



COURSE OUTLINE BRIEFS

DEPARTMENT OF
**ANIMAL
SCIENCES**



SARGODHA UNIVERSITY

Pathway to Progress

FACULTY OF
AGRICULTURE



OVERVIEW

Animal Science is the study of animals and animal products. The Animal Science discipline includes education and experience about the technology of breeding, feeding, producing, managing and marketing animals as well as animal products. This includes all husbandry facets of livestock species (cattle, sheep, goats, poultry, ostriches and horses) and the products derived from them (meat, milk & dairy products, wool, mohair, eggs, skin & leather and feathers) as well as relevant aspects of aquatic (fish, etc.) and wildlife species.

The Department of Animal Sciences was established in 2010 to produce trained and skilled work force, having a focus on innovation and entrepreneurship, capable of employing knowledge inputs for the rapid and sustainable animal production of Pakistan.

The Department is offering MSc (Hons.) in Animal Nutrition and BSc (Hons.) in Animal Sciences programs designed to meet the ever-growing needs in the field of animal sciences. There are four core subjects of Animal Sciences i.e. Animal Breeding and Genetics, Animal Nutrition, Livestock Management and Poultry Science.

The Department prepares its graduates for career in a broad range of professions. These include but not limited to teaching, research, extension services, consultancy, government advisory or regulatory roles, livestock trading and international animal agriculture. Animal Sciences graduates can get placement as managers at dairy, beef, sheep, goat, poultry, camel and ostrich farms. The graduates can also be employed as sales/marketing managers for hatcheries, breeding organizations, feed and food processing industries. There is increasing demand for managers of large production operations and technical positions in areas such as nutrition, animal breeding, research, management, sales and consultancy in commercial companies.

We have a strong and dedicated faculty along with excellent classrooms, animal farms, research laboratories and advising experiences for students. Our faculty is particularly useful in providing guidance in the selection of an area of emphasis and appropriate skills consistent with the student's career goals.

Academic Programs Offered

1. BSc (Hons) Animal Sciences
2. MSc (Hons) Animal Nutrition

BSc (Hons) Animal Sciences

Eligibility: At least 45% marks in FSc (Pre-Medical)

Duration: 04 Year Program (08 Semesters)

Degree Requirements: 136 Credit Hours

Semester-I

Course Code	Course Title	Credit Hours
ANSC-5101	Introduction to Animal Husbandry	2(1+1)
ANSC -5102	Fundamentals of Animal Nutrition	2(1+1)
ANSC -5103	Fundamentals of Livestock Production	3(2+1)
AGRO-5901	Basic Agriculture	3(2+1)
URCI-5109	Introduction to Information & Communication Technologies	3(2+1)
URCE-5102	Language Comprehension & Presentation Skills	3(3+0)
URCI-5105/ ISLS-5108	Islamic Studies/Ethics (for Foreigner or Non-Muslims)	2(2+0)

Semester-II

ANSC -5104	Introduction to Veterinary Anatomy	3(2+1)
URCE-5103	Academic Writing	3(3+0)
AGEC-6522	Economics of Livestock Production	3(3+0)
FSAT-5101	Introduction to Food Science and Technology	3(2+1)
AEXT-5401	Intro to Agricultural Extension & Rural Development	3(3+0)
URCP-5106	Pakistan Studies	2(2+0)

Semester-III

ANSC -5105	Introduction to Poultry Science	2(1+1)
ANSC -5106	Introduction to Animal Physiology	3(2+1)
ANSC -5107	Introduction to Veterinary Preventive Medicine	2(1+1)
PLBG-5201	Introductory Genetics	3(2+1)
ENTO-5101	Introductory Entomology	3(2+1)
AGEC-5502	Agribusiness, Marketing and Trade	3(3+0)
URCC-5110	Citizenship Education and Community Engagement	3(3+0)

Semester-IV

ANSC -5108	Animal Breeding Plans and Policies	3(2+1)
ANSC -5109	Principles of Animal Nutrition	3(2+1)
ANSC -5110	Range Livestock Production	2(1+1)

ANSC -5111	Introduction to Farm Animal Health	3(2+1)
AEXT-5402	Communication Skills in Agricultural Extension	3(2+1)
STAT-5126	Statistics for Agricultural Sciences	3(3+0)

Semester-V

ANSC -6112	Principles of Heredity	2(1+1)
ANSC -6113	Introductory Molecular Genetics	2(1+1)
ANSC -6114	Principles of Milk Production	2(1+1)
ANSC -6115	Metabolism of Primary Nutrients	2(2+0)
ANSC -6116	Management of Dairy Animals	2(1+1)
ANSC -6117	Incubation Principles and Hatchery Management	2(1+1)
ANSC -6118	Rural Poultry Farming	3(2+1)
AGRO-6912	Forage and Fodder Production	3(2+1)

Semester-VI

ANSC -6119	Introductory Population Genetics	2(1+1)
ANSC -6120	Principles of Animal Breeding	2(1+1)
ANSC -6121	Minerals and Vitamins in Nutrition	2(1+1)
ANSC -6122	Principles of Small Ruminant Production	2(1+1)
ANSC -6123	Poultry Housing and Equipment	2(1+1)
ANSC -6124	Poultry Hygiene and Disease Prevention	2(1+1)
ANSC -6125	Physiology of Reproduction	3(2+1)
ANSC -6126	Basic Microbiology	3(2+1)

Semester-VII

ANSC -6127	Animal Breeding Practices	3(2+1)
ANSC -6128	Nutrient Requirements of Farm Animals	3(2+1)
ANSC -6129	Principles of Poultry Nutrition	3(2+1)
ANSC -6130	Behavior and Welfare of Farm Animals	3(2+1)
ANSC -6131	Poultry Farm Management	3(2+1)
ANSC -6132	Draught Animal Production	2(1+1)

Semester-VIII

ANSC -6133	Selection for Economic Traits in Farm Animals	2(1+1)
ANSC -6134	Feed Evaluation, Formulation and Processing Technology	3(2+1)
ANSC -6135	Principles of Meat Production	3(2+1)
ANSC -6136	Poultry Feeding Practices	3(2+1)
ANSC -6137	Research Project / Internship	4(0+4)

MSc (Hons) Animal Nutrition

Eligibility: BSc (Hons) / BS 4 Years or equivalent 16 Years of Education in the relevant field

Duration: 02 Year Program (04 Semesters)

Degree Requirements: Minimum 24 credit hours course work + 6 credit hours thesis and research hours

Course Code	Course Title	Credit Hours
ANNU-7101	Physiological and Biochemical Basis of Nutrition	3(3+0)
ANNU-7102	Feed Resources and their Nutritive Value	3(2+1)
ANNU-7103	Vitamins in Nutrition	3(3+0)
ANNU-7104	Minerals Nutrition	3(2+1)
ANNU-7105	Analytical Techniques in Nutrition	4(0+4)
ANNU-7106	Research Methods in Nutrition	3(2+1)
ANNU-7107	Protein Metabolism	3(3+0)
ANNU-7108	Energy Metabolism	3(3+0)
ANNU-7109	Lipids in Nutrition	3(3+0)
ANNU-7110	Advanced Analytical Techniques in Nutrition	3(0+3)
ANNU-7111	Poultry Feeds and Nutrition	4(3+1)
ANNU-7112	Ruminant Nutrition	4(3+1)
ANNU-7113	Feed Ingredient Storage and Processing	2(2+0)
ANNU-7114	Advanced Animal Feed Industry	3(2+1)
ANNU-7115	Molecular Nutrition and Nutrigenomics	2(2+0)
ANNU-7116	Metabolic Disorders	2(2+0)
ANNU-7117	Recent Advances in Nutrition	2(2+0)
ANNU-7118	Toxin and Antinutritional Factors in Feedstuffs	3(2+1)
ANNU -7119	Special Problem	1(1+0)
ANNU -7120	Seminar	1(1+0)
ANNU-7121	Nutrition of Broilers	3(2+1)
ANNU-7122	Nutrition of Layers	3(2+1)
ANNU-7123	Nutrition of Dairy Animals	3(2+1)
ANNU-7124	Nutrition of Beef Animals	3(2+1)
ANNU-7125	Nutrition of Calves	2(2+0)
ANNU-7126	Nutrition of Small Ruminants	3(2+1)
ANNU-7127	Nutrition of Laboratory Animals	2(1+1)
ANNU-7128	Camel and Equine Nutrition	2(2+0)
ANNU-7129	Nutrition of Pet and Zoo Animals	3(3+0)
ANNU-7130	Fish Nutrition	2(2+0)
STAT-7151	Statistical Methods for Agricultural Research-I	3(3+0)



BSc
(Hons)
ANIMAL SCIENCES



Animal husbandry is the branch of agriculture concerned with animals that are raised for meat, fiber, milk, eggs, or other products. Animal husbandry includes education and experience about the technology of breeding, feeding, producing, managing and marketing animals as well as animal products. This includes all husbandry facets of livestock species (cattle, sheep, goats, poultry, ostriches and horses) and the products derived from them (meat, milk & dairy products, wool, mohair, eggs, skin & leather and feathers) as well as relevant aspects of aquatic (fish, etc.) and wildlife species. It includes day-to-day care, selective breeding and the raising of livestock. The major types of animal husbandry practices include dairy, poultry, sheep, goat farming. This course will help the students to understand the importance of livestock in national economy. They will get a comprehensive knowledge about nutrition, management, breeding and genetic potential of local breeds of livestock. Students will be trained to handle and manage animals for different procedures at livestock farm.

Contents

1. Importance of livestock in economy of Pakistan
2. Zoological classification of farm animals
3. Livestock management
4. Introduction to breeding and genetics
5. Local breeds of livestock
6. Reproductive cycle in farm animals
7. Common feeds and their classification
8. Basic principles of feeding dry, pregnant and milking animals
9. Classes, breeds and varieties of poultry
10. Broiler and layer management

Practical

1. Demonstration and identification of various breeds of livestock
2. Demonstration of male and female reproductive organs
3. Body points of animals
4. Handling and restraining of animals
5. Grooming and cleaning of animals
6. Housing plans
7. Milk quality analyses; identification of
8. Feed samples; formulation of balanced ration for livestock
9. Poultry breeds
10. Visit to livestock shows/farms

Recommended Texts

1. Banerjee, G. C. (1998). *A Textbook of Animal Husbandry*. New Delhi, India: Oxford and IBH Publications.
2. Shah, S.I. (1994). *Animal Husbandry*. Islamabad, Pakistan: National Book Foundation.

Suggested Readings

1. Haq, A., & Akhtar, M. (2004). *Poultry Farming*. Pakistan: Higher Education Commission of Pakistan.
2. Khan, B. B., Yaqoob M., Riaz M., Younas M., & Iqbal A. (2004). *Livestock Management Manual*. Faisalabad : University of Agriculture, Department of Livestock Management.

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 end of course, 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

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. Cheeke, P.R. (2004). *Applied Animal Nutrition, Feeds and Feeding*. Canada: Delmar Publisher.
2. Pond, W.G., & Church, D.C. (2005). *Basic Animal Nutrition and Feeding*. India: Wiley.

Suggested Readings

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.

The livestock species play very important economic and socio-cultural roles for the wellbeing of rural households, such as food supply, source of income, asset saving, source of employment, soil fertility, livelihoods, transport, agricultural traction, agricultural diversification and sustainable agricultural production. Livestock production is predominantly familiar being chickens, goats, cattle, horses, buffaloes and sheep the main species. Beyond the economic function, each livestock species also performs social and cultural functions. The animals raised with large-scale feedlots practice generate fewer pollutants than those raised in households. The shift towards industrial production of livestock and poultry is easier to manage from the environmental perspective, but adequate large-scale cultivation is encouraged. Regulation control, manure treatment and financial subsidies for the manure treatment and utilization are recommended to achieve the ecological agriculture. The aim of this course is to identify and characterize the different roles that livestock and livestock species play in rural communities, highlighting the importance of animal production for the wellbeing and rural development, and relate the functions performed by livestock production with economic, social and cultural attributes of the communities.

Contents

1. Role of livestock; its importance and production trends
2. Livestock species and breeds, cattle, sheep, goats, camel, equine, fish and wildlife
3. Zoological classification of domestic animals
4. General management practices
5. Farm housing and sanitation
6. Livestock production systems
7. Livestock housing systems
8. Housing and management of dairy animal
9. Milking herd, dry stock, and replacement calves
10. Milking parlor; types and designs and equipment
11. Housing and management of small ruminants (sheds and shelters)
12. Plans for economical housing under different climatic conditions
13. Transportation and welfare of animals

Practical

1. Identification of breeds of farm animals
2. Body measurements for weight estimation
3. Preparing animals for shows, Score card, Record keeping
4. Exercises on measurements and facilities for housing
5. Visit to livestock farms and shows

Recommended Texts

1. Banergee, G.C. (1998). *A textbook of Animal Husbandry*. New Delhi, India: Oxford and IBH Publications.
2. Khan, B.B., Yaqoob, M., Riaz, M., Younas, M., & Iqbal, A. (2004). *Livestock Management Manual for Introductory Courses*: Faisalabad: University of Agriculture, Department of Livestock Management.

Suggested Readings

1. Mackintosh, J.B. (1993). *Sheep production in Pakistan*. Islamabad: Agricultural Research Council.
2. Shah, S.I. (1994). *Animal Husbandry*. Islamabad, Pakistan: National Book Foundation.

The main aim of this course is to provide the basic knowledge and background about Pakistan's Agriculture. It will enable the students to understand the basic terminologies of agriculture, its different branches, allied disciplines, salient features of Pakistan's agriculture including climate, land resources etc. as well as the problems of Pakistan agriculture. There will be detailed discussion about the various agro-ecological zones of Pakistan. Basic knowledge about agricultural inputs such as seed, fertilizer, irrigation etc. will be communicated. Crop growth related problems like weeds, insect pests will be elaborated. The students will be able to understand the conventional and international system of land measurement. The knowledge of post-harvest technology is also shared with the students.

Contents

1. Agriculture, history, importance, branches and allied sciences
2. Salient features of Pakistan's agriculture
3. Climate, land and water resources
4. Agro ecological zones of Pakistan. Farming systems
5. Tillage: objectives and types. Seed: types and quality
6. Crop nutrients, manures and fertilizers, sources and methods of application
7. Irrigation: systems, types and management. Crop protection measures
8. Crop rotation. Harvesting, processing, storage and marketing of farm produce
9. Agro-based industries
10. Environmental pollution and health hazards

Practical

1. Land measuring units
2. Demonstration of hand tools and tillage implements
3. Identification of meteorological instruments
4. Identification of crop plants, weeds and seeds
5. Identification of organic and inorganic fertilizers
6. Calculation of nutrient-cum-fertilizer unit value
7. Demonstration of various irrigation methods
8. Field visits

Recommended Texts

1. Bashir, E., & Bantel, R. (2001), *Soil Science*, Islamabad: National Book Foundation.
2. Brady, N.C., & Weil, R.R. (2013). *Elements of the Nature and Properties of Soils* (3rd ed.). New Jersey: Pearson Education.

Suggested Readings

1. Das, D.K. (2011). *Introductory Soil Science* (3rd ed.). New Delhi: Kalyani Publications.
2. Hillel, D. (2008). *Soil in the Environment: Crucible of Terrestrial Life*. Burlington: Elsevier.
3. Singer, M. J., & Munns, D. N. (2002). *Soils- An Introduction* (5th ed.). New Jersey: Prentice-Hall.

The course introduces students to information and communication technologies and their current applications in their respective areas. The students will learn the basic understanding of computer software, hardware, and associated technologies to get maximum benefit related to their study domain. Students will learn how the information and communications systems can improve their work ability and productivity, how Internet technologies like e-commerce applications and mobile computing can influence the businesses and workplace. At the end of semester, students will get basic understanding of computer systems, storage devices, operating systems, e-commerce, data networks, databases, and associated technologies. They will also learn Microsoft Office tools that includes Word, Power Point, Excel. They will also learn Open office being used on other operating systems and platforms. Specific software's related to specialization areas are also part of the course. The course will also cover computer ethics, social media norms and cyber laws.

Contents

1. Introduction, Overview and its types
2. Hardware: Computer Systems & Components, Storage Devices and Cloud Computing
3. Software: Operating Systems, Programming and Application Software
4. Introduction to Programming Language
5. Databases and Information Systems Networks
6. The Hierarchy of Data and Maintaining Data
7. File Processing Versus Database Management Systems
8. Data Communication and Networks
9. Physical Transmission Media & Wireless Transmission Media
10. Applications of smart phone and usage
11. The Internet, Browsers and Search Engines
12. Websites Concepts, Mobile Computing and their applications
13. Collaborative Computing and Social Networking
14. E-Commerce & Applications
15. IT Security and other issues
16. Cyber Laws and Ethics of using Social media
17. Use of Microsoft Office tools (Word, Power Point, Excel), mobile apps or other similar tools
18. Other IT tools/software specific to field of study

Recommended Texts

1. Vermaat, M. E. (2018). *Discovering computers: digital technology, data and devices*. Boston: Course Technology Press.

Suggested Readings

1. Schneider, G. M., & Gersting, J. (2018). *Invitation to computer science*. Boston: Cengage Learning.
2. Timothy J. O., & Linda I. (2017). *Computing essentials* (26th ed.). San Francisco: McGraw Hill Higher Education.

The course seeks to develop a linguistic competence by focusing on basic language skills in integration to make the use of language in context. It also aims at developing students' skills in reading and reading comprehension of written texts in various contexts. The course also helps in developing students' vocabulary building skills as well as their critical thinking skills. The contents of the course are designed based on these language skills: listening skills, pronunciation skills, comprehension skills and presentation skills. The course provides practice in accurate pronunciation, stress and intonation patterns and critical listening skills for different contexts. The students require a grasp of English language to comprehend texts as organic whole, to interact with reasonable ease in structured situations, and to comprehend and construct academic discourse. The course objectives are to enhance students' language skill management capacity, to comprehend text(s) in context, to respond to language in context, and to write structured response(s).

Contents

1. Listening skills
2. Listening to isolated sentences and speech extracts
3. Managing listening and overcoming barriers to listening
4. Expressing opinions (debating current events) and oral synthesis of thoughts and ideas
5. Pronunciation skills
6. Recognizing phonemes, phonemic symbols and syllables, pronouncing words correctly
7. Understanding and practicing stress patterns and intonation patterns in simple sentences
8. Comprehension skills
9. Reading strategies, summarizing, sequencing, inferencing, comparing and contrasting
10. Drawing conclusions, self-questioning, problem-solving, relating background knowledge
11. Distinguishing between fact and opinion, finding the main idea, and supporting details
12. Text organizational patterns, investigating implied ideas, purpose and tone of the text
13. Critical reading, SQ3R method
14. Presentation skills, features of good presentations, different types of presentations
15. Different patterns of introducing a presentation, organizing arguments in a presentation
16. Tactics of maintaining interest of the audience, dealing with the questions of audience
17. Concluding a presentation, giving suggestions and recommendations

Recommended Texts

1. Helgesen, M., & Brown, S. (2004). *Active listening: Building skills for understanding*. Cambridge: Cambridge University Press.
2. Mikulecky, B. S., & Jeffries, L. (2007). *Advanced reading power: Extensive reading, vocabulary building, comprehension skills, reading faster*. New York: Pearson.

Suggested Readings

1. Horowitz, R., & Samuels, S. J. (1987). *Comprehending oral and written language*. San Diego: Academic Press.
2. Roach, C. A., & Wyatt, N. (1988). *Successful listening*. New York: Harper & Row.

Islamic Studies is the academic study of Islam and Islamic culture. The basic sources of the Islamic Studies are the Holy Qur'an and Sunnah or Hadith of the Holy Prophet Muhammad ﷺ. The learning of the Qur'an and Sunnah guides the Muslims to live peacefully. It engages the students in the study of Islam as a textual tradition inscribed in the fundamental sources of Islam; Qur'an and Hadith, history and cultural contexts. The subject seeks to introduce Islam through a large variety of expressions (literary, poetic, social, and political) and through a variety of methods (literary criticism, hermeneutics, history, sociology, and anthropology). It provides introduction to foundations of Islam that include Qur'anic studies, Hadith and Seerah of Prophet Muhammad (PBUH), Islamic philosophy, and Islamic law, culture and theology through the textual study of Qur'an and Sunnah. It is one of the best systems of education which grooms a person with the qualities which he/she should have as a human being.

Contents

1. Study of the Qur'an
2. *Surah Al-Baqarah, Al-Furqan, Al-Ahzab, Al-Mu'minoon, Al-An'am, Al-Hujurat, Al-Saff*
3. Study of the Hadith (Introduction to Hadith literature, Selected Ahadith (Text and Translation)
4. Introduction to Qur'anic Studies
5. Basic Concepts of Qur'an
6. History of Quran
7. Basic Concepts of Hadith
8. History of Hadith
9. Kinds of Hadith
10. Uloom –ul-Hadith
11. Sunnah & Hadith
12. Seerat ul-Nabi (PBUH), necessity and importance of Seerat
13. Pact of Madinah, Khutbah Hajjat al-Wada' and ethical teachings of Prophet (PBUH)
14. Legal Position of Sunnah
15. Islamic Culture & Civilization
16. Characteristics of Islamic Culture & Civilization
17. Historical Development of Islamic Culture & Civilization
18. Comparative Religions and Contemporary Issues
19. Impact of Islamic civilization

Recommended Texts

1. Hassan, A. (1990). *Principles of Islamic jurisprudence*. New Delhi: Adam Publishers.
2. Zia-ul-Haq, M. (2001). *Introduction to al-Sharia al-Islamia*. Lahore: Aziz Publication.

Suggested Readings

1. Hameedullah, M. (1942). *Muslim conduct of state*. Lahore: Sh M Ashraf Publisher.
2. Hameedullah, M. (1957). *Introduction to Islam*. Lahore: Sh M Ashraf Publisher.
3. Hameedullah, M. (1980). *Emergence of Islam*. New Delhi: Adam Publishers.

This course is an introduction to the philosophical study of morality including the theory of right and wrong behavior, the theory of value (goodness and badness), and the theory of virtue and vice. Besides providing familiarity with the primary questions addressed within moral philosophy and the most influential answers given by well-known philosophers, this course is designed to help students develop their abilities to read, explicate, analyze, and evaluate philosophical literature, write and express themselves well about their own ethical positions, and think critically and analytically about ethical issues. This course is intended for the students who have had little or no prior exposure to philosophy. It will provide a broad but reasonably detailed examination of the central issues of moral philosophy and will also consider how these can be applied to several contemporary moral problems. This course has been designed to familiarize about some of the most important theories and figures of moral philosophy in the hope that you can develop a clear understanding of the questions that recur in ethical debate.

Contents

1. Overview of moral philosophy
2. Theoretical ethics
3. Moral concepts and justify moral principles and theories
4. Applied ethics: an Islamic point of view
5. Metaphysics and morality
6. Moral objectivism and relativism
7. Features of moral objectivism
8. Qur'an and sunnah on ethics
9. Individual relativism
10. God and morality
11. Criticism and its manners
12. Reason and emotion
13. Principles of moral reasoning
14. Ethics in *Seerah* and *Taswwuf*
15. Gender and morality
16. Significant Muslim masters of ethics
17. Rule-utilitarianism, moral foundations of authorities
18. The social contract, libertarianism, welfare liberalism

Recommended Texts

1. Mackenzie, J. S. (1983). *A manual of ethics*. London: University Tutorial Press.
2. Nadwi, S. S. (1999). *Ethics in Islam*. Karachi: Darul-Ishaat.

Suggested Readings

1. Cahn, S. M., & Markie, P. (2019). *History, theory, and contemporary issues*. Oxford: Oxford University Press.
2. Williams, B. (1972). *Morality: An introduction to Ethics*. Cambridge: Cambridge University Press.

The course aims to introduce students with basic anatomy of farm animals. Veterinary anatomy is the study of the internal biological structures and systems of animals, including the respiratory, cardiovascular, reproductive and neurological systems. Undergraduate programs in veterinary technology and animal science often include animal anatomy classes. The anatomy of animals has long fascinated people; with mural paintings depicting the superficial anatomy of animals, dating back to the Paleolithic era. Anatomy and physiology are unarguably fundamental aspects of medical education and can be taught in many ways including dissection, 'self-directed learning' and 'problem-based learning'. Recent developments in technology have allowed digital anatomical models to be implemented into university curricula, allowing wider access to the study of anatomy for the contemporary student. This course will help the students to identify different anatomical structures of livestock. They will be able to differentiate animal species based on internal structures. Approach of students towards therapeutic treatments for different anomalies will become easy due to proper understanding of anatomical positions of different organs.

Contents

1. Anatomical terminology, classification and functions of skeleton
2. Muscular and nervous system; skeletal muscles and their functions; muscle contraction; levers
3. Neurons: receptors; the reflex arc
4. Digestive system: the mouth, teeth, tongue, salivary glands, pharynx, esophagus, ruminant and non-ruminant, stomach, intestines, pancreas, liver and spleen; the peritoneum
5. Respiratory system: the nostrils, nasal cavity, pharynx, larynx and trachea; pleura and lungs
6. Urinary system: the kidneys, ureters, urinary bladder and urethra
7. Genital system: male genital organs including scrotum, testes, spermatic cord, vesiculae seminalis, prostate, uterus masculinus, bulbourethra glands and the penis
8. Female genital organs including ovaries, fallopian tubes, uterus, vagina, vulva and mammary glands
9. Endocrine glands: hypophysis cerebri, epiphysis cerebri, thyroid, parathyroid, adrenal, pancreas, ovaries and testes
10. Angiology study of heart pericardium and major arteries and veins; superficial lymph glands
11. Anesthesiology: study of sense organs and the common integuments

Practical

1. Identification of various bones, ligaments, tendons and their attachment to the bones
2. Form, structure and topographical study of various organs located in the thoracic, abdominal and pelvic cavities of different domestic animals

Recommended Texts

1. Frandson, R. D. (1975). *Anatomy and Physiology of Farm Animals*. Philadelphia, USA: Lea and Febiger.
2. Sisson, A., & Grossman, J. D. (1972). *Anatomy of Domestic Animals*. Philadelphia, USA: W.B. Saunders.

Suggested Readings

1. Ankers R.M., & Denbow, D.M. (2008). *Anatomy and Physiology of Domestic Animals*. UK: Blackwell Publishing.
2. Molgaard. (1999). *Veterinarian Anatomy and Physiology*. USA: Delmar Publishers.

Academic writing is a formal, structured and sophisticated writing to fulfill the requirements for a field of study. The course aims at providing understanding of writer's goal of writing (i.e. clear, organized and effective content) and to use that understanding and awareness for academic reading and writing. The objectives of the course are to make the students acquire and master the academic writing skills. The course would enable the students to develop argumentative writing techniques. The students would be able to the content logically to add specific details on the topics such as facts, examples and statistical or numerical values. The course will also provide insight to convey the knowledge and ideas in objective and persuasive manner. Furthermore, the course will also enhance the students' understanding of ethical considerations in writing academic assignments and topics including citation, plagiarism, formatting and referencing the sources as well as the technical aspects involved in referencing.

Contents

1. Academic vocabulary
2. Quoting, summarizing and paraphrasing texts
3. Process of academic writing
4. Developing argument
5. Rhetoric: persuasion and identification
6. Elements of rhetoric: Text, author, audience, purposes, setting
7. Sentence structure: Accuracy, variation, appropriateness, and conciseness
8. Appropriate use of active and passive voice
9. Paragraph and essay writing
10. Organization and structure of paragraph and essay
11. Logical reasoning
12. Transitional devices (word, phrase and expressions)
13. Development of ideas in writing
14. Styles of documentation (MLA and APA)
15. In-text citations
16. Plagiarism and strategies for avoiding it

Recommended Texts

1. Swales, J. M., & Feak, C. B. (2012). *Academic writing for graduate students: Essential tasks and skills* (3rd ed.). Ann Arbor: The University of Michigan Press.
2. Bailey, S. (2011). *Academic writing: A handbook for international students* (3rd ed.). New York: Routledge.

Suggested Readings

1. Craswell, G. (2004). *Writing for academic success*. London: SAGE.
2. Johnson-Sheehan, R. (2019). *Writing today*. Don Mills: Pearson.
3. Silvia, P. J. (2019). *How to write a lot: A practical guide to productive academic writing*. Washington: American Psychological Association.

Livestock is a subsector of Pakistan's agriculture sector which contributes approximately 56% of value addition in agriculture and nearly 11% to the gross domestic product (GDP). Livestock production makes a major contribution to agriculture value added services. This course is about animal production and management economics. The objectives of the course are to provide students with an advanced understanding of the economics of animal feeds and feeding, to provide a good understanding of principles of aggregate demand and supply in livestock trade and to provide students with an understanding of marketing margins for dairy products, integration and management of livestock enterprises, integration of livestock and crop enterprises. After taking this course, students will be able to know economics of livestock production. Student will also be able to know 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

1. Importance of livestock in the economy of Pakistan
2. Comparative economics of livestock and crop enterprises
3. Economics of Livestock and Poultry
4. Economic analysis of Livestock Products
5. Cost and profitability estimations procedures
6. Labor-input estimate
7. Capital input estimate
8. Economics of milk, Beef and hides and skins
9. Economics of green fodder
10. Dry fodder and concentrates
11. The livestock industry structure and problems
12. Economic losses due to various factors
13. Techniques of estimation of losses
14. Economic analysis of budgeting with different techniques
15. Economics of genetic engineering in Livestock
16. Measures of economic efficiency
17. Uncertainty and risk
18. Trend and future of livestock and poultry

Recommended Texts

1. Ahmed, B., Ahmed, M., & Chaudhry, M. A. (1996). *Economics of Livestock Production*, Faisalabad: University of Agriculture, Faculty of Agri. Economics and Rural Sociology.
2. Ruhela, A. (2010). *Livestock Economics*. Jaipur, India: Oxford Book Company.

Suggested Readings

1. Bernad, C.S., & Nix, J.S. (1979). *Farm Planning and Control* (2nd ed.). Cambridge: University Press.
2. Kay, R. D., Edwards, W., & Duffy, P. (2007). *Farm Management: Planning, Control and Implementation* (6th ed.). London: McGraw Hills.
3. Khan, M.J., & Rehman, H. (1982). *Papers and Proceedings of the Workshop on Economics of Village Livestock*. Lahore: Punjab Economic Research Institute.

This is an introductory course which enables the students to understand the basics of food science and technology. Students will explore and gain an understanding into the history of food science and the factors that have shaped food science in Pakistan, the organizations involved in food manufacturing, food regulatory processes, food composition, its classification depending on sources, consumption pattern and basic analysis of food components. The course is the study of the physical, biological, and chemical makeup of food; the causes of food deterioration; and the concepts underlying food processing. Food scientists and technologists apply scientific disciplines including chemistry, engineering, microbiology, and nutrition to the study of food to improve the safety, nutrition, wholesomeness and availability of food. Depending on their area of specialization, food scientists may develop ways to process, preserve, package, and/or store food according to industry and government specifications and regulations. It could involve enhancing the taste, making it last longer, making sure it's safe to eat or even boosting its nutritional content.

Contents

1. Introduction to food science, food technology, relationship with other disciplines
2. Career opportunities
3. Significance of food science and technology
4. Food industry: history, developments, important food industries in Pakistan
5. Food sources: plants, animals and marine
6. Food constituents and their functions: water, carbohydrates, lipids, proteins, vitamins, minerals.
7. Classification of foods on the basis of perishability and pH
8. Food spoilage agents: enzymes, microorganisms, pests, physical factors
9. Principles of food preservation: prevention or delay of autolysis, microorganisms and pests

Practical

1. Use of basic food laboratory equipment.
2. Estimation of Moisture, Fat, Protein, Carbohydrates, Fiber and Ash content in food samples.
3. Determination of soluble solids, total solids, pH, Acidity, total sugars, Specific gravity and Refractive index.

Recommended Texts

1. Awan, J. A. (2018). *Food science and technology*. Faisalabad, Pakistan: Unitech Communications.
2. Robert, L. S., Ramirez, A. O., Clarke, A. D. (2015). *Introducing Food Science* (2nd ed.) Boca Raton, Florida: CRC Press.

Suggested Readings

1. Potter, N. N., & Hotchkiss, J. H. (2012). *Food science*. Berlin, Germany: Springer Science & Business Media.
2. Stewart, G. F., & Amerine, M. A. (2012). *Introduction to food science and technology*. London, UK: Elsevier.

The main purpose of this course is to give brief introduction of Agricultural Extension education at undergraduate level. The students must know the history and philosophy of agricultural education in the development of present era agricultural system across the world. The following such as concepts of Extension education and rural development, principles of effective extension work, concepts of program planning, research, program evaluation and their importance in agricultural extension and rural development work, Role of communication and ICTs in extension work and development activities in rural areas for the growth of the masses are important to disseminate among undergraduate students so that students will prepare themselves to learn more advance ideas in agricultural education and research.

Contents

1. Agricultural extension; its definition, objectives and importance
2. Types of education, Brief history/recent trends in agricultural extension
3. Organizational setup of agricultural extension in Pakistan
4. Rural development, its definition/concept, objectives, importance and indicators
5. Elements of rural development process
6. Rural development through agricultural extension work in Pakistan
7. Characteristics and problems of Pakistani farmers
8. Current issues and problems of rural development and extension work in Pakistan
9. Roles and duties of extension workers at various organizational levels
10. Extension programs and activities since 1947 to date in Pakistan
11. Role of communication and ICT in Extension and Rural Development work
12. Principles of effective extension work
13. Adoption and diffusion of agricultural innovations
14. Agricultural Technology and its application for Pakistani farmers
15. Extension, research and farmer's linkages
16. Basic concept of planning, monitoring and evaluation in Agricultural Extension

Recommended Texts

1. Ison, R., & Russell, D. (2004). *Agricultural Extension and Rural Development: Breaking out of Knowledge Transfer Traditions*. Cambridge: University Press.
2. Ray, G.L. (2006). *Extension Communication and Management*. New Dehli:Kalyani Publishers.

Suggested Readings

1. Bashir, E. (2005). *Extension Methods* (2nd ed.). Islamabad: National Book Foundation.
2. Leeuwis, C., & Van den Ban, A. (2004). *Communication for rural Innovation: Rethinking Agricultural Extension* (3rd ed.). Wiley-Blackwell.
3. Narasaiah, M.L. (2003). *Approaches to Rural Development*. New Delhi (India) :Discovery Publishing House.

The course is designed to acquaint the students of BS Programs with the rationale of the creation of Pakistan. The students would be apprised of the emergence, growth and development of Muslim nationalism in South Asia and the struggle for freedom, which eventually led to the establishment of Pakistan. While highlighting the main objectives of national life, the course explains further the socio-economic, political and cultural aspects of Pakistan's endeavors to develop and progress in the contemporary world. For this purpose, the foreign policy objectives and Pakistan's foreign relations with neighboring and other countries are also included. This course has been developed to help students analyze the socio-political problems of Pakistan while highlighting various phases of its history before and after the partition and to develop a vision in them to become knowledgeable citizens of their homeland.

Contents

1. Contextualizing Pakistan Studies
2. Geography of Pakistan: Geo-Strategic Importance of Pakistan
3. Freedom Movement (1857-1947)
4. Pakistan Movement (1940-47)
5. Muslim Nationalism in South Asia
6. Two Nations Theory
7. Ideology of Pakistan
8. Initial Problems of Pakistan
9. Political and Constitutional Developments in Pakistan
10. Economy of Pakistan: Problems and Prospects
11. Society and Culture of Pakistan
12. Foreign Policy Objectives of Pakistan and Diplomatic Relations
13. Current and Contemporary Issues of Pakistan
14. Human Rights: Issues of Human Rights in Pakistan

Recommended Texts

1. Kazimi, M. R. (2007). *Pakistan Studies*. Karachi: Oxford University Press.
2. Sheikh, J. A. (2004). *Pakistan's Political Economic and Diplomatic Dynamics*. Lahore: Kitabistan Paper Products.

Suggested Readings

1. Hayat, S. (2016). *Aspects of Pakistan Movement*. Islamabad: National Institute of Historical and Cultural Research.
2. Kazimi, M. R. (2009). *A Concise History of Pakistan*. Karachi: Oxford University Press.
3. Talbot, I. (1998). *Pakistan: A Modern History*. London: Hurst and Company.

This is a graduate level introductory course about the commercial poultry and rural poultry farming in Pakistan. Study of poultry as a science is one of the major disciplines of animal science and includes broiler, layer and breeder production and hatchery management. This course tells about components of commercial poultry industry and basic terms used in the poultry science. This course also tells about role of poultry industry in national economy and importance of poultry in our daily lives. It also elaborates the history and status of poultry production in Pakistan. This course also studies the types of poultry birds, their species and breeds and body characteristics. This course is aimed at introducing the commercial poultry housing and poultry farming as an enterprise. After taking this course, students will be able to know the importance of poultry farming, the basics of commercial poultry farming and significance of poultry business.

Contents

1. Importance of poultry science
2. Status of poultry production in Pakistan
3. Classification of world poultry
4. Poultry breeds and their characteristics
5. Strains for egg and meat production
6. Basic terms used in poultry production
7. Poultry housing and its types
8. Equipment used in poultry production
9. Poultry feeding
10. Selection and culling in poultry
11. Waste management
12. Rural poultry production
13. Biosecurity
14. Record keeping

Practical

1. Description and demonstration of different poultry breeds
2. Body parts of chicken
3. Structure of egg
4. Selection and culling techniques
5. Dead bird disposal pit
6. Visit to commercial poultry farms

Recommended Texts

1. Haq, A., & Akhtar M. (2004). *Poultry Farming*. Islamabad, Pakistan: Higher Education Commission.
2. Parsad, J. (2015). *Poultry Production and Management* (5th ed.). New Delhi, India: Kalyani Publishers.

Suggested Readings

1. Bell, D. D., & William, D. W. Jr. (2002). *Commercial Chicken Meat and Egg Production* (5th ed.). USA: Springer publisher.
2. Boushy, El. A. H., & Van der Poel, A. F. B. (2000). *Handbook of Poultry Feed from Waste*. Netherlands: Springer.

This course will help the students to understand functioning of different systems and organs of domestic animals. They will be able to differentiate between the normal and abnormal physiology of all vital organs, which will ultimately help them to identify the problem with the animals. Veterinary physiology deals with the investigation of animal systems and the functioning of these biological systems. It includes the study of how animals work and the physical and chemical processes that occur within animals. Animal physiologists study how animals react to internal and external elements in their environment. The examples of various biological processes in animals include gas exchange, blood and circulation, osmoregulation, digestion, nervous and muscle systems and endocrinology. Animal Physiology studies include the anatomy, histology and endocrine functioning of the physiological processes of livestock, under specific conditions. This also includes the possible manipulation of the reproductive processes by means of accelerated breeding techniques for more efficient livestock and poultry production. The main objective of the course is to make students able to understand physiology of farm animals.

Contents

1. Introduction: intracellular organization and physiology
2. Body fluids, blood, lymph, cerebrospinal fluid, synovial fluid
3. Blood circulation and cardiovascular system
4. Physiological properties and cellular and chemical constituents of blood, blood coagulation, blood groups and their importance in livestock
5. The conduction system of the heart; regulation of cardiac output, regulation of the heart and blood vessels; regional circulation and pulmonary circulation
6. Respiratory system: mechanism of respiration, types of breathing, air volumes and capacities exchange of gases, control of respiration, artificial respiration
7. Difference between simple stomach and poly gastric animals (Digestive system)
8. Water balance and excretion: electrolytes, physiology of the kidney and physiology of the skin
9. Endocrine glands and their secretions and functions, physiology of lactation
10. Nervous system, spinal cord and brain functions, autonomic nervous system
11. Rumen biochemistry

Practical

1. Collection of blood in different species of animals and use of anticoagulants
2. Measurement of normal pulse, respiration and rectal temperature
3. Hematological experiments, determination of blood groups, determination of blood pressure
4. Determination of various lung capacities and volume
5. Urine examination for normal constituents, microscopic examination of urine; test for saliva
6. Dissection for location for endocrine glands in rat and chicken

Recommended Texts

1. Cunningham, J.G., & Bradley, G.K. (2007). *Textbook of Veterinary Physiology* (4th ed.). Philadelphia: Saunders.
2. Mohrman, D.E., & Heller L.J. (2006). *Cardiovascular Physiology*. New York: McGraw Hill.

Suggested Readings

1. Ankers, R.M., & Denbow, D.M. (2008). *Anatomy and Physiology of Domestic Animals*. UK: Blackwell Publishing.
2. Rahman, Z. U., Aslam B., & Khaliq, T. (2010). *Physiology-I*. Faisalabad: University of Agriculture, Department of Physiology and Pharmacology.

The course provides the students theoretical and practical knowledge about veterinary medicine and imparts skills to diagnose and prevent important livestock diseases in Pakistan. Medicine is the art and science of healing. Preventive healthcare, or prophylaxis, consists of measures taken for disease prevention. Veterinary medicine is the branch of medicine that deals with the prevention, control, diagnosis and treatment of disease, disorder and injury in animals and along with this, it also deals with animal rearing, husbandry, breeding, research on nutrition and product development . The scope of veterinary medicine is wide, covering all animal species, both domesticated and wild, with a wide range of conditions, which can affect different species; however, this course deals with the domestic animals only. Preventive veterinary medicine is a field of veterinary medicine that focuses on the detection and dissemination of information to prevent, control, or eradicate diseases that may affect both animals and humans. This course introduces the students with basic concept of preventive medicine. The students will study about concept of modern disease diagnostic techniques.

Contents

1. Concept of disease and health in animal and human medicine
2. Importance of animal diseases in national economy, signs of health and disease
3. Types of animal diseases on the basis of etiology
4. Stress and immune system, body defense against diseases
5. Principles of treatment of diseases, prevention, control and eradication of diseases
6. Etiology, epidemiology, pathogenesis, diagnosis, treatment, prevention, control and eradication (where relevant) of important diseases/disorders of livestock
7. Macro and micro element deficiencies and imbalances relevant in Pakistan
8. Disinfection, biosecurity and metaphylaxis
9. Zoonosis, WTO Accord in relation to the animal diseases prevalent in Pakistan
10. Drug residues, veterinary medicine in relation to human health

Practical

1. Behavior of different animal species as it relates to the practice of veterinary medicine. Demonstration of methods of restraining of different animal species
2. Recording the cardinal parameters of health (Body temperature, pulse and respiration)
3. Demonstration of disease diagnostic methods
4. Methods of drug administration in animals (oral and parenteral)
5. Demonstration of veterinary first aid procedures

Recommended Texts

1. Robert F. K. (2001). *Viral Diseases of Cattle* (2nd ed.). USA: Wiley publishers, Iowa State University Press.
2. Radostits, O.M., Gay, C.C., Blood, D.C., & Hinchcliff, K.W. (2000). *Veterinary Medicine* (10th ed.). Philadelphia, USA: W.B. Saunders Co.

Suggested Readings

1. Chakrabarti, A. (2000). *A Textbook of Preventive Veterinary Medicine*. New Delhi, India : CBS & IBH Publications.
2. Hungerford, T.G. (1991). *Hungerford's Diseases of Livestock* (9th ed.). Sydney, Australia: McGraw-Hill Book.

The course provides an overview of Genetics. Genetics is a field of biology that studies how traits are passed from parents to their offspring. The passing of traits from parents to offspring is known as heredity, therefore, genetics is the study of heredity. This introduction to genetics takes you through the basic components of genetics such as DNA, genes, chromosomes and genetic inheritance. Genetics is built around molecules called DNA. DNA molecules hold all the genetic information for an organism. It provides cells with the information they need to perform tasks that allow an organism to grow, survive and reproduce. A gene is one particular section of a DNA molecule that tells a cell to perform one specific task. Heredity is what makes children look like their parents. During reproduction, DNA is replicated and passed from a parent to their offspring. This inheritance of genetic material by offspring influences the appearance and behaviour of the offspring. The environment that an organism lives in can also influence how genes are expressed.

Contents

1. Definition of genetics, concepts of heredity and variation
2. Cell and cell divisions. Mendelian genetics: chromosome
3. Theory of heredity, various genotypic and phenotypic ratios and their modifications
4. Differences between allelic and non-allelic interactions (epistasis), illustration of epistasis
5. Pleiotropy and multiple allelism
6. Multiple factor hypothesis.
7. Linkage and crossing over
8. Sex determination: sex-linked and sex influenced traits
9. Chromosomal aberrations
10. Nucleic acids: nature, structure and function
11. Classical vs modern concepts of gene

Practical

1. Study of cell divisions and gametogenesis
2. Calculation of monohybrid and dihybrid ratios
3. Numerical examples: gene interaction, multiple alleles and multiple factor inheritance
4. Calculation of linkage from test cross and F_2 data

Recommended Texts

1. Klug, W.S., & Cummings, M. R. (2003). *Concepts of Genetics* (7th ed.). Singapore: Pearson Education.
2. Singh, B.D. (2004). *Genetics*. New Delhi: Kalyani Publishers.

Suggested Readings

1. Khan, I.A., Azhar, F.M., Ali, Z., & Khan, A.A. (2008). *Solving Numerical Genetic Problems*. Faisalabad: University of Agriculture.
2. Singh, P. (2003). *Elements of Genetics* (2nd ed.). Delhi: Kalyani Publishers.
3. Stansfield, W.D. (1988). *Theory and Problems of Genetics* (4th ed.). New York, NY: McGraw-Hill Book.

This course is aimed to make the students familiar with the basic information about the study of insects. The students would be able to know about arthropods and especially insects with their morphological features, identify insects of economic importance and acquire working skills for collecting, mounting, and preserving insects. The course briefs about the basic external and internal morphological and anatomical features along with their basic functioning principles. Students will learn as well about the insect classification and nomenclature. They can easily identify the insect order, family and type and can properly collect, mount and preserve these invertebrates for further studies. Insect body features and their habits help for their identification. This is a basic course that enables the students to further understand the ways and techniques adopted for the control and management of economically important insect pests.

Contents

- 1 Introduction
- 2 Phylum Arthropoda and its classification
- 3 Metamorphosis and its types
- 4 External and internal morphology and physiology with a reference to typical insect, 'ak' grasshopper, *Poekiloceruspictus*
- 5 Insect classification and nomenclature
- 6 Salient characters of insect orders with important families and examples of important members

Practical

- 1 Characters of classes of Arthropoda
- 2 Collection and preservation of insects
- 3 Morphology and dissection of a typical insect (digestive, reproductive, excretory, nervous, circulatory and tracheal systems)
- 4 Temporary mounts of different types of appendages of insects
- 5 Observations for types of metamorphosis

Recommended Texts

1. Lohar, M.K. (1998). *Introductory Entomology*. Hyderabad: Kashif Publications.
2. McGavin, G. C. (2001). *Essential entomology: an order-by-order introduction*. USA: Oxford University Press.

Suggested Readings

1. Mani, M.S. (1990). *General Entomology* (4th ed.) Delhi: Oxford/IBH Publishing Co.
2. Tonapi, G.T. (1994). *Experimental Entomology, an Aid to Lab. and Field Studies*. Delhi: C.B.S. Publishers.

Students will be involved in learning activities that generally prepare them to apply the economic and business principles involved in the organization, operation, and management of the farm, ranch or agribusiness. Typical instructional activities include hands-on experiences with applying modern economic and business principles involved in the organization, operation, and management of agricultural businesses including the production and marketing of agricultural products and services and knowhow of new trends in international trade of agricultural commodities. After completing the course, students will be well-equipped with the basic concepts of Agribusiness and Trade.

Contents

1. Definition, concepts, Important features and scope of Agribusiness Management
2. Elements and Functions of management
3. Forms of business organizations
4. Agribusiness financial management
5. Agricultural marketing; Marketing channels, functionaries and margins
6. Role of agri. marketing in economic development
7. Agricultural marketing problems
8. The changing world and interdependence
9. Basis of trade; gains from trade
10. Concept of absolute and comparative advantage; pattern of trade
11. Brief introduction of major trade agreements

Recommended Texts

1. Kohls, R.L., Uhl, J.N., & Hurt, C. (2007). *Marketing of Agricultural Products* (10th ed.). New Jersey: Prentice Hall.
2. Salvatore, D. (2007). *International economics* (9th ed.): Wiley Publisher.

Suggested Readings

1. Downey, W.D., & Erickson, S. P. (2002). *Agribusiness Management*, Singapore: McGraw Hill Education.
2. Hoekman, B. M., Mattoo, A., & English, P. (2002). *Development, Trade and the WTO-A Handbook*. Washington, DC: The World Bank.

In order to secure the future of a society, citizens must train younger generations in civic engagement and participation. Citizenship education is education that provides the background knowledge necessary to create an ongoing stream of new citizens participating and engaging with the creation of a civilized society. Community engagement seeks to better engage the community to achieve long-term and sustainable outcomes, processes, relationships, discourse, decision-making, or implementation. This course will provide a critical interrogation of the central conceptual issues as well as an examination of how to design a program of effective community engagement. This course begins by asking: Why involve citizens in planning and policymaking? This leads to an examination of the politics of planning, conceptualizations of "community" and, to the tension between local and professional knowledge in policy making. This course will also analyze different types of citizen engagement and examine how to design a program of public participation for policy making. Approaches to evaluating community engagement programs will also be a component of the course.

Contents

1. Introduction to Citizenship Education and Community Engagement: Orientation
2. Introduction to Active Citizenship: Overview of the ideas, Concepts, Philosophy and Skills
3. Identity, Culture and Social Harmony: Concepts and Development of Identity
4. Components of Culture and Social Harmony, Cultural & Religious Diversity
5. Multi-cultural society and inter-cultural dialogue: bridging the differences, promoting harmony
6. Significance of diversity and its impact, Importance and domains of inter-cultural harmony
7. Active Citizen: Locally active, globally connected
8. Importance of active citizenship at national and global level
9. Understanding community, Identification of resources (human, natural and others)
10. Human rights, Constitutionalism and citizens' responsibilities: Introduction to human rights
11. Universalism vs relativism, Human rights in constitution of Pakistan
12. Public duties and responsibilities
13. Social Issues in Pakistan: Introduction to the concept of social problem, Causes and solutions
14. Social Issues in Pakistan (Poverty, Equal and Equitable access of resources, unemployment)
15. Social Issues in Pakistan (Agricultural problems, terrorism & militancy, governance issues)
16. Social action and project: Introduction and planning of social action project
17. Identification of problem, Ethical considerations related to project
18. Assessment of existing resources

Recommended Books

1. Kennedy, J. K., & Brunold, A. (2016). *Regional Context and Citizenship Education in Asia and Europe*. New York: Routledge Falmer.
2. Macionis, J. J., & Gerber, M. L. (2010). *Sociology*. New York: Pearson Education.

Suggested Readings

1. British, Council. (2017). *Active Citizen's Social Action Projects Guide*. Scotland: British Council.
2. Larsen, K. A., Sewpaul, V., & Hole, G. O. (Eds.). (2013). *Participation in Community Work: International Perspectives*. New York: Routledge.

This is an undergraduate level course which describes the importance of selection by nature and important aspects of the domestication process. Mankind started to create breeds accompanied with artificial selection 250 years ago. Nowadays, breeding of high productive farm animals, like cattle, pigs and poultry is in the hands of multinational companies which invest a lot of money in state-of-the-art breeding programs. The breeding of sheep, goats, horses and companion animals, e.g. the dog is based on individual breeders collaborating in the setting of a herd book or a breeder's association. Animal breeding is aiming at the improvement of animals by changing their genetic abilities for important traits. These traits are determined by the requirements and wishes from the society which might change over time. Animal breeding is highly influenced by research and developments in population-, quantitative- and molecular genetics. Sometimes, unexpected negative effects of animal breeding are observed that require adequate corrections. A breeding program will be presented here as a circular activity. Each generation, the program starts with formulating the breeding goal and ends with a critical review of the results obtained in the next generation. The evaluation might lead to a reconsideration of the breeding goal for the next round of selection.

Contents

1. History of animal genetics
2. Animal genetic resources of Pakistan
3. Role of animal breeding in livestock production
4. Opportunities for breeding and improvement of farm animals and poultry
5. Animal genetic resources
6. National breeding policy, Constraints and future breeding plans.
7. Emerging breeding technologies, Selection methods and kinds.
8. Various systems of breeding: inbreeding, line-breeding, out-breeding, out-crossing, crossbreeding, grading up
9. Development of inbred lines, selection for best combining abilities, reciprocal recurrent selection. Traits of economic importance in cattle/buffalo, sheep/goat and poultry.
10. Role of breed registry societies/associations in developed countries and its application in Pakistan.
11. Conservation of animal genetic resources: scope, techniques and problems
12. Biotechnologies in animal breeding

Practical

1. Exercises on biometrical concepts related to measures of central tendency
2. Measures of dispersions and association among traits at phenotypic and genetic level

Recommended Texts

1. Lasley, J. F. (1987). *Genetics of Livestock Improvement*. New Jersey, USA: Prentice-Hall; Englewood Cliffs.
2. Willis, M. B. (1998). *Dalton's Introduction to Practical Animal Breeding*. UK: Blackwell Science.

Suggested Readings

1. Bourdon, R. M. 2000. *Understanding Animal Breeding*. Upper Saddle River, NJ, USA: Prentice-Hall.
2. Legates, J. E., & Warwick, E. J. (1990). *Breeding and Improvement of Farm Animals*. New York, USA: McGraw-Hill.

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

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. Ensminger, M.E. , Oldfield J.E., & Heinemann, W.W. (1990). *Feeds and Nutrition Digest*. California, USA: The Ensminger Publishing.
2. McDonald, P., Edwards, R.A., Greenhalgh, J.F.D., & Morgan, C.A. (2002). *Animal Nutrition*. UK: Longman scientific and technical publisher.

Suggested Readings

1. Cheeke, P.R. (2004). *Applied Animal Nutrition, Feeds and Feeding*. Canada: Delmar Publisher.
2. Khan, M.L. (2001). *Poultry Feeds and Nutrition*. Urdu Bazar, Lahore.: Kitabistan Pub.
3. Pond, W.G. & Church, D.C. 2005. *Basic Animal Nutrition and Feeding*. India.: Wiley.

Rangeland, also called Range, any extensive area of land that is occupied by native herbaceous or shrubby vegetation which is grazed by domestic or wild herbivores. Temperate and tropical forests that are used for grazing as well as timber production can also be considered rangeland. Rangelands thus occupy about 40–50 percent of the land area of the Earth. In concrete terms, range-management practices center on the regulation of the number of animals allowed to graze on a given range, along with the duration and season of their grazing. The stocking of a range must be carefully regulated so that the existing grasses are not depleted or exhausted from overgrazing. Overgrazing of the vegetation reduces the production of forage; exposes the soil to sealing, baking, and erosion; reduces the infiltration of water into the soil; increases water runoff and flooding; and induces unfavorable changes in the botanical composition of the vegetation. After completing the course, students will be well-equipped with the basic concepts of range livestock production.

Contents

1. Introduction to ranges; basic concepts and terminology
2. Range statistics; ecological zones of world/Pakistan
3. Soil, plant and animal relationship; various range animals
4. Range management policy
5. Vegetation manipulation and other tools for improvement
6. Important range and cultivated grasses; trees and shrubs as animal feed
7. Grazing management systems and supplementary feeding
8. Grazing capacity and stocking rates; effect of climate on animals and vegetation
9. Shelter on ranges and fence types; housing of range livestock; wild animals
10. Poisonous plants their hazards and prophylactic measures on ranges

Practical

1. Identification of various range grasses, trees, shrubs and cultivated forages
2. Preservation/mounting of important range grass samples
3. Determining range carrying capacity and forage production
4. Animal units and stocking rates
Animal take off rate
5. Visit to rangelands

Recommended Texts

1. Muhammad, N. (1989). *Rangeland Management in Pakistan*. Kathmandu, Nepal: Intl. Centre for Integrated Mountain Development.
2. Qureshi, M. A. A., Khan, G. S., & Yaqoob, M. S. (1993). *Range Management in Pakistan*. Ganpat Road, Lahore: Kazi Publications.

Suggested Readings

1. Heady, H.F. (1975). *Rangeland Management*. New York, USA: McGraw Hill Book.
2. Qureshi, M.A.A., Ishaq, M. & Khan, R.A. (2000). *Field Exercises in Range management and Wildlife*. Faisalabad: University of Agriculture.

This course will help to improve the knowledge of students about health and diseases of farm animals, which is to be applied in their professional life. Farmers can improve the health, welfare and productivity of their animals through animal health planning. Animal Health Planning is a continuous improvement method that encourages the development of health building and disease control measures appropriate to the particular farm circumstances leading to a system that is progressively less dependent on veterinary medicines without jeopardizing welfare. A farm animal health plan is an active management tool aimed at promoting the health and welfare of farm animals by setting out disease prevention, detection and management procedures. It should be based on farm specific issues and at its most basic, it should be ensured that illness, injury and mortality amongst farmed animals are at minimum levels. More progressively, it should also be seen as providing procedures that promote positive health and welfare. This course will provide a comprehensive knowledge about vaccines and vaccination schedules of common diseases of our farm animals. Students will be able to collect samples for disease diagnosis.

Contents

1. Concept of farm animal medicine/herd medicine
2. Methods of prevention and control of diseases in farm animals
3. Recognition of systemic disorders and introduction to bacterial, viral, fungal, parasitic and metabolic disorders in farm animals
4. Biosecurity on farms , systemic disorders
5. Bacterial and viral diseases: fungal diseases: ring worm, aspergillosis, histoplasmosis, dermatophilosis, candidiasis, degnala disease and mycotoxicosis
6. Parasitic diseases: coccidiosis, bebesiosis, and theileriosis
7. Diseases caused by nematodes, cestodes, termatodes and arthropodes
8. Metabolic disorders and deficiency diseases: parturient haemoglobinuria, milk fever, transit tetany, lactation tetany, hypomagnasemic tetany, ketosis
9. Vitamin and mineral deficiencies/imbbalances
10. Poultry diseases: gumboro, ND, pullorum, CRD etc.

Practical

1. Vaccination and deworming schedule for farm animals
2. Mastitis microbiology; evaluation of milking machine
3. Microbiological examination of milk and other dairy products for potential human pathogens
4. Diagnostic techniques for brucellosis, hydatidosis etc.
5. Detection of milk and other dairy products, manual and computerized farm records

Recommended Texts

1. Kahrs, R. (2001). *Viral Diseases of Cattle*. Oxford, UK: Blackwell Science.
2. Radostits, O.M., Gay, C.C., Hinchcliff, K.W., & Constable, P.D. (2007). *Veterinary Medicine- A Textbook of the Disease of Cattle, Sheep, Pigs, Goats and Horses* (10TH ed.). Philadelphia, USA: W.B. Saunders Co.

Suggested Readings

1. Hungerford. T. G. (1991). *Hungerford's Disease of Livestock* (9th ed.). Sydney: McGraw-Hill.
2. Khan, B.B. (2008). *Health and Husbandry of Dairy Animals*. Faisalabad, Pakistan: Pak TM. Printers.

The world has now embraced the largest revolution so far in the history of mankind called communication revolution. Everything has been tagged to communication. Communication provides the way to resolve mutual conflicts not only between two individuals, groups but also between the countries. Communication has lot more importance in the human growth and development. The main aim of this course is to develop effective communication skills among students. How to develop communication ethics and techniques with other stakeholders in the society is also important to learn. At the end of this course, the students will be able to define the given concepts of communication, identify the types of communication, conduct interviews and will be able to demonstrate improved communication skills.

Contents

1. Concept, Purpose and scope of communication in Agricultural extension
2. Forms of communication in the past, present and future
3. Communication and the concept of global community
4. Communication as the problem-solving approach
5. Communication process, elements and their role in effective communication
6. Principles of communication
7. Basic communication models
8. Forms of communication: interpersonal, intrapersonal and impersonal; Written, verbal and non-verbal communication
9. Barriers to communication and measures to overcome these barriers

Practical

1. The students will be involved in developing and critically analyzing different extension messages. Each student will have to design a project for class presentation
2. Students will have to practice different forms of communication in the class

Recommended Texts

1. Calvert, P. (2000). *The communicator's Handbook. Tools, Techniques and technology* (4th ed.). USA: Maupin House Publishing.
2. Muhammad, S. (2005). *Communication Skills & Leadership Development*. Faisalabad: Unitech Communications.

Suggested Readings

1. Murphy, H. A., Hildebrandt, H. P., & Thomas, J. P. (2000). *Effective business communication*. Islamabad: NBF.

This course is designed for undergraduate programs of agriculture sciences. The objective of this course is to impart basic and applied knowledge about statistics for collection, presentation, analysis and interpretations of data related to agriculture issues. After completing this course agriculture students will be able to understand the general concepts of basic statistics, to conduct agriculture surveys, to understand design of experiments, and other statistical tools. These statistical concepts are further will be helpful to complete a research related to agriculture sciences. Moreover, over students will also learn some statistical software such as Minitab, SPSS and Design Expert to improve their computational and analytical skills.

Contents

1. Definition and importance of Statistics in Agriculture
2. Data, Different types of data and variables
3. Classification and Tabulation of data
4. Frequency distribution, Graphical representation of data
5. Measure of Central tendency and Measure of Dispersion
6. Calculation of averages, Range, variance, Standard deviation and coefficient of variation
7. Regression and Correlation Analysis: Simple and Multiple regression, correlation cases
8. Sampling and its types: Probability and non-Probability Sampling
9. Simple random sampling, stratified random sampling, Systematic sampling
10. Sampling and non-sampling error
11. Sampling distribution of mean and difference between two means.
12. Inference Theory: Estimation and testing of hypothesis, Type-I and type-II error
13. Testing of hypothesis about mean and difference between two means using Z-test and t-test, Paired t-test
14. Test of association of attributes using χ^2 (chi-square) Testing hypothesis about variance
15. ANOVA and its assumptions, One-way ANOVA, Two-way ANOVA.

Recommended Texts

1. Muhammad, F. (2000). *Statistical methods and data analysis*. Pakistan: Ilmi Kitab Khana.
2. Rao, G. N. (2007). *Statistics for agricultural sciences* (2nd ed.). Hyderabad: BS Publication.

Suggested Readings

1. Crawshaw, J., & Chambers, J. A. (1994). *Concise course in A. level statistic with world examples*. USA: Springer.
2. Lawal, B. (2014). *Applied statistical methods in agriculture, health and life sciences*. USA: Springer.
3. Sahu, P. K. (2016). *Applied statistics for agriculture, veterinary, fishery, dairy and allied fields*. USA: Springer.

This is an undergraduate level course about the principles involved in heredity. The aim of the course is to understand the basic concepts in the field of genetics. The learning objective of the course is to understand how the behavior of chromosomes during Meiosis can explain Mendel's Laws of Equal Segregation and Independent Assortment. Their key features of chromosomal behavior in meiosis that causes the alleles to be segregated. Genetics is the study of how heritable traits are transmitted from parents to offspring. Humans have long observed that traits tend to be similar in families. It wasn't until the mid-nineteenth century that larger implications of genetic inheritance began to be studied scientifically. Genetic is the fascinating subject of biological science which offers a lot of scope for the welfare of mankind. This course covers the sequence in which the discoveries in the science of genetics were made commencing with the Mendelian genetics. Lead into the fact that the study of heredity is called genetics. Pass out chromosome sticks and the nucleus cut from construction paper. Review meiosis and ask what the sticks and labels are representative of based on our study of meiosis. Use the chromosome models to lead into the concepts of chromosome pairs, genes, dominant trait, recessive trait, heterozygous, genotype and phenotype. This course will help the students to understand about basic knowledge of Mendelian genetics.

Contents

1. Genetics: historical development and scope
2. Genetic basis of inheritance: cell and cell division
3. Physical basis of inheritance
4. Gametogenesis, Mendelism: basic terminology
5. Mendel's laws, monohybrid and polyhybrid crosses
6. Allelic and non-allelic interactions and examples
7. Probability: concept and laws of probability, Chi-square test and its applications
8. Modified segregation ratios, Multiple allelomorphism
9. Genetics of sex: sex determining mechanisms
10. Sex linkage and its variation
11. Polygenic inheritance, Pleiotropy
12. Linkage, crossing over and chromosomal mapping, Extranuclear inheritance
13. Multiple allele and its inheritance, Genetic counselling

Practical

1. Microscopic studies on animal cells undergoing mitosis and meiosis
2. Numerical problems on topics discussed in theory

Recommended Texts

1. Hamilton, M. (2009). *Population Genetics*. UK: Wiley Blackwell.
2. Khan, F. H., & Singh, A. (2002). *Principles of Genetics and Animal Breeding*. India: Jaypee Brothers Medical Publishers.

Suggested Readings

1. Susan, L. E. (2001). *Theory and Problems of Genetics; Schaum's Outline of Genetics*. USA: McGraw-Hill.
2. Weaver, R. F., & Hedrick, P. W. (1997). *Genetics*. Iowa, USA: WM. C. Publishers.

Molecular genetics is the field of biology that studies the structure and function of genes at a molecular level and thus employs methods of both molecular biology and genetics. The study of chromosomes and gene expression of an organism can give insight into heredity, genetic variation, and mutations. Molecular genetics is a powerful methodology for linking mutations to genetic conditions that may aid the search for treatments/cures for various genetic diseases. Students will build a comprehensive working knowledge of proteins - their chemistry and their role as enzymes, structural, recognition, and signaling molecules, nucleic acids - their structures, properties, and their roles in the storage and transmission of genetic information, the roles of biomolecules in cellular signaling, metabolism, structure, and cellular organization the thermodynamics of specific molecular transformations, as well as integrated complex processes, and the integration, interaction, and regulation of complex developmental, signaling, and metabolic pathways at the organism level.

Contents

1. Biochemical basis of heredity: the nature of genetic material, nucleic acids
2. Structure of DNA and RNA, DNA replication, Protein synthesis and its regulation
3. Developmental aspects of genetic control, Gene expression and cell differentiation
4. Control of gene expression in eukaryotes, Genetic basis of immune response
5. Components of immune system, immune response
6. Genetic diversity, genetic diversity in immune system
7. Mutations, gene mutations and their types
8. Variation in chromosome structure and number
9. Genetic engineering: basic concepts of recombinant DNA technology
10. Gene cloning and manipulation, application and future
11. Causes of variation in gene expression
12. Phenotypic expression of gene, Biochemical genetics
13. Concept of different types of genetics

Practical

1. Demonstration of various cytogenetic techniques, Karyotyping and banding
2. DNA extraction, Gel electrophoresis

Recommended Texts

1. Hodge, R. (2009). *Genetic Engineering: Manipulating the Mechanisms of Life*. New York, USA: infobase Publishing.
2. Khan, F. H., & Singh, A. (2002). *Principles of Genetics and Animal Breeding*. India: JP Brothers Medical Publishers Ltd.

Suggested Readings

1. Lewis, R. (2005). *Human Genetics*. New York, USA: McGraw-Hill.
2. Tamarin R. H. (1998). *Principles of Genetics* (6th ed.). USA: William C. Brown Pub.

Milk is a nutrient-rich, white liquid food produced by the mammary glands of mammals. It is the primary source of nutrition for infant mammals before they are able to digest other types of food. Early-lactation milk contains colostrum, which carries the mother's antibodies to its young and can reduce the risk of many diseases. It contains many other nutrient including protein and lactose. Interspecies consumption of milk is not uncommon, particularly among humans, many of whom consume the milk of other mammals. As an agricultural product, milk, also called dairy milk, is extracted from farm animals during or soon after pregnancy. India is the world's largest producer of milk, and is the leading exporter of skimmed milk powder, yet it exports few other milk products. The ever-increasing rise in domestic demand for dairy products and a large demand-supply gap could lead to India being a net importer of dairy products in the future. This course will help the students to identify the various aspects that lead to ideal milk production.

Contents

1. Structure and functions of mammary gland
2. Blood and nerve supply to the udder
3. Mammogenesis, lactogenesis and galactogenesis
4. Synthesis of milk; milk ejection- neural and hormonal component
5. Milking methods
6. Factors affecting milk production and composition
7. Measure to increase milk production
8. Common malpractices used in milk production
9. Physical and chemical properties of milk
10. Hygienic milk production
11. Collection and transportation, processing and marketing of milk
12. Dairy products
13. Milk ordinance, udder and milk borne diseases

Practical

1. Milking practice; hand versus machine milking
2. Milk let down and its inhibition; removal of residual milk
3. Milking time hygiene; screening tests; macro and microstructure of udder
4. Analysis of milk; cleaning and sanitizing of barns and equipment
5. Visit to milk processing plants

Recommended Texts

1. Khan, B.B. (2008). *Health and Husbandry of Dairy Animals*. Faisalabad, Pakistan: Pak TM. Printers.
2. Phillips, C.J. C. (2010). *Principles of Cattle Production* (2nd ed.). Cambridge, UK: Cabi Publisher.

Suggested Readings

1. Bilal, M.Q., & Ahmad, A. (2004). *Dairy Hygiene and Disease Prevention*. Faisalabad, Pakistan: Bilal and Usman printers.
2. Davis, J.G. (1994). *Milk Testing*. India: Agro-Botanical Pub.

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

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. Maynard, L.A. Loosli, J.K., Hintz, H.F., & Warner, R.G. (1991). *Animal Nutrition* (7th ed.). New York, USA.: McGraw Hill Book.
3. McDonald, P., Edwards, R.A., Greenhalgh, J.F.D., & Morgan, C.A. (2002). *Animal Nutrition*. UK: Longman scientific and technical publisher.

Suggested Readings

1. Moren, L. A. (1994). *Biochemistry*. USA: Neil Peterson Publishers; Prentice Hall.
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* (4th ed.). NY, USA: Worth Publishing.

Dairy is a universal agricultural production: people milk dairy animals in almost every country across the world, and up to one billion people live on dairy farms. It is a vital part of the global food system and it plays a key role in the sustainability of rural areas in particular. Dairy farming is a class of agriculture for long-term production of milk, which is processed (either on the farm or at a dairy plant, either of which may be called a dairy) for eventual sale of a dairy product. It is a well-known fact that the dairy industry actively contributes to the economies of a number of communities, regions and countries. An increasing demand worldwide is noticeably emerging at present, and the industry is globalizing, thus increasing the scope and intensity of the global dairy trade. However, the question of how and on what criteria we can objectively assess the economic benefits of the dairy sector still remains. The course aims to summarize the different aspects of dairy economy.

Contents

1. Scope and importance of the dairy industry of Pakistan
2. Characteristics of local, exotic and crossbred dairy animals
3. Principles of profitable dairy production
4. Buffalo and cow as major dairy animals, selection of dairy animals
5. Establishing a dairy enterprise, raising dairy replacement stock
6. Management of sire, pregnant and lactating animals
7. Grazing management of dairy animals, significance of dry buffalo/cow therapy
8. Thermal stress and buffalo/cow performance
9. Feeding for economical milk production, dairy herd improvement associations
10. Dairy system models, modern trends in dairy industry
11. Buying and selling guide, prophylactic measures, common ailments

Practical

1. Daily feeding management practices
2. Care, handling and feeding of calves, Weaning practices
3. Use of score card for animal judging, Protecting animals from inclement weather
4. Mastitis screening tests; suckling, drenching, dipping, foot bath and spraying
5. Vaccination and preventive measures
6. Improved fodder and forage production, harvesting and feeding/grazing practices
7. Hay and silage making practices, Preparing feasibility reports
8. Use of computer for record keeping
9. Visit to livestock farms and shows

Recommended Texts

1. Banerjee, G.C. (1998). *A textbook of Animal Husbandry*. New Delhi, India: Oxford and IBH Publishing.
2. Bath, D.L., Dickenson, F.N., & Tucker, H.A. (1985). *Dairy Cattle; Principles, Practices, Problems, Profits*. Philadelphia: Lea & Febiger.

Suggested Readings

1. Shah, S.I. (1994). *Animal Husbandry*. Islamabad, Pakistan: National Book Foundation.
2. Mackintosh, J.B. (1983). *Sheep Production in Pakistan*. Islamabad: PARC.

This course is aimed at provision of complete information regarding hatching of eggs to produce quality day old chicks for commercial poultry farming systems. It also tells about the history, current status and importance of hatchery industry in Pakistan. This course critically focuses on standards for handling, storage and selection of hatching eggs to maximize profitability of the business. It also elaborates the ways to troubleshoot the problems related to fertility of hatching eggs on breeder farms and issues related to hatchability of eggs at hatchery. It also tells about the practices that may be adopted at commercial hatching egg facility and ways to get optimum hatchability. It also tells about types of incubators and working of setters and hatchers used in commercial hatching industry. It also studies the sanitization of hatching eggs to produce disease free chicks, proper removal of hatchery wastes, and maintenance of different records to successfully run the hatchery business.

Contents

1. History and development of hatchery industry in Pakistan
2. Collection, handling, selection, fumigation, storage and transport of hatching eggs
3. Seasonal hatching, Incubation methods
4. Types of incubators and incubation requirements
5. Role of computer in modern hatchery operations, Setting and candling of eggs
6. Daily changes in embryonic development during incubation
7. Effect of maternal nutrition on growth and development of embryo
8. Physical act of hatching
9. Factors influencing fertility, hatchability and quality of chicks
10. Taking off the hatch, Hatchery services, Hatchery sanitation and waste disposal
11. Trouble shooting during incubation, Incubation records

Practical

1. Planning and designing of hatchery, Demonstration of parts of incubator
2. Setting and candling of hatching eggs
3. Handling of incubator, Disinfection and fumigation of incubator
4. Observing daily changes during embryonic development
5. Sexing, grading, detoeing and dubbing of day-old chicks
6. Examining malposition of embryo, Dead embryo and dead in shell
7. Estimation of fertility and hatchability, Trouble tracing chart of the chick embryo
8. Fertility report of hatchery, Visit to commercial hatcheries

Recommended Texts

1. Brown, T. (2010). *Poultry Farming*. Canada: Apple Academic Press.
2. Donald, D. B. and W.D. Weaver, Jr. (2007). *Commercial Chicken Meat and Egg Production*. India: Springer.

Suggested Readings

1. Lakhotia R.L. (2003). *Poultry Eggs*. Jodhpur, India: Agrobios.
2. Sexena, H.C. (2009). *Hatchery Practice and Management*. Lucknow, Uttar Pradesh, India: International Book Distributing Co., Publishing Division, IBDC.

This is a graduate-level course about rearing of rural or backyard poultry birds. This course mainly focuses on importance of rural poultry farming, knowledge about different rural breeds of poultry, and management of rural poultry and evaluates existing system and identifies measures to improve them. This course also tells about the diet formulation of rural poultry birds. It also tells about the standard practices that may be adopted to improve production backyard poultry. It also focuses on breeding of rural poultry birds and ways to improve hatchability by using natural incubation or small-scale incubators. This course also tells about the major health issues and medication of backyard poultry. This course also tells about the ways to select a good producing bird in backyard system. This course also critically studies the perceptions of people about poultry and poultry products. This course also helps to chalk out the plan for the start of a new backyard poultry business.

Contents

1. Status of rural poultry production in Pakistan
2. Significance and scope of rural poultry farming
3. Desires commercial poultry products, Consumer attitudes
4. Choosing right rural breed/strain for meat and egg production
5. Housing and equipment, Natural incubation
6. Incubation requirements, Characteristics of broody hen
7. Selection of hatching eggs, Management during incubation
8. Management during brooding, growing and laying
9. Selection of feed ingredients
10. Feed formulation for rural poultry, Feeding and watering practices
11. Vaccination, medication and parasitic control
12. Impact of season on performance of rural poultry
13. Record keeping, Marketing of rural poultry and its products
14. Measures to improve rural poultry production in Pakistan

Practical

1. Demonstration of suitable breeds for rural poultry production
2. Types of houses and equipment
3. Nest preparation for natural incubation, Small scale incubators
4. Differentiation between laying and a non-laying hen, Vaccination and medication
5. Preparation and handling of small incubators
6. Feasibility report for 100 rural poultry birds, Visit to government poultry farms

Recommended Texts

1. Bell D.D., & Weaver, W.D. (2002). *Commercial Chicken Meat and Egg Production* (5th ed.) Norwell Massachusetts, USA: Kluwer Academic Publishers.
2. Brown, T. (2010). *Poultry Farming*. USA: Apple Academic Press.

Suggested Readings

1. Prasad, J. (2008). *Poultry Production and Management* (3rd ed.). New Delhi, India: Kalyani Publishers.
2. Sonaiya, E.B., & Swan, S.E.J. (2008). *Small Scale Poultry Production*. New Delhi, India: Discovery Publishing House.

The major constraint in the development of livestock sector in Pakistan is poor availability of nutrients. The ever-decreasing area under fodder production coupled with its scarcity period is the main factor which deteriorates the normal fodder supply. Forages and fodders are important agronomic crops that constitute important and basic component of animal feed. To develop skills regarding fodder production technology in graduate level students, a separate course was included in scheme of studies. This is very important course due to increasing demand of fodder for livestock throughout the year. During studying the students will be taught about the different fodders their complete production technology and management, Pasture management and factors affecting productivity of pasture. It makes the students able to know about different choices of fodder availability during different season throughout the year. Techniques of fodder preservation silage, hay, haylage will be practically demonstrated and students will be equipped with all such techniques after completion of this course.

Contents

1. Importance and characteristics of forages and fodders
2. Critical period of fodder scarcity.
3. Factors influencing productivity and quality
4. Methods of increasing biomass production
5. Factors affecting chemical composition and nutritive value of forages
6. Preservation of fodders and forages (silage and hay making)
7. Toxicity due to chemicals and poisonous plants
8. Establishment of grasses and legumes in range lands
9. Constraints in fodder production and remedies

Practical

1. Identification of forage, fodder crops and poisonous plants
2. Estimation of sprout density
3. Carrying capacity
4. Preparation of fodder calendar
5. Measurement of cover frequency
6. Preparation of silage and hay

Recommended Texts

1. Hedayetullah, M., & Zaman, P. (2019). *Fodder Crops of the World, Vol-I, Major fodder crops*. Florida, USA: Apple Academic Press.
2. Balasubramanian, P.O., & Polanippan, S.P. (2001). *Principles and Practices of Agronomy*. India: Agrobios.

Suggested Readings

1. Advan, R.L. (2018). *New Perspective in Forage Crops*. Brazil: Intech open.
2. Singh, A.K. (2011). *Forage and Fodder*. Delhi, India: Daya Publishing House.

Population genetics is a subfield of genetics that deals with genetic differences within and between populations and is a part of evolutionary biology. Studies in this branch of biology examine such phenomena as adaptation, speciation, and population structure. Population genetics was a vital ingredient in the emergence of the modern evolutionary synthesis. Traditionally a highly mathematical discipline, modern population genetics encompasses theoretical, lab, and field work. Population genetic models are used both for statistical inference from DNA sequence data and for proof/disproof of concept. What sets population genetics apart today from newer, more phenotypic approaches to modelling evolution, such as evolutionary game theory and adaptive dynamics, is its emphasis on genetic phenomena. But of course, there is a link between all three types of study: the genetics of variation. And broadly speaking, population genetics can be defined as the study of the genetical basis of naturally occurring variation, with the aim of describing and understanding the evolutionary forces that create variation within species and which lead to differences between species. The course provides the students theoretical and practical knowledge of the population genetics. Students practically and theoretically trained for getting better genotype in the next generation. This course will help students gain an insight into the latest techniques for livestock improvement through genetics.

Contents

1. Gene and genotypic frequency; Hardy-Weinberg law
2. Forces affecting gene frequency and composition of population
3. Quantitative characters and their inheritance
4. Measures of central tendency and dispersion for quantitative traits
5. Basic theorems of additivity of variance, regression and correlation concepts
6. Nature and causes of variation in quantitative traits and partitioning of hereditary variance
7. Concepts of heritability and repeatability and methods of their estimation
8. Genetic and phenotypic correlations; Genetic basis and causes of variation
9. Lethal Factors; Genetic disorders and genetic resistance to diseases
10. Genetic constitution of population; Population- Genetic properties of population

Practical

1. Exercises on gene and genotypic frequencies in random mating populations
2. Exercises on the estimation of heritabilities, repeatabilities and genetic correlation from given data
3. Case studies for lethal, semi-lethal and other genetic abnormalities in farm animals

Recommended Texts

1. Hamilton, M. (2009). *Population Genetics*. CA, USA: John Wiley & Sons.
2. Khan, F. H., & Singh, A. (2002). *Principles of Genetics and Animal Breeding*. India: JP Brothers Medical Publishers.

Suggested Readings

1. Li, C. C. (1988). *First Course in Population Genetics*. California, USA: The Box wood Press, Pacific Grove.
2. Nicholas, F. W. (1996). *Introduction to Veterinary Genetics*. Oxford, UK: Clarendon Press.

This course deals with the concept that enables combining fundamental and modern knowledge in the breeding and selection of animals based on balanced and quality manner. This course can be divided into several thematic sections. The first one relates to the classical notions of domestic animals breeding such as the history of breeding, domestication, breed, hereditary and non-hereditary variability and description of general and production traits. The second section focuses on the basic concepts in population and quantitative genetics, as well as biometrics. The third unit is dedicated to the principles of selection and domestic animals improving. The fourth unit relates to the current concepts and objectives of the molecular markers use in domestic animals' selection and breeding. The course provides the students theoretical and practical knowledge and skills to identify their characteristics according to their nature and systems of breeding. Students practically trained to rearing, production, reproduction and nutritional management of livestock This course will help students gain an insight into the latest techniques of breeding and breeding plans.

Contents

1. Selection: natural and artificial selection
2. Methods of selection; tandem method, independent culling level and selection index.
3. Kinds of selection
4. Selection for single and multiple traits, correlated response, genetic effects of selection
5. Methods of assessing genetic progress
6. Various systems of breeding
7. Development of inbred lines; selection for best combining abilities; reciprocal recurrent selection.
8. Breeding for threshold characters; Genetic drift its role in inbreeding.
9. Breeding Value and its importance; Genetic gain
10. Breeding goal

Practical

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

Recommended Texts

1. Bourdon, R. M. (2000). *Understanding Animal Breeding*. Upper Saddle River, New Jersey: Prentice-Hall.
2. Legates, J. E., & Warwick, E. J. (1990). *Breeding and Improvement of Farm Animals*. New York: McGraw-Hill.

Suggested Readings

1. Lush, J. L. (1943). *Animal Breeding Plans*. USA: The Iowa State College Press.
2. Weller, J. I. (1994). *Economic Aspects of Animal Breeding*. USA: Springer publishers.

Vitamins and minerals are one 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

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

Recommended Texts

1. McDowell, L.R. (1992). *Minerals in Animal and Human Nutrition*. California, USA: Academic press.
2. McDowell, L.R. (2000). *Vitamins in Animal Nutrition*. London: Academic Press; Harcourt Brace Jovanovich Publishers.

Suggested Readings

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.

This is the course of undergraduate level about small ruminants. Livestock play an important role in the rural economy of Pakistan. It produces food, enhances crop production, generates cash income, provides year-round employment, spreads risk and provides fuel and transport. In the mountainous, rainfed, saline affected and desert areas of Pakistan, where crop production is uncertain, farmers subsist on livestock farming. Sheep and goats are reared as a subsidiary source of livelihood in these areas and utilized for milk, mutton, skin and wool production. The growth pattern of goat population in Pakistan shows an annual increase of 3.04% per year. Meat (mutton) production from both sheep and goats in the country has generally increased rapidly over the last two decades at a rate of 3.67% to meet the demand of ever-growing population. On the other hand, high emphasis on wool production may lead to a reduction in mutton produced per head as both ewes and wethers that would otherwise be sent to slaughter may be kept for wool production. Students will get familiarize with principles of small ruminant production.

Contents

1. Scope of small ruminant industry in Pakistan
2. Share in national economy; world distribution
3. Domestication of small ruminants
4. Feeding, breeding, selection, kidding/lambing, rearing and housing; nursing orphan kids/lambs
5. System of production; sheep and goat as meat and dairy animals
6. Measures for increased production
7. Preparing feasibility reports
8. Characteristics and utility of wool, hair/mohair; shearing and handling of wool/hair
9. Sheep and goats on ranges
10. Transportation and marketing; slaughter and flaying; showing of sheep/goats
11. Keeping flock healthy, common ailments

Practical

1. Identification of different sheep and goat breeds; judging for milk, meat and wool/hair production
2. Farm practices such as castration, hoof trimming, condition scoring etc.
3. Grading and sorting wool; studying characteristics of hair, wool and mohair in the lab
4. Flaying and skin preservation
5. Various farm records; practical prophylactic measures
6. Shepherd calendar; visit to sheep and goat farms

Recommended Texts

1. Mackintosh, J.B. (1993). *Sheep Production in Pakistan*. Islamabad: PARC.
2. Pulina, G. (2004). *Dairy Sheep Nutrition*. USA: Cabi Publisher.

Suggested Readings

1. Ensminger, M.E., & Parker, R. O. (1986). *Sheep and Goat Science*. USA: Interstate Printers and Publishers.
2. Khan, B.B., Iqbal, A., & Mustafa, M.I. (2003). *Sheep and Goat Production*. Faisalabad: University of Agriculture, Department of Livestock Management.

This is a graduate level course about construction of commercial poultry houses. The course is aimed at elaboration and understanding of different poultry housing equipment, their purchase, installation and running. It focuses on standard civil engineering recommendations for construction of poultry house and designing of house for the provision of comfortable zone to birds so that they can perform optimally under intensified conditions. This course focuses on calculating the needs of air exchange for minimum ventilation and for the control of temperature power ventilated houses. It also gives the knowledge about understanding the need of insulation in a commercial poultry shed along with calculation of insulation requirements of shed buildings for hot and cold areas. At the completion of course, students will be able to design the commercial poultry house and to prepare plan for the designing and construction of poultry houses along with feeding, watering, lighting and ventilation system installation.

Contents

1. Importance and purpose of poultry housing
2. Poultry housing systems
3. Types and styles of poultry houses
4. Selection of site and location of poultry house
5. Construction of poultry farm buildings; Heating and cooling systems
6. Role of house design and insulation poultry housing
7. Open-sided and environmentally controlled housing
8. Brooding, rearing and laying house equipment; Feeding and watering systems
9. Automation in housing, equipment and effective climate control in poultry houses
10. Feasibility report of poultry housing

Practical

1. Basic principles for site selection and poultry house construction
2. Demonstration of poultry farm buildings
3. Designing of farm buildings; Poultry house insulation material
4. Demonstration and operation of poultry farm equipment
5. Automatic feeding and watering systems and its trouble shooting
6. Poultry housing practices; Visit to poultry farms

Recommended Texts

1. Donald, D.N & Waver, W.D. (2007). *Commercial Chicken Meat and Egg Production*. India: Springer.
2. Maton, A., Daelemans, J. & Lambrecht, J. (1985). *Housing of Animals: Construction and Equipment of Animal House*. Amsterdam, the Netherlands: Elsevier Science Publishers.

Suggested Readings

1. Sonaiya, E.B., & Swan, S.E.J. (2008). *Small Scale Poultry Production*. New Delhi, India: Discovery Publishing House.
2. Brown, T. (2010). *Poultry Farming*. USA: Apple Academic Press.

This graduate level course deals with the understanding of disease prevention practices that must be adopted in commercial poultry farming. This course critically focuses on pathogenic poultry diseases, their diagnosis and recommendations to cope up these diseases. This course also tells about non-pathogenic diseases. This course is aimed at sanitation of poultry buildings and studies the strategies to biologically secure the birds. This course critically focuses on different stages of biosecurity and prophylactic measures that may be practiced reducing the occurrence of disease on poultry farms and the procedures that may be followed to reduce the medication cost in an intensive poultry system. This course also gives some knowledge about disease transmission in poultry birds and also tells about different chemicals used for disinfection of the poultry facilities. After taking this course, students will be able to understand the diagnosis of diseases along with the knowledge of treatment of the major diseases and immunization procedure for prevention of different poultry diseases.

Contents

1. Importance of poultry hygiene and disease prevention
2. Terms related to poultry health and hygiene
3. Disinfectants and their application
4. Cleaning and disinfections of poultry houses and equipment
5. Fumigation and its importance
6. Prophylactic measures against bacterial, viral, parasitic, and mycotic diseases
7. Biosecurity measures
8. Significance of clean drinking water in poultry
9. Nutritional disorders and their prevention
10. Practices to control vertically and horizontally transmitted diseases

Practical

1. Poultry carcass inspection
2. Blood, organs and carcass specimen collection and dispatch to the diagnostic laboratory
3. Vaccines and vaccination
4. Disinfectants, medicines and vaccines available in market
5. Common practices for bio-security measures
6. Dead bird disposal
7. Visit to poultry disease diagnostic laboratory

Recommended Texts

1. Donald, D.N., & Waver, W.D. (2007). *Commercial Chicken Meat and Egg Production*. India: Springer.
2. Chauhan, H.V.S., & Roy, S. (2007). *Poultry Diseases, Diagnostic and Treatment*. New Delhi, India: New Age International Publishers.

Suggested Readings

1. Haq, A., & Ahmad, T. (2001). *Poultry Hygiene and Disease Prevention*. Lahore, Pakistan: Pak Book Empire.
2. Vegad, J.L. (2007). *Poultry Diseases: A guide for Farmers and Poultry Professionals*. Lucknow, India: International Book.

This course will help to improve the knowledge of students about anatomy and physiology of reproductive system of farm animals. Theriogenology (reproduction) is the branch of Animal Science concerned with reproduction, including the physiology and pathology of male and female reproductive systems of animals and the clinical practice of veterinary obstetrics, gynecology, and andrology. Theriogenologists are veterinarians with advanced training in animal reproduction and obstetrics. The Theriogenology and Reproductive Medicine Service handles all phases of breeding services including artificial insemination for a variety of large and small animal patients, advanced assisted reproductive techniques, breeding soundness evaluations of male and female, obstetrics, management of diseases or complications of the postpartum period, and medical or surgical management of diseases of the male and female reproductive tract. This course will help the students to master different techniques for estrous detection in cows and buffalos. Students will be able to identify different reproductive problems in farm animals.

Contents

1. Physiology of female reproduction
2. Puberty and breeding season in farm animals
3. Hormones of hypothalamus, pituitary, placenta, ovaries and uterus; estrous cycle, oogenesis, ovulation, fertilization, gestation and parturition
4. Involution of uterus and post-partum ovarian activity
5. Methods of heat detection and pregnancy diagnosis; reproductive efficiency parameters
6. Factors affecting the reproductive efficiency of farm animals
7. Physiology of male reproduction; puberty in farm animals
8. Hormone of the testes; spermatogenesis; methods of semen collection
9. Physical characteristics of the semen of farm animals; artificial insemination

Practical

1. Functional anatomy of male and female reproductive system
2. In vitro palpation of female reproductive organs for anatomical and morphological study
3. Observation of oestral activity
4. Breeding soundness examination of the bull: physical examination of the bull
5. Preparation of artificial vagina
6. Semen collection and evaluation

Recommended Texts

1. Hafez, E.S.E., & Hafez, B. (2000). *Reproduction in farm animals* (7th ed.). Philadelphia, USA: Lea and Febiger.
2. Ball, P.J.H., & Peters, A.R. (2004). *Reproduction in Cattle* (3rd ed.). Oxford, UK: Blackwell Publishing.

Suggested Readings

1. I.A.E.A. (2007). *Improving the Reproductive Management of Dairy Cattle subjected to Artificial Insemination*. Rome: Joint FAO/IAEA Program of Nuclear Technique in Food and Agriculture, FAO.
2. Ball, P.J.H., & Peters R.A. (2003). *Reproduction in Cattle* (3rd ed.). USA: Wiley Blackwell Publishers.

The aim of this course is to introduce students with basic concepts of microbiology. Microorganisms are typically too small to be seen with the naked eye. Bacteria, fungi, viruses, protozoa, and algae are the major groups of microorganisms. As an application of microbiology, medical microbiology is often introduced with medical principles of immunology as microbiology and immunology with food microbiology and veterinary microbiology focusing on microbes beneficial and harmful for food and animal industry. This course focuses on classical and modern approaches to the study of microorganisms and their roles/applications in everyday life, medicine, research, and the environment. Microbial cell structure, function, growth, genetics, metabolism, evolution, and ecology. Study of disease, infection, and immunology. This course will help the students to identify important microbes of livestock and poultry. They will be able to isolate, cultivate and identify the important pathogenic and beneficial microbes related with the livestock industry.

Contents

1. Introduction to Microbiology
2. Scope, history, terminology, branches and applied areas of Microbiology
3. Diversity of microbes, Differentiation between Prokaryotes and Eukaryotes.
4. Taxonomy of bacteria: basis of taxonomy, origin and evolution of bacteria, species concept in bacteria ,Morphology and detailed anatomy of bacterial cell
5. Microbial growth and requirements: Physicochemical requirements; pH, temperature, oxidation reduction potential, gaseous and nutritional requirements
6. Microbial multiplication and growth curves
7. Structure and physiology of fungi, The yeasts Morphology and reproduction
8. Fundamental characteristics of viruses: Definition and history of virology; general properties of viruses, methods for studying viruses
9. Microscopy: light, dark field, fluorescent, polarizing, phase contrast and special stains
10. A brief introduction to structure and propagation of fungi, protozoa, algae, viruses and bacteriophages

Practical

1. Safety in the microbiological laboratory: contamination and decontamination
2. Demonstration of laboratory equipment, their basic functions and handling
3. Microscopy: An outline of principles and applications: Light, dark field, fluorescent, polarizing, phase contrast and electron microscopes
4. Preparation of slides for microbiological examination including cleaning and disposing of slides
5. Preparations, performing Gram staining
6. Sterilization and disinfection

Recommended Texts

1. Collins, C.H., Lyne, B.M., & Grange, J.M. (2000). *Microbiological Methods* (8th ed.). Oxford .UK.: Butter Worth Heinemann.
2. Jawetz, E., & Levinson, W. (2000). *Medical Microbiology and Immunology* (5th ed.). London, UK: Prentice Hall.

Suggested Readings

1. Parker. M.T., & Collin, L.H. (1998). *Topley and Wilson's Principles of Bacteriology*. Virology & Immunity (9th ed). London, UK: Edward Arnold.
2. Schaehter, M., Medoff, G., & Schlessinger, D. (1997). *Mechanism of Microbial Diseases*. Williams and Wilkins, Baltimore.

This course will help to revise the skills and abilities to demonstrate your knowledge and understanding of principles, practices, techniques and strategies related to animal breeding and genetics. It also helps to apply the knowledge and understanding of these principles, practices, techniques and strategies to realistic breeding scenarios. This course aims to analyze and evaluate information relating to animal breeding and genetics. It shows to know how to develop breeding management programmes and recommend breeding strategies in context with appropriate justification. This will need to use understanding of animal breeding and genetics, along with the skills in carrying out research based on a set task brief. Selective breeding can be unintentional, e.g., resulting from the process of human cultivation; and it may also produce unintended – desirable or undesirable – results. Animal breeding is a branch of animal science that addresses the evaluation (using best linear unbiased prediction and other methods) of the genetic value (estimated breeding value, EBV) of livestock. The students will be able to understand the implementations of economic values with the farming. The students will be able to answer the questions based on researches and knowledge of animal breeding and genetics.

Contents

1. Role of animals breeding in livestock production
2. Opportunities for breeding and selection in Pakistan
3. Conservation of animal's genetic resources in Pakistan. Scope techniques and problems
4. Constraints in improving the productivity of livestock under traditional breeding system
5. Review of breeding practices used by developed countries for increasing the performance of farm animals
6. Emerging breeding technologies for increased beef and milk productivity
7. Selection for superior breeding stock for beef and dairy animals
8. Developmental genetics; Evolutionary development and life cycle development
9. Systems of breeding in beef animals; heritability repeatability values
10. Methods to improve productivity; genetic correlation among traits

Practical

1. Exercises on History sheets manually
2. Computation of various productive and reproductive traits in different farm animals from available records

Recommended Texts

1. Bourdon, R. M. (2000). *Understanding Animal Breeding*. Upper Saddle River, New Jersey: Prentice-Hall.
2. McDowell, R.E. (1994). *Dairying with Improved Breeds in Warm Climates*. Raleigh, NC, USA: Kinnic Publishers.

Suggested Readings

1. Oldenbroek, K. (2007). *Utilization and conservation of farm animal genetics resources*. The Netherlands: Wageningen academic publisher.
2. Piper, L., & ruvinsky, A. (1997). *The genetic of sheep*. Cambridge, UK: Uni. Press.

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

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

Suggested Readings

1. NRC (2000). *Nutrient Requirement of Beef Cattle* (7th ed.). Washington DC, USA: National Academy Press.
2. NRC (2001). *Nutrient Requirement of Dairy Cattle* (7th ed.). Washington DC, USA: National Academy Press.

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' knowledge will improve about poultry nutrition and will be able to formulate rations for different classes of poultry.

Contents

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 Text

1. Lesson, S., & Summers, J.D. (2001). *Commercial Poultry Nutrition* (4th ed.). Canada: University Book.
2. NRC. (1994). *Nutrient Requirements of Poultry*. USA: National Academy of Sciences.

Suggested Readings

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 is an undergraduate level course about welfare of farm animals. Globally, livestock production is the largest user of agricultural land and livestock. Humans farm animals to provide food and animal products to satisfy the 7.4 billion people alive in the world and to cater for a change in dietary preference to one in which greater quantities of meat and dairy products are consumed. Although humans have been farming animals for a very long time there is still much to learn about farmed animals' needs, and how best to develop practical and economic environments and production systems that not only minimize welfare challenges, but also provide a good quality of life. While considerable progress has been made in improving farm animal welfare over the past few decades (such as better-quality veterinary care, enhanced nutrition, and a greater understanding of animal behavior and genetics), there are still some long-standing welfare issues facing today's farmed animals that have proved difficult to deal with. This course will provide an account of behavior and welfare of farm animals to the students.

Contents

1. Basic terminology of behavior and welfare
2. Development of behavior, basic concepts; why to study behavior
3. Behavioral profiles of farm animals (dairy animals, small ruminants, equines and camels); types of animal's behavior; communication; hormones and behavior
4. Behavior in relation to training, handling, feeding, transport and slaughter of animals
5. Animal well-being (the ultimate goal); rights of animals (legal and moral)
6. Eliminating all sorts of stress

Practical

1. Methods of assessing behavior; demonstration about five freedoms observing territoriality, social behavior including courtship, mate guarding, mate choice and play behavior; determining flight and fight zones in various species
2. Observing aggressive, sexual and eliminative behavior and observing cases of undue stress on account of beating, exposure to severe hot and cold weather, carelessness in feeding, overcrowding, overloading, underfeeding and overworking by lame, emaciated and diseased animals, then writing report based on these observations

Recommended Texts

1. Prasad, S (2004). *Animal behavior*. New Delhi, India: CBS publishers.
2. Robbins, P.S., & Judge. (2013). *Organizational behavior*. UK.: Pearson education.

Suggested Readings

1. Blackshaw, J.K. (2003). *Notes on some topics of applied animal behavior*. Australia: School of vet. Sci., University of Queensland.
2. Goodenough, J. (1993). *Perspectives of animal behavior*. New York.: John Wiley and Sons.

This graduate level course specifically focuses on broiler, layer and breeder farming. This course covers all aspects of a commercial poultry farm. This course also gives some knowledge about the management of game birds. It is aimed at studying the husbandry of birds in different environment; poultry waste management, welfare of commercial poultry birds and troubleshooting of poultry farm to understand the causes of poor performance of birds. This course focuses on poultry farm practices including beak trimming, molting, medication and vaccination. This course also gives some knowledge about vices observed in poultry birds reared under intensified system and remedies to avoid abnormal behaviors in commercial birds. This course also elaborates different techniques that should be learnt to be a good manager of a commercial poultry farm. This course also tells about how a commercial poultry farm can be run successfully. Along with chicken this course also tells about the farming of quails, ducks, geese, peafowl, ostrich and turkeys.

Contents

1. Preparation for receiving day old chicks
2. Brooding, rearing and laying management of broilers, layer and breeders
3. Cage vs floor management
4. Management of quails, ducks, geese, peafowl, ostrich and turkeys
5. Feeding practices for broilers, layers and breeders; Light management
6. Causes of poor performance of layer and breeder flocks
7. Managerial practices to boost egg and meat production
8. Management of flock during hot and cold climates cannibalism; Vices and their remedies in poultry; Induced molting of spent layers and breeders
9. Trouble shooting in poultry farms; Poultry welfare
10. Poultry wastes disposal; Characteristics of an ideal poultry farm manager
11. Significance of record keeping; Use of computers in record keeping

Practical

1. Demonstration and handling of various types of brooders
2. Vaccination, medication, beak trimming and detoeing techniques
3. Remedies for different vices in poultry; Application of induced molting techniques
4. Preparation of birds for transportation; Computerized record keeping at farms
5. Feasibility report of 1000 broiler, layer and breeder flocks

Recommended Texts

1. Bell, D.D., & Weaver, W.D. (2002). *Commercial Chicken Meat and Egg Production* (5th ed.). Norwell Massachusetts 02061, USA: Kluwer Academic Publishers.
2. Brown, T. (2010). *Poultry Farming*. USA: Apple Academic Press.

Suggested Readings

1. Donald, D.N., & Waver, W.D. (2007). *Commercial Chicken Meat and Egg Production*. India: Springer.

2. Haq, A. and Akhtar, M. (2004). *Poultry Farming*. H-9, Islamabad, Pakistan: Higher Education Commission of Pakistan.
3. Jull, M.A. (2003). *Successful Poultry Management*. Delhi, India: Bio-Tech Books.

ANSC-6132

Draught Animal Production

2(1+1)

The importance of draught animal welfare can be viewed from a number of different perspectives: economic, ecological, social, cultural, and emotional or affective. Draught animals have contributed a great deal to human civilization. Even in this century, when petroleum-based mechanical and electrical equipment has replaced animals in advanced countries, draught animals still play an important role in certain developing countries and will continue to do so for many years. Despite the past and present contribution of draught animals to mankind, the care of these animals is currently neglected, with the result that owners of draught animals are incurring losses, and society suffers accordingly. Therefore, measures are required to foster care and welfare of draught animals. Greater care of draught animals will also improve human welfare. The poor working conditions of these animals often adversely affects their productivity. The students will learn that the application of improved technology and better management (i.e. through better feed and health services, and improved design of agricultural implements and carts) could considerably improve the welfare of these animals.

Contents

1. Contribution of draught animals to agriculture and national economy
2. Draught animal vs. mechanical power; types and breeds of draught animals
3. Selection, housing; management and feeding during work and rest;
4. Work performance and energetics; comparative efficiency of draught animals
5. Types of harnesses and equipment; ailments of draught animals, their welfare and prospects in Pakistan

Practical

1. Breaking and training of draught animals
2. Measuring draught power and efficiency
3. Use of different types of harnesses
4. Examination and certification of draught animals for soundness

Recommended Texts

1. Khan, B.B., A. Iqbal., & M. Riaz. (2003) *Production and Management of Camels*. Faisalabad, Pakistan: Pak. TM. Printers.
2. Payne, W.A.J. (1999). *An Introduction to Animal Husbandry in the Tropics*. Singapore: ELBS. Longman.

Suggested Readings

1. Iqbal, S.I. (1994). *Animal Husbandry*. Islamabad, Pakistan: National Book Foundation.
2. Kacker, R.N., & B.S. Panwar. (1996). *Textbook of Equine Husbandry*. New Delhi: Vikas Pub.
3. Khan, B.B., A. Iqbal., M. Yaqoob & M. Riaz. (2005). *Husbandry and Health of Horse*. Faisalabad, Pakistan: Pak. TM. Printers.

This is undergraduate level course deals with the understanding of selective breeding, domestication and traits that have the economic value for the human beings. Domesticated animals are known as breeds, normally bred by a professional breeder, while domesticated plants are known as varieties, cultivars, or cultivars. In animal breeding, techniques such as inbreeding, linebreeding, and outcrossing are utilized. In this course we discuss the selective breeding and domestication of farm animals. The deliberate exploitation of selective breeding to produce desired results has become very common in agriculture and experimental biology. Selective breeding can be unintentional, e.g., resulting from the process of human cultivation; and it may also produce unintended – desirable or undesirable – results. Selecting for breeding animals with superior EBV in growth rate, egg, meat, milk, or wool production, or with other desirable traits has revolutionized livestock production throughout the world. The scientific theory of animal breeding incorporates population genetics, quantitative genetics, statistics, and recently molecular genomics. The students will be able to understand the implementations of economic values with the farming.

Contents

1. Traits of economic importance in farm animals; Selection of dairy heifers and bulls
2. Use of standardized records, relative economic values; Breeding values and selection indices; Crossbreeding for milk and meat production.
3. Traits of economic importance in poultry and their improvement.
4. Formation of breeding stock for layers and broilers; Development of dual-purpose birds and rural poultry; National breeding policy for improvement and conservation of livestock.
5. Review of the animal breeding practices used by the developed countries.
6. Future breeding plans for genetic improvement of farm animals in different agro-ecological zones of Pakistan
7. Emerging biotechnologies for increasing animal productivity

Practical

1. Exercises on the maintenance and standardization of productive and reproductive records; Estimation breeding value using standardized records.
2. Exercises on the estimation of relative economic values; Construction of selection indices for large and small animals.
3. Orientation of computer packages for animal conservation and evaluation

Recommended Texts

1. Kintore, C. (2013). *Recent Advances in Animal Breeding*. Delhi, India: DK publishers and distributors.
2. Lasley, J. F. (1987). *Genetics of Livestock Improvement*. Englewood Cliffs, New Jersey: Prentice-Hall international Inc.

Suggested Readings

1. McDowell, R.E. (1994). *Dairying with Improved Breeds in Warm Climates*. Raleigh, NC. USA: Kinnic Publishers, Inc.
2. Muir, W.M., & Aggrey., S.E. (2003). *Poultry Genetics, Breeding and Biotechnology*. Wallingford, Oxon, UK: CAB International.

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

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. Banerjee G.C. (1999). *Feeds and Principles of Animal Nutrition*. New Delhi, India: Oxford, IBH Publishing.
2. Cheeke, P.R. (1992). *Applied Animal Nutrition*. Feeds and Feedings. Canada: Delmar Publishers.

Suggested Readings

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

The term meat industry describes modern industrialized livestock agriculture for production, packing, preservation and marketing of meat. In economics, it is a fusion of primary (agriculture) and secondary (industry) activity and hard to characterize strictly in terms of either one alone. The greater part of the entire meat industry is termed meat packing industry- the segment that handles the slaughtering, processing, packaging, and distribution of animals such as cattle, pigs, sheep and other livestock. A great portion of the ever-growing meat branch in the food industry involves intensive animal farming in which livestock are kept almost entirely indoors or in restricted outdoor settings like pens. This course will help to identify many aspects of the raising of animals for meat has become industrialized, even many practices more associated with smaller family farms. The production of livestock is a heavily vertically integrated industry where the majority of supply chain stages are integrated and owned by one company.

Contents

1. Development of meat industry in Pakistan; important mutton, beef and dual-purpose breeds; meat terminology; system of meat animal production
2. Breeding and feeding management; veal and dairy beef
3. Species-wise off take rate carcass evaluation; cuts and meat grades
4. Feed additives to enhanced growth and fattening
5. Growth rate and fattening potential of indigenous livestock breeds
Factor affecting carcass and meat quality; pre-slaughter changes in carcass
6. Spoilage of meat; hygienic meat production; meat storage and preservation
7. Buffalo and camel as beef animals; marketing of meat animals and meat
Economics of meat production; meat byproducts
8. Feasibility reports; modern slaughterhouses

Practical

1. Body conformation of beef/meat animals; dressing percentage; carcass composition and cuts; judging meat animals
2. Condition scoring of meat animals; preparing animals for slaughterhouse
3. Scoring of carcass conformation and fatness; humane handling and animal welfare
4. Slaughterhouse management; practical tips for housing and feeding of meat animals
5. Design of modern slaughterhouse; visit to slaughterhouse and feedlots

Recommended Texts

1. Herenda, D. C., ettriqui, G.P., Seneviratna A. P., & Da silva, T. J. P. (1994). *Manual on meat production inspection for developing countries*. Rome. Italy: FAO.
2. Hill, D. (1990). *Cattle and beef production in the tropics*. Singapore: ELBS, Longman.

Suggested Readings

1. Ensminger, M.E. (1990). *Beef Cattle Science*. Daville, Illinois, USA: The Interstate Printers.
2. Gracey, J. F., & Huey, R. J. (1999). *Meat Hygiene*. London. UK: W. B. Saunders Company.

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

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 verses 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. Brown, T. (2010). *Poultry Farming*. USA: Apple Academic Press Inc.
2. Donald, D.N., & Waver, W.D. (2007). *Commercial Chicken Meat and Egg Production*. India. Springer.

Suggested Readings

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

Main objective of this course is to prepare students for advanced animal science studies and to improve their skills in farm animal management operations. The students will be attached singly or in groups with the field staff of various livestock farms (Dairy farms, Poultry farms, Sheep goat farms etc.), feed mills, Research labs, Hatcheries or Veterinary hospitals. Both in case of Research Project or Internship, every student will write a comprehensive report based on his/her field experiences, according to the following guidelines

1. Introduction
2. Objectives of apprenticeship training program
3. Data Collection and data analysis
4. Outcomes of Research Project or Internship
5. Future plans
6. Problems faced by field staff (host institutes/department), farmers and internee
7. Suggestions for improvement of Research Project or Internship
8. Conclusions

At the end of the course every student has to pass Departmental Comprehensive Exam including all Major, supporting or foundation courses.



MSc
(Hons)
ANIMAL NUTRITION

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

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

Suggested Readings

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.

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 exiting 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

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 Readings

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.

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

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, Harcourt Brace Jovanovich, Publishers.

Suggested Readings

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

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.
2. O'Del, B.L. & Sunde, R.A. (1997). *Handbook of Nutritionally Essential Mineral Elements*. New York, USA: Marcel Dekker.

Suggested Readings

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.

This course is aimed at improving skills of students regarding feed analysis for different nutrient composition. The 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 presents 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

1. Sampling of feeds for chemical analysis; preparation, grinding, labeling and preservation
Maintenance of laboratory equipment and setting up a nutritional laboratory
2. Cleaning and washing of glassware
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 fiber (NDF), acid detergent fiber (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: AOAC International.
2. FAO. (1995). *Tropical Animal Feeding*. Rome, Italy: A Manual for Research Workers, FAO.

Suggested Readings

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

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

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, fiber and protein degradability; Bioassays 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 Readings

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.

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

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 Readings

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.

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 another 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

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: Pearson Education.

Suggested Readings

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

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

Suggested Readings

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. (1991). Fatty acid synthesis in eukaryotes. *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 presents 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

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: AOAC International.
2. Kaneko, J.J., Harvey, J.W. & Bruss, M.L. (1997). *Clinical Biochemistry of Domestic Animals* (5th ed.). London, U.K: Academic Press.

Suggested Readings

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

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

1. Digestion, metabolism and absorption of nutrients in poultry
2. Nutritional requirement of broilers, layers and breeders
3. Feed resources and their nutritional profile; Effect of amino acid – energy ratio on growth
4. Essential amino acids and their role; Feed additives, micronutrients (Vit. & Min.) and their role
5. Feeding program for broilers (starter, grower and finisher) and broilers breeders
6. Molting of layers and breeders
7. Feeding of poultry in hot weather and stress
8. Feeding of indigenous poultry, ducks, quails, geese turkeys etc.
9. Nutrient deficiencies / diseases and their prevention
10. Anti-nutritional factors in feedstuffs and their effects on bird's performance
11. Effect of feed on meat and egg quality; Storage of feeds; Measure to avoid feed wastage
12. 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 boilers, layers and breeders
3. Physical evaluation of feedstuffs; Laboratory analysis of feeds and feedstuffs
4. 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.
2. Lesson, S., & Summers, J.D. (2001). *Broiler Breeder Production*. Guleph, Ontario, Canada: University Books.

Suggested Readings

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

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
10. 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, USA: The Ensminger Publishing.
2. Etgen, W.M., & Reaves, P.M. (1992). *Dairy Cattle Feeding and Management*. USA: John Wiley & Sons.

Suggested Readings

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

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 equipment 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

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.

Suggested Readings

1. Saucer, D.B. (1992). *Storage Cereal Grains and Their Products* (4th ed.). Newbury, Berks, UK: CPL Scientific Publishing.
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. Its 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

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 micromixers and feed-additives in animal feed
8. Manufacturing of compound feeds
9. Selecting, cleaning, grinding, mixing and storing of feed ingredients
10. Effect of processing on feed; Significance and choice of processing methods
11. 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.
2. Bebb, D.L. (1990). *Mechanized Livestock Feeding*. Oxford, UK: BSP Professional Books.

Suggested Readings

1. Ensminger, M.E., Oldfield, J.E., & Heinemann, W.W. (1990). *Feeds and Nutrition Digest* (2nd ed.). Clovis, CA, USA: The Ensminger Publishing.
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

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. Zempleni, 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 Readings

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

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.
2. Bebb, D.L. (1990). *Mechanized Livestock Feeding*. Oxford, UK: BSP Professional Books.

Suggested Readings

1. Ensminger, M.E., Oldfield, J.E., & Heinemann, W.W. (1990). *Feeds and Nutrition Digest* (2nd ed.). Clovis, CA, USA: The Ensminger Publishing.
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

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., Church, D.C. (2005). *Basic Animal Nutrition and Feeding*. India: Wiley.

Suggested Readings

1. Ensminger, M.E., Oldfield, J.E., & Heinemann, W.W. (1990). *Feeds and Nutrition Digest* (2nd ed.). Clovis, CA, USA: The Ensminger Publishing.
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

1. Introduction to feed toxins and antinutritional factors in indigenous feedstuffs
2. Protease inhibitors
3. Physiochemical properties of inhibitors, nutritional significance of protease inhibitors
4. Effect of processing techniques
5. Tannins, their occurrence in plant, tannin physio-chemistry their role in digestion and absorption of nutrients; General properties of hemagglutinins/lectins
6. 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.

Suggested Readings

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.
3. Caygill, C., & Harvey, I. M. (2002). *Secondary Plant Products*. The Netherlands: Empress Publishing.

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. Special problem writing work gives students a lot of scope to improve themselves.

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.

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 bird's 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

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.
2. Leeson, S., & Summers, J.D., (2010). *Broiler Breeder Production*. UK: Nottingham University Press.

Suggested Readings

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 optimize 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

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 Readings

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

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 Readings

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.

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

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.

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

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 Readings

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.

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

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 habit 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.
2. Fehr, P.M. (1991). *Goat Nutrition*. Netherlands: Pudoc Wageningen.

Suggested Readings

1. NRC. (2003). *Nutrient Requirements of Sheep*. National Research Council, Washington, DC: 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

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, fiber, 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.
2. Poole, B.T. (1986). *The UFAW Handbook on the Care and Management of Laboratory Animals* (6th ed.). London: Longman Scientific Technical.

Suggested Readings

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., & McNitt, J. I. (1987). *Rabbit Production*. Danville, Illinois: Interstate Printers & Publishers.

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

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 racehorses
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.
2. Higgins, A.J., & Wright, I.M. (1999). *The Equine Manual*. London, UK: Saunders.

Suggested Readings

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.

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 is 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

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, amount 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 Readings

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.

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

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 Readings

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.

This course is designed for MSc (Hons)/MPhil programs of agriculture sciences. This course provides the applied statistics background for survey and experimental work in Agriculture. 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 agriculture 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 agricultural 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 will further support the student's research.

Contents

1. Importance of Statistics in agriculture research
2. Selection of statistical tools based on scale of measurements
3. Analysis of Count and Frequency data
4. Measures of central tendency and dispersion
5. Some concepts of hypothesis testing. T, Z, Chi-square and F tests. Contingency Tables
6. Diversity Indices
7. Concept of ANOVA and its types
8. Correlation Analysis: Simple correlation, multiple correlation, and Partial correlation
9. Regression Analysis: Simple and multiple regression
10. Generalized linear models: logistic regression, Poisson regression, Gamma regression, Inverse Gaussian regression
11. Non-linear regression
12. Dose Response Curves

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.). Hyderabad, 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.