# SCHEME OF STUDIES

# FOR

# M. Phil. Animal Nutrition

## (Master of Philosophy Animal Nutrition)

**Department of Livestock Production and Management**

**Faculty of Veterinary and Animal Sciences**

***Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi***

# List of Courses
# for
# M. Phil. Animal Nutrition

| Course No. | Course Title | Credit Hours |
|---|---|---|
| AN-701 | Physiology and Biochemistry of Nutrition | 3(3-0) |
| AN-702 | Feeds and Feeding | 3(2-2) |
| AN-703 | Energy Metabolism | 3(2-2) |
| AN-704 | Protein Metabolism | 3(2-2) |
| AN-705 | Mineral Nutrition | 3(2-2) |
| AN-706 | Vitamin Nutrition | 3(2-2) |
| AN-707 | Analytical Techniques in Animal Nutrition | 3(0-6) |
| AN-708 | Research Methods in Animal Nutrition | 3(2-2) |
| AN-709 | Avian Nutrition | 3(2-2) |
| AN-710 | Ruminant Nutrition | 3(3-0) |
| AN-711 | Equine Nutrition | 2(2-0) |
| AN-712 | Pet Nutrition | 3(3-0) |
| AN-713 | Animal Feed Milling Industry | 3(2-2) |
| AN-719 | Special Problem | 1(1-0) |
| AN-720 | Seminar | 1(1-0) |
| AN-799 | Thesis | 6(0-12) |

## DETAIL OF COURSES

### AN-701 PHYSIOLOGY AND BIOCHEMISTRY OF NUTRITION 3(3-0)

**Theory**

Chemistry of essential nutrients and their functions. Digestive physiology of ruminants and non-ruminants. Digestion and absorption of carbohydrates, proteins, lipids, minerals and vitamins in gastro-intestinal tract. Metabolism of carbohydrates, lipids, proteins, water, minerals and vitamins. Hormonal regulation of feed intake, digestion, absorption and metabolism. Intermediary metabolism of carbohydrates, lipids and proteins. Nutrients need, calorimetry and basal metabolism.

**Books Recommended**


1. Wu, G. 2021. Principles of Animal Nutrition. Taylor & Francis, UK
2. Murray. R., V. Rodwell, D. Bender, K. M. Botham, P. A. Weil and P. J. Kennelly. 2018. Harper's Illustrated Biochemistry. 31st Edition. McGraw-Hill Medical, USA.
3. Guyton, A.C. and J. E. Hall. 2010. Text book of Medical Physiology. 12th Edition. W.S. Saunders Co., Philadelphia, USA.
4. Martin, D.W., P.A. Mayes and V.M. Rodwell, 2006. Harper's Review of Biochemistry. Lange Medical Publication, Maruzen, Asia, Singapore.
5. Sarwar, M., and S.A. Chaudhry. 2000. The Rumen: Digestive Physiology and Feeding Management. University of Agriculture Press, Faisalabad.


### AN-702 FEEDS AND FEEDING 3(2-2)

**Theory**

Feed resources of Pakistan; their availability, dynamics and characteristics. Nutritional value of feed stuffs and factors affecting nutritional quality of feeds. Feed supplementation during different physiological phases of animal. Role of fiber and functional feeds in animal nutrition. Specialty feeding (by pass nutrients) for high yielders. Factors affecting voluntary feed intake. Feeding standards and their application. Toxicants and anti-nutritional factors in feeds and techniques for their detoxification. Livestock nutrition and environment interaction. Mitigation of rumen methanogenesis, Livestock nutrition and feed safety

**Practicals**

Least cost feed formulation by using computer softwares. Feed evaluation. Treatment of roughages. In vivo, in vitro and in sacco techniques. Preparation of hay and silages. Visit to feed mills, livestock farms and fodder production institutes.

**Books Recommended**


1. Wu, A. 2019. Food Safety and Mycotoxins. Springer, NY, USA.
2. Yucel, B and Taşkın, T. 2018. Animal Husbandry and Nutrition. IntechOpen, UK.
3. Jurgens, M. H., K. Bregendahl, J. Coverdale and S. L. Hansen. 2012. Animal Feeding and Nutrition. 11th edition. Kendall Hunt Publishing, Dubuque, Iowa.
4. McDonald, P., R.A. Edwards, J.F.D. Greenhalgh and C.A. Morgan. 2010. Animal Nutrition. Low Price Ed. Pearson Education Asia, Singapore.
5. Perry, T.W., A.E. Cullision and R.S. Lowery. 2008. Feeds and Feeding.6th Edition. Prentice Hall, New Jersey, USA.

**AN-703 ENERGY METABOLISM 3(3-2)**

**Theory**

Energy metabolism in relation to nutrition. Energy production in the body. Intermediary metabolism of carbohydrates, lipids and proteins. Energy production in ruminants. Feed energy and its partitioning. Calorigenic effect and composition of ration. Energy systems for livestock. Fasting energy metabolism and basal metabolism. Factors affecting BMR. Energy needs for maintenance, growth, reproduction, production and work. Metabolic disorders related to disturbed energy metabolism.

**Practicals**

Measurement of feed energy; bomb calorimetry and animal calorimetry. Determination of True Metabolizable Energy of feed in poultry birds. Measurements of energy needs through feeding trials.

**Books Recommended**


1. Peiretti, P.G. 2020. In Vitro Digestibility in Animal Nutritional Studies. MDPI Books Publishing, Basel, Switzerland.
2. Chizzotti, M,L. 2019. Energy and protein metabolism and nutrition. Wageningen Academic Publishers, Netherlands.
3. McDonald, P., R.A. Edwards, J.F.D. Greenhalgh and C.A. Morgan. 2010. Animal Nutrition. Low Price Ed. Pearson Education Asia, Singapore.
4. Jan Dijkstra, J., and J. M. Forbes. 2005. Quantitative Aspects of Ruminant Digestion and Metabolism. 2nd Ed. CAB International North America.
5. NRC. 2001. Nutrient Requirements of Dairy Cattle. 7th Revised Edition. National Academy Press, Washington, USA.


**AN-704 PROTEIN METABOLISM 3(2-2)**

**Theory**

Protein sources, classification, digestion and absorption. Biosynthesis and major pathways of protein metabolism. Protein systems for livestock. Techniques for estimation of protein requirements. Protein and amino acid requirements for growth, production, reproduction and work. Protein and immunity. Protein energy relationships. Protein quality. Rumen bypass proteins and methods of protection of proteins from rumen degradation. Concept of Amino Acid supplementation. Balancing NPN and true protein ratio in livestock ration. Ammonia/urea toxicity in animals. Managing nitrogen emission from animal waste.

**Practicals**

Nitrogen balance experiments. Analysis of NPN and true protein of feeds. In vitro pepsin solubility measurement. Determination of in vivo amino acid digestibility.

**Books Recommended**


1. Chizzotti, M,L. 2019. Energy and Protein Metabolism and Nutrition. Wageningen Academic Publishers, Netherlands.
2. Veerakumari, L. Biochemistry. 2019. MJP Publishers.
3. CSIRO. 2007. The Nutritional Requirements of Domesticated Ruminant. Australian Commonwealth Scientific and Research Organization. CSIRO Publishing, Australia.

4. James, J.D., and J.M. Forbes. 2005. Quantitative Aspects of Ruminant Digestion and Metabolism. 2nd Edition. CAB International North America.
5. D'Mello, J.P.F. 2003. Amino Acid in Animal Nutrition. CAB International North America.

**AN-705 MINERAL NUTRITION 3(2-2)**

**Theory**

Essential minerals and their classification, chemistry, functions, metabolism and inte-relationship. Mineral imbalances and deficiency symptoms. Minerals locations in the body. Problems of mineral nutrition in animals. Role of minerals in animal growth, health, production and reproduction. Animal requirements, sources, geographical distribution, deficiency and excess of minerals in Pakistan. Environmental issues and mineral supplementation strategies.

**Practicals**

Analysis and estimation of minerals in feed samples. Diagnosis of mineral disorders in farm animals. Formulation and preparation of mineral mixtures and licks.

**Books Recommended**

1. Suttle, N.F. 2021. Mineral Nutrition of Livestock. CABI International.
2. Hynd, P.L. 2019. Animal Nutrition: From Theory to Practice. CABI, Boston, Massachusetts.
3. McDonald, P., R.A. Edwards, J.F.D. Greenhalgh and C.A. Morgan. 2010. Animal Nutrition. Low Price Ed. Pearson Education Asia, Singapore.
4. Suttle, N. and E. J. Underwood. 2007. Mineral Nutrition of farm Livestock. CABI, NY, USA.
5. Taylor-Pickard, J.A. and L.A. Tucker. 2005. Re-defining Mineral Nutrition. Nottingham University Press. Nottingham, UK.

**AN-706 VITAMIN NUTRITION 3(2-2)**

**Theory**

History and development of the vitamin concepts and classification. Fat Soluble Vitamins: vitamin A. D. E and K, chemistry, metabolism, functions, deficiency, bioassay, interactions with other nutrients, sources and toxicity. Water Soluble Vitamins; vitamin B-Complex and vitamin-C, chemistry, functions metabolism, deficiency, sources and interrelationships with other vitamins and nutrients. Stability of vitamins under different storage conditions.

**Practicals**

Techniques for the determination of vitamins. Experimental procedure for inducing and correcting vitamins deficiency in birds. Vitamin composition of feeds. Preparation of vitamin supplements.

**Books Recommended**

1. Mahmoudi, M. and Rezaei, N. 2019. Nutrition and Immunity. Springer, NY, USA.
2. P. L. Hynd. 2019. Animal Nutrition: From Theory to Practice. CABI, Boston, Massachusetts.
3. McDonald, P., R.A. Edwards, J.F.D. Greenhalgh and C.A. Morgan. 2010. Animal Nutrition. Low Price Ed. Pearson Education Asia, Singapore.
4. Zempleni, A., and R. B. Rucker. 2007. Handbook of Vitamins. 4th Edition. CRC Press, USA.
5. McDowell, L.R. 2000. Vitamins in Animal and Human Nutrition, 2nd Edition, Iowa State University Press, Ames.USA.

**AN-707 ANALYTICAL TECHNIQUES IN ANIMAL NUTRITION 3 (0-6)**

**Practicals**

Sampling of feeds for chemical analysis; preparation, grinding, labeling and preservation. Maintenance of laboratory equipments and setting up nutritional laboratory. Preparation of buffers and determination of pH. Determination of dry matter by different methods Proximate analysis of feed. Van Soest analysis offeed. . Macro and micro mineral analyses. Determination of fatty acid profile of feeds. Determination of anti-nutritional components in feed stuffs. Determination of nitrites and nitrates in forages. Screening of feeds for mycotoxin. Chemical analysis of blood, urine and milk.

**Books Recommended**


1. Prabhu T. M. 2020. Analytical Techniques In Animal Nutrition Research. New India Publishing Agency- Nipa.
2. Toldra, F. 2019. Advances in Food and Nutrition Research. Elsevier Science & Technology, USA.
3. AOAC. 2019 Official Methods of Analysis of the Association of Official Analytical Chemists, 21st Edition. Arlington Virginia, USA.
4. FAO. 2004. Assessing Quality and Safety of Animal Feeds. http://www.fao.org/docrep/007/y5159e/y5159e00.htm#Contents. FAO. Rome.
5. Undersander, D., D. R. Mertens, and N. Thiex. 2003. Forage Analysis Procedures, National Forage Testing Association. Omaha, NE, USA.


**AN-708 RESEARCH METHODS IN ANIMAL NUTRITION 3(2-2)**

**Theory**

Planning, designing, execution, evaluation and economic appraisal of nutritional experiments. Feeding experiments with small and large ruminants and poultry. Digestibility trials with total collection and indicator methods. Balance trials: nitrogen balance, mineral balance and energy balance. In vitro techniques for feed evaluation., In sacco technique for dry matter, fibre and protein degradability. Bio-assays in poultry feeding. Techniques involved in gut health monitoring.

**Practicals**

Measurements of in vivo and in vitro digestibility, rumen volume and digesta flow rate. Sampling and analysis of rumen contents for rumen metabolites, bacterial and protozoal biomass. Statistical analysis of experimental data by using different software's.

**Books Recommended**


1. Toldra, F. 2019. Advances in Food and Nutrition Research. Elsevier Science & Technology, USA.
2. Bedford, M.R., M. Choct and H. V.Neill. 2016. Nutrition Experiments in Pigs and Poultry: A Practical Guide. CAB Intl. NY. USA.
3. Dryden, G. 2008. Animal Nutrition Science. CAB International, USA.
4. Kaps, M. and W.R. Lamberson. 2004. Biostatistics for Animal Science. CAB Intl. NY. USA.
5. Zar, J. H. 2009. Biostatistical Analysis. 5th Edition. Prentice Hall, USA.
6. Kothari, C. R. 2008. Research Methodology: Methods and Techniques. New Age International, New Delhi, India.


**AN-709 AVIAN NUTRITION 3(2-2)**

**Theory**

Importance of quality and quantity of various nutrients in poultry rations. Feed and host interaction; Abnormalities due to malnutrition. Nutrient allowances and feeding standards. Effect of protein-energy and Ca-P ratios on growth and egg production. Role of added levels of vitamins, minerals and their effect on growth and egg production. Concept of computation of poultry rations. Amino acid requirements and correcting the deficiencies on the basis of digestible amino acids in poultry rations. Formulation of suitable vitamin and mineral supplements. Effect of feed on the chemical composition of eggs. Use of feed additives for the improvement of growth and egg production. Anti-nutritional factors in feed ingredients.

**Practicals**

Techniques for the evaluation of intestinal health. Formulation of balanced rations for all classes of birds. Computerized feed formulation. Metabolic trials on birds. Preparation of mineral and vitamin premixes. Evaluation of feed quality. Chemical analysis of egg and meat. Visits to poultry feed mills and allied industries.

**Books Recommended**


1. Leeson, S. and Summers, J.D. 2019. Scott's Nutrition of the Chicken. International Book Distributing Company, India.
2. Gupta, R.C., A. Srivastava and R. Lall Nutraceuticals in Veterinary Medicine. 2019. Springer, NY, USA.
3. Paneri, P.F., E. Christaki and I. Giannenas. 2019. Feed additives: aromatic plants and herbs in animal nutrition and health. San Diego : Elsevier Science & Technology, USA.
4. Lee, A. R. 2008. Poultry Feeds and Feeding. Kosta Press, UK.
5. Pesti, G.M., R. I. Bakalli, J. P. Driver, A. Atencio and E. H. Foster. 2005. Poultry Nutrition and Feeding. Trafford publishing, Trafford 1663 Liberty Drive, Bloomington, IN 47403. UK.
6. Lesson, S. and J.D. Summers. 2008. Commercial Poultry Nutrition. 3rd Edition. University Book, P.O. Box 1326, Guleph, Ontario, Canada.


**AN-710 RUMINANT NUTRITION 3(3-0)**

**Theory**

Principles of feeding ruminant livestock at different physiological stages. Development of rumen and feeding of pre-ruminant calves. Classification and function of rumen micro-organisms. Microbial growth and nutrition. Energetic efficiency, nitrogen and energy transaction and rumen digesta kinetics. Manipulation of rumen ecosystem through dietary, chemical and biotechnological approaches. Fibre fraction, composition, fermentation and its utilization by ruminants. Homeostasis and Homeorhesis. Metabolic problems and dysfunctions. Nutrient supply and meeting requirements for growth, production and reproduction. Digestion in the rumen. Microbial protein synthesis. Energy metabolism and utilization of carbohydrates and fats. Vitamins and minerals needs of ruminants. Feeding problems, nutritional disorders and deficiencies. Manipulation of rumen fermentation. Mitigation of rumen methanogenesis.

**Books Recommended**


1. Chizzotti, M. L. 2019. Energy and Protein Metabolism and Nutrition. Wageningen Academic Publishers, Netherlands.
2. Yucel, B and Taşkın, T. 2018. Animal Husbandry and Nutrition. IntechOpen, UK.
3. NRC , 2001. Nutrient Requirements of Dairy Cattle. 7th Revised Edition. National Academy Press, Washington, USA.

4. McDonald, P., R. A. Edwards, J.F.D. Greenhalgh and C.A. Morgan. 2010. Animal Nutrition. Low Price Ed. Pearson Education Asia, Singapore.
5. Jan Dijkstra, J., and J. M. Forbes. 2005. Quantitative Aspects of Ruminant Digestion and Metabolism. 2nd Ed. CAB International, NY, USA.

**AN-711 EQUINE NUTRITION 2(2-0)**

**Theory**

Economic importance of feed for equines. Importance of primary nutrients. Forages, concentrates, protein supplements and special feeds for horses. Feed preparation and feed allowances. Rations for pleasure, training and race horses. Feeding brood mares, stallions, foals, weanling, yearling, adult horses and mules. Equine feeding systems. Nutritional disorders and their control.

**Books Recommended**

1. Saastamoinen, M. 2020. Horse Feeding and Management. MDPI Books Publishing, Basel, Switzerland..
2. Preston, L. 2016. The Ultimate Guide to Horse Feed, Supplements, and Nutrition. Skyhorse Publishing, USA.
3. Frape, D. 2010. *Equine Nutrition and Feeding, 4th Ed.* John Wiley and Sons. USA.
4. Pagan, J.D. 2008. Advances in Equine Nutrition-III. Nottingham University Press, Nottingham, UK.
5. NRC. 2007. Nutrient Requirements of Horses. 6th Revised Ed. National Research Council, National Academy Press, Washington, D.C., USA.

**AN-712 PET NUTRITION 3(3-0)**

**Theory**

Principles of feeding pet animals. Nutritional needs of pet animals at different life stages. Feeding regimes for pet animals throughout life. Common pet food ingredients. Pet food supplements. Types of pet foods. Commercial and homemade pet diets. Pet food labels. Diets for medical conditions. Feeding problems. Nutritionally responsive disorders.

**Books Recommended**

1. de Blas, C andJ. Wisewan. 2020. Nutrition of the Rabbit. CABI. NY, USA.
2. Nunes, C. and V. Kumar. 2018. Enzymes in Human and Animal Nutrition: Principles and Perspectives.
3. Case, L. P. 2005. The Dog: Its Behavior, Nutrition, and Health. 2nd Edition. Wiley-Blackwell, USA.
4. Wortinger, A. 2007. Nutrition for Veterinary Technicians and Nurses. 1st Edition. Wiley-Blackwell, USA.
5. Linda, P. C., P. C. Daniel, A. H. Diane and D. Leighann. 2006. Canine & Feline Nutrition: A Resource for Companion Animal Professionals. 4th Edition. John Wiley and Sons. USA.

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**AN-713 ANIMAL FEED MILLING INDUSTRY 3(2-2)**

**Theory**

Present status and problems of feed industry in Pakistan. Conducting feasibility study for establishing a feed mill. Layout plan and designing of animal feed mill unit. Installation of animal feed mill unit. Operational mechanism and management of animal feed mills. Procurement and storage of feed ingredients. Formulation of different feeds. Importance and composition of micromixes and additives in animal feed. Manufacturing of animal feeds. Selecting, cleaning, grinding, mixing and storing of feed ingredients. Nutrient losses and other changes during storage. Effect of processing on feed, significance and choice of processing methods. Quality control in feed milling industry. Feed laws. Marketing techniques.

**Practicals**

Feed raw material storage and handling. Storage structure designing and management. Feed processing methods, pelleting, extrusion, and chemical treatment. Preparation of micromixes. Mixing of feeds. Analysis of finished feed products. Visit to local markets and feed mills.

**Books Recommended**


1. Paneri, P.F., E. Christaki and I. Giannenas. 2019. Feed Additives: Aromatic Plants and Herbs in Animal Nutrition and Health. San Diego : Elsevier Science & Technology, USA.
2. Gremmels, J.F. 2012. Animal Feed Contamination. Woodhead Publishing Limited.
3. Changchui H. E. 2002. Protein Sources for the Animal Feed Industry. Food and Agriculture Organization of the United Nations, Rome, Italy.
4. McEllihiney, R.R. 2005. Feed Manufacturing Technology V. American Feed Industry Association, Inc. Arlington, USA.
5. Turret, R. A. I. 2003. Grain & Feed Milling Technology. Cornell University Press, USA.


**AN-719 SPECIAL PROBLEM 1(1-0)**

A study of problem(s) of special concern will be assigned to the student in Animal Nutrition.

**AN-720 SEMINAR 1(1-0)**

**AN-799 Thesis 6(0-12)**