

Minutes of the meeting of National Curriculum Revision Committee (NCRC) to finalize the revised draft curriculum of Animal Breeding and Genetics held at UGC Regional Centre, Karachi from May 14 – 16, 2001.

Meeting of National Curriculum Revision Committee (NCRC) on the subject of Animal Breeding and Genetics was held in UGC Regional Centre, Karachi from May 14-16, 2001 to finalize the revised draft curriculum of Animal Breeding and Genetics prepared in the meeting of NCRC held in March 12-14, 2001. Following attended the meeting:

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| 01. | Dr. Muhammad Sajjad Khan Associate Professor and Chairman Department of Animal Breeding and Genetics, University of Agriculture, Faisalabad. | Convener |
| 02. | Mr. Abdul Hussain Nizamani, Associate Professor and Chairman, Department of Animal Breeding and Genetics, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University, Tandojam. | Member |
| 03. | Mr. Muhammad Ata-ullah Khan Research Officer, Animal Production Division, Directorate of Veterinary Research Institute, Peshawar. | Member/Secretary |
| 04. | Mr. Umer Ayaz, Lecturer, Animal Breeding & Genetics, Veterinary Medical Institute, Faculty of Agriculture, Gomal University, D.I.Khan. | Member |
| 05. | Dr. Mushtaq Ahmad Mian, Professor and Dean, Faculty of Animal Husbandry and Veterinary Sciences, NWFP Agricultural University, Peshawar | Member |
| 06. | Dr. M. Akhtar Qureshi, Assistant Professor, Faculty of Agriculture, AJK University Rawalakot Campus. | Member |
| 07. | Dr. Ulfat-un-Nabi Khan, CSO/Director, Animal Sciences Institute , NARC, PO NIH, Islamabad. | Member |

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| 08. | Mr. Jalees Ahmed Bhatti, Lecturer, Animal Husbandary Section, College of Veterinary Sciences, Lahore. | Member |
| 09. | Dr. Haleem ul Hasnain, Representative of PVMC, House No. 13, Street No. 6, F-8/3, Islamabad. | Member |
| 10. | Lt. Col. Tariq Mahmood Khan, RV&FC Representative of GHQ, Rawal Pindi. | Member |
| 11. | Mr. Zaheer Ahmed Awan, Education officer, University Grants Commission, Islamabad. | Co-ordinator |

The meeting started with the recitation from the Holy Quran by Prof. Dr. Mushtaq Ahmad Mian. Dr. Iqbal A Panhwar, Director General, U.G.C., Regional Centre, Karachi welcomed the participants and assured them of all possible help and assistance to make this programme a success. The Convener of the committee then briefed the members on the work done in the last meeting and asked them to give their views on the first draft already circulated. Prof. Mushtaq highlighted the policy of UGC for having uniformity in the syllabi at the national level in order to make the effort of NCRC more fruitful and widely applicable. Dr. Nizamani, pointed out that their DVM programme of study is different to some extent from the that of University of Agriculture, Faisalabad and Gomal University, D I Khan and therefore while revising curriculum it should be taken into consideration as well.

Dr. Mushataq Ahmad stressed that there should be a minimum base line for a national curriculum for Animal Breeding and Genetics as the purpose of NCRC is to devise a uniform curricula for all the institutions imparting education in the field of Animal Sciences. Dr. Haleem ul-Hasnain also stressed on the uniformity of syllabus so that courses of study finalized in the meeting of NCRC are applicable at national level. He also appreciated the efforts of the UGC in providing a national forum to have broader spectrum of opinion on the subject. He further suggested that efforts may be made to minimize the disparity among the educational institutions if not eliminated totally.

The committee then took up the agenda of the meeting and started discussion on the course contents of postgraduate courses. After this, the undergraduate courses were discussed one by one. Recommendations were chalked out towards the end of the meeting. The revised undergraduate and postgraduate courses are given in Annexure A and B and the recommendations are given in Annexure C.

Annexure A

Revised Curriculum for Undergraduate Teaching in Animal Breeding and Genetics

ABG-301 Principles of Heredity 3(2-2)

Theory: Genetics: historical development and scope. Genetic basis of inheritance: cell and cell division, gametogenesis. Mendelism: basic terminology, Mendel's laws, monohybrid and polyhybrid crosses. Probability: concept and laws of probability. Chi-square test and its applications. Modified segregation ratios. Multiple allelomorphism. Genetics of sex: sex determining mechanisms, sex linkage and its variation. Polygenic inheritance, Pleiotropy. Linkage, crossing over and chromosomal mapping.

Practical: Microscopic studies on the animal and plant cells undergoing mitosis and meiosis. Preliminary Drosophila experiments for genetic studies. Exercises on relevant topics discussed in theory.

Books Recommended

1. Gardner, E. J., M. J. Simmons and D. P. Snustad. 1991. Principles of Genetics. John Wiley and Sons, New York.
2. Griffiths, A. J. F., J. H. Miller, D. T. Suzuki, R. C. Lewontin and W. M. Gelbart. 1993. An Introduction to Genetic Analysis. W. H. Freeman and Company, New York.
3. Klug, W.S. and M.R. Cummings. 1999. Essentials of Genetics. Prentice Hall, Inc., New Jersey, USA.
4. Lewis, R. 1999. Human Genetics. McGraw-Hill Co. Inc., NY.
5. Stansfield, W. E. 1991. Schaum's Outline of Theory and Problems of Genetics. McGraw-Hill Book Co. New York.
6. Tamarin, R. 1999. Principles of Genetics. 6th Ed. McGraw-Hill Book Co., Boston, USA.
7. Weaver, R. F. and P. W. Hedrick. 1997. Genetics. Wm. C. Publishers, Dubuque, Iowa.

ABG302 Introductory Molecular Genetics 3(2-2)

Theory: Biochemical basis of heredity: the nature of genetic material, nucleic acids, structure of DNA and RNA, DNA replication, transcription, and translation. The protein synthesis and its regulation. Developmental aspects of genetic control: gene expression and cell differentiation, control of gene expression in eukaryotes. Genetic basis of immune response: components of immune system, immune response, genetic diversity in immune system. Mutations: gene mutations and their types, variation in chromosome structure and number. Genetic engineering: basic concepts of recombinant DNA technology, gene cloning and manipulation, application and future. Extranuclear inheritance.

Practicals: Demonstration of various cytogenetic techniques, Karyotyping and Banding, DNA extraction and sequencing.

Books Recommended

1. Kingsman, S. M. and A. J. Kingsman. 1988. Genetic Engineering. Blackwell Scientific Publication, London.
2. Klug, W.S. and M.R. Cummings. 1999. Essentials of Genetics. Prentice Hall, Inc., New Jersey, USA.
3. Lewis, R. 1999. Human Genetics. McGraw-Hill Co. Inc., New York.

Practical: Estimation of genetic gain; evaluation of livestock on the basis of their own performance, pedigree and progeny. Calculation of breeding values from single and repeated records. Measurement of coefficient of relationship and inbreeding by methods of paths and variance-covariance chart. Measurement of heterosis. Estimation of genetic changes in performance traits due to various mating systems.

Books Recommended

1. Bourdon, R. M. 2000. Understanding Animal Breeding. Prentice-Hall, Inc. Upper Saddle River, New Jersey.
2. Lasley, J. F. 1987. Genetics of Livestock Improvement. Prentice-Hall International Inc. Englewood Cliffs, New Jersey.
3. Lush J. L. 1969. Animal Breeding Plans. Iowa State University, Press, Ames, Iowa.
4. Legates, J. E. and E. J. Warwick. 1990. Breeding and Improvement of Farm Animals. McGraw-Hill Publishing Co., New York.
5. Willis, M. B. 1998. Dalton's Introduction to Practical Animal Breeding. Blackwell Science Ltd., UK.

ABG-501

Selection For Economic Traits in Farm Animals

4(3-2)

Theory: Traits of economic importance in dairy animals, genetic correlations among the economic traits, their heritability and repeatability values, genetic methods to improve productivity, selection of dairy heifers and bulls, use of standardized records, relative economic values, breeding values and selection indices. Traits of economic importance in beef animals, genetic parameters of these traits, feasibility of producing beef animals in Pakistan, crossbreeding for milk and meat production. Traits of economic importance in draught animals, correlation among these traits, methods of their genetic improvement, role of crossbreeding in draught animals. Traits of economic importance in sheep and goats, genetic correlation among these traits, their heritability and repeatability values, methods to improve productivity, female selection, selection of rams and bucks. Traits of economic importance in poultry and their improvement, formation of breeding stock for layers and broilers, development of dual purpose birds and rural poultry. Introduction to various statistical packages for genetic parameters and breeding value estimation.

Practical: Exercises on the maintenance and standardization of productive and reproductive records. Estimation of Expected Real Producing Ability (ERPA) and Breeding Value using standardized records. Exercises on the estimation of genetic parameters. Calculation of relative economic values. Construction of selection indices for large and small animals. Calculating different genetic parameters through computers.

Books Recommended

1. Bourdon, R. M. 2000. Understanding Animal Breeding. Prentice-Hall, Inc. Upper Saddle River, New Jersey.
2. Crawford, R. D. 1990. Poultry Breeding and Genetics. Elsevier, Amsterdam, The Netherlands.
3. Lasley, J. F. 1987. Genetics of Livestock Improvement. Prentice-Hall international Inc. Englewood Cliffs, New Jersey.
4. Legates, J.E. and E.J. Warwick. 1990. Breeding and Improvement of Farm Animals. McGraw-Hill Publishing Co., New York.
5. Mackintosh, J. B. (Ed.). 1993. Sheep Production in Pakistan. Pakistan Agricultural Research Council, Islamabad.

variance; heritability, repeatability and genetic correlations. Concept of gene and genotypic frequency, forces that change the gene frequency and genetic structure of a population: selection, mutation, migration and random drift. General principles of selection: Selection on the basis of individual performance, pedigree, family, progeny and all available information. Breeding systems based on relationships and phenotypes, pure-breeding, crossbreeding and grading up.

Practical: Laboratory demonstrations on cell division and gametogenesis, exercises on segregation ratios and probability. Exercises on calculation of coefficients of relationship and inbreeding. Record keeping and evaluation of individual, pedigree and progeny performance, selection exercises and assessment of genetic gain.

Books Recommended

1. Klug, W.S. and M.R. Cummings. 1999. Essentials of Genetics. Prentice Hall, Inc., New Jersey, USA.
2. Legates, J.E. and E.J. Warwick. 1990. Breeding and Improvement of Farm Animals. McGraw Hill Publishing Co., New York.
3. Nicholas, F. W. 1996. Introduction to Veterinary Genetics. Clarendon Press, Oxford.
4. Willis, M. B. 1998. Dalton's Introduction to Practical Animal Breeding. Blackwell Science Ltd., UK.

ABG-601

Animal Breeding Practices

4(3-2)

Theory: Role of animal breeding in livestock production. Opportunities for breeding and improvement of farm animals in Pakistan. Conservation of animal genetic resources in Pakistan: scope, techniques and problems. National breeding policy for improvement and conservation of livestock. Constraints in improving the productivity of livestock under traditional breeding systems. Review of the breeding practices used by the developed countries for increasing the performance of farm animals. Future breeding plans for improvement of farm animals for increasing productivity in different agro-ecological zones of Pakistan. Emerging breeding technologies for increased animal productivity.

Practical: Computation of various productive and reproductive traits (calving interval, dry period, service period, productive life, herd life, fertility rate, hatchability etc.) in different farm animals from the available records. Exercises on the feasibility of purebreeding and crossbreeding in farm animals for milk, meat, wool/hair and egg production under local conditions. Project preparation on specific topics. Use of internet databases on animal genetic resources.

Books Recommended

1. Bourdon, R. M. 2000. Understanding Animal Breeding. Prentice-Hall, Inc. Upper Saddle River, New Jersey.
2. CUSOTA. 1991. U.S. Dairy Industry at a Crossroad: Biotechnology and Policy Choices. Congress of the United States, Office of the Technology Assessment. U.S. Govt. Printing Office, Washington, DC.
3. McDowell, R. E. 1994. Dairying with Improved Breeds in Warm Climates. Kinnic Publishers, Inc., Raleigh, NC.
4. MINFAL. 1991. National Agricultural Policy. Ministry of Food, Agriculture and Cooperatives. Government of Pakistan, Islamabad.

5. Oldenbroek, J. K. (ed). 1999. Genebanks and the Conservation of Farm Animal Genetic Resources. DLO Institute for Animal Science and Health, The Netherlands.

ABG-602 Applied Animal Breeding and Internship 5(0-10)

Requirements of identification and recording of farm animals for genetic improvement programs. Needs for data processing and evaluation at national level. Genetic progress simulation. Review of the current projects on livestock improvement in the country. Future animal breeding policy. Report writing. Visits to the livestock farms, livestock production research institutes, semen production units, poultry breeding farms and other related organizations for practical training under the guidance of a teacher as well as the staff of the institute/farm concerned. Submission of a concise report on the practical experience gained during the visit of these organizations. Practical training will especially cover the following:

- a) Identification of animals: identification methods, coding of identification numbers for computer entry and analysis. Attributes of various breeds pertaining to economic importance and score carding.
- b) Record keeping: Maintenance of history sheets and other registers for recording information on various species. Daily record keeping schedules.
- c) Conversion of information from different registers and history sheets for electronic data storage, analysis and presentation. Use of computer packages for data handling. Selection of animals on the basis of individual, pedigree, progeny and other information. Appraisal of sire summaries.
- d) Breed improvement work being done at various livestock stations on buffalo, indigenous and crossbred cattle, sheep and goat: Plan of work, performance and evaluation of progress achieved.
- e) Rectal palpation for checking the condition of reproductive organs, heat detection and pregnancy diagnosis. Insemination of buffalo, cattle, sheep, goats and poultry. Calving and lambing forecast. Semen collection from bulls, its evaluation, dilution, preservation and storage. Management of bulls and rams used for semen collection.

Books Recommended

1. Bourdon, R. M. 2000. Understanding Animal Breeding. Prentice-Hall, Inc. Upper Saddle River, New Jersey.
2. Hafez, E. S. E. and B. Hafez. 2000. Reproduction in Farm Animals. 7th Edition. Lea and Febiger, Philadelphia.
3. Khan, U.N. 1994. Genetic Improvement of Native Cattle Through Crossbreeding and Introduction of Exotic Dairy Cattle in Pakistan. Pakistan Science Foundation, Islamabad.
3. Naqvi, A. and S. M. Jafar. 1989. Dairy Cattle Breeding in Pakistan. Pakistan Agricultural Research Council, Islamabad.
4. Van Horn, H. H. and C. J. Wilcox. 1992. Large Dairy Herd Management. American Dairy Science Association. Champaign, Illinois.
5. Willis, M. B. 1998. Dalton's Introduction to Practical Animal Breeding. Blackwell Science Ltd., UK.

Annexure B

Revised Curriculum for Postgraduate Teaching in Animal Breeding and Genetics

ABG-701 General Genetics 4(3-2)

Theory

The scope and significance of modern genetics, heredity and phenotype. Cytological basis of inheritance; the cell cycle. Sex chromosomes and sex determination. Mendelian genetics, modifications of segregation ratios, multiple allelomorphism. Linkage, crossing over and chromosome mapping. Genetic variation: variation in chromosome number and arrangement; mutation and mutagenesis; extra-chromosomal inheritance. The Chemical basis of heredity, the genetic material, nucleic acids' structure and analysis, replication and synthesis of DNA, organization of DNA in chromosomes, gene structure, function and regulation. Immunogenetics. Genetic engineering: Techniques for gene cloning; application of rDNA technology. Qualitative vs quantitative inheritance, genetic and artificial selection, gene frequency and forces affecting it; Control of quantitative characteristics; Darwinism and evolution; conservation of genetic resources.

Practicals

Numerical exercises on problems discussed in theory. Laboratory exercises and analysis of breeding experiments with *Drosophila/tribolium* illustrating the laws of heredity. Demonstration of various cytogenetic techniques.

Books recommended

1. Brown, T.A. 1995. Gene Cloning, an Introduction. 3rd Ed. Chapman and Hall, London, UK.
2. Hartwell, L., A. Reynolds, L. Hood, M. L. Goldberg, L. M. Silver, R. C. Veres. 2000. Genetics: From Genes to Genomes. McGraw Hill Co., Boston, USA.
3. Klug, W.S. and M.R. Cummings. 1999. Essentials of Genetics. Prentice Hall, Inc., New Jersey, USA.
4. Lewis, R. 1999. Human Genetics. McGraw Hill Co., Boston, USA.
5. Stansfield, W.E. 1991. Schaum's Outline of Theory and Problems of Genetics. McGraw-Hill Book Co., New York.
6. Tamarin, R. 1999. Principles of Genetics. 6th Ed. McGraw-Hill Book Co., Boston, USA.

ABG-702 Population Genetics 4(3-2)

Theory

Review of the basic concepts of genetics and statistics. Genetic structure of populations: Hardy-Wienberg law and equilibrium; gene and genotypic frequencies. Gene counting methods, Maximum Likelihood estimation of gene frequency. Fisher's fundamental theorem of natural selection. Relationship and inbreeding coefficient for an autosomal locus; for a sex-linked locus. Consanguineous matings and rare traits inbreeding in a randomly mating population of finite size, effective population size. Evaluation and uses of Hardy-Wienberg equilibrium, assumptions underlying Hardy-Wienberg equilibrium. Changes in gene frequencies: Mutation, migration, selection, random drift. Genetic basis of variation: Mode of gene expression, measurement of variation. Heredity and environment: Role of heredity and environment in influencing quantitative traits and its measurement. Genetic correlation and genotype-environment interactions. Genetic integration of Mendelian populations, Bay's theorem.

Practicals

Exercises on changes in gene and genotypic frequencies under different conditions. Measurement of relationship and inbreeding. Estimation of variance components, Binomial and multinomial distributions. Simulation studies on Bays Theorem and Maximum Likelihood estimation procedures.

Books recommended

1. Doolittle, D.P. 1987. Population Genetics: Basic Principles. Springer-Verlag, New York, U.S.A.
2. Falconer, D. S. and T.F.C. Mackay. 1996. Introduction to Quantitative Genetics. 4th Edition. Longman Group Ltd., England.
3. Hartle, D. L. and A. G. Clark. 1989. Principles of Population Genetics. Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, U.S.A.
4. Van Vleck, L.D, Pollak and E.A.B. Oltenace. 1987. Genetics for Animal Sciences. W. H. Freeman and Co. New York, U.S.A.
5. Wallace, B. 1981. Basic Population Genetics. Columbus University Press, New York, U.S.A.

ABG-703**Animal Breeding Plans****4(3-2)****Theory**

Genetic principles in animal breeding. Heredity and environment, genetic parameters: heritability, repeatability and methods of their estimation; phenotypic , genetic and environmental correlations. Breeding plans based on selection, aids to selection, selection between and within populations. Mixed model solutions and Best Linear Unbiased Prediction (BLUP). Selection limits, selection intensity, accuracy of selection, selection index and correlated response. Estimation of genetic and economic gains. Optimizing genetic progress. Breeding plans based on relationship: Likeness between relatives and degree of relationship. Inbreeding, linebreeding. Outbreeding systems, rotational crossing; Crossing to produce a synthetic, grading up. Family structure of populations. Breeding plans based on somatic likeness. Nucleus system: Open and closed nucleus system, MOET. Simulation of selection process.

Practicals

Problems on the determination of breeding value of an individual using lifetime average, pedigree information, progeny performance and other sources. Estimation of breeding values using Best Linear Unbiased Prediction (BLUP) procedures. Exercises on selection differential, genetic gain and selection indices.

Books recommended

1. Bourdon, R.M. 2000. Understanding Animal Breeding. Printice Hall, Upper Saddle River, NJ, U.S.A.
2. Lasley, J.F. 1987. Genetics of Livestock Improvement. 4th Edition Printice Hall, Inc., Englewood cliffs, New Jersey, U.S.A.
3. Legates, J.E., and E.J. Warwick. 1990. Breeding and Improvement of Farm Animals. McGraw-Hill publishing Co., New York, U.S.A.
4. Lush, J.L. 1969. Animal Breeding Plans. Iowa State University Press Ames, Iowa, U.S.A.
5. Nicholas, F. W. 1996. Introduction to Veterinary Genetics. Clarendon Press, Oxford, U. K.

ABG-704**Breeding of Farm Animals****4(3-2)****Theory**

Objectives in the breeding of farm animals, role of animal breeder in improving livestock economy. Existing livestock genetic resources with particular emphasis on production potentials; comparison with foreign breeds and basis for the superior/inferior performance. Breeding policies for cattle, buffaloes, sheep and goats and other livestock species in Pakistan. Strategies for improved use and conservation of livestock. Inbreeding and crossbreeding for livestock improvement: Development and uses of inbred lines in poultry. Heterosis: genetic aspects, exploitation, crossbreeding systems. Detection and elimination of genetic defects and lethals from the stock. Maintenance of performance records, their standardization and optimal use. Large scale genetic evaluation. Interpreting genetic evaluation information.

Practicals

Exercises on the evaluation of productive traits of various breeds of livestock. Exercises on standardization of records, genetic evaluation and selection, Computer usage for animal evaluation. Review paper required. Visits to different breeding farms.

Books recommended

1. Bourdon, R.M. 2000. Understanding Animal Breeding. Prentice Hall, Upper Saddle River, NJ, U.S.A.
2. Lasley, J.F. 1987. Genetics of Livestock Improvement. 4th Edition, Prentice Hall, Inc., Englewood Cliffs, New Jersey, U.S.A.
3. Legates, J.E. and E.J. Warwick. 1990. Breeding and Improvement of Farm Animals. McGraw-Hill publishing Co., New York, U.S.A.
4. Piper, L. and A. Ruvinsky. 1997. The Genetics of Sheep. CAB International. Wallingford, Oxon, UK.
5. Van Horn, H.H. and C.J. Wilcox. 1992. Large Dairy Herd Management. American Dairy Science Association, Champaign, Illinois, U.S.A.

ABG-705**Advanced Animal Breeding****4(4-0)****Theory**

Current animal breeding, estimation of genetic parameters, selection for economic merit, testing and selection within stocks. Role of A.I. and other related techniques in enhancing the genetic progress. Multi Trait Across Country Evaluation (MACE) and its application. Genetic technologies: role of biotechnology in animal production, recombinant DNA techniques, recombinant DNA for the improvement of domestic animals; Micro-manipulation: cloning, homozygous diploids, androgenesis and gynogenesis, sex selection, chimaeras, transfer of genes. The direct detection of genotype, DNA polymorphism. Expected genetic and economic gains. Detecting major genes, basic concepts of marker based analysis, influence of markers on production and reproduction in farm animals, mapping and characterizing Quantitative Trait Loci (QTL), genetic maps. Review of the recent literature in animal breeding.

Books recommended

1. Babiuk, L.A, J.P. Phillips and M. Moo-Young. 1989. Animal Biotechnology. Pergamon Press, New York, U.S.A.
2. Hartwell, L., A. Reynolds, L. Hood, M. L. Goldberg, L. M. Silver, R. C. Veres. 2000. Genetics: From Genes to Genomes. McGraw Hill Co., Boston, USA.
3. Kingsman, S.M. and A.J. Kingsman. 1988. Genetic Engineering. Blackwell Scientific Publications, Oxford, U.K.

4. Lynch, M. And B. Walsh. 1998. Genetics and Analysis of Quantitative Traits. Sinauer Associates, Inc., Publishers, Sunderland, MA, U.S.A.
5. Nicholas, F.W. 1996. Veterinary Genetics. Clarendon Press, Oxford, U.K.

ABG-706 Statistical Methods in Animal Production Research 4(3-2)

Theory

Basic biometrical concepts and definitions. Data description for single and multiple variables. Probability and its distributions. Estimation and hypothesis testing. Concepts and application of regression and correlation, least squares analysis. Introduction to analysis of variance and assumption underlying it. Principles of planning of animal experiments.. Concepts behind using various experimental designs such as completely randomized design, randomized complete block designs and Latin square design with and without factorial arrangements. Changeover, crossover and other designs. Relative efficiencies of these designs. Multiple comparisons. Fixed, random and mixed models. Estimation of variance components under various statistical models. Categorical animal data analysis, animal production data management and report preparation.

Practical

Introduction to various computer packages for animal data handling and processing. Numerical exercises on various experimental methods listed in the theory manually and by using computers.

Books recommended

1. Damon, R.A. Jr. and W.R. Harvey. 1987. Experimental Design, ANOVA & Regression. Harper & Row Publisher, New York, U.S.A.
2. Mead, R., R.N. Curnow and A.M. Hasted. 1993. Statistical Methods in Agriculture and Experimental Biology. Chapman and Hall, London.
3. Snedecor, G.W. and W.G. Cochran. 1991. Statistical Methods. Iowa State University Press, Ames, Iowa, U.S.A.
4. Sokal, R.R. and F.J. Rohlf. 1995. Biometry. W.H Freeman and Co., New York.
5. Steel, R.G.D. and J.H. Torrie, 1980. Principles and Procedures of Statistics. McGraw-Hill Kogakusha, Ltd. London, U.K.
6. Williams, B. 1993. Biostatistics. Chapman and Hall, London.

ABG-707 Efficiency of Reproduction in Farm Animals 4(2-4)

Theory

Genetic basis of variation in reproductive functions. Relationship of reproduction to genetic improvement in domestic animals; Pre- and post natal selection of genetic and reproductive material; the problem of reduced fertility and reproductive efficiency and its relation to lifetime productive efficiency; Measures of reproductive efficiency in farm animals; Genetic and environmental basis of the differences in reproductive efficiency; Fertility level of males for use in artificial insemination; Reduction in estrous period, quiescent heat and anestrus; Embryonic losses; Issues related to prolificacy; Manipulation of reproductive cycle, Feeding and management practices in improving fertility traits; Augmenting reproductive rate, Application of biotechnology for improving reproductive efficiency. Exploitation of genetic variation in reproductive performance for improvement.

Practicals

Practice on the slaughter house material and experimental live animals. Rectal palpation of genital organs at various stages of reproductive cycle. Practice in various methods of heat detection; correction of reproductive problems. Hormonal application and other techniques. Practice in pregnancy diagnosis in various livestock species. Measurement of reproductive fitness in males. Determining reproductive efficiency in males and females.

Books recommended

1. Cupps, P. T. 1991. Reproduction in Domestic Animals. Academic press, Inc., London.
2. Gordon, I. 1983. Controlled Breeding in Farm Animals. Pergamon Press, Oxford, England, U.K.
3. Hafez, E. S. E. and B. Hafez. 2000. Reproduction in Farm Animals. 7th Edition. Lea and Febiger, Philadelphia.
4. Land, R.B. and D.W. Robinson. 1985. Genetics of Reproduction in Sheep. Garden Cioty Press Ltd., Butter Worths, London. U.K.
5. Legates, J.E. and E.J. Warwick. 1990. Breeding and Improvement of Farm Animals. McGraw-Hill publishing Co., New York, U.S.A.
6. Salisbury G.W., N.L Van Demark and J.R. Lodge. 1985. Physiology of Reproduction and Artificial Insemination of Cattle. C. B. S. Publishers and Distributors, Delhi, India.

ABG-708**Biometrical Genetics****4(3-2)****Theory**

Statistical concepts in animal genetics. Review of matrix algebra and linear models, elementary probability and its application to Mendelian inheritance. Metric characters, population mean, average effect, breeding value, dominance deviations, interaction deviations. Sources of genetic variation in single and multilocus traits, sources of environmental variation. Estimation of variance components: parent-offspring regression, sib analysis, cross-classified designs, genotype x environment interaction, maternal effects and other genetic models. Estimation of breeding values.

Practical

Numerical exercise on various topics covered in theory. A review paper presentation on biometrical genetics would be required.

Books recommended

1. Becker, W. A. 1992. Manual of Quantitative Genetics, 5th Edition. Academic Enterprises Pullman, Washington, U. S. A.
2. Falconer, D. S. and T.F.C. Mackay. 1996. Introduction to Quantitative Genetics. 4th Edition. Longman Group Ltd., England.
3. Lynch, M. and B. Walsh. 1998. Genetics and Analysis of Quantitative Traits. Sinauer Associates, Inc., Publishers, Sunderland, MA, U.S.A.
4. Narain, P. 1990. Statistical Genetics. Wiley Eastern Limited, New Dehli, India.

ABG-709**Theory of Genetic Selection****4(4-0)****Theory**

Genetic basis of variation, components of genotypic variation, experimental assessment of genetic variance components, methods of selection for qualitative and quantitative characteristics, mutivariate selection theory, selection response and its prediction, change of

gene frequency under artificial selection, recurrent selection and reciprocal recurrent selection; genetic and environmental correlations, correlated response to selection, asymmetry of response, genotype by environment interaction, prediction and optimization of response through computer simulation, selection index, finding of weights, application of selection index in breeding value estimation, Mendelian markers and quantitative traits, marker assisted selection.

Books recommended

1. Chapman, A.B. 1985. General and Quantitative Genetics. Elsevier Science Publishers, New York.
2. Falconer, D. S. and T.F.C. Mackay. 1996. Introduction to Quantitative Genetics. 4th Edition. Longman Group Ltd., England.
3. Hartle, D. L. and A. G. Clark. 1989. Principles of Population Genetics. Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, U.S.A.
4. Van Vleck, L. D. 1993. Selection Index and Introduction to Mixed Model Methods. CRC Press, Inc., Boca Raton, Florida, U.S.A.

ABG-710

Theory of Inbreeding

4(4-0)

The concept of inbreeding and its measurement. Wright's method of path coefficients and variance co-variance chart, Malecot's concept of relationship and inbreeding. Distribution, mean and variance of gene frequency in small populations. Genotypic frequencies with inbreeding. Regular systems of inbreeding. Inbreeding with two loci. Effects of inbreeding on the variance, effective population size. Dangers of inbreeding, inbreeding depression and heterosis. Practical uses of relationship coefficients. Selection and inbreeding, simulation as applied to inbreeding.

Books recommended

1. Falconer, D. S. and T.F.C. Mackay. 1996. Introduction to Quantitative Genetics. 4th Edition. Longman Group Ltd., England.
2. Hartle, D. L. and A. G. Clark. 1989. Principles of Population Genetics. Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, U.S.A.
3. Wright, S. 1958. Systems of Mating and Other Papers. Iowa State University Press, Ames, Iowa. U.S.A.

ABG-711

Experimental Techniques in Population Genetics

4(2-4)

Theory

The lifecycle of *Drosophila melanogaster*, Genetics of embryonic development in *Drosophila* and *Tribolium*, different stages, methods of breeding and recording. Methods of genetic analysis with respect to gene action and properties of genetic material. Analytical procedures by means of markers. Verification of theories of population genetics on the colonies of the above species with special emphasis on quantitative traits like bristle number, larval weight, etc. Review of research work done.

Practicals

Handling and breeding of *Drosophila* and/or *Tribolium* species. Experiments of gene frequency, genotypic ratios, Hardy-Weinberg law, and departures from it in small populations. Demonstration of selection and inbreeding experiments for verification of quantitative theory.

Books recommended

1. Campos-Ortega, J.A. and V. Hartenstein. 1985. The Embryonic Development of *Drosophila melanogaster*. Springer-Verlag, New York, U.S.A.
2. Demerec, M. and B.P. Kaufmann. 1962. *Drosophila* guide: Introduction to Genetics and Cytology of *Drosophila melanogaster*. Carnegie Institution of Washington, Washington, D.C, USA.
3. Falconer, D. S. and T.F.C. Mackay. 1996. Introduction to Quantitative Genetics. 4th Edition. Longman Group Ltd., England.
4. Graf, U., N. van Schaik and F.E. Wurgler. 1992. *Drosophila* Genetics - A Practical Course. Springer - Verlag, Berlin Heidelberg, New York.

ABG-712**Animal Cytogenetics****4(3-2)****Theory**

Basic tenets of cytogenetics. Chromosomal theory of inheritance. The cell: cell mechanics. Normal karyotypes, abnormal karyotypes and its causes. Chromosomal abnormalities in farm animals. Architecture of the chromosome, Prokaryotic and eukaryotic chromosomes. Inactivation and elimination of chromosomes. Molecular cytogenetics: DNA as the genetic material, DNA sequences and genome evolution; control of gene expression, DNA replication and repair mechanisms, mutations, induction and detection. Non chromosomal inheritance and maternal effects. Genetic resistance to diseases. Major Histocompatibility Complex (MHC) and immune response. Genetic engineering: Gene transfer methodologies, genetic markers and their application.

Practicals

Micro and Macro methods for short-term culture of peripheral blood for chromosomal analysis, DNA extraction, electrophoresis, chromosomal studies using banding techniques. Karyotyping of different species of farm animals for numerical and structural abnormalities. Gene cloning. Review paper required.

Books recommended

1. Eldridge, F.E. 1985. Cytogenetics of Livestock. AVI Publishing Co., Westport, Connecticut, U.S.A.
2. McGregor, H.C. 1993. An Introduction to Animal Cytogenetics. Chapman and Hall, London.
3. Nicholas, E.W. 1996. Veterinary Genetics. Clarendon Press, Oxford, U.K.
4. Swanson, C.P., T. Merz and W.J. Young. 1990. Cytogenetics. Printice Hall of India, Private Ltd. New Delhi, India.

ABG-713**Poultry Genetics and Breeding****4(3-2)****Theory**

Basic genetic concepts. Poultry genetic resources, reproductive biology in relation to genetics and breeding, sex determination, genetics of the plumage, skin, growth, meat production, egg production, egg composition, fertility, diseases and behavior. Genetic controls in selection, genotype by environment interaction, heterosis and inbreeding. Development of commercial synthetic layers and broilers, Molecular and immunogenetic aspects of poultry genetics, genetic engineering, mutations and major variants in the fowl. Breeding for fancy poultry, Breeding for rural poultry production systems. Conservation of poultry genetic resources.

Practicals

Exercises on relevant topics covered in the theory. Visits to various hatcheries and breeding farms.

Books recommended

1. Crawford, R.D. 1990. Poultry Breeding and Genetics. Elsevier, New York, U.S.A.
2. Gardener, E.J., M. J. Simmons and D.P. Snustad. 1991. Principles of Genetics. John Wiley and Sons, Inc., New York, U.S.A.
3. North, M.O. and D.D. Bell. 1990. Commercial Chicken Production Manual. AVI Publishing Co., Inc. Westport, Connecticut, U.S.A.

ABG-714**Fish Genetics and Breeding****4(4-0)****Theory**

Basic genetic concepts, fish genetic resources, reproductive biology of aquaculture species in relation to genetics and breeding, traits of economic importance in commercial fish production, genetic potential and productivity, component of variation. Methods of genetic improvement of aquaculture species: selection and hybridization, strain and crossbreeding, cryopreservation. Sex control, gynogenesis, androgenesis, polyploid, production of transgenics, maintenance and conservation of the genetic base. Role of biotechnologies and future outlook. Review paper assignment.

Books recommended

1. Anonymous, 1988. Proceedings of International Symposium on Aquaculture Research Needs for 2000 A.D. November 15-18, 1988, New Delhi, India. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India.
2. Bridge, T.W. and G.A. Boulenger. 1989. A Complete Manual of Fishes. Cosmo Publication, New Delhi, India.
3. Das, P. and A.G. Jhingran. 1989. Fish Genetics in India. Today and Tomorrow's Printers and Publishers, New Delhi, India.
4. Purdon, C.E. 1995. Genetic and Fish Breeding. Chapman and Hall, London, U.K.
5. Sinha, V.R.P. and H.C. Srivastava. 1991. Aquaculture Productivity. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

ABG-719

Special Problem

1(1-0)

ABG-720

Seminar

1(1-0)

Annexure C

Recommendations

The NCRC met to finalize the available undergraduate and postgraduate curriculum in Animal Breeding and Genetics offered by different institutions in Pakistan. As mentioned in the first draft, it was realized that a large degree of variation exists in quantitative and qualitative aspects of the curriculum being offered by various institutions both at under- and postgraduate levels even when the name of the degree program is the same. For example, one course of 4 credit hours is offered at the University of Agriculture Faisalabad (UAF) and Gomal University, D.I Khan (ABG-504) for the DVM degree, while at Sindh Agriculture University Tandojam (SAUT) three courses (ABG-401, ABG-402, ABG-601) of 13 credit hours are being offered. The composite degree program (DVM and B.Sc.(Hons) A. H) at SAUT further complicates the situation. Similarly, at postgraduate level, the name of the degree offered at the above two institutions is M.Sc.(Hons) Animal Breeding and Genetics, but the minimum duration of the degree program is one year at SAUT while it is 2-years at UAF. The courses offered and the credit hours required are substantially different. It was agreed that courses be updated both at undergraduate and postgraduate levels irrespective of the degrees offered at various institutions. Institutions may then choose the required courses from the common list and adopt them according to their own nomenclature.

It was also noted that the earlier recommendations made by the NCRC, in its meeting held in 1997 at Lahore, have not been fully implemented. For example, the Animal Breeding and Genetics discipline relies heavily on statistics/biometry and computers have become a prerequisite for teaching animal genetic and breeding techniques. In the meeting under reference, it was recommended that the computers should be provided for proper training of the students in Animal Breeding and Genetics but it has not been implemented so far. Computer training to the trainers of Animal Breeding and Genetics has not been provided, neither has the provision of running expenditures for teaching courses in molecular genetics. The revision of courses will remain on paper only and will serve no useful purpose if the necessary funds are not provided for the procurement of equipments, required textbooks, reference books and periodicals. It was also pointed out that computational facilities at the UGC Regional Office at Karachi need upgradation. The Data Show/Data Display Unit facility if provided will enhance the quality of curriculum meetings at this centre. In the light of discussions held throughout the meeting, following recommendations were finalized for implementation by UGC:

1. Uniform curriculum should be implemented for courses to be undertaken at under- and postgraduate level at various institutions when degrees offered have the same name. Also the duration of degree programs offered by various institutions should be uniform. The qualifications to pursue higher degrees should also be similar at all levels.
2. Computers should be provided to various departments teaching Animal Breeding and Genetics courses.
3. Funds for the purchase of books, periodicals and other teaching material be provided to practically implement the revised curriculum.
4. Funds for chemicals/glassware etc. to Animal Breeding and Genetics departments be provided along with the provision of equipment required to demonstrate/conduct experiments both at under and post-graduate level, especially for experiments in molecular genetics.
5. The teachers in Animal Breeding and Genetics disciplines should be given training in the following areas through refresher courses:
 - a. Application of computers in animal genetics
 - b. Animal breeding tools in the computer age
 - c. Molecular genetic techniques for teaching and research
6. For practical training under internship programs, departments/faculties should be facilitated in logistics and other expenses.
7. The introduction of review paper and seminar at undergraduate level, already in practice at NWFP Agricultural University, Peshawar, may be considered by other institutions.
8. To avoid duplication of research in Animal Breeding and Genetics discipline, a list of M.Sc/ Ph.D theses (along with brief abstracts) be published every year by UGC and circulated to the institutions.

Dr. Muhammad Ata-Ullah Khan
Secretary

Dr. Muhammad Sajjad Khan
Convener