publication.
- Oldenbroek K and van der Waaij L. 2014.Text Book of Animal Breeding and Genetics.Wageningen University and Research Centre (Free Online).

Course Title : Pet Animal Breeding (Dogs and Cats)
Course Code : AGB 612
Credit Hours : 1+0=1

Theory

Unit No.	Lecture No.	Name of Topic
I	1	Breeds of dogs: Classification of breeds, important Indian and exotic breeds
	2	Breeds of dogs: Classification of breeds, important Indian and exotic breeds
	3	Pedigree breeding and maintenance of breeding records
	4	Pedigree breeding and maintenance of breeding records
	5	Kennel Club
	6	Breed associations
	7	Breed associations
	8	Breeding management of dog.
	9	Breeding management of dog.
II	10	Breeds of cats: Classification of breeds, important Indian and exotic breeds.
	11	Breeds of cats: Classification of breeds, important Indian and exotic breeds.
	12	Pedigree breeding and maintenance of breeding records.
	13	Pedigree breeding and maintenance of breeding records.
	14	Breeding management of cat.
	15	Breeding management of cat.

Teaching methods
Blackboard; PPT-animations; Research article discussion in the classroom

Learning outcome
Different breeds of cats and dogs and their breeding management

SuggestedReading

- Battaglia CL. 1990. Dog Genetics: How to Breed Better Dogs. TFH Publications.
- Harmer H. 1974.Dogs and How to Breed Them, 2nd ed. Gifford Publications.
- Hedberg K. 1992. The Dog Owner's Manual on Selecting, Raising and Breeding Dogs.

Watermark Press.
- Moore AS. 1981. Breeding Purebred Cats: A Guide for the Novice and Small Breeder. AbraXesPublication.
- Robinson R. 1997. Genetics of Cat Breeders.Science Direct Publications.
- Vella CM and McGonagle JJ. 1997. Breeding Pedigreed Cats. Howell Book House.
- Vella C and Shelton L. 1999.Genetics for Cat Breeders and Veterinarians.Elsevier.
- Vine LL. 1977. Breeding, Whelping and Natal Care of Dogs.Acro Publication, NY.
- White K. 1980. Dog Breeding: A Guide to Mating and Whelping. Bartholomew Publications.

Course Title : Wild Animal Genetics and Breeding
Course Code : AGB 613
CreditHours : 1+0

Theory

Unit No.	Lecture No.	Name of Topic
I	1	Wild life Biodiversity in India
	2	Adaptation and Natural selection, Species and Speciation
	3	Population dynamics; Variation; Loss of genetic variation;
	4	Hardy Weinberg equilibrium.
II	5	Inbreeding and Inbreeding depression
	6	Effective population size, Demographic bottleneck
	7	Genetic considerations in the translocation of wild animals
	8	Wild animal breeding in nature and captivity
	9	Captive breeding projects and principles
	10	Concept of landscape genetics.
III	11	Conservation of wild animals; Cryopreservation of semen and embryos of endangered species; Frozen zoo concept
	12	Genetic markers and its various types
	13	Application of molecular and cytogenetic techniques in wildlife breeding
	14	Genetic defects in wild animals
	15	Wildlife Protection Act

Teaching methods
Blackboard; PPT-animations; Research article discussion in the classroom

Learning outcome
Breeding and conservation methods of wild animals

SuggestedReading

- Devera GK, Katerina VT and Charlotte KB. 2012. Wild Animals in Captivity: Principles and Techniques of Zoo Management. University of Chicago Press.
- Kleiman DG, Allen ME, Thompson KV and Lumpkin S. 1997. Wild Mammals in Captivity-
- Principles and Techniques. Chicago Press.
- Linda JS. 2017. A Field Guide of Tracking Mammals in North East. Countryman Press.
- Nicholas FW. 1987. Veterinary Genetics. OXford Science Publication.
- Parragon. 2006. The Encyclopaedia of Wildlife. Parragon Books Service Ltd.
- Ranjitsinh MK. 2017. A Life with Wildlife: From Princely India to the Present, Harper Collins Publications.
- Saha GK and Mazumdar S. 2017. Wildlife Biology: An Indian Perspective. PHI Learning Pvt Ltd.

Course Title : Equine Breeding
Course Code : AGB 614
Credit Hours : 1+0=1

Theory

Unit No.	Lecture No.	Name of Topic
I	1	Equine population in India
	2	Domestic diversity, its origin, history and utilization
	3	Breeds of native and exotic horses
	4	Types and classes of light and work-horses.
II	5	Cytogenetics of horses and donkeys
	6	Breeding of horses and donkeys and production of mules
	7	Foaling and care of foal
	8	Important quantitative and qualitative traits and their inheritance
	9	Recording and handling of breeding data
	10	Standardization of records
III	11	Stallion and mare complementation
	12	Judging criteria for elite animals
	13	Conservationstrategies;Selectingthemareandthestallionforbreeding
	14	Ongoing breed improvement programmes
	15	Biotechnology in equine breeding programmes

Teaching methods
Blackboard; PPT-presentations; Research article discussion in the classroom

Learning outcome
Breeding and conservation methods of equines

Suggested Reading

- McKinnon AO, Squres EL, Vaala WE and Varner DD. 2011.Equine Reproduction.Wiley Blackwell.
- Morel MCGD. 2008. Equine Reproductive Physiology, Breeding and Stud Management. CABI.
- Samper JC. 2008. Equine Breeding Management and Artificial Insemination. Science Direct Publications.

Course Title : Camel Breeding
Course Code : AGB 615
Credit Hours : 1+0

Theory

Unit No.	Lecture No.	Name of Topic
I	1	Population dynamics and economic importance
	2	Breeds of the camel
	3	Production systems and herd structure
	4	Inheritance of important economic traits
	5	Recording and handling of breeding data, Standardization of records
	6	Cytogenetics of the camel
	7	Behaviour and breeding management
II	8	Judging criteria for elite animals
	9	Selection of breeding stock
	10	Breeding seasons, Methods for detection of heat
	11	Natural service and artificial insemination
	12	Breed improvement programmes
III	13	Conservation strategies

	14	Immune status of camel
	15	Molecular genetics in camel breeding
Teaching methods Blackboard; PPT-presentations; Research article discussion in the classroom		
Learning outcome Breeding and conservation methods of camels		
Suggested Reading • Dmitriez NG and Ernst LK. 1989. Animal Genetic Resources of the USSR. FAO. • Wilson RT. 1984. The Camel.Longman. • Selected Research Articles		

Course Title : Yak and Mithun Breeding
Course Code : AGB 616
Credit Hours : 1+0=1

Theory

Unit No.	Lecture No.	Name of Topic
I	1	Population dynamics and economic importance of Yak and Mithun
	2	Breeds/ types of yak
	3	Breeds/ types of Mithun
	4	Production systems; important economic traits and their inheritance
	5	Recording and handling of breeding data; Standardization of records
	6	Cytogenetics of Yak and Mithun
	7	Behaviour and breeding management.
II	8	Judging criteria for elite animals
	9	Selection of breeding stock
	10	Breeding seasons; Methods for detection of heat
	11	Natural service and artificial insemination
	12	Breed improvement. programmes
III	13	Conservation of Yak
	14	Conservation of Mithun
	15	Molecular genetics in Yak and Mithun breeding
Teaching methods Blackboard; PPT-presentations; Research article discussion in the classroom		
Learning outcome Breeding and conservation methods of Yak and Mithun		
SuggestedReading • Das PJ, Deori S and Deb SM. 2017.Arunachali Yak. NRC on Yak, Dirang, India. • Gupta SC, Gupta N and Nivsarkar AE. 1996. Mithun - A Bovine of Indian Origin. • Nivsarkar AE, Gupta SC and Gupta N. 1997. Yak Production. ICAR Publication. • Pal RN. 2003. The Yak, 2nd ed. FAO; RAP Publication. • Selected Research Articles		

Course Title : Statistical Methods in Animal Breeding
Course Code : AGB 617
CreditHours : 2+1

Theory

Unit No.	Lecture no.	Name of Topic
I	1	Measures of central tendency
	2	Measures of central tendency

	3	Measures of dispersion
	4	Measures of dispersion
	5	Correlation
	6	Regression
	7	Probability
	8	Theory of distributions
	9	Transformation of data
	10	Sampling: Theory, need and properties
	11	Concept of Estimators
	12	Standard error and importance
II	13	Basics of statistical inferences
	14	Parametric tests: *Z* distribution
	15	Parametric tests: *t* distribution
	16	Parametric tests:*F* distribution
	17	Non-parametric test: c^2 sign test
	18	Non-parametric test: run test
	19	Non-parametric test: rank test
	20	Confidence interval
III	21	Analysis of variance
	22	Analysis of variance: Oneway
	23	Analysis of variance: twoway
	24	EXperimental designs
	25	EXperimental designs: CRD
	26	EXperimental designs: RBD
	27	EXperimental designs: LSD
	28	Missing plot techniques
	29	Analysis of covariance
	30	Analysis of covariance

Practical

Practical No.	**Name of Topic**
1	Measures of central tendency
2	Measures of dispersion
3	Correlation
4	Regression
5	Transformation of data
6	Probability
7	Z tests
8	ttests
9	Ftests
10	c^2tests
11	CRD
12	RBD
13	LSD
14	Analysisofcovariance
15	Analysisofcovariance
Teaching methods Blackboard; PPT-presentations	
Learning outcome Application of statistical methods in animal breeding	
Suggested Reading	

- Gianola D and Hammond K. 1990.Advances in Statistical Methods for Genetic Improvement of Livestock.Springer.
- Gupta SC and Kapur VK. 2014. Fundamentals of applied statistics. Sultan Chand and Sons.
- Gupta SC. 2016. Fundamentals of Statistics. Himalaya Publishing House Pvt Ltd.
- Pillai SK and Sinha HC. 1968. Statistical Methods for Biological Workers. Ram Prasad and Sons.
- Snedecor GW and Cochran WG. 1989. Statistical Methods. Wiley India Publications.

Lecture Schedule of Ph.D (Animal Genetics and Breeding) courses

Course Title :Molecular Genetics II
Course Code :AGB 701
Credit Hours : 2+0

Theory

Unit No.	Lecture No.	Name of Topic
I	1.	Eukaryotic genome
	2.	Gene families
	3.	Pseudogenes
	4.	SnRNPs
	5.	Types of RNA including miRNA
	6.	Types of RNA including miRNA
	7.	Gene conversion
	8.	Tandem repeats
	9.	Minisatellites and microsatellites
	10.	Sequencing of EST
II	11.	Transposable elements
	12.	Transcription and RNA processing
	13.	Translation; Regulation of gene expression
	14.	Differential expression analysis
	15.	Serial analysis of gene expression
	16.	Selective gene amplification
	17.	The proteasome and longevity of proteins
	18.	Gene editing
	19.	Gene targeting
	20.	Gene knock-out and silencing
III	21.	Transgenic animals: Application, ethical issues
	22.	Transgenic animals: Application, ethical issues
	23.	Gene therapy
	24.	Bio-pharming
	25.	Cloning;
	26.	Genome imprinting
	27.	Epigenetic modification
	28.	Creation of SNP chips and microarray technology
	29.	Next-generation sequencing
	30.	Genomic selection.

Teaching methods - Blackboard; PPT-presentations; Research article discussion in the classroom

Learning outcome - Epigenetic Modification and transgenic animal production

Suggested Reading

- Brown TA. 2006. Genome 3. Garland Science Publishers
- Clark DP. 2012. Molecular Biology. Academic Cell
- Hugo van den Berg. 2015. Cell Biology and Molecular Genetics. IPO Publishers
- Pasternak JJ. 2005. An Introduction to Human Molecular Genetics: Mechanisms of Inherited Diseases. Wiley

- Puehler A and Timmis KN. 1984.Advanced Molecular Genetics. Springer
- Watson, JD, Tania AB, Bell SP, Gann A, Levine A and Losick R. 2017. Molecular Biology of the Gene.Pearson Education Publication Snedecor GW and Cochran WG. 1989. Statistical Methods. Wiley India Publications.

Course Title : Trends in Animal Breeding
Course Code : AGB 702
Credit Hours : 2+0

Theory

Unit No.	Lecture No.	Name of Topic
I	1	Identification of novel traits
	2	Role of novel traits in breed improvement programme
	3	Development of mixed model equations
	4	Development of mixed model equations
	5	Advancement in biometrical methods-artificial neural network
	6	Advancement in biometrical methods-artificial neural network
	7	Advancement in biometrical methods-Bayesian approach
	8	Advancement in biometrical methods-Bayesian approach
	9	Detection of QTL
	10	Detection of QTL
	11	Ancestry informative markers for admixture analysis
	12	Ancestry in formative markers for admixture analysis
II	13	Formulation of detailed breeding plans
	14	Formulation of detailed breeding plans
	15	Breeding for disease resistance and functional traits;
	16	Breeding for climate resilience
	17	Inheritance of animal behavior traits
	18	Breeding for animal welfare
	19	Breeding for animal welfare
	20	Impact analysis of different breed improvement programme in cattle & buffalo
	21	Impact analysis of different breed improvement programme in sheep & goat
	22	Impact analysis of different breed improvement programme in poultry and other livestock species
III	23	Advanced techniques in genetic manipulation
	24	Advanced techniques in genetic manipulation
	25	Advanced techniques in genetic manipulation for multiplication and improvement of livestock species
	26	Advanced techniques in genetic manipulation for multiplication and improvement of livestock species
	27	Advanced techniques in genetic manipulation for multiplication and improvement of livestock species
	28	Use of sexed semen
	29	Gene introgression
	30	Gene cloning

Teaching methods- Blackboard; PPT-presentations; Research article discussion in the classroom

Learning outcome- Breeding for disease resistance and functional traits; Breeding for climate resilience

Suggested Reading

- Brah GS. 2016. Animal Breeding: Principles and Applications. Kalyani Publishers.
- Lynch M &Walsh B.1998.Genetics & Analysis of Quantitative Traits. Oxford University Press.
- Morde RA and Thompson R. 2014.Linear Models for the Prediction of Animal BreedingValues.CABI.

- Oldenbroek K and van der Waaij L. 2014.Text book of Animal Breeding and Genetics.Wageningen University and Research Centre (Free Online).
- Tomar SS. 2010. Textbook of Animal Breeding.Universal Publishers.
- Zeggini E and Morris A. 2010.Analysis of Complex Disease Association Studies.Academic Press.

Course Title : Biometrical Genetics II
Course Code : AGB 703
CreditHours : 2+1

Theory

Unit No.	Lecture No.	Name of Topic
I	1	Multivariate analysis
	2	Discriminant function
	3	Discriminant function
	4	D^2analysis
	5	D^2analysis
	6	Principal component analysis
	7	Principal component analysis
	8	Path analysis
II	9	Mating designs Basis
	10	Mating designs Basis
	11	Diallel Cross
	12	Diallel Cross
	13	Partial diallel cross
	14	Partialdiallel cross
	15	NCD-1,2,3forreciprocaleffects
	16	NCD-1,2,3formaternaleffects
III	17	Prediction of recombinant inbred lines using genetic parameters
	18	Prediction of recombinant inbred lines using genetic parameters
	19	Advances in genotype-environment interaction and selection indices
	20	Advances in genotype-environment interaction and selection indices
	21	Advances in genotype-environment interaction and selection indices
IV	22	QTL mapping
	23	Analysis of SNP data for genomic selection
	24	Analysis of SNP data for genomic selection
	25	Advances in the estimation of variance component
	26	Prediction of breeding value
	27	Threshold
	28	Dominance
	29	Random regression and survival models
	30	Random regression and survival models

Practical

Practical No.	Name of Topic
1	Discriminant function
2	D^2analysis
3	Principal component analysis
4	Path analysis
5	Estimation of GCA and SCA through diallel

6	Estimation of GCA and SCA through partial diallel
7	NCD-1
8	NCD-2
9	NCD-3
10	Advances in construction of selection indices
11	Advances in construction of selection indices
12	QTL mapping
13	QTL mapping
14	Analysis of SNP data for genomic selection
15	Advances in estimation of variance components

Teaching methods
Blackboard; PPT-presentations Research article discussion in the classroom

Learning outcome
Students can analyze data on Animal Genetics using different Biometrical Techniques

Suggested Reading

- Choudhuri S. 2014. Bioinformatics for Beginners.Academic Press.
- Daniel S and Daniel G. 2012.Likelihood, Bayesian, and MCMC Methods in Quantitative Genetics.Springer.
- Kute N and Shinde G. 2016.Principles of Biometrical Genetics.Daya Publications.
- Marther K. 1997. Biometrical Genetics.Springer.
- Michael JK and Harpal SP. 1996.The Genetical Analysis of Quantitative Traits.Springer.
- Pawar IS and Singh S. 2010. Theory and Application of Biometrical Genetics.CBS Publications.
- Weller JI. 2016. Genomic Selection in Animals. John Wiley and Sons.
- Womack JE. 2012. Bovine Genomics. John Wiley and Sons.

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Course Title : Advances in Selection Methodology
Course Code : AGB 704
Credit Hours : 2+1=3

Theory

Unit No.	Lecture No.	Name of Topic
I	1	Fundamental theorem of natural selection
	2	Fundamental theorem of natural selection
	3	Selection in finite populations
	4	Selection in finite populations
	5	Effect on genetic structure and variance
	6	Effect on genetic structure and variance
	7	Design of selection experiments for testing selection theory
	8	Design of selection experiments for testing selection theory
II	9	Measurement of genetic and environmental trends
	10	Measurement of genetic and environmental trends
	11	Advances in selection indices: Multistage, restricted and retrospective selection indices
	12	Advances in selection indices: Multistage, restricted, and retrospective selection indices
	13	Advances in selection indices: Multistage, restricted, and retrospective selection indices
	14	Advances in selection indices: Multistage, restricted, and retrospective selection indices
III	15	Empirical evaluation of selection theory
	16	Genetic slippage

	17	Limits to the selection
	18	Asymmetry of response
	19	Selection Experiments
	20	The effect of selection on variance
IV	21	Selection for threshold traits
	22	Selection under single and multiple trait animal models
	23	Selection under single and multiple trait animal models
	24	Direct and correlated response through various selection indices
	25	Direct and correlated response through various selection indices
	26	Relationship between BLUP and selection index
	27	Selection using markers and entire genome
	28	Selection using markers and entire genome
	29	MethodsforanalyzingGSdatalikeRR-BLUP,Bayes-1,2and3
	30	MethodsforanalyzingGSdatalikeRR-BLUP,Bayes-1,2and3

Practical

Practical No.	Name of Topic
1	Determination of culling levels and selection intensity
2	Determination of culling levels and selection intensity
3	Estimation of direct and correlated response
4	Estimation of direct and correlated response
5	Estimation of relative economic values
6	Estimation of relative economic values
7	Construction of various selection indices
8	Construction of various selection indices
9	Construction of various selection indices
10	Prediction of breeding value using advance methods
11	Prediction of breeding value using advance methods
12	Prediction of breeding value using advance methods
13	QTL analysis using LDMAS and LEMAS
14	QTL analysis using LDMAS and LEMAS
15	QTL analysis using LDMAS and LEMAS

Teaching methods

Blackboard; PPT-presentations, Research article discussion in the classroom

Learning outcome

They will be acquainted with all the theoretical techniques of the advanced selection methodology

Suggested Reading

- Balakrishnan N, Nagaraja HN and Kannan N. 2007.Advances in Ranking, Multiple Comparisons and Reliability.Springer.
- Cameron ND. 1997. Selection Indices and Prediction of Genetic Merit in Animal Breeding. CABI.
- Daniel S and Daniel G. 2012.Likelihood, Bayesian and MCMC Methods in Quantitative Genetics.Springer.
- Draper NR and Smith H. 1998.Applied Regression Analysis.J Wiley and Sons.
- Henderson CR. 1984.Applications of Linear Models in Animal Breeding.CABI.
- Legarra A, Lourenco DAL and Vitezica ZG. 2018. Bases for Genomic Prediction. INRA (Free Online).
- Morde RA and Thompson R. 2014.Linear Models for the Prediction of Animal Breeding Values, CABI.

Course Title : Bioinformatics in Animal Breeding
Course Code : AGB 705
Credit Hours :1+1=2

Theory

Unit No.	Lecture No.	Name of Topic
I	1	Overview of bioinformatics,
	2	Database concepts,
	3	Algorithms
	4	Information resources for protein and genome databases: Gene Bank EMBL, SWISSPROT, PROSITE
II	5	Nucleotide and protein sequence analysis, Pair-wise and multiple sequence alignments
	6	Phylogeny
	7	Big SNP data analysis methods
	8	Micro-array processing, Clustering
	9	Software for secondary database search and analysis
III	10	Genetic characterization
	11	Use of bioinformatics tools for identifying QTL and selection of elite germplasm
	12	GWAS
	13	Development of DNA chips
	14	NGS data analysis
	15	NGS data analysis

Practical

Practical No.	Name of Topic
1	Database development
2	Algorithms
3	Nucleotide and protein sequence analysis,
4	Nucleotide and protein sequence analysis,
5	Pair-wise and multiple sequence alignments
6	Phylogeny and dendrogram
7	Micro-array processing,
8	Micro-array processing,
9	Clustering
10	Secondary database search and analysis
11	Genetic characterization
12	Identifying QTL
13	GWAS
14	NGS data analysis
15	NGS data analysis

Teaching methods
Blackboard; PPT-presentations Research article, discussion in the classroom

Learning outcome
Nucleotide and protein sequence analysis and phylogenetic analysis

SuggestedReading

- Attwood TK and Parry-Smith DJ. 2001. Introduction to Bioinformatics. Benjamin-

Cummings Publishing Company.
- Bishop M. 1999. Genetics Databases.Elsevier.
- Jiang R, Zhang X and Zhang MQ. 2013. Basics of Bioinformatics. Springer.
- Luke A. 1997. DNA Sequencing: From Experimental Methods to Bioinformatics. BIOS Scientific Publishers
- Ramsden J. 2009. Bioinformatics: An Introduction. Springer.
- Stekel D. 2003.Microarray Bioinformatics.Cambridge University Press.
- Wu CH and McLarty JW. 2000. Neural Networks and Genome Informatics. Elsevier Science.
- Xiong J. 2006. Essential Bioinformatics. Cambridge University Press

Course Title :Animal Cytogenetics and Immunogenetics II
Course Code : AGB 706
Credit Hours :2+0=2

Theory

Unit No.	Lecture No.	Name of Topic
I	1	Structure of eukaryotic chromosomes
	2	Structure of eukaryotic chromosomes
	3	Evolution of karyotype
	4	Evolution of karyotype
	5	Various in vitro cell culture techniques
	6	Various in vitro cell culture techniques
	7	Cell lines and utility
	8	Cell lines and utility
	9	Genotoxicity
	10	Genotoxicity
II	11	Somatic cell genetics
	12	Stem cell genetics
	13	Molecular cytogenetics
	14	Gene mapping
	15	ISH, FISH
	16	Radiation hybrid mapping
	17	Fibre-FISH, PRINS
	18	Fibre-FISH, PRINS
	19	Positional cloning
	20	Spectral karyotyping
III	21	Image analysis
	22	Chromosome painting
	23	Chromosome walking
	24	Micro-dissection of chromosomes
	25	Structure and functions of major histocompatibility complex
	26	Structure and functions of major histocompatibility complex
	27	T Cell receptor
	28	CD4
	29	Interleukins
	30	Toll-like receptors and their functions
Teaching methods		

Blackboard; PPT-presentations Research article discussion in the classroom
Learning outcome Students get a good grip on different gene mapping techniques and image analysis
SuggestedReading • Agarwal S and Naik S. 2008.Fundamentals of Immunogenetics Principles and Practices.IBD Publisher. • Christiansen FT and Tait BD. 2012.Immunogenetics: Methods and Applications in Clinical Practice. Springer. • Gersen SL and Keagle MB. 2013. The Principles of Clinical Cytogenetics.Springer. • Litwin SD. 1989. Human Immunogenetics.CRC Press. • Tyagi R. 2009. Textbook of Cytogenetics.Discovery Publishers.

Course Title : Statistical Software in Animal Breeding
Course Code : AGB 707
Credit Hours : 1+1

Theory

Unit No.	Lecture No.	Name of Topic
I	1	Data preparation and Job control commands for statistical analysis of data
	2	Data preparation and Job control commands for statistical analysis of data
	3	Introduction to statistical and standard software packages
	4	Introduction to statistical and standard software packages
II	5	Use of software for t-test
	6	Use of software for Chi-squares test
	7	Use of software for F-test, ANOVA (CRD, RBD and LSD)
	8	Use of software for F-test, ANOVA (CRD, RBD and LSD)
	9	Use of software for Correlation and regression (simple, multiple, curvilinear, stepwise)
	10	Use of software for Discriminant analysis
III	11	Graphic features of the software packages
	12	Linear programming using appropriate software package
	13	Least-squares analysis
	14	Data mining techniques such as neural networks, genetic algorithms and fuzzy logic for predictive modelling
	15	Data mining techniques such as neural networks, genetic algorithms and fuzzy logic for predictive modelling

Practical

Practical No.	Name of Topic
1	Data preparation and generation
2	Import and Export of data from spreadsheet and database packages
3	Import and Export of data from spreadsheet and database packages
4	Use of software for t-test
5	Chi-squares test
6	F-test, ANOVA (CRD, RBD)
7	F-test, ANOVA (LSD)

8	Correlation and regression (simple, multiple)
9	Correlation and regression (curvilinear,stepwise)
10	Correlation and regression (stepwise)
11	Discriminant analysis
12	Graphic features of the software packages
13	Use of software for linear programming problem
14	Least-squares analysis
15	Use of software for neural networks and fuzzy logic models for prediction

Teaching methods

Blackboard; PPT-presentations; Research article discussion in the classroom

Learning outcome

Students get an idea on the availability of different statistical and standard software packages and their application in Animal Breeding

Suggested Reading

- Balding DJ, Bishop M and Cannings C. 2001.Handbook of Statistical Genetics.J Wiley and Sons.
- Boldman K, Kriese LA, Van Vleck LD, Van Tassell CP and Kachman SD. 1995.Manual for Use of MTDFREML. ARS, USDA (Free online)
- Dempfle L. 1990. Statistical Aspects of Design of Animal Breeding Programs.Springer.
- Freund RJ, Mohr D and William WJ. 2010. Statistical Methods. Academic Press.
- Henderson CR. 1984.Applications of Linear Models in Animal Breeding. University Guelph Press
- Isik F, Holland J and Maltecca C. 2017.Genetic Data Analysis for Plant and AnimalBreeding.Springer.
- Lynch M and Walsh B. 1990. Genetics and Analysis of Quantitative Traits.OXford..