# ANIMAL GENETICS AND BREEDING

## Course Structure

<table>
<thead>
<tr>
<th>COURSE NO.</th>
<th>COURSE TITLE</th>
<th>CREDITS</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGB 601*</td>
<td>ANIMAL CYTOGENETICS AND IMMUNOGENETICS</td>
<td>2+1</td>
<td>I</td>
</tr>
<tr>
<td>AGB 602</td>
<td>MOLECULAR GENETICS IN ANIMAL BREEDING</td>
<td>2+1</td>
<td>II</td>
</tr>
<tr>
<td>AGB 603*</td>
<td>POPULATION AND QUANTITATIVE GENETICS IN ANIMAL BREEDING</td>
<td>2+1</td>
<td>I</td>
</tr>
<tr>
<td>AGB 604*</td>
<td>SELECTION METHODS AND BREEDING SYSTEMS</td>
<td>3+1</td>
<td>II</td>
</tr>
<tr>
<td>AGB 605*</td>
<td>BIOMETRICAL TECHNIQUES IN ANIMAL BREEDING</td>
<td>3+1</td>
<td>I</td>
</tr>
<tr>
<td>AGB 606</td>
<td>CONSERVATION OF ANIMAL GENETIC RESOURCES</td>
<td>2+0</td>
<td>I</td>
</tr>
<tr>
<td>AGB 607</td>
<td>CATTLE AND BUFFALO BREEDING</td>
<td>2+1</td>
<td>II</td>
</tr>
<tr>
<td>AGB 608</td>
<td>SMALL FARM ANIMAL BREEDING</td>
<td>2+0</td>
<td>II</td>
</tr>
<tr>
<td>AGB 609</td>
<td>POULTRY BREEDING</td>
<td>2+1</td>
<td>I</td>
</tr>
<tr>
<td>AGB 610</td>
<td>LABORATORY ANIMAL BREEDING</td>
<td>1+0</td>
<td>II</td>
</tr>
<tr>
<td>AGB 691</td>
<td>MASTER’S SEMINAR</td>
<td>1</td>
<td>I, II</td>
</tr>
<tr>
<td>AGB 699</td>
<td>MASTER’S RESEARCH</td>
<td>20</td>
<td>I, II</td>
</tr>
<tr>
<td>AGB 701</td>
<td>RECENT ADVANCES IN ANIMAL GENETICS</td>
<td>2+0</td>
<td>I</td>
</tr>
<tr>
<td>AGB 702</td>
<td>RECENT TRENDS IN ANIMAL BREEDING</td>
<td>2+0</td>
<td>II</td>
</tr>
<tr>
<td>AGB 703</td>
<td>ADVANCES IN BIOMETRICAL GENETICS</td>
<td>2+1</td>
<td>II</td>
</tr>
<tr>
<td>AGB 704**</td>
<td>ADVANCES IN SELECTION METHODOLOGY</td>
<td>2+1</td>
<td>I</td>
</tr>
<tr>
<td>AGB 705</td>
<td>BIOINFORMATICS IN ANIMAL GENETICS AND BREEDING</td>
<td>2+0</td>
<td>I</td>
</tr>
<tr>
<td>AGB 706</td>
<td>ADVANCES IN MOLECULAR CYTOGENETICS</td>
<td>2+0</td>
<td>II</td>
</tr>
<tr>
<td>AGB 707**</td>
<td>UTILIZATION OF NON-ADDITIVE GENETIC VARIANCE IN FARM ANIMALS</td>
<td>2+1</td>
<td>I</td>
</tr>
<tr>
<td>AGB 791</td>
<td>DOCTORAL SEMINAR I</td>
<td>1</td>
<td>I, II</td>
</tr>
<tr>
<td>AGB 792</td>
<td>DOCTORAL SEMINAR II</td>
<td>1</td>
<td>I, II</td>
</tr>
<tr>
<td>AGB 799</td>
<td>DOCTORAL RESEARCH</td>
<td>45</td>
<td>I, II</td>
</tr>
</tbody>
</table>

*Compulsory for Master’s programme; **Compulsory for Doctoral programme*
ANIMAL GENETICS AND BREEDING

Course Contents

AGB 601 ANIMAL CYTOGENETICS AND IMMUNOGENETICS

Objective
To educate about basic principles of cytogenetics and immunogenetics and their applications in improving farm animals.

Theory
UNIT-I: Development in animal cytogenetics and immunogenetics of farm animals. Immunoglobulins and their types: antigen-antibody interactions, Immune response, ELISA.
UNIT-II: Major histocompatibility complex; genetics of biochemical variants and their applications; Ir-genes and concepts of disease resistance including major genes; hybridoma and its significance; concept of immuno-fertility, BoLA, BuLA, TLRs, Interleukins.
UNIT-III: Chromatin structure of eukaryotes; chromosome number and morphology in farm animals banding and karyotyping; chromosomal and genetic syndromes, DNA packing in chromosomes, Z+B DNA, FISH chromosome painting and PRINS. RH Panel Mapping.
UNIT-IV: Mutation and assays of mutagenesis; sister chromatid exchanges; recombinant DNA technique and its application in animal improvement programme.

Practical
Polymorphism of haemoglobulins, transferrins, enzymes/proteins; preparation of monovalent blood reagent-isoinmunization, titre testing and absorption of polyvalent serum; identification of bar 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.

Suggested Readings
Hare WCD & Elizabeth L Singh 1999. Cytogenetics in Animal Reproduction. CABI.

AGB 602 MOLECULAR GENETICS IN ANIMAL BREEDING

Objective
To educate about molecular techniques to identify molecular markers as an aid to selection.

Theory
UNIT-I: Basic concept: Genesis and importance of molecular techniques; Genome organization – physical and genetic map, current status of genome maps of livestock.
UNIT-II: Molecular markers and their application; RFLP, RAPD, Microsatellite/Minisatellite markers, SNP marker, DNA fingerprinting.
UNIT-III: DNA sequencing, Genome sequencing, Genomic Library, Polymerase Chain Reaction (PCR), its types (PCR-RFLP, AS-PCR etc.) and applications; Transgenesis and methods of gene transfer.
UNIT-IV: Statistical techniques for analyzing molecular genetic data, Quantitative Trait Loci (QTL) mapping and its application in animal breeding, Genome scan, Candidate gene approach, Genomic selection, Marker Assisted Selection- basic concept.

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


AGB 603  
**POPULATION AND QUANTITATIVE GENETICS IN ANIMAL BREEDING**  
**Objective**  
To study genetic structure of animal population and importance of genetic variation and covariation among traits.

**Theory**  
**UNIT-II**: Small population: random genetic drift, effective population size, pedigreed populations, regular and irregular inbreeding systems.
**UNIT-III**: Quantitative genetics-gene effects, population mean and variance and its partitioning, biometric relations between relatives.
**UNIT-IV**: Genetic and phenotypic parameters-their methods of estimation, uses, possible biases and precision. Scale effects and threshold traits.

**Practical**  

**Suggested Readings**  

AGB 604  
**SELECTION METHODS AND BREEDING SYSTEMS**  
**Objective**  
To explain the methodology of selection and breeding systems for genetic improvement of livestock and poultry.

**Theory**  
**UNIT-I**: Type of selection and their genetic consequences. Response to selection and its prediction and improvement of response to selection.

**Practical**  
Estimation of breeding values from different sources of information. Prediction of direct and correlated response to different bases of selection. Computation of breeding values using different sources of information for female and male selection. Computation of
realized heritability and genetic correlation. Selection index: Computation, Accuracy and response in component traits. Estimation of heterosis for different types of crosses. Estimation of GCA and SCA.

**Suggested Readings**


**Suggested Readings**


**Objective**

To educate about the various biometrical techniques for data analysis and their applications in animal breeding research.

**Theory**

UNIT-II: Introduction to matrix algebra, types of matrices and matrix operations. Determinants and their properties, methods of finding inverse of a matrix and their application.
UNIT-IV: Linear models in animal breeding, Methods of analysis of unbalanced animal breeding data. Adjustment of data. Data base management and use of software packages in animal breeding.

**Practical**

Matrix applications, determinant and inverse of matrices; Building of models for various types of data; Estimation of variance components; Least squares method for analysis of research data; Collection, compilation, coding, transformation and analysis of animal breeding data by using above biometrical techniques with computer application.

**Suggested Readings**

Suggested Readings
Lasley JF. 1987. *Genetics of Livestock Improvement*. 3rd Ed. IBH.

**AGB 607 CATTLE AND BUFFALO BREEDING** 2+1 SEM - II

Objective
To educate about the concept of cattle and buffalo breeding.

Theory
UNIT-I: History of dairy cattle and buffalo breeding. Breeds of cattle and buffalo and their characterisation. Inheritance of important economic traits. Recording and handling of breeding data. Standardization of records. Computation of correction factors for the adjustment of the data. Estimation of breeding values of the cows and bulls.
UNIT-II: Sire evaluation methods using single trait and multiple traits: construction of Sire indices, Sire evaluation under animal model, sire mode; and maternal grand sire model. Open nucleus breeding systems with MOET.
UNIT-IV: Considerations in the import of exotic germplasm for breeding cattle in the tropics. Appraisal of buffalo and cattle breeding programme. Role of breed associations in dairy improvement.

Practical

Suggested Readings
Lasley JF. 1987. *Genetics of Livestock Improvement*. 3rd Ed. IBH.

**AGB 608 SMALL FARM ANIMAL BREEDING** 2+0 SEM - II
(Sheep, Goat, Swine and Rabbit)

Objective
To educate about the small farm animal breeding concepts.

Theory
UNIT-I: Breeds–Economic traits–Prolificacy-Breeding records and standardization.
UNIT-II: Genetic parameters – Selection of males and females – Breeding systems. Development of new breeds.
UNIT-III: Breeding policy – Breeding research – Conservation of breeds.
UNIT-IV: Culling and replacement – EADR.

Suggested Readings

**AGB 609 POULTRY BREEDING** 2+1 SEM - I

Objective
To educate about the advances in poultry breeding practices.

Theory
UNIT-I: Origin and history of poultry species: Chicken, turkey, duck and quail – Important qualitative traits in poultry including lethals – Economic traits of egg-type chicken and their standardization – Selection criteria – Aids to selection: Index selection and Osborne index – Restricted selection index – Economic traits of meat – type chicken and their standardization.


UNIT-IV: Biochemical variants and immunogenetics of poultry – Use of molecular genetics in poultry breeding – Quantitative trait loci and marker-assisted selection – Conservation of poultry genetic resources.

Practical
Inheritance of qualitative traits – Economic traits of egg-type and meat-type chicken – Procedures of standardization – Estimations of heritability, 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 – Diallel cross.

Suggested Readings
Suggested Readings
Selected articles from journals.

AGB 702 RECENT TRENDS IN ANIMAL BREEDING 2+0 SEM - II

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

Theory
UNIT-I: Biometrical models and their analytical techniques on simulated and actual animal breeding data using computer application and use of programme in the field of animal breeding.
UNIT-II: Formulation of detailed breeding plans ongoing breed improvement programmes and their impact analysis in various species of livestock under different situations.
UNIT-III: Advanced techniques in genetic manipulation for multiplication and improvement of livestock species.

Suggested Readings
Selected articles from journals.

AGB 703 ADVANCES IN BIOMETRICAL GENETICS 2+1 SEM - II

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

Theory
UNIT-I: Mating designs; genetic basis of triple test cross analysis (TTC); triallel analysis, partial diallel crosses and mating design for studying reciprocal and maternal differences.
UNIT-II: Models for studying the inheritance of endosperm characters; classificatory problems; discriminant function, $D^2$ analysis; principal component analysis.
UNIT-III: Use of genetic parameters for prediction of recombinant inbred lines; advances in studies of genotype environment interaction and selection indices.
UNIT-IV: Generation matrix and its use in population genetics; gene mapping of QTL (quantitative trait loci).

Practical

Suggested Readings
Selected articles from journals.

AGB 704 ADVANCES IN SELECTION METHODOLOGY 2+1 SEM - I

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

Theory
UNIT-II: Methods of measurement of genetic and environmental trends. Advances in selection indices Multistage, Restricted and retrospective selection indices.
UNIT-IV: Selection for threshold traits; single and multiple trait best linear unbiased estimation (BLUE) and prediction (BLUP); selection under single and multiple trait animal models; direct and correlated response through various selection indices, relationship between BLUP and selection index; fundamentals of marker assisted selections.

Practical
Estimation of relative economic values; determination of culling levels and selection intensity; construction of various indices; estimation of direct and correlated response; QTL analysis using LDMAS & LEMAS.
Suggested Readings
Selected articles from journals.

AGB 705 BIOINFORMATICS IN ANIMAL GENETICS AND BREEDING 2+0 SEM - I

Objective
To educate about basic concepts of bioinformatics and their applications in Animal Genetics and Breeding.

Theory
UNIT-I: Overview of bioinformatics, Database concepts, Algorithms, Information resources for protein and genome databases: Gene Bank, EMBL, SWISSPROT, PROSITE.
UNIT-II: Nucleotide and protein sequence analysis, Pair-wise and multiple sequence alignments, Phylogeny, Micro-array processing, Clustering, Analysis software, Secondary database search.
UNIT-III: Genetic characterisation, Use of bioinformatics tools for identifying QTL and selection of elite germplasm.

Suggested Readings
Selected articles from journals.

AGB 706 ADVANCES IN MOLECULAR CYTOGENETICS 2+0 SEM - II

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

Theory
UNIT-II: Somatic cell genetics – Stem cell genetics – Molecular cytogenetics and gene mapping – ISH, FISH, Radiation hybrid mapping, Fibre-FISH, PRINS.
UNIT-IV: Image analysis – Chromosome walking – Chromosome painting.

Suggested Readings
Selected articles from journals.

AGB 707 UTILISATION OF NON-ADDITIVE GENETIC VARIANCE IN FARM ANIMALS 2+1 SEM - I

Objective
To educate about the recent advances in estimation of non-additive genetic variation and possible use in developing synthetic population of livestock and poultry.

Theory
UNIT-I: Heterosis – forms and genetic basis; detection and estimation of non-additive genetic variance – average dominance, overdominance.
UNIT-II: Partitioning of between cross variance – general combining ability, specific combining ability and reciprocal effects; methods of analyzing diallel crosses; utilization of non-additive genetic variance.
UNIT-III: Crossbreeding systems – crossbreeding effects; recurrent and reciprocal recurrent selection and their forms.
UNIT-IV: Development of specialized sire and dam lines; inbred lines and their maintenance; inbreeding and hybridization.

Practical
Computation of degree of dominance using NC Plans; analysis of partial and complete diallel cross data; estimation of crossbreeding effects; estimation of genetic correlation among paternal purebred and crossbred half sibs; computation of response through RS and RRS.

Suggested Readings
Selected articles from journals.
ANIMAL GENETICS AND BREEDING

List of Journals

- Animal Breeding Abstract
- Animal Science
- Asian – Australasian Journal of Animal Science
- Biometrics
- Data Agricultural Scandinavica
- Genetics
- Heredity
- Hoard’s Dairyman
- Indian Buffalo Journal
- Indian Journal of Animal Breeding & Genetics
- Indian Journal of Animal Production & Management
- Indian Journal of Animal Science
- Indian Journal of Animal Science
- Indian Journal of Dairy Science
- Indian Journal of Dairy Science
- Indian Journal of Poultry Science
- Indian Journal of Small Ruminant
- Indian Veterinary Journal
- Journal of Animal Science
- Journal of Dairy Science
- Journal of Indian Society of Agriculture Statistics
- Livestock Production Science
- Newzealand Journal of Agri. Research
- The Cell
- Theoretical and Applied Genetics
- Veterinary Record
- World Animal Review
- World Poultry Science Journal

e-Resources

- http://www.genome.gov
- http://www.hgsc.bcm.tmc.edu/projects/bovine
- http://www.animalgenome.org
- http://www.blackwell-synergy.com
- http://www.genomics.liv.ac.uk
- http://www.biomedcentral.com
- http://www.genomealliance.org.au
- http://www.csiro.au
- http://www.isag.org.uk
- http://www.ebi.ac.uk/imgt/

Broad Topics for Master’s and Doctoral Research
• Characterization and cataloging of chromosomal profiles of different species of livestock and poultry.
• Studies on Major Histo-compatibility Complex in reference to traits of economic importance.
• To study mutagenic and cytogenic effects of pesticides and agro-chemicals on the genome of domestic animals.
• Molecular characterization of milk proteins/DGATI gene in cattle and buffalo.
• Comparative gene mapping of indigenous vs exotic livestock species including poultry.
• Studies on crossbreeding parameters for evolving synthetic germplasm of livestock and poultry.
• Designing of selection strategies and breeding systems for improving market-based commercial traits.
• Optimization of breeding strategies for genetic improvement of indigenous livestock and poultry based on field data.
• Evaluation of breeding strategies for conservation of indigenous livestock and poultry breeds.
• Development of synthetic germplasm suitable for rural husbandry with low inputs.
• Genetic studies of nutraceutical animal products of livestock and poultry.
• Genetic-economic evaluation and multiplication of superior germplasm of livestock and poultry.
• Selection strategies for traits of economic importance incorporating molecular markers.
• Evaluation of models for evolving field recording systems.
• Genetic studies on disease resistance in livestock and poultry.
• Animal Genetic Resources characterization and evaluation using field survey and molecular markers.
• Animal Genetic Resource enhancement through selection/crossbreeding/reproductive biotechnology/molecular biology.
• Identification of molecular markers for economic traits.
• Genetic basis for improvement in quantitative traits.
• Breeding tools for Sire evaluation.
• Appropriate models for evaluating animal breeding values.
• Transgenesis and gene transfer.