

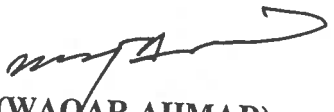


UNIVERSITY OF SARGODHA
OFFICE OF THE REGISTRAR
(ACAD BRANCH)

NOTIFICATION

On the recommendations of Academic Council made in its 21st (2/2024) meeting held on 07.06.2024, the Syndicate in its 67th (3/2024) meeting held on 12.07.2024 approved the revised curricula of the following programs for implementation w.e.f. Fall 2024:

- | | |
|-------------------------------------|-----------|
| I. M.Sc (Hons.) in Animal Nutrition | Annex-'A' |
| II. M.Phil in Animal Sciences | Annex-'B' |
| III. Ph.D in Animal Sciences | Annex-'C' |


(WAQAR AHMAD)
Additional Registrar (General)
Dated: 31.01.2025

No. SU/Acad/25/ 119

Distribution:

- Chairman, Department of Animal Sciences
- Controller of Examinations
- Director Academics

C.C:

- Dean, Faculty of Agriculture
- Principal, College of Agriculture
- Director QEC
- Secretary to the Vice-Chancellor
- PA to Registrar
- Notification File

Scheme of Studies for the Degree of
M.Sc. Honors in Animal Nutrition



Implementation w.e.f. Fall Semester, 2024

DEPARTMENT OF ANIMAL SCIENCES
COLLEGE OF AGRICULTURE
UNIVERSITY OF SARGODHA
2024

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Chairman
Department of Animal Sciences
College of Agriculture
University of Sargodha

Handwritten signature: *Verifed Naor*
Date: 24-01-2025

Nomenclature of the Program:

M.Sc. (Hons.) Animal Nutrition

1. Department Brief:

Department of Animal Sciences is committed to improve the productivity and profitability of livestock and poultry production through quality education in different areas of animal science and basic, applied and adaptive research since its establishment in 2012. Currently, department of Animal Sciences is offering B.Sc. (Honors) Animal sciences and M.Sc. (Honors) Animal Nutrition. In upcoming semester department is going to offer M.Phil. and Ph.D. Animal Sciences (specialization in Animal Nutrition; Microbiology). The department has one undergraduate, one postgraduate and one animal diagnostic laboratory. The department has the poultry research facilities to conduct animal trials for research. University Veterinary Hospital was established under the umbrella of Department of Animal Sciences in 2010 to provide animal health facilities to local community.

2. Program Learning Objectives:

The Program Learning Objectives for a M.Sc. (Hons.) Animal Nutrition encompasses a comprehensive set of goals designed to equip students with the knowledge, skills, and competencies necessary for success in the field. By the end of this program, students are expected to demonstrate a profound understanding of Animal Nutrition principles, including nutritional research methods/techniques, conventional and nonconventional feed resources available in Pakistan specifically and in general globally.

1. To empower graduates of M.Sc. (Hons.) Animal Nutrition to learn and apply techniques and principles and procedures to resolve the issues of local livestock and poultry farmers in Pakistan and worldwide.
2. Enabling graduates to raise productivity and profitability of the farming community enabling the country to raise living standards of rural masses
3. To enable the graduates to step into research and development (R&D) effectively through best teaching methodology and lab standards as well as promoting effective Research and Development activities in the sector of animal nutrition in line with advances in the international as well as sister institutions
4. Graduates will have hands on training in their specialized field of animal nutrition through research.
5. Enable students to work in a team and to achieve a goal.
6. Encourage students to speak out their thoughts fluently and confidently
7. To pursue higher studies in any international university of high repute



3. **Program Structure:**

| | | | |
|--|--|-------|--|
| Duration | Minimum 1.5-Years (3-Semesters), Maximum 4-Years (8-Semesters) | | |
| Entry Requirements: | Candidates having Bachelor of Science (Hons.) degree in Animal Sciences, Animal Nutrition, Poultry Science, DVM, Dairy Science, Animal Breeding and Genetics and Livestock Manager field from HEC recognized Institutions with minimum CGPA 2.0/4.0 in B.Sc. (Hons.) or BS degree (16 years of education) in semester system | | |
| Intra-disciplinary fields allowed for admission | Not Applicable | | |
| Degree Completion Requirements: | Total Credit Hours of Course Work: | 26-30 | |
| | Total Credit Hours of Thesis/Courses In Lieu of thesis: | 06 | |
| | Total Credit Hours of Program: | 32-36 | |
| Program Mode (select one) | I. Thesis Track | | |
| Specialization (if any) | Not Applicable | | |

4. **List of Deficiency Courses of Level-6: (for intra-disciplinary admissions only)**

| Sr. No. | Course Code | Course Title | Credit Hours | Prerequisite |
|---------|-------------|--------------|--------------|--------------|
| 1. | Nil | Nil | Nil | Nil |

5. List of Mandatory/Compulsory/Core Courses:

| Sr. No. | Course Code | Course Title | Credit Hours | Prerequisite |
|---------|-------------|--|--------------|--------------|
| 1. | ANNU-7101 | Physiological and Biochemical Basis of Nutrition | 3(3-0) | Nil |
| 2. | ANNU-7105 | Analytical Techniques in Nutrition | 4(0-4) | Nil |
| 3. | ANNU-7106 | Research Methods in Nutrition | 3(2-1) | Nil |
| 4. | ANNU-7119 | Special Problem | 1(1-0) | Nil |
| 5. | ANNU-7120 | Seminar | 1(1-0) | Nil |
| 6. | STAT-7153 | Statistical Methods for Animal Sciences Research-I | 3(3-0) | Nil |

6. List of Elective Courses:

| Sr. No. | Course Code | Course Title | Credit Hours | Prerequisite |
|---------|-------------|---|--------------|--------------|
| 1. | ANNU-7102 | Feed Resources and their Nutritive Value | 3(2-1) | Nil |
| 2. | ANNU-7103 | Vitamins in Nutrition | 3(3-0) | Nil |
| 3. | ANNU-7104 | Minerals Nutrition | 3(2-1) | Nil |
| 4. | ANNU-7107 | Protein Metabolism | 3(3-0) | Nil |
| 5. | ANNU-7108 | Energy Metabolism | 3(3-0) | Nil |
| 6. | ANNU-7109 | Lipids in Nutrition | 3(3-0) | Nil |
| 7. | ANNU-7110 | Advanced Analytical Techniques in Nutrition | 3(0-3) | Nil |
| 8. | ANNU-7111 | Poultry Feeds and Nutrition | 4(3-1) | Nil |
| 9. | ANNU-7112 | Ruminant Nutrition | 4(3-1) | Nil |
| 10. | ANNU-7113 | Feed Ingredient Storage and Processing | 2(2-0) | Nil |
| 11. | ANNU-7114 | Advanced Animal Feed Industry | 3(2-1) | Nil |
| 12. | ANNU-7115 | Molecular Nutrition and Nutrigenomics | 2(2-0) | Nil |
| 13. | ANNU-7116 | Metabolic Disorders | 2(2-0) | Nil |
| 14. | ANNU-7117 | Recent Advances in Nutrition | 2(2-0) | Nil |
| 15. | ANNU-7118 | Toxin and Antinutritional Factors in Feedstuffs | 3(2-1) | Nil |
| 16. | ANNU-7121 | Nutrition of Broilers | 3(2-1) | Nil |
| 17. | ANNU-7122 | Nutrition of Layers | 3(2-1) | Nil |
| 18. | ANNU-7123 | Nutrition of Dairy Animals | 3(2-1) | Nil |
| 19. | ANNU-7124 | Nutrition of Beef Animals | 3(2-1) | Nil |
| 20. | ANNU-7125 | Nutrition of Calves | 2(2-0) | Nil |
| 21. | ANNU-7126 | Nutrition of Small Ruminants | 3(2-1) | Nil |
| 22. | ANNU-7127 | Nutrition of Laboratory Animals | 2(1-1) | Nil |
| 23. | ANNU-7128 | Camel and Equine Nutrition | 2(2-0) | Nil |
| 24. | ANNU-7129 | Nutrition of Pet and Zoo Animals | 3(3-0) | Nil |
| 25. | ANNU-7130 | Fish Nutrition | 2(2-0) | Nil |

7. Thesis:

| | | |
|---|--------|----|
| 1 | Thesis | 06 |
|---|--------|----|

Scheme of Studies
M.Sc. (Hons.) Animal Nutrition

Semester-I

| Category | Course Code | Course Title | Credit Hours | Pre-Requisite |
|--------------|-------------|--|-------------------|---------------|
| Compulsory-1 | ANNU-7101 | Physiological and Biochemical Basis of Nutrition | 3(3-0) | Nil |
| Compulsory-2 | STAT-7153 | Statistical Methods for Animal Sciences Research-I | 3(3-0) | Nil |
| Elective-1 | ANNU-71xx | <i>To be selected from the list</i> | 3(x-x)/ 4(x-x) | Nil |
| Elective-2 | ANNU-71xx | <i>To be selected from the list</i> | 3(x-x)/ 4(x-x) | Nil |

Total Credit Hours: 12-14 *عربي 2*

Semester-II

| Category | Course Code | Course Title | Credit Hours | Pre-Requisite |
|--------------|-------------|-------------------------------------|-------------------|---------------|
| Compulsory-3 | ANNU-7105 | Analytical Techniques in Nutrition | 4(0-4) | Nil |
| Compulsory-4 | ANNU-7106 | Research Methods in Nutrition | 3(2-1) | Nil |
| Elective-3 | ANNU-71xx | <i>To be selected from the list</i> | 2(x-x)/ 3(x-x) | Nil |
| Elective-4 | ANNU-71xx | <i>To be selected from the list</i> | 3(x-x)/ 4(x-x) | Nil |

Total Credit Hours: 12-14

Semester-III

| Category | Course Code | Course Title | Credit Hours | Pre-Requisite |
|--------------|-------------|-----------------|--------------|---------------|
| Compulsory-5 | ANNU-7119 | Special Problem | 1(1-0) | Nil |
| Compulsory-6 | ANNU-7120 | Seminar | 1(1-0) | Nil |

Total Credit Hours: 2

Semester-IV

| Category | Course Code | Course Title | Credit Hours | Pre-Requisite |
|----------|-------------|--------------|--------------|-----------------------|
| | | Thesis | 06 | Coursework Completion |

Program Summary:

| Category | Minimum No. of Courses | Minimum No. of Credit Hours |
|-------------------------------------|-------------------------------|------------------------------------|
| Compulsory Courses | 06 | 15 |
| Elective Courses | 04 | 11 |
| Thesis or Courses in Lieu of Thesis | 01 | 06 |

Note:

1. The Regulations related to MS/M.Phil. /M.Sc. (Hons.) or equivalent approved by the Syndicate from time to time shall also be applicable.
2. Number and nature of Deficiency Courses are to be decided by Graduate Program Committee in start of each session
3. Department can change the order of Core/Compulsory and Elective Courses as per availability of resources or demand.
4. Department can change the course offering as per available resources but shall be uniform for one session.

COURSE CONTENTS
M.Sc. (Hons.) Animal Nutrition
(List of Deficiency Courses)

ANSC-5102

Fundamentals of Animal Nutrition

2(1-1)

This course tells about types, availability pattern and characteristics of feed resources of Pakistan. It also critically studies nutrient composition, utilization and significance of different feed stuffs used locally for feed manufacturing of livestock commercial poultry. This course gives an idea about effects of different feedstuffs on animal performance as well as use of non-conventional feed resources in animals. The main focus will be on the elementary principles of farm animal nutrition, including anatomy, nutritional digestion, absorption, metabolism, and a general overview of the nutrients necessary for animal growth and development. By the course's end, students will understand how an animal's digestive system and nutritional requirements influence the ingredients and makeup of feed. After taking this course, students will be able to know that what to feed to animals and what feeding strategies should be used to economically fulfill the nutrient requirements of animals in commercial and semi-intensive system of livestock production.

Contents

Theory

1. Feed resources, their classification and utilization
2. physical characteristics of common feeds
3. anti-nutritional factors in feed ingredients
4. voluntary feed intake; factors affecting nutrient intake in livestock and poultry
5. Water: its importance, factors affecting water needs in animal body; and effects of deprivation
6. Nutrition in relation to body maintenance; growth and production

Practical


1. Proximate analysis of feeds and feed ingredients:
2. Feed ingredients and feed storage practices under farm conditions
3. Introduction to different components of feed mills; conservation of forage

Recommended Texts

1. Pond, W.G. & Church, D.C. (2005). *Basic Animal Nutrition and Feeding*. India: Wiley
2. M.F Fuller (2004). *The encyclopedia of animal nutrition*: CABI Pub

Suggested Books

1. McDonald, P., Edwards, R.A., Greenhalgh, J.F.D. & Morgan, C.A. (2002) . *Animal Nutrition*. UK.: Longman scientific and technical publisher.
2. Singh, P.K. (2014). *Forage Conservation Techniques*. India: NIPA.
3. Cheeke, P.R. (2004). *Applied Animal Nutrition, Feeds and Feeding*. Canada: Delmar Publisher.



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This is the course of under graduate level about animal nutrition. This course provides the student with the scientific principles of animal nutrition and feeding, furthering knowledge of the chemical composition and physical properties of feeds, digestion processes, nutrient metabolism, feed evaluation systems, nutrient requirements, and intake control and estimation mechanisms. It includes a series of practical activities to analyze feeds and make a nutritional evaluation as well as to estimate intake and nutrient requirements. The aim of the course is to acquaint students with basic concepts of nutrition and animal nutrition. This course focuses mainly on the chemical basis of nutrition and biochemical and physiological processes that are involved in nourishment of body. It elaborates how food and its components are utilized and why nutrients are essential for life. This course tells about functions of essential nutrients like proteins, fat, carbohydrates, vitamins and minerals. It also studies details of inter-conversion of nutrients and hormonal regulation of different biochemical processes. After taking this course students will be able to deeply understand basal body metabolism which is required for life and ways to estimate nutrient requirements.

Contents

Theory

1. Importance of nutrition in livestock and poultry production
2. history, scope and development of science of nutrition
3. basic concepts in animal nutrition
4. classification of nutrients and their functions
5. soil plant animal relationship
6. digestive systems
7. digestion and absorption of nutrients in different classes of livestock and poultry
8. flow of nutrients in animal body

Practical

1. Identification of feed ingredients through visual and microscopic methods;
2. Parts of digestive system in ruminant and monogastric animals;
3. Collection of feed ingredients samples and their preparation

Recommended Texts

1. McDonald, P., Edwards, R.A., Greenhalgh, J.F.D. & Morgan, C.A. (2002). *Animal Nutrition*. UK: Longman scientific and technical publisher.
2. Pond, W.G. & Church, D.C. 2005. *Basic Animal Nutrition and Feeding*. India.: Wiley.

Suggested books

1. Khan, M.L. (2001). *Poultry Feeds and Nutrition*. Urdu Bazar, Lahore.: Kitabistan Pub. Co.
2. Cheeke, P.R. (2004). *Applied Animal Nutrition, Feeds and Feeding*. Canada: Delmar Publisher.

This under-graduate level course critically focuses on nutrition of poultry birds to get optimum performance. It also critically focuses on production problems related to poultry feeding and feeding standards of the poultry birds. It is aimed at production problems related to poultry nutrition and feeding standards of the poultry birds. This course gives the knowledge about different poultry feeding methods and nutrient requirements of poultry birds and breeder raised for day old broiler chick production. It also explicitly tells about feedstuffs available for formulation and preparation of commercial feeds for poultry birds along with measures to improve quality of feed and standard storage practices. This course also tells about feed additives and their mixing in poultry feed. After taking this course students will be able to understand methods of feeding of poultry and manufacturing commercial poultry feed. After taking this course students will improve about poultry nutrition and will be able to formulate rations for different classes of poultry.

Contents

Theory

1. Sources and classification of nutrients and their functions
2. digestion and absorption of nutrients
3. metabolism of water, carbohydrates, protein and fats
4. hormonal control of metabolism
5. feed additives: antibiotics, coccidiostats, antioxidants, probiotics and prebiotics enzymes, toxin binders, flavoring agents, anti-nutritional factors in feed ingredients
6. diet specifications for different poultry birds
7. amino acids and energy ratio in poultry rations
8. nutrient requirements of commercial layers, broilers, breeders, quails, ducks and turkeys.

Practical

1. Composition of feedstuffs used in poultry rations;
2. Characteristics of poultry rations;
3. Formulation of rations for broilers, layers and breeders, quails, ducks, and turkeys; Introduction to computer ration formulation.
4. Economics of poultry rations; Visits to feed mills and poultry farms.

Recommended Texts

1. Lesson, S. & Summers, J.D. (2009). *Commercial Poultry Nutrition* (3rd ed.). Canada:University Book.
2. NRC. (1994). *Nutrient Requirements of Poultry*. USA: National Academy of Sciences.

Suggested Books

1. Sing, R. A. (2004). *Poultry Production*. New Delhi, Ludhiana: Kilyani Publishers.
2. Dagher, N. J. (1995). *Poultry Production in Hot Climates*. UK: CAB International.

This course focuses on protein which is a primary nutrient in nutrition of the animals. It elaborates metabolic and biochemical pathways regarding nutrient utilization. The pathways of metabolism rely upon nutrients that they breakdown in order to produce energy. This energy in turn is required by the body to synthesize new proteins, nucleic acids (DNA, RNA) etc. The most important metabolic pathways are: glycolysis - glucose oxidation in order to obtain ATP. Citric acid cycle (Krebs' cycle) - acetyl-CoA oxidation in order to obtain GTP and valuable intermediates. oxidative phosphorylation - disposal of the electrons released by glycolysis and citric acid cycle. This course gives details about chemical nature and functioning of nutrients. This course also studies non-conventional feed sources and digestion and metabolism of nutrients in body. After taking this course students will be able to understand the nutrition of nutrients, requirements, estimation of quality of dietary nutrients.

Contents

Theory

1. Metabolic functions of water.
2. Metabolism of carbohydrates: classification, digestion, absorption and utilization in monogastric and ruminant animals; glycolysis, lactic acid and volatile fatty acid fermentation, citric acid cycle, pentose phosphate pathway, gluconeogenesis, glycogenesis and glycogenolysis.
3. Metabolism of Lipids: classification, digestion, absorption and utilization in monogastric and ruminant animals; beta oxidation of fatty acids, fate of glycerol with respect of fat synthesis, glucose/glycogen synthesis and its oxidation, storage of fat, catabolism of fat and ketosis.
4. Metabolism of proteins: classification, digestion, absorption and utilization in monogastric and ruminant animals;
5. essential and non-essential amino acids, protein quality, ideal protein, fate of absorbed amino acids, transamination, deamination, decarboxylation and interconversion of amino acids;
6. Utilization of non-protein nitrogenous compounds in ruminants.

Recommended Texts

1. Leeson, S & Summers D. J. (2008). *Commercial Poultry Nutrition*. Nottingham, England: Nottingham University Press.
2. McDonald, P., Edwards, R.A., Greenhalgh, J.F.D. & Morgan, C.A. (2002). *Animal Nutrition*. UK: Longman scientific and technical publisher.

Suggested Books

1. Moren, L. A. (1994). *Biochemistry*. USA: Neil Peterson Publishers, Prentice Hall Inc.
2. Sarwar, M. & Zia-ul-Hasan.(2000). *Nutrient Metabolism in Ruminants*. Faisalabad.: University of Agriculture Press.
3. Lehninger A. L., Nelson, D.L. & Cox, M.M. (2004). *Principles of Biochemistry* (4thed.). NY, USA: Worth Publishing.

Vitamins and minerals are two of the main types of nutrients that your body needs to survive and stay healthy. Vitamins are organic substances (made by plants or animals) help your body grow and work the way it should whereas minerals are inorganic elements that come from the soil and water and are absorbed by plants or eaten by animals. Minerals are those elements that our bodies need to develop and function normally. Those essential for health include calcium, phosphorus, potassium, sodium, chloride, magnesium, iron, zinc, iodine, chromium, copper, fluoride, molybdenum, manganese, and selenium. This course tells about significance of minerals and vitamins in animal nutrition. This course studies details of chemical nature of all macro, micro minerals, water soluble and fat soluble vitamins and estimation of their quantity in animal feed. This course critically focuses on essentiality of all minerals and vitamins, their role in metabolism and performance of animals and understanding of effects deficiencies of different minerals on animal health and production. After taking this course students will be able to know about minerals and vitamin nutrition and biochemical and metabolic functions of different micro, macro minerals water and fat soluble vitamins.

Contents

Theory

1. Historical perspective of minerals and vitamins
2. essential mineral elements and their distribution in living body
3. classification and their functions
4. interrelationship and efficiency of calcium, phosphorus, magnesium, sodium, potassium, chlorine, iron, copper, cobalt, manganese, iodine, molybdenum, fluorine, zinc and selenium
5. relationship of minerals with dietary components and mineral toxicity
6. vitamins: classification, chemical structure and functions of vitamin A, D, E, K, C and B-complex
7. deficiencies, hypervitaminosis; interrelationship among vitamins and other nutrients
8. Different sources of minerals and vitamins.

Practical

1. Preparation of feed samples for mineral and vitamin analysis.
2. Demonstration of analytical techniques for mineral and vitamin analyses.

Recommended Texts

1. Steve Blake (2007). *Vitamins and Minerals Demystified*: McGraw Hill LLC
2. McDowell, L.R. (2000). *Vitamins in Animal Nutrition*. London: Academic Press Inc., Harcourt Brace Jovanovich, Publishers.

Suggested Books

1. Sarwar, M. & Zia-ul-Hasan. (2000). *Nutrient Metabolism in Ruminants*. Faisalabad.: University of Agriculture Press.
2. McDonald, P., Edwards, A.R., Greenhalgh, J.F.D. & Morgan, C.A. (2004). *Animal Nutrition* (7th ed.). Singapore: Pearson Education Pvt. Ltd.

This under-graduate level course is aimed at nutrition of farm animals for better performance and health. After taking this course students will be able to understand the basics of nutrient requirement estimation of cattle, buffaloes, sheep, goats, camels and horses for maintenance, growth, production and reproduction. It focuses on production problems related to ruminant nutrition and process of ingestion, digestion and metabolism of different essential nutrients in farm animals. Farm animals require four main groups of nutrients to live, grow, produce and reproduce - water, energy, protein, and minerals and vitamins. The nutrient requirement of each animal varies with difference in age, sex, body weight, physiological status and type of specie. This course gives the knowledge about nutrient requirements of ruminants raised for different purposes. It also explicitly tells about feedstuffs available for farm animals and preparation of commercial feeds for ruminants along with measures to improve quality of feed and utilization of non-conventional feed resources.

Contents

Theory

1. Feeding standards, history, usefulness and limitations
2. nutrient requirements of cattle, buffaloes, sheep, goats, camels and horses for maintenance, growth, production and reproduction
3. measurement of body needs, feeding trials, digestibility and balance trials
4. factors affecting digestibility and balance of nutrients
5. respiratory quotients; partitioning of nutrients in the body
6. factors governing energy, protein, minerals and vitamins needs of farm animals
7. Concepts of rumen bypass nutrients.

Practical

1. Determination of acid detergent fiber (ADF) and neutral detergent fiber (NDF).
2. Determination of nutrient digestibility and nitrogen balance.
3. Determination of energy value of feedstuffs. .

Recommended Texts

1. NRC (2000). *Nutrient Requirement of Beef Cattle*. Washington DC, USA: National Academy Press.
2. NRC (2001). *Nutrient Requirement of Dairy Cattle*. Washington DC, USA: National Academy Press.
3. NRC (1994). *Nutrient Requirement of Poultry*. Washington DC, USA: National Academy Press.

Suggested Books

1. Ensminger, M.E., Oldfield, J.E. & Heinemann, W.W. (1990). *Feeds and Nutrition Digest*. California, USA: The Ensminger Publishing Co.
2. McDonald, P., Edwards, R.A. , Greenhalgh, J.F.D. & Morgan, C.A. (2004). *Animal Nutrition*. U.K: Longman Scientific and Technical Publisher.

This course is aimed at understanding the nutrition of poultry birds to get optimum performance. It also critically focuses on production problems related to poultry feeding and feeding standards of the poultry birds. This course gives the knowledge about different poultry feeding methods and nutrient requirements of poultry birds raised for different purposes. It also explicitly tells about feedstuffs available for poultry and preparation of commercial feeds for poultry along with measures to improve quality of feed and standard storage practices. This also focuses on feeding of poultry birds reared in hot and cold areas. This course also tells about different feeding systems used in commercial poultry farming. This course also focuses on evaluation poultry feed and on farm preparation of balance feed along with feasibility of home feed mixing. This course also tells about feed additives and their mixing in poultry feed. After taking this course students will be able to understand methods of feeding of poultry and manufacturing commercial poultry feed.

Contents

Theory

1. Importance of poultry feeding, principles of poultry feeding
2. Common feedstuffs used in poultry rations
3. Poultry feed formulation
4. Feeding methods and their advantages
5. Forms of feed
6. Feed and water quality in relation to performance of chickens
7. Factors affecting quality of feed
8. Measures to avoid feed toxicity
9. Manual versus automatic feeding systems
10. Feed and water space requirements; Poultry feed additives
11. Storage of poultry feed to maintain quality; Types of poultry diets
12. Poultry feeding strategies during hot and cold climates; Measures to avoid wastage of feed

Practical

1. Different feeding methods
2. Feeding practices; Evaluation of poultry feed by gross examination
3. Storage of commercial feed at farm; Mixing of feed additives in poultry feed
4. Home feed mixing; Economics of home feed mixing
5. Visit to commercial feed mills and environment controlled poultry houses

Recommended Texts

1. P. V. Sreenivasaiah (2006). *Scientific poultry production*: International Book Distributing Company
2. Donald, D. B. and W.D. Weaver, Jr. (2007). *Commercial Chicken Meat and Egg Production*. India: Springer Pvt. Ltd.

Suggested Books

1. Ramsubba, R.V & Bhosale, D.T. (2004). *Handbook of Poultry Nutrition*. Lucknow, India: International Book Distribution Co.
2. Jull, M.A. (2003). *Successful Poultry Management*. Delhi, India: Bio-Tech Books.

This course tells about types, availability pattern and characteristics of feed resources of Pakistan. It also critically studies nutrient composition, utilization and significance of different feed stuffs used locally for feed manufacturing of livestock commercial poultry. This course gives an idea about effects of different feedstuffs on animal performance as well as use of non-conventional feed resources in animals. The main objectives of this course are to (a) Train students in determining the quality of raw feedstuffs and processed animal feeds. (b) Equip students with techniques involved in nutritive quality and feed efficiency estimation/determination. (c) Familiarize students with different processes involved in feed milling. (d) Train students in least cost feed formulation for various classes of livestock and poultry. After taking this course, students will be able to know that what to feed to animals and what feeding strategies should be used to economically fulfill the nutrient requirements of animals in commercial and semi-intensive system of livestock production. They will be able to determine the quality of animal feedstuffs. Students would be able to formulate balance diet and process feeds for different animal species.

Contents

Theory

1. Techniques for estimating nutritive value of feed stuffs and their validity
2. in vivo and laboratory techniques
3. factors affecting the nutritive value of feeds
4. measures of protein quality for monogastric; protein efficiency ratio, gross protein value; the essential amino acid index; protein evaluation systems for ruminants
5. natural toxicants of feeds and detoxification
6. feeding systems for livestock and poultry; raw feed material handling and storage
7. mixing processing and storage of finished; quality control in feed processing
8. forms of feeds and least cost ration formulation for ruminant livestock; equine, pets and poultry
9. Feed laws and regulations

Practical

1. Use of computer for least cost ration formulation for various classes of livestock and poultry; Availability pattern of feedstuffs in local market and their price structure; Manufacturing of wholesome feed
2. Demonstration of feeding trials for estimating feed efficiency; Visit of feed mills.

Recommended Texts

1. Miller. W.J. (2012). *Dairy cattle feeding and nutrition*. Academic Press Inc., NY.
2. Leeson. S. & Summers. J.D. (2008). *Commercial Poultry Nutrition*. Nottingham University Press, England.

Suggested Books

1. Ensminger M.E., Oldfield, J.E. & Heinemann, W.W. (1990). *Feeds and Nutrition Digest*. California, USA: The Ensminger Publishing Co.
2. McEllihiney, R.R. (1994). *Feed Manufacturing Technology IV*. California, USA: American Feed Industry Association, Co.

(List of Mandatory/Compulsory/Core Courses)

ANNU-7101 **Physiological and Biochemical Basis of Nutrition**

3(3-0)

This postgraduate level course focuses mainly on the chemical basis of nutrition and biochemical and physiological processes that are involved in nourishment of body. It elaborates how food and its components are utilized and why nutrients are essential for life. This course tells about functions of essential nutrients like proteins, fat, carbohydrates, vitamins and minerals. It also studies details of inter-conversion of nutrients and hormonal regulation of different biochemical processes. After taking this course students will be able to deeply understand (a) an understanding of the dietary requirements, uptake, transport, metabolism and functions of vitamins and minerals (b) basal body metabolism which is required for life and ways to estimate nutrient requirements. (c) Knowledge of the consequences of vitamin and mineral deficiency and excessive uptake. (d) An understanding of the physiological regulation of food intake and energy metabolism and how various nutritional states (starvation, obesity) affect body composition and energy metabolism.

Contents

Theory

1. Chemistry of essential nutrients and their functions
2. Biochemical and physiological basis of nutritional requirements
3. Digestion and absorption of nutrients in gastro-intestinal tract
4. Metabolism of water, carbohydrates, lipids, proteins, minerals and vitamins
5. Hormonal regulation of metabolism and intermediary metabolism
6. Nutrients need, calorimetry and basal metabolism

Recommended Texts

1. Guyton, A.C. (2007). *Text book of Medical Physiology*. Philadelphia, USA: W.S. Saunders Co.
2. Lehninger A. L., Nelson, D.L. & Cox, M.M.. (2004). *Principles of Biochemistry* (4th ed.). NY: Worth Publishing.

Suggested Books

1. Martin, D.W., Mayes, P.A. & Rodwell, V.M. (1998). *Harper's Review of Biochemistry*. Maruzen, Asia, Singapore: Lange Medical Publication.
2. Robert K.M., Granner, D.K., Mays, P.A. & Rodwell, V.M. (2003). *Harper's Illustrated Biochemistry* (26th Ed.) NY: Lange Medical Publication.
3. Sarwar, M. & Chaudhry, S.A. (2000). *The Rumen: Digestive Physiology and Feeding Management*. Faisalabad: Univ. of Agriculture Press.



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This course is aimed at improving skills of students regarding feed analysis for different nutrient composition. Course focuses on various laboratory analytical techniques used in nutrition, maintenance of laboratory equipment and preparation of different chemical solutions for laboratory procedures. Course also tells about screening of different toxins present in feedstuff. It critically studies estimation of nutrients present in feed which is required to sustain optimum feed quality. After taking this course students will be to prepare and analyze feed and feed ingredient samples for protein, fiber, fat and different essential nutrients. At the end of course students will be cognizant of the potential hazards they face while working in Laboratory. Fires with organic solvents, acid and base burns, and toxic fumes and vapors are common hazards in almost any nutrition laboratory. Generally, lab safety is a matter of common sense, but there are several rules that must be followed. Each student is required to follow Standard Laboratory Procedures.

Contents Theory

1. Sampling of feeds for chemical analysis; preparation, grinding, labeling and preservation
Maintenance of laboratory equipments and setting up a nutritional laboratory
2. Cleaning and washing of glasswares
3. Use of analytical balance
4. Preparation of buffers and determination of pH
5. Determination of dry matter by different methods (heat and toluene)
6. Analysis of neutral detergent fibre (NDF), acid detergent fibre (ADF), lignin and acid insoluble ash/silica
7. Preparation of samples for mineral analysis
8. Determination of anti-nutritional components in feedstuffs
9. Determination of nitrites and nitrates in forages
10. Screening of feeds for mycotoxins
11. Chemical analysis of blood, urine and milk

Recommended Texts

1. AOAC. (2006). *Official Methods of Analysis of the Association of Official Analytical Chemists* (20th ed.) Arlington Virginia 22209.
2. FAO. (1995). *Tropical Animal Feeding*. Rome, Italy: A Manual for Research Workers, FAO.

Suggested Books

1. ILCA. (1993). *Feed Evaluation*. Addisababa, Ethiopia: International Livestock Centre for Africa.
2. Pomerans, & Melon, C. (1994). *Food Analysis; Theory and Practice*. Elsevier Publishers.
3. Van Soest, P.J. (1994) *Nutritional ecology of the ruminant* (2nd ed.) Ithaca: Cornell University Press.



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This post-graduate level course is aimed at improving the research skills of students in field of nutrition. It covers both traditional research methods and new technologies, and focuses on a range of complex topics, including energy compensation, nutrient-gene interactions and metabolic adaptation. It considers statistical issues as well as application of data to policy development. It also provides students with the required scientific basics of nutrition research in the context of a systems and health approach. This course focuses on understanding research problems, exploration of scientific data, preparation of research proposals and plans. This course also tells about techniques used in research which is specific to nutrition and conduct of research. This course also studies the designing of research experiments and collection, statistical analysis and interpretation of research data. After taking this course students will have improved scientific writing skills and will be able to scientifically defend their research projects.

Contents

Theory

1. Concepts of review of scientific literature; Sources for data search and digital library access; Definition of research problem; Types of research problem
2. Development of synopsis; Selection of statistical design
3. Concepts of experimental controls, treatment specifications
4. Type of research animals/birds and their selections and housing management
5. Logistics and costs of research plan
6. Collection, tabulation and interpretation of research data/results
7. Use of computer software for data handling and presentation
8. Scientific report writing and citation

Practical

1. Feeding experiments with small and large ruminants
2. Sampling and analysis of rumen contents for rumen metabolites, bacterial and protozoal biomass
3. Measurements of in vivo and in vitro digestibility, rumen volume and digesta flow rate; Balance trials for nitrogen, mineral and energy
4. In sacco technique for dry matter, fibre and protein degradability; Bio-assays in poultry feeding
5. Statistical analysis of experimental data; Use of computer for data analysis


Recommended Texts

1. FAO. (1995). *Tropical Animal Feeding*. Rome, Italy: A Manual for Research Workers, FAO.
2. Steel, R.G.D. & Torrie, J.H.. (2003). *Principles and Procedures of Statistics*. Tokyo: International Student Edition McGraw Hill Kagakusha, Ltd.

Suggested Books

1. Petrie, A. & Watson, P. (2006). *Statistics for Veterinary and Animal Science*. Ames, USA: Iowa State University Press.
2. Van Soest, P.J. (1994). *Nutritional Ecology of Ruminants*. Ithaca, USA: Comstock Publishing Associates, Cornell University Press.

The special problem is intended to instruct students on proper techniques for scientific research and methodologies. The students are expected to prepare directed assignment and collect information and material related to current research interest. Special problem means an assignment that is expected to be temporary and is designated as a special assignment by the academic supervisor in its sole discretion. The main purpose of special problem is to increase the learning capabilities of students. The more we use our brains, the more they develop. Students learn a lot more when they read or practice something by themselves. Similarly, the purpose of assignments is to increase the practical skills of students. The main objectives of special problem assigned to students are: to enhance the knowledge of a subject, helps to develop writing skills and to enhance time management and organizing skills. It enhances your planning and organizing skills: The special problem make you do your work by prioritizing the needs and time frames. It helps you in completing all your tasks very peacefully instead of creating any panic. Scopes for improvement: Special problem writing work gives students a lot of scopes to improve themselves.



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ANNU-7120

Seminar

1(1-0)

The seminar is intended to instruct students on proper techniques for presentation of scientific material. Each student is expected to prepare and present a scientific seminar and to submit written documentation supporting that seminar. A seminar is a form of academic instruction, either at an academic institution or offered by a commercial or professional organization. It has the function of bringing together small groups for recurring meetings, focusing each time on some particular subject, in which everyone present is requested to participate. Seminars provide a chance to interact with experts from the specific field. Discussing about the relevant topics of the particular subject, students tend to learn about the latest information and new skills related to the concerned subject. Seminars are important and beneficial for those who have difficulty learning in a typical classroom setting where reading and writing are required. There is often a sense of friendship associated with seminar attendance, because everyone is attending with a like interest in learning about a subject important to them. Attending a seminar has numerous benefits, including improving communication skills, gaining expert knowledge, networking with others and renewing motivation and confidence.

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This course designed for MSc (Hons)/MPhil programs of animal sciences. This course provides the applied statistics background for survey and experimental work in Animal Sciences. Case studies and critical examples are used to work through commonly experienced research problems (from sampling designs to the ethical consideration) and to explain how they may be approached, solved or prevented with statistical means. The importance of statistical science in animal sciences research is obvious, where the collection, analysis and interpretation of numerical data are concerned. Statistical principles apply in all areas of experimental work and they have a very important role in animal related experiments. Statistics plays an important role in experimentation. While many scientific problems could be solved by different statistical procedures. Furthermore, some statistical software knowledge will be provided to the students to improve their analytical skills. These activities are further supports the student's research.

Contents

Theory

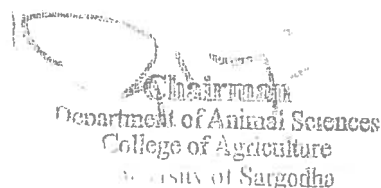
1. Introduction and Importance of Statistics in animal research
2. Hypothesis testing., Type-I error, Type-II error, z test, t-test (single sample, Paired sample and independent sample)
3. Basic principles of experimental design.
4. Layout analysis of CRD, RCBD, Latin Square Designs.
5. Inference after ANOVA.
6. Analysis of Count and Frequency data.
7. Chi-Square Test of Association and Proportion.
8. Correlation Analysis: Simple correlation and multiple correlation.
9. Regression Analysis: Simple and multiple regression.
10. Non-linear regression.
11. Logistic Regression.

Recommended Texts

1. Montgomery, D.C. (2017). *Design and analysis of experiments* (9th ed.). New York: John Wiley & Sons.
2. Rao, G.N. (2007). *Statistics for agricultural sciences* (2nd ed.). India, BS Publication.

Suggested Readings

1. Lawal, B. (2014). *Applied statistical methods in agriculture, health and life sciences*. USA: Springer.
2. Sahu, P.K. (2016). *Applied statistics for agriculture, veterinary, fishery, dairy and allied fields*. USA: Springer.
3. Gbur, E.E., Stroup, W.W., McCarter, K. S., Durham, S., Young, L. J., Christman, M., West, M. & Kramer, M. (2012). *Analysis of generalized linear mixed models in the agricultural and natural resources sciences*. USA: Soil Science Society of America.



(List of Elective Courses)

ANNU-7102 Feed Resources and their Nutritive Value

3(2-1)

In Pakistan, nutritional requirements of animals are mainly met through fodder crops, shrubs, grasses and agro industrial wastes. Improving the quantity and quality of feeds can enhance livestock production up to 50% from existing genetic pool of animals. The main objective of this course is to explore the available feed resources and to suggest the remedies to minimize the gap between nutrients availability and nutrients requirements of animals. This course tells about types, availability pattern and characteristics of feed resources of Pakistan. It also critically studies nutrient composition, utilization and significance of different feed stuffs used locally for feed manufacturing of livestock commercial poultry. This course gives an idea about effects of different feedstuffs on animal performance as well as use of non-conventional feed resources in animals. After taking this course, students will be able to know that what to feed to animals and what feeding strategies should be used to economically fulfill the nutrient requirements of animals in commercial and semi-intensive system of livestock production.

Contents

Theory

1. Feed resources of Pakistan
2. Classification, availability, requirements, dynamics and characteristics
3. Nutritive value of feedstuffs and factors affecting nutritional quality of feeds in livestock and poultry Feeding standards and their application. Strategic supplementation
4. Associative effects of feeds for livestock and poultry
5. Methods of improving nutritive value of feedstuffs
6. Feeding rumen bypass proteins and lipids
7. Utilization of NPN compounds in livestock feeds and its significance
8. Factors affecting voluntary feed intake
9. Significance of feed additives for livestock and poultry
10. Toxins and anti-Nutritional factors in feedstuffs

Practical

1. Chemical analysis, in-vivo, in-vitro and in-sacco techniques for feed evaluation
2. Techniques for estimation of feed toxins; Chemical and biological treatments of roughages
3. Preparation of hay and silage; Use of computer in feed formulation
4. Visits to feed mills, livestock farms and research institutes

Recommended Texts

1. Anonymous. (1989). *Feeding Standards of Pakistan*. Lahore: PSI.
2. Cheeke, P.R. (2004). *Applied Animal Nutrition, Feeds and Feeding*. Canada: Delmar Publisher.

Suggested Books

1. NRC. (2005). *Nutrient Requirements of Dairy Cattle*. Washington, USA: National Academy Press,
2. Perry, T.W., Cullison, A.E. & Lowrey, R.S.(1999). *Feeds and Feeding* (5th ed.). New Jersey, USA: Prentice Hall.

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Vitamins are defined as a group of complex organic compounds present in minute amounts in natural foodstuffs that are essential to normal metabolism and lack of which in the diet causes deficiency diseases. Vitamins are required in trace amounts (micrograms to milligrams per day) in the diet for health, growth, and reproduction. This postgraduate level course tells about significance of vitamins in nutrition of the animals. This course studies details of chemical nature of all water soluble and fat soluble vitamins and estimation of their quantity in animal feed. This course critically focuses on essentiality of vitamins, their role in metabolism and performance of animals and understanding of effects deficiencies of different vitamins on animal health and production. After taking this course students will be able to know about the nutrition of vitamins and biochemical and metabolic functions of different vitamins and strategic inclusion of their synthetic sources in commercial animal feed.

Contents

Theory

1. History and development of the vitamin concepts and their classification
2. Fat-soluble vitamins: vitamin A, D, E and K; functions, deficiency, bioassay interactions with other nutrients, sources, requirements and hypervitaminosis
3. Water-soluble vitamins: vitamin B-complex and vitamin-C; functions, deficiency, sources, requirements and interrelationships with other vitamins and nutrients
4. Chemistry and metabolism of the fat soluble and water soluble vitamins and their roles in animals
5. Integrates cellular biochemistry and metabolism of the vitamins in the vertebrate animals
6. Stability of vitamins under different storage conditions

Practical

1. Analytical procedure for estimating vitamins in feedstuffs
2. Experimental procedure for inducing and correcting vitamins deficiency in birds
3. Vitamin composition of feeds; Preparation of vitamin supplements

Recommended Texts

1. McDonald, P., Edwards, R.A. & Greenhalgh, J.F.D. (1996). *Animal Nutrition*. U.K: Longman Scientific and Technical, Publisher.
2. McDowell, L.R. (2000). *Vitamins in Animal and Human Nutrition*. London: Academic Press Inc., Harcourt Brace Jovanovich, Publishers.

Suggested Books

1. Sarwar, M. & Zia-ul-Hasan. (2000). *Nutrient Metabolism in Ruminants*. Faisalabad: University of Agriculture Press.
2. Martin, D.W., Mayes, P.A. & Rodwell, V.M.. (1998). *Harper's Review of Biochemistry*. Maruzen, Asia, Singapore: Lange Medical Publication.

Mineral elements exist in the cells and tissues of the animal body in a variety of functional, chemical combinations and in characteristic concentrations, which vary with the element and the tissue. The concentrations of essential elements must usually be maintained within quite narrow limits if the functional and structural integrity of the tissues is to be safeguarded and the growth, health and productivity of the animal are to remain unimpaired. This course tells about significance of minerals in animal nutrition. This course studies details of chemical nature of all macro and micro minerals and estimation of their quantity in animal feed. This course critically focuses on essentiality of all minerals, their role in metabolism and performance of animals and understanding of effects deficiencies of different minerals on animal health and production. After taking this course students will be able to know about minerals nutrition and biochemical and metabolic functions of different micro and macro minerals and strategic inclusion of organic and inorganic mineral sources in commercial animal feed.

Contents

Theory

1. Historical perspectives of minerals
2. Essential minerals and their classification, chemistry, functions, metabolism and interrelationships
3. Mineral absorption and role of chelating agents
4. Mineral imbalances, toxicity and deficiency symptoms
5. Mineral distribution in the animal body
6. Mineral requirements, sources, geographical distribution, deficiency and excess in Pakistan
7. Soil, plant and animal relationship
8. Problems associated with mineral nutrition
9. Role of minerals in growth, production and reproduction
10. Diagnosis, treatment and prevention of mineral deficiencies in livestock and poultry

Practical

1. Estimation of minerals in feed samples
2. Diagnosis of mineral disorders in farm animals
3. Formulation and preparation of mineral mixtures and licks

Recommended Texts

1. McDowell, L.R. (1992). *Minerals in Animal and Human Nutrition*. California, USA: Academic press Inc.
2. O'Del, B.L. & Sunde, R.A. (1997). *Handbook of Nutritionally Essential Mineral Elements*. New York, USA: Marcel Dekker, Inc.

Suggested Books

1. Sarwar, M. & Zia-ul-Hasan. (2000). *Nutrient Metabolism in Ruminants*. Faisalabad: University of Agriculture Press.
2. Underwood, E.J. (1999). *Mineral Nutrition of Livestock*. New York: Acad. Press Inc.

Proteins are of paramount importance for biological systems. Out of the total dry body weight, 3/4th is made up of proteins. Proteins are used for body building; all the major structural and functional aspects of the body are carried out by protein molecules. Abnormality in protein structure will lead to molecular diseases with profound alterations in metabolic functions. This course focuses on protein which is a primary nutrient in nutrition of the animals. It elaborates metabolic and biochemical pathways regarding protein utilization. This course gives details about chemical nature of proteins and amino acids and index for understanding the quality of protein in relation to nutrition. This course also studies non-conventional protein sources and digestion and metabolism of protein in body. After taking this course students will be able to understand the nutrition of proteins, requirements of protein, estimation of quality of protein and relation of protein with other essential dietary nutrients.

Contents

Theory

1. Protein sources, classification, digestion and absorption
2. Basic biochemistry and cell biology related to processes involved in protein synthesis and degradation and the regulation of these processes
3. Absorption and distribution of amino acids in the body
4. Biosynthesis and major pathways of metabolism of proteins; Techniques for estimation of protein requirements; Protein requirements for growth, production, reproduction and work
5. Protein energy relationships; Protein quality; Concept of amino acids supplementation
6. Rumen by-pass protein and methods of protection of feed protein from rumen degradation; Balancing NPN and true protein ratio in livestock rations; Ammonia/urea toxicity in animals

Practical

1. Nitrogen balance experiments; Analysis of NPN and true protein in feeds
2. In vitro pepsin solubility measurement; In sacco protein degradability technique

Recommended Texts

1. Agriculture Research Council, (1989). *The Nutrient Requirements of Ruminant Livestock*. London: ARC.
2. Alderman, G. (1993). *Energy and Protein Requirements of Ruminants*. Wallingford, Oxon, U.K: CAB International.

Suggested Books

1. Church, D.C. (1988). *Ruminant Animals: Digestive Physiology and Metabolism*. Englewood Cliffs, New Jersey: Reston Book, Princeton Hall.
2. McDonald, P., Edwards, A.R., Greenhalgh, J.F.D. & Morgan, C.A. (2004). *Animal Nutrition* (7th ed.) Singapore: Pearson Education Pvt. Ltd.

Energy metabolism is central to life and the main function of the respiratory system is to maintain aerobic metabolic processes in the body. Livestock obtain their energy from feed. Once in the body, the macromolecules found in food undergo a series of degenerative reactions that yield the necessary substrates to promote the continuation of a process known as energy metabolism. The result of this very precise series of chemical and biological reactions is the transformation of energy in its free form into energy that can be fully utilized by the animal body. This course critically focuses on energy which is the major nutrient that is required by the body to do work and to be alive. This course studies the techniques used in estimation of energy demands of body in relation to different physiological stages and climates. This course critically analyzes different energy systems used for nutrition of animals as well as energy needs in relation to other essential nutrients provision. After taking this course students will be able to estimate the nutrient requirements of animals and to understand how energy is metabolized by body and energy expenditures for different physiological activities.

Contents

Theory

1. Principles of Bioenergetics
2. Methods and Techniques used in Studies of Energy Metabolism
3. Energy metabolism in relation to nutrition
4. Whole Animal, Organ, and Tissue Metabolism
5. Feed Intake
6. Calorigenic Value of Feeds and Energy Balance
7. Regulation of Energy Metabolism
8. Energy Utilization in Maintenance, Growth, Pregnancy, Lactation, Work and Under-nutrition
9. Energy Requirements in Relation to Climate
10. Energy Partitioning in Lactating and Growing Animals
11. Protein-Energy Interrelationships
12. Energy systems for livestock
13. Factors affecting energy requirements
14. Measurements of energy needs through BMR and feeding trials for maintenance, growth, reproduction, production and work

Recommended Texts

1. Church, D.C. (1988). *Ruminant Animals: Digestive Physiology and Metabolism*. Englewood Cliffs, New Jersey: Reston Book, Princeton Hall.
2. McDonald, P., Edwards, A.R. , Greenhalgh, J.F.D. & Morgan, C.A.(2004). *Animal Nutrition* (7th ed.) Singapore: Pearso Education Pvt. Ltd.

Suggested Books

1. NRC. (2005). *Nutrients Requirements of Dairy Cattle*. Washington DC. USA : National Academy Press.
2. Van Soest, P. J. (1994). *Nutritional Ecology of Ruminants*. Ithaca, USA: Comstock Publishing Associate, Cornell University Press.

Lipids are a heterogeneous group of compounds, including fats, oils, steroids, waxes, and related compounds. They are concentrated sources of energy as well as structural components of cell membranes. A certain amount of dietary fat is required for normal bodily functions. Lipids perform three primary biological functions within the body: they serve as structural components of cell membranes, function as energy storehouses, and function as important signaling molecules. The three main types of lipids are triacylglycerols (also called triglycerides), phospholipids, and sterols. This course focuses on lipids in nutrition of the animals. It elaborates metabolic and biochemical pathways regarding lipids utilization. This course gives details about chemical nature of lipids, fats and fatty acids and role of lipids in maintaining life. This course also studies digestion and metabolism of lipids in body. It critically studies scenario of fat metabolism under different physiological situations. It also elaborates biosynthesis of different fats and fatty acids in body. After taking this course students will be able to understand the nutrition of lipids, requirements of lipids and diseases related to impaired fat metabolism.

Contents Theory

1. Lipids their importance and functions
2. Digestion and absorption of lipids
3. Nomenclature and classification of fatty acids
4. Omega-3 and omega-6 fatty acids
5. Fatty acid biosynthesis, Acetyl-coA as a central precursor for biosynthesis of lipids, elongation and desaturation of fatty acids, Beta-oxidation, Ketone bodies synthesis
6. Structure and functions of triacylglycerol
7. Cholesterol synthesis and transport
8. Lipoproteins: role of lipoprotein in the transport of triacylglycerol and cholesterol
9. Role of lipid mediators
10. Eicosanoids, and inflammation
11. Diseases related to lipid metabolism
12. Oxidation of lipids and use of different antioxidants

Recommended Texts

1. Guyton, A.C. & Hall, J.E. (2011). *Text book of Medical Physiology*. Philadelphia, USA: W.S. Saunders Co.
2. Lehninger A. L., Nelson, D.L. & Cox, M.M. (2004). *Principles of Biochemistry* (4th ed.) NY: Worth Publishing.

Suggested Books

1. Robert K.M., Bender, D.A., Botham, K.M., Kennely, P.J., Rodwell, V.W. & Weil, P.A. (2012). *Harper's Illustrated Biochemistry* (29th ed.). USA: McGraw Hill.
2. Goodridge A. G. *Fatty acid synthesis in eukaryotes. In: Biochemistry of Lipids, Lipoproteins and Membranes* (D. E. Vance and J. Vance, eds.). Amsterdam: Elsevier Science Publishers.

This course is aimed at understanding advanced techniques regarding feed analysis for different nutrient composition. Course focuses on advanced analytical techniques used in nutrition, maintenance of laboratory equipment and preparation of different chemical solutions for laboratory procedures. Course also tells about analysis of blood samples for different metabolites. It critically studies estimation of nutrients present in milk. After taking this course students will be to prepare and analyze feed and feed ingredient samples for amino acid analysis, energy contents, vitamins, minerals and different essential nutrients present in milk along with estimation of different blood metabolites. At the end of course students will be cognizant of the potential hazards they face while working in Laboratory. Fires with organic solvents, acid and base burns, and toxic fumes and vapors are common hazards in almost any nutrition laboratory. Generally, lab safety is a matter of common sense, but there are several rules that must be followed. Each student is required to follow Standard Laboratory Procedures.

Contents

Theory


1. Electrophoresis and chromatographic techniques
2. Flame photometry, Spectrophotometer and atomic absorption spectrophotometry techniques Amino acid analysis
3. Gas chromatography
4. Quantitative determination of mycotoxins
5. Blood analysis for urea, cholesterol, glucose and other metabolites
6. Calorimetric determination of energy contents of feedstuffs
7. Milk urea nitrogen determination
8. Analytical procedure for estimating vitamins in feedstuffs

Recommended Texts

1. AOAC. (2006). *Official Methods of Analysis of the Association of Official Analytical Chemists* (20th Ed.) Arlington, Virginia 22209.
2. Kaneko, J.J., Harvey, J.W. & Bruss, M.L. (1997). *Clinical Biochemistry of Domestic Animals* (5th ed.) London, U.K: Academic Press

Suggested Books

1. Sahoo, A., Sankhyan, S.K. & Karim, S.A. (2012). *Techniques in Animal Nutrition Research*. India: Satish Serial Publishing House.
2. Pomerans, & Melon, C. (1994). *Food Analysis; Theory and Practice*. Elsevier Publishers.
3. Van Soest, P.J. (1994). *Nutrition Ecology of Ruminants*. USA: Cornell University Press.


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Feed is the most important input for poultry production in terms of cost, and the availability of low-priced, high-quality feeds is critical if poultry production is to remain competitive and continue to grow to meet the demand for animal protein. For maximum growth and good health, intensively reared poultry need a balanced array of nutrients in their diet. The nutrients required by birds vary according to species, age and the purpose of production – whether the birds are kept for meat or egg production. This post-graduate level course critically focuses on nutrition of poultry birds to get optimum performance. It is aimed at production problems related to poultry nutrition and feeding standards of the poultry birds. This course gives the knowledge about different poultry feeding methods and nutrient requirements of poultry birds raised for different purposes. It also explicitly tells about feedstuffs available for poultry and preparation of commercial feeds for poultry along with measures to improve quality of feed and standard storage practices. After taking this course, students will be able to understand methods of poultry feed analysis and manufacturing commercial poultry feed for broilers, layers and breeders.

Contents

Theory

4. Digestion, metabolism and absorption of nutrients in poultry
5. Nutritional requirement of broilers, layers and breeders; Feed resources and their nutritional profile; Effect of amino acid – energy ratio on growth
6. Essential amino acids and their role; Feed additives, micronutrients (Vit. & Min.) and their role; Feeding program for broilers (starter, grower and finisher) and broilers breeders; Molting of layers and breeders
7. Feeding of poultry in hot weather and stress; Feeding of indigenous poultry, ducks, quails, geese turkeys etc.; Nutrient deficiencies / diseases and their prevention
8. Anti-nutritional factors in feedstuffs and their effects on birds performance; Effect of feed on meat and egg quality; Storage of feeds; Measure to avoid feed wastage
9. Recent trends in poultry nutrition, feed restriction; Water requirement, its quality and significance

Practical

1. Identification, classification & characterization of common feed ingredients
2. Least cost feed formulation for different age groups of broilers, layers and breeders
3. Physical evaluation of feedstuffs; Laboratory analysis of feeds and feedstuffs; Visits to commercial feed mills and poultry farms

Recommended Texts

1. Ensminger, M.E., Oldfield, J.E. & Heinemann, W.W. (1999). *Feeds and Nutrition Digest* (2nd ed). California. USA: The Ensminger Publishing Co.
2. Lesson, S. & Summers, J.D. (2001). *Broiler Breeder Production*. Guelph, Ontario, Canada: University Books.

Suggested Books

1. Lesson, S. & Summers, J.D. (2002). *Scott's Nutrition of the chicken*. Guelph, Ontario, Canada: International Book Distributing Co.
2. Lesson, S. & Summers, J.D. (2005). *Commercial poultry Nutrition*. Guelph, Ontario, Canada: University Books.

Ruminant nutrition consists of low- protein forages, fiber-rich and crop residues. Ammonia, sulfur and phosphorus are the most limiting nutrients. Ruminants are the mammals that can ferment the food in specialized stomach prior to digestion by bacterial actions to acquire nutrients. Ruminant nutrition research is aimed primarily at the optimal utilization of available raw materials to increase the production efficiency of cattle, sheep and goats. There is a strong focus on rumen metabolism and roughage fermentation rates. This post-graduate level course is aimed at nutrition of ruminants for better performance and health. It focuses on production problems related to ruminant nutrition and process of ingestion, digestion and metabolism of different essential nutrients in ruminant animals. This course gives the knowledge about nutrient requirements of ruminants raised for different purposes. It also explicitly tells about feedstuffs available for ruminants and preparation of commercial feeds for ruminants along with measures to improve quality of feed and utilization of non-conventional feed resources. After taking this course, students will be able to understand processes involved in ruminant nutrition, feeding systems used in ruminants and manufacturing of feed for different physiological stages of the animals.

Contents

Theory

1. Digestive physiology, digestion and absorption; Factors affecting digestion
2. Grass and Legume Forage Species; Corn Silage Quality –
3. Dry Matter Intake; digestion and metabolism of different nutrients
4. Rumen digestion and metabolism
5. Nutritional requirements of different classes of dairy animals;
6. Feeding systems and Feed formulation for calves, heifers, dry, pregnant and lactating cows
7. Nutritional disorders/ metabolic diseases
8. Feeding of high yielding cows; bypass proteins, lipids and feeding frequency
9. Feed additives and feed supplements; Efficient usage of urea and other NPN sources in dairy feeding

Practical


1. Practical nutrition for lactating dairy cows; Digestion trials, measurement of digestion kinetics; Digestibility through indicator methods; Computerized feed formulation for different classes of animals; Hay and silage preparation

Recommended Texts

1. Ensminger, M.E., Old field, J.E. & Heinemann, W.W. (1990). *Feed and Nutrition Digest*. California 93612, USA: The Ensminger Publishing Company.
2. Etgen, W.M. & Reaves, P.M.. (1992). *Dairy Cattle Feeding and Management*. USA: John Wiley & Sons.

Suggested Books

1. McDonald, P., Edwards, A.R. , Greenhalgh, J.F.D. & Morgan, C.A. (2004). *Animal Nutrition* (7th ed.) Singapore: Pearson Education Pvt. Ltd.
2. NRC. (2005). *Nutrient Requirement of Goat, Angora, Dairy & Meat Goat in Temperate and Tropical Countries*. Washington USA: National Academy Press.


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This post-graduate level course focuses at studying the available feed ingredients in market. It aimed at understanding the trading of cereals and agro-industrial by-products which are used in animal feed manufacturing. It also studies processes involved in storage of ingredients and pre-storage procedures that are aimed at increasing storage life of the ingredient. It also critically focuses on equipments used for processing and storage of ingredients. After taking this course, students will be able to understand procurement of feed ingredients and feed storage practices to reduce ingredient quality losses during storage. Students will be able to recognize their responsibility to provide quality products to their customers, and their intent should be to provide consistent quality products by implementing sound quality control procedures. Furthermore they will be able to use quality feed ingredient sources, and not from the use of inferior, spoiled, or otherwise damaged or contaminated ingredients; the protection of both human and animal health also being prime considerations in the production of quality cost-effective animal feeds. Also students will work with producers (farmers) to enhance production.

Contents

Theory

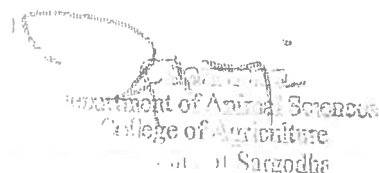
1. Cereals and cereal by-products
2. Oil seeds and oilseed by-products
3. Animal by-products; Seasonal production and market supply of grains and agro-industrial by-products used in poultry feed industry
4. Future trading and purchase agreements
5. Principles of storage
6. Bulk storage of raw materials
7. Weighing and cleaning of raw materials, aspiration
8. Pre-storage processing and advanced drying technologies
9. Post-storage processing
10. Losses during storage and their control
11. Commercial grain silos; Concrete bins
12. Construction of godowns; Bin construction and designs
13. Adequate roof support, roof loads, fan and ventilating bin foundation
14. Bin management and maintenance; Safety measures in stores

Recommended Texts

1. Kudra, T. & Mujumdar, A.S. (2009). *Advanced Drying Technologies*. (2nd ed.). London, UK: CRC Press.
2. McEllihiney, R.R. (1994). *Feed Manufacturing Technology IV*. Arlington, VA, USA: American Feed Industry Association, Inc.

Suggested Books

1. Saucer, D.B. (1992). *Storage Cereal Grains and Their Products* (4th ed.). Newbury, Berks, UK: CPL Scientific Publishing Services Limited.
2. Niranjana, P.S., Chahal, U.S., Srivastava, V. & Kumar, S. (2010). *Handbook of Applied Animal Nutrition*. India: IBDC Publishers.



This post-graduate level course is aimed at understanding the commercial feed milling industry. It critically studies the status of feed mill industry in Pakistan and problem faced by local feed mills. It also focuses on all processes involved in manufacturing of commercial feed. It studies processing of feed ingredients, feed mill operations, sampling and quality control of feed ingredients and compound feed and techniques used to successfully store the ingredients during their abundant availability period. After taking this course students will be able to formulate commercial rations for different classes of livestock and poultry and to learn techniques involved in quality feed manufacturing and marketing. Students will be able to recognize their responsibility to provide quality products to their customers, and their intent should be to provide consistent quality products by implementing sound quality control procedures. Furthermore they will be able to use quality feed ingredient sources, and not from the use of inferior, spoiled, or otherwise damaged or contaminated ingredients; the protection of both human and animal health also being prime considerations in the production of quality cost-effective animal feeds.

Contents

Theory

1. Present status and problems of feed industry in Pakistan
2. Preparation of feasibility report to establish a feed mill
3. Construction and designing of feed mill; Operational mechanism of feed mill
4. Procurement of raw materials; Sampling equipment and techniques
5. Grains and raw material storage; Nutrient losses and other changes during storage
6. Formulation of rations for different classes of livestock and poultry
7. Importance and composition of micromixes and feed-additives in animal feed
8. Manufacturing of compound feeds; Selecting, cleaning, grinding, mixing and storing of feed ingredients
9. Effect of processing on feed; Significance and choice of processing methods
10. Quality control in feed milling industry and feed laws; Feed marketing techniques

Practical

1. Feed raw material storage and handling
2. Feed processing
3. Physical and chemical treatments
4. Preparation of micro-mixes
5. Chemical analysis of raw material and finished feed
6. Visit to local markets and feed mills

Recommended Texts

1. McEllihiney, R.R. (1994). *Feed Manufacturing Technology IV*. Arlington, VA, USA: American Feed Industry Association, Inc.
2. Bebb, D.L. (1990). *Mechanized Livestock Feeding*. Oxford, UK: BSP Professional Books.

Suggested Books

1. Ensminger, M.E., Oldfield, J.E. & Heinemann, W.W. (1990). *Feeds and Nutrition Digest* (2nd ed.) Clovis, CA, USA: The Ensminger Publishing Company.
2. Sharma, A.K. (2012). *Animal Nutrition*. India: Oxford Book Company.

This post-graduate level course is aimed at understanding Molecular Nutrition and Nutrigenomics. Nutrigenomics is a branch of nutritional genomics and is the study of the effects of foods and food constituents on gene expression. This means that nutrigenomics is research focusing on identifying and understanding molecular-level interaction between nutrients and other dietary bioactive compounds with the genome. The integration of the animal genome project with nutritional, genetic research, and health outcomes studies has led to the emergence of nutrigenetics and nutrigenomics. These disciplines investigate in a systematic fashion the effect of genetic makeup on individual dietary response and the role of dietary factors and bioactive nutrient products in gene expression, and stability respectively. Effective and specific interventions for disease prevention using principles of “personalized” nutrition require a better knowledge of gene-diet interactions, an area that remains poorly explored. Management and prevention of diseases will benefit tremendously from personalized medicine including individualized nutritional therapy. Student will be able to know the basis of molecular nutrition by exploring nutrigenetics of cardiovascular diseases and cancer using polyunsaturated fatty acids intake as an example, and nutrigenomics of nutrients on cellular senescence, DNA damage, and epigenetics.

Contents

Theory

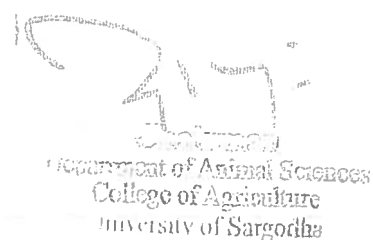
1. Key concepts in molecular biology for the study of Nutrition
2. Nutrigenomics
3. Proteomics and metabolomics
4. Concepts, opportunities and challenges
5. Role of nutrients and dietary components in regulation of gene expression and stability
6. Role of nutrients in signal transduction and proteolysis
7. Interrelationship of genetic variation and individual nutrient requirements
8. Application of nutrigenomics in health and nutrition
9. Metabolic imprinting
10. Engineering of metabolic pathways to improve animal nutrition and health.

Recommended Texts

1. Zemleni, J. & Daniel H. (2003) *Molecular Nutrition*. USA: CABI Publishing.
2. Brigelius-Flohe, R. & Joost H.G. (2006) *Nutritional Genomics*. USA: Wiley Interscience.
3. Ordovas, J.M. & Parnell, L. (2007) *Nutrigenetics and Nutrigenomics* (1st ed.). NY,USA: Wiley-Liss.

Suggested Books

1. Mine, Y., Miyashita K. & Shahidi F. (2009). *Nutrigenomics and Proteomics in Health and Disease: Food Factors and Gene Interactions* (1st ed.). San Francisco, CA, USA: Wiley-Blackwell.
2. Merched A.J. & Chan L. (2013). *Nutrigenetics and nutrigenomics of atherosclerosis*. *Curr Atheroscler Rep* 15(6):328.



A metabolic disorder occurs when the metabolism process fails and causes the body to have either too much or too little of the essential substances needed to stay healthy. Animal bodies are very sensitive to errors in metabolism. These are diseases of livestock caused by productivity practices when the body reserves on calcium, magnesium or energy cannot meet the metabolic needs. This post-graduate level course focuses on various types of disorders in animals which are caused by impaired metabolism. It critically analyzes the causes of alteration in metabolism and nutritional and genetic mechanisms involved in these types of disorders. It is also aimed at understanding the negative effects of metabolic disorders on health and production of farm animals. In addition, it studies the nutritional remedies that may be used in prevention of metabolic disorders. After taking this course students will be able to understand the underlying mechanisms involved in development of metabolic disorders and nutritional tools to prevent such type of disorders.

Contents

Theory

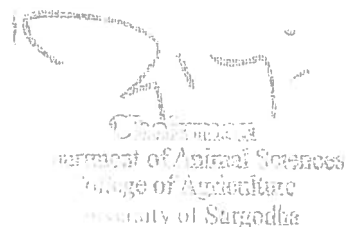
1. Metabolic disorders arising from alterations in metabolism and their impact on animal productivity
2. Causes, production losses and prevention of Milk Fever, Ketosis and Polioencephalomalacia
3. Mechanisms and prevention of urea toxicity
4. Bloat; Parakeratosis
5. Acidosis; Grass Tetany; Picca and Sway Back disease
6. Nitrate/nitrite toxicity in ruminants
7. Causes and prevention of Rickets, Osteomalacia and Osteoporosis
8. Protein-energy malnutrition
9. Kwashiorkor and Marasmus.

Recommended Texts

1. McEllihiney, R.R. (1994). *Feed Manufacturing Technology IV*. Arlington, VA, USA: American Feed Industry Association, Inc.
2. Bebb, D.L. (1990). *Mechanized Livestock Feeding*. Oxford, UK: BSP Professional Books.

Suggested Books

1. Ensminger, M.E., Oldfield, J.E. & Heinemann, W.W. (1990). *Feeds and Nutrition Digest* (2nd ed.) Clovis, CA, USA: The Ensminger Publishing Company.
2. Leeson, S., Diaz, G.J. & Summers, J.D. (1995). *Poultry Metabolic Disorders and Mycotoxins*. Guelph, Canada: University Books.



This post-graduate level course critically focuses on history, development and present scope of nutrition science in improving the performance of livestock and poultry. This course also studies regarding recent developments and milestones achieved in the field of animal nutrition. It is aimed at browsing of well reputed journals in animal nutrition and reviewing the literature for understanding present status and for identification of potent future research areas. In this course students are made to write an annual review of the changes and updates in the field of animal nutrition, especially progresses in the study of feeds. Review is divided in four parts, Part I discusses topics related to nutrition in non-ruminant animals, while Part II covers ruminant nutrition. Part III tackles studies about general nutrition such as the use of growth promoters in animal feeds and predicting the response to variation and diet, and Part IV deals with feed compounding and its effects. After taking this course students will be able to understand the identification of research problems and reviewing of literature for improving their insight about the subject and updating their knowledge about the field of animal nutrition.

Contents

Theory

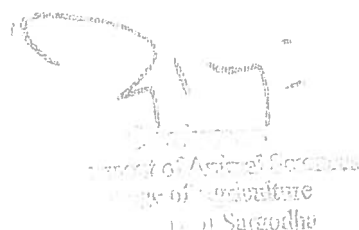
1. History, development and present scope of nutrition in improving the performance of livestock and poultry
2. Compilation of classic papers
3. Review of current abstracts, indices, journals and other publications
4. Assignments on different topics and preparation of abstracts
5. Index cards and summaries for further references
6. Identification of areas for future research
7. Presentation
8. Use of information technology (IT) in literature searching.

Recommended Texts

1. Garnsworthy, P.C. & Wiseman, J. (2007). *Recent Advances in Animal Nutrition*. The Netherlands: Empress Publishing.
2. Pond, W.G. and D.C. Church. 2005. *Basic Animal Nutrition and Feeding*. India: Wiley.

Suggested Books

1. Ensminger, M.E., Oldfield, J.E. & Heinemann, W.W. (1990). *Feeds and Nutrition Digest* (2nd Ed.) Clovis, CA, USA: The Ensminger Publishing Company.
2. Sharma, A.K. (2012). *Animal Nutrition*. India: Oxford Book Company.



Anti-nutritional factors referred to as anti-nutrients, anti-nutritive factors, secondary substances or plant secondary metabolites, are constituents which may be used either by themselves or through their metabolic products. They interfere with animal feed utilization and affect the health and production of animals. Anti-nutritional factors may produce several adverse effects: reduce nutrient intake, digestibility, nutrient absorption etc.. Low levels of anti-nutritional factors in any animal feeds are recommended and high levels of this factor are forbidden. This course is aimed at critically studying the possible toxins and anti-nutritional substances present in feed stuffs. It elaborates occurrence of anti-nutritional factors, their probable effects, involvement in digestion and absorption and their chemical nature. It also studies the effects of toxins and anti-nutritional factors on health and production of the animals. It also focuses on mechanisms involved in reducing their negative effects as well as techniques used to detoxify feed toxins and anti-nutritional factors. After taking this course students will be able to understand the chemistry of feed toxins and strategies to reduce their effect and level in feed.

Contents

Theory

1. Introduction to feed toxins and antinutritional factors in indigenous feedstuffs
3. Protease inhibitors
4. Physiochemical properties of inhibitors, nutritional significance of protease inhibitors
5. Effect of processing techniques
6. Tannins, their occurrence in plant, tannin physio-chemistry their role in digestion and absorption of nutrients; General properties of hemagglutinins/lectins
7. Toxicity symptoms produced by lectins and their detoxification; Glucosinolates, saponins and gossypol in feedstuffs; Mycotoxins and alkaloids in feedstuffs; Detoxification mechanisms and measures to control the adverse effects of toxins and antinutritional factors in livestock and poultry feeds

Practical

1. Determination of lectins in feedstuffs; Determination of glucosinolates in feedstuffs
2. Methods for identification and quantitative determination of saponins and tannins
3. Isolation and analysis of gossypol; Estimation of chlorogenic acid and trypsin inhibitors; Determination of mycotoxins in feedstuffs

Recommended Texts

1. Cheeke, P.R. (2004). *Applied Animal Nutrition, Feeds and Feeding*. Canada: Delmar Publisher.
2. Ensminger, M.E., Oldfield, J.E. & Heinemann, W.W. (1990). *Feeds and Nutrition Digest*. Clovis, California, USA: The Ensminger Publishing Co.

Suggested Books

1. Irvin E.L. (1980). *Toxic Constituents of Plant Foodstuffs*. New York: Academic Press.
2. Leeson, S. & Summers, J.D. (2001). *Scott's Nutrition of the Chicken*. Guelph, Ontario, Canada: International Book Distributing Co.
3. Caygill, C. & Harvey, I. M. (2002). *Secondary Plant Products*. The Netherlands: Empress Publishing.



The problem with feeding broilers today is not the knowledge of optimum nutrients to use for maximum gains and feed efficiency but how to align the growth of broilers to minimize mortality and skeletal disorders to produce more saleable meat after processing. Geneticists have developed breeding stocks that will produce broilers that grow at a rapid rate, mainly because of the birds insatiable appetite. The modern broiler has the genetic potential to grow at such a rapid rate that the bird will gain more body mass than its heart, lungs, or bones can support. This post-graduate level course critically focuses on nutrition of broiler birds to get optimum performance. It is aimed at production problems related to broiler nutrition and feeding standards of the broiler birds. This course gives the knowledge about different poultry feeding methods and nutrient requirements of broiler birds and breeder raised for day old broiler chick production. It also explicitly tells about feedstuffs available for formulation and preparation of commercial feeds for broilers along with measures to improve quality of feed and standard storage practices. After taking this course, students will be able to understand methods of broiler feed analysis and manufacturing commercial poultry feed for broilers and broiler breeders.

Contents

Theory

1. Digestion, metabolism and absorption of nutrients in broilers
2. Feed resources and their nutritional profile
3. Nutritional requirement of broilers
4. Effect of amino acid-energy ratio on growth of broilers
5. Essential amino acids and their role in broilers
6. Feed additives: Micronutrients and their role
7. Feeding program for broilers (starter, grower, and finisher) and broiler breeders
8. Nutrient adjustments during hot weather and stress
9. Nutrient deficiencies diseases and their prevention
10. Effect of nutrition on meat quality

Practical

1. Least cost feed formulation for different age groups of broilers and breeders
2. Physical evaluation of feedstuffs
3. Laboratory analysis of feeds and feed ingredients
4. Visits to commercial feed mills and commercial broiler/ breeder farms

Recommended Texts

1. Leeson, S. & Summers, J.D. (2001). *Scott's Nutrition of the Chicken*. Guelph, Ontario, Canada: International Book Distributing Co.
2. Leeson, S. & Summers, J.D., (2010). *Broiler Breeder Production*. UK: Nottingham University Press.

Suggested Books

1. NRC. (1994). *Nutrient Requirements of Poultry* (9th ed.) Washington, DC, USA: National Academy Press,
2. Leeson, S. & Summers, J.D., (2009). *Commercial Poultry Nutrition*. UK: Nottingham University Press.

The aim of layer diets is to optimise egg production (in terms of egg numbers, egg size or egg mass), provide the nutrition required to safeguard health and maintain the desired body weight. As with layer pullets, different breeders recommend different feeding strategies for their birds, including the number of different diets fed during the laying stage. Feeding management for layer pullets aims to maintain a growth rate that will lead to the pullet reaching sexual maturity at the desired age while avoiding obesity. This post-graduate level course critically focuses on nutrition of commercial layers to get optimum egg production. It is aimed at production problems related to layer nutrition and feeding standards of the commercial layers and layer breeders. This course gives the knowledge about different poultry feeding methods and nutrient requirements of commercial layers during brooding, growing and laying phases of life. It also explicitly tells about feedstuffs available for poultry and preparation of commercial feeds for layers along with measures to improve quality of feed and standard storage practices. After taking this course, students will be able to understand methods of poultry feed analysis and manufacturing commercial poultry feed for commercial layers and layer breeders.

Contents

Theory

1. Process of digestion and absorption of nutrients in layers
2. Nutrient requirements of commercial and breeder layers
3. Feed resources for layers and their nutritional profile
4. Feeding programs during brooding, growing and laying phases
5. Feed restriction: Nutrition of molted breeder and commercial layer flock
6. Effect of feed on egg quality and production
7. Effect of Ca:P and amino acid:energy on egg production
8. Role of feed additives in layer feeds
9. Nutritional deficiencies diseases in layers
10. Anti-nutritional factors in layer feed ingredients and their effects on layer performance
11. Feeding adjustments during hot climate
12. Pre-breeder and layer breeder nutrition
13. Effect of nutrition on egg quality

Practical

1. Evaluation of different types of layer feeds
2. Feed formulation and practical feeding program for breeder and laying flocks
3. Visits to breeder and commercial layer farms

Recommended Texts

1. Leeson, S. & Summers, J.D. (2001). *Scott's Nutrition of the Chicken*. Guelph, Ontario, Canada: International Book Distributing Co.
2. NRC. (1994). *Nutrient Requirements of Poultry* (9th ed.). Washington, DC, USA: National Academy Press,

Suggested Books

1. Leeson, S. & Summers, J.D. (2009). *Commercial Poultry Nutrition*. UK: Nottingham University Press.
2. Hurwith, S. ; Bornstein, S., (1973).- *The protein and amino acid requirement of laying hens : suggested models for calculation*.- Poultry Science, 52, pp. 1124-1 134.

Feed costs for the dairy cattle herd represent 60 to 70% of the total cost associated with the production of milk. In addition, properly implemented dairy cattle nutrition programs can improve milk production, health, and reproductive performance of dairy cows for both the milking herd and dry cows. In this course various aspects of dairy cow nutrition and feeding and dairy feeding management are provided. This post-graduate level course is aimed at nutrition of dairy animals for better milk production and health. It focuses on milk production problems related to nutrition and process of ingestion, digestion and metabolism of different essential nutrients in dairy animals. This course also studies the effect of nutrition on milk quality and feeding animal in relation to the level of production. This course gives the knowledge about nutrient requirements of dairy animals. It also explicitly tells about feedstuffs available for dairy animals and preparation of commercial feeds for dairy animals along with measures to improve quality of feed and utilization of non-conventional feed resources. After taking this course, students will be able to understand processes involved in nutrition of replacement heifers and dry and milking animals and feeding systems used in dairy nutrition and manufacturing of feed for different physiological stages of dairy animals.

Contents

Theory

1. Digestive physiology: Digestion and absorption; Factors affecting digestion
2. Feed resources: Fodders, crop residues and concentrates
3. Nutritional requirements of different classes of dairy animals; Requirements for maintenance, growth, production, and reproduction
4. Feeding systems: Feeding on complete feed, fodder plus supplementation, silage, haylage and hay; Feed formulation for calves, heifers, dry, pregnant and lactating cows
5. Nutritional management of breeding bulls; Minerals and reproduction in dairy
6. Feeding of high yielding cows; Bypass proteins, lipids and feeding frequency
7. Feeding management of dairy animals under tropical conditions
8. Nutritional disorders and deficiency diseases
9. Nutrition and milk quality; Feed additives and feed supplements
10. Efficient usage of urea and other NPN sources in dairy feeding

Practical

1. Digestion trials; Measurement of digestion kinetics
2. Digestibility through indicator methods; Computerized feed formulation for different classes of animals; Hay and silage preparation.

Recommended Texts

1. Sarwar, M. & Chaudhary, S.A. (2000). *The Rumen: Digestive Physiology and Feeding Management*. Faisalabad: Friends Science Publishers.
2. Etgen, W.M. & Reaves, P.M. (1992). *Dairy Cattle Feeding and Management*. New York, USA: John Wiley & Sons.

Suggested Books

1. Minson, D.J. (1990). *Forage in Ruminant Nutrition*. New York, USA: Harcourt Brae Jovanovich Publishers.
2. Ensminger, M.E., Oldfield, J.E. & Heinemann, W.W. (1990). *Feed and Nutrition Digest*. Clovis, CA, USA: The Ensminger Publishing Company.

Nutrient requirements of cattle change with age, stage of production, sex, breed, environmental conditions and basal diet quality and amount. Therefore, gaining knowledge of nutrient requirements and the factors influencing these requirements is a necessary first step to designing a nutrition program that is both efficient and cost effective. This post-graduate level course focuses on efficient beef production with optimum nutrition and process of ingestion, digestion and metabolism of different essential nutrients in beef animals. This course also studies the effect of nutrition on meat quality and feeding animals for maintenance, growth and fattening. This course gives the knowledge about nutrient requirements of beef animals in different phases of beef animal's life. It also explicitly tells about feedstuffs available for beef animals and preparation of feeds for buffalo and cattle calves along with measures to improve quality of feed and utilization of non-conventional feed resources. After taking this course, students will be able to understand processes involved in nutrition of beef animals and feeding systems used in beef nutrition and manufacturing of feed for different physiological stages of beef animals.

Contents

Theory

1. Digestive physiology: Digestion and absorption, factors affecting digestion
2. Feed resources: Fodders, crop residues, concentrates and non-conventional feed resources Nutritional requirements of male buffalo and cow calves
3. Requirements for maintenance, growth and feedlot fattening
4. Nutrition of breeding animals
5. Feeding system: Total mixed ration, silage haylage and hay
6. Ration formulation for veal and beef production
7. Feeding of indigenous beef breeds
8. Nutrition and beef quality
9. Nutritional disorders and deficiency problems
10. Feed additives and supplements
11. Use of urea and other NPN sources for beef animals

Practical

1. Digestion methods; Measure of digestion kinetics
2. Digestibility through indicator methods; Feed formulation for beef animals
3. Preparation of feed and feed supplements
4. Feeding various classes of beef animals; Visits to feedlots.

Recommended Texts

1. Gordon, M.D. (2008). *Animal Nutrition Science*. Wallingford, Oxfordshire, UK: CABI Publishing,
2. Sarwar, M. & Chaudhary, S.A. (2000). *The Rumen: Digestive Physiology and Feeding Management*. Faisalabad: Friends Science Publishers.

Suggested Books

1. NRC. (2000). *Nutritional Requirements of Beef Cattle* (7th ed.). Washington, DC, USA: National Academy Press.
2. Ensminger, M.E. (1993). *Beef Cattle Science*. Danville, IL, USA: Interstate Printers and Publishers Inc.

This course focuses on nutritional management of calves and process of ingestion, digestion and metabolism of different essential nutrients in young buffalo and cattle calves. This course also studies the effect of nutrition on development of ruminant digestive system. This course gives the knowledge about preparation of milk starter and additives used for milk replacer manufacturing. This course also studies the nutrition of veal calves and formulation of calf starter rations and creep feeds. It also explicitly tells about weaning of buffalo and cattle calves along with measures to improve ruminal development. Nutrient requirements of cattle change with age, stage of production, sex, breed, environmental conditions and basal diet quality and amount. Therefore, gaining knowledge of nutrient requirements and the factors influencing these requirements is a necessary first step to designing a nutrition program that is both efficient and cost effective. After taking this course, students will be able to understand processes involved in nutrition of beef animals and feeding systems used in beef nutrition and manufacturing of feed for different physiological stages of beef animals.

Contents

Theory

1. Role of colostrum in early calf nutrition
2. Development of calf's digestive system
3. Factors affecting the development of calf stomach into a ruminant digestive system
4. Role of nutrition in the development of non-ruminant to a ruminant digestive system
5. Nutrient requirements of calves
6. Protein, energy, minerals and vitamins
7. Calf milk replacers: Advantages and limitations
8. Feed additives
9. Veal production: Kinds of veal and economics of veal production
10. Prospects of quality meat production from surplus calves
11. Creep feeding
12. Fattening of calves: Concept and procedure
13. Prevention of calf scour, respiratory problems and vices through proper feeding

Recommended Texts

1. Church D.C. (1993). *The Ruminant Animal: Digestive Physiology and Nutrition*. Long Grove, IL, USA: Waveland Press.
2. Davis, C.L. & Drackley, J.K.. (1998). *The Development, Nutrition, and Management of Young Calf*. Ames, IA, USA: Iowa State University Press.

Suggested Books

1. NRC. (2001). *Nutrient Requirements of Dairy Cattle*. Washington, DC, USA: National Academy Press.
2. Van Horn, H.H. & Wilcox, C.J. (1992). *Large Herd Dairy Management*. Champaign, IL, USA: Management Services, American Dairy Science Association.


Chairman
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Small ruminant production is the main source of income of farmers living in arid and semiarid regions. Sheep and goats raised in these areas are generally confronted with severe nutritional deficits during food scarcity period which exacerbate disease and health problems and consequently low productive and reproductive performance. Small ruminants require energy, protein, vitamins, minerals, fiber, and water. Energy (calories) is usually the most limiting nutrient, whereas protein is the most expensive. Deficiencies, excesses, and imbalances of vitamins and minerals can limit animal performance and lead to various health problems. This post-graduate level course focuses on efficient mutton production with optimum nutrition and process of ingestion, digestion and metabolism of different essential nutrients in small ruminants. This course also studies the effect of nutrition on mutton quality and feeding sheep and goat for maintenance, growth and fattening and wool and mohair production. This course gives the knowledge about nutrient requirements of grazing and stall feed sheep and goat for growing, breeding and lactating small ruminants. It also explicitly tells about feedstuffs available for mutton producing animals and preparation of feeds for sheep and goat along with measures to improve quality of feed and utilization of non-conventional feed resources. After taking this course, students will be able to understand processes involved in nutrition of small ruminants and feeding systems used in small ruminant nutrition.

Contents

Theory

1. Digestive physiology
2. Digestion and absorption
3. Factors affecting digestion in sheep and goats
4. Feed resources; range land grasses, shrubs, fodders and concentrates etc.
5. Nutritional requirements of sheep and goats
6. Requirement for maintenance, growth, wool and mohair production
7. Feeding for mutton production
8. Feeding of breeding animals (flushing ration)
9. Feeding systems; grazing vs stall feeding
10. Comparison of eating habits of sheep and goats
11. Feeding dairy goats, special feeding regimes for sacrificial and show animals
12. Nutritional disorders and deficiency diseases in sheep and goats

Practical

1. Feed formulation
2. Supplement preparations
3. Preparation of mineral blocks/mixtures
4. Urea treatment of straw
5. Observations on a grazing habits of sheep/goat

Recommended Texts

1. Ensminger, M.E., Old field, J.E. & Heinemann, W.W. (1990). *Feed and Nutrition Digest*. Clovis, California, USA: The Ensminger Publishing Company.
2. Fehr, P.M. (1991). *Goat Nutrition*. Netherlands: Pudoc Wageningen.

Suggested Books

1. NRC. (2003). *Nutrient Requirements of Sheep*. National Research Council, Washington D.C.: National Academy Press.
2. NRC. (2005). *Nutrient Requirement of Goat, Angora, Dairy & Meat Goat in Temperate and Tropical Countries*. Washington USA: National Academy Press.

Nutrient Requirements of Laboratory Animals includes nutrient requirements different laboratory animals i.e rat, mouse, rabbit, hamster, gerbil, and vole. This course will give expert understanding of the lipid, carbohydrate, protein, mineral, vitamin, and other nutritional needs of these animals. This post-graduate level course focuses on care and management of laboratory animals used in nutritional studies. This course also studies raising methods and breeding of laboratory animals. This course gives the knowledge about nutrient requirements of laboratory animals. It also explicitly tells about feedstuffs available for laboratory animals and preparation of diet and formulation of feeds for laboratory animals. After taking this course, students will be able to understand the ways to evaluate different experimental diets by using laboratory animals and to study different nutritional deficiencies in laboratory animals.

Contents

Theory

1. Raising of laboratory animals: selection, supply, production and breeding methods
2. Nutrition, feeding and selection of diets
3. Availability of nutrients in feedstuffs; Nutrient requirements
4. Nutrients: energy, fibre, protein, vitamins, essential fatty acids, minerals and water
5. Practical feeding: feed intake, supplements, fixed and variable formula diets
6. Formulation of diets; Acceptability, microbiological consideration, sterilization, storage, transport and influence of diet on experimental results
7. Special diets and practices; Purified diets; Chemically defined diets
8. Germ free diets; Post-operative diets; Paired feeding, coprophagy
9. Nutritional deficiency diseases and their treatment

Practical

1. Formulation of diets for different laboratory animals
2. Feeding of vitamin deficient diets to laboratory animals for manifestation of nutritional diseases and supplementation of vitamins to study its recovery
3. Determination of water and nitrogen ratio at different stages of growth of Albino rats

Recommended Texts

1. Ensminger, M.E., Oldfield, J.E. & Heinemann, W.W. (1990). *Feeds and Nutrition Digest*. Clovis, California, USA: The Ensminger Publishing Co.
2. Poole, B.T. (1986). *The UFAW Handbook on the Care and Management of Laboratory Animals* (6th ed.). London: Longman Scientific Technical.

Suggested Books

1. Niranjana, P.S., Chahal, U.S., Srivastava, V., Kumar, S. (2010). *Handbook of Applied Animal Nutrition*. , India: IBDC Publishers.
2. Cheeke, P. R., Patton, N. M., Lukefahr, S. D., and McNitt, J. I. (1987). *Rabbit Production*. Danville, Illinois: Interstate Printers & Publishers, Inc.

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Camels have a lower dry matter intake than cattle or horses. Camels typically consume only 1.7% of bodyweight as dry matter, compared with 3-4% bodyweight for horses and cattle. Camels require 70% of dry matter intake as roughage. Horses require six main classes of nutrients to survive; they include water, fats, carbohydrates, protein, vitamins, and minerals. This course focuses on camel and equine nutrition and process of ingestion, digestion and metabolism of different essential nutrients in camels and equines. This course also studies feeding of animals for maintenance, growth and fattening and racing, exercising and breeding animals. This course gives the knowledge about nutrient requirements of camels and equines in different phases of life. It also explicitly tells about feedstuffs available for camels and equines and preparation of feeds for camels and equines. After taking this course, students will be able to understand processes involved in nutrition of camels and equines improving growth and milk production with nutrition and manufacturing of feed for physiological stages of equines and camels and nutrition for improving athletic performance of animals.

Contents

Theory

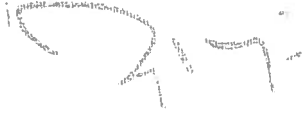
1. Digestive physiology of camels and equines
2. Digestion and absorption of nutrients
3. Feed resources for camels and equines
4. Nutritional requirements for maintenance, growth, lactation, pregnancy and work
5. Feeding systems: Feeding for beef production and race camel
6. Formulation for pleasure, training and race horses
7. Feeding brood mares, stallions, foals, weanlings, yearlings, adult horses, mules and donkeys Nutritional disorders and deficiency diseases
8. Feed additives and supplements.

Recommended Texts

1. Wilson, R.T. (1998). *Camels*. London, UK: Technical Centre for Agricultural and Rural Co-operation MacMillan Education Ltd.
2. Higgins, A.J. & Wright, I.M. (1999). *The Equine Manual*. London, UK: Saunders.

Suggested Books

1. NRC. (1998). *Nutrient Requirements of Horses*. Washington, DC, USA: National Research Council, National Academy Press.
2. Pond, W.G. & Church, D.C. (2005). *Basic Animal Nutrition and Feeding*. India: Wiley.
3. Niranjana, P.S., Chahal, U.S., Srivastava, V., Kumar, S. (2010). *Handbook of Applied Animal Nutrition*. India: IBDC Publishers.


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The field of zoo and exotic animal nutrition continues to make advances that result in better diets. Exotic animal nutritionists in zoos and in the feed industry are studying problems and generating information on proper nutritional management for many species. The minimum nutrient requirements established by the National Research Council (NRC) for domestic and laboratory animals can be useful starting points in setting target nutrient levels for an exotic species. This post-graduate level course focuses on canine nutrition and naturally available feed resources for pets and zoo animals. This course also studies the effect of nutrition on health of pets, cats and dogs. This course gives the knowledge about nutrient requirements of pet animals in different phases of life. This course also tells about nutritional deficiencies and diseases caused by improper nutrition. It also reviews the nutrition of wild animals and roughage feeding in wild environment. After taking this course, students will be able to understand processes involved in nutrition of pet animals and methods used to prepare and feed the supplement for pet animals.

Contents

Theory

1. Small and large pet animal's optimum requirements
2. Natural foods for pets
3. Feed supplements, their types, form and quality, feeding practices
4. Canine nutrition: Amounts of feed, feeding requirements of orphaned puppies, methods of feeding
5. Forms of dog food
6. Types of dog food
7. Feed requirement during geriatric care, Rx diets
8. Feline Nutrition: Methods of feeding
9. Forms of cat food, types of cat food, amounts of feed
10. Important nutritionally caused diseases of dog and cat
11. Use of roughages in wild animals, toxic substances
12. Rabbit and Rodent nutrition

Recommended Texts

1. Charles T.R. (1983). *Wildlife Feeding and Nutrition*. New York, USA: Academic Press,
2. Hudson, R.J. (1989). *Wildlife Production Systems: Economic Utilization of Wild Ungulates*. New York: Cambridge.

Suggested Books

1. Burger, I.H. (1990). *Nutrition of the Dog and Cat*. New York: Cambridge.
2. Pond, W.G. & Church, D.C. (2005). *Basic Animal Nutrition and Feeding*. India: Wiley.
3. Niranjana, P.S., Chahal, U.S., Srivastava, V. & Kumar, S. (2010). *Handbook of Applied Animal Nutrition*. India: IBDC Publishers.

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Fish Nutrition includes nutrient requirements and metabolism in major species of fish used in aquaculture or scientific experiments. It covers nutrients required and used in cold water, warm water, fresh water, and marine species for growth and reproduction. It also highlights basic physiology and biochemistry of the nutrients and applications of these principles to scientific and practical diet formulations and to manufacturing techniques for major species used worldwide in aquaculture. This post-graduate level course focuses on optimum nutrition of fish and process of ingestion, digestion and metabolism of different essential nutrients in fish. This course gives the knowledge about nutrient requirements of fish. It also explicitly tells about feedstuffs available for fish and preparation of aquarium feeds. It critically studies feeding systems used in fish nutrition and feed additives and supplements used for fish. After taking this course, students will be able to understand processes involved in nutrition of fish and manufacturing of aquarium and floating feed for commercial fish farming.

Contents

Theory

1. Digestion, absorption and metabolism of nutrients
2. Nutritional requirements of fish
3. Different kinds of fish feeds
4. Feed resources, availability and nutrient profile of feed ingredients
5. Feed formulation, handling and storage of feed
6. Feeding systems
7. Feeding of aquarium fish
8. Nutritional disorders and diseases of fish
9. Feed additives and supplements

Recommended Texts

1. Shepherd C.J. & Bromage, N.R., (1998). *Intensive Fish Farming*. Oxford, London: B.S.P. Professional Books.
2. Jean, G, Kaushik, S., Bergot, P. & Metailler, R. (2001). *Food Sciences Nutrition and Feeding of Fish and Crustaceans*. Verlag London: Springer

Suggested Books

1. Goddard, S. (1996). *Feed Management in Intensive Aquaculture*. New York, USA: Champan and Hall.
2. Lee, J.S. (1992). *Aquaculture-An Introduction*. Illinois: Interstate.
3. Pond, W.G. & Church, D.C. (2005). *Basic Animal Nutrition and Feeding*. India: Wiley.