Animal Physiology
Course Structure – At a Glance
M.V.Sc. (Animal Physiology)

A. Major (24+1 credits)

<table>
<thead>
<tr>
<th>CODE</th>
<th>COURSE TITLE</th>
<th>CREDITS</th>
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<tbody>
<tr>
<td>AP 611</td>
<td>Haematology, Cardiovascular and Respiratory Physiology</td>
<td>2+1</td>
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<tr>
<td>AP 612</td>
<td>Renal Physiology and Body Fluid Dynamics</td>
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<tr>
<td>AP 613</td>
<td>Bioenergetics of Productive Processes</td>
<td>2+1</td>
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<tr>
<td>AP 614</td>
<td>Physiology of Animal Reproduction</td>
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<tr>
<th>CODE</th>
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<tbody>
<tr>
<td>AP 621</td>
<td>Physiology of Digestion</td>
<td>2+1</td>
</tr>
<tr>
<td>AP 622</td>
<td>Physiology of Lactation</td>
<td>2+1</td>
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<tr>
<td>AP 623</td>
<td>Neuromuscular Physiology</td>
<td>2+0</td>
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<tr>
<td>AP 624</td>
<td>Chemical Bioregulation in Physiological Functions</td>
<td>2+1</td>
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<tr>
<td>AP 625</td>
<td>Environmental Physiology</td>
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<tr>
<td>AP 629</td>
<td>Master's Seminar</td>
<td>1+0</td>
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<tr>
<td>AP 699</td>
<td>Master's Research</td>
<td>20</td>
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B. Minor Courses to be taken up by M.V.Sc. students of Animal Physiology from any one of the following disciplines (Minimum 6 credits).

- Animal Nutrition
- Animal Biochemistry
- Animal Biotechnology

C. Supporting Courses (Minimum 3 credits)

- DES&M
- Animal Biochemistry
- Animal Biotechnology

Note: Total credit hours should be minimum 40 in both Semester I and II.
Ph.D. (Animal Physiology)
A. Major (15+2 credits)

**SEMESTER - I**

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>AP 711</td>
<td>Biotechniques in Animal Production</td>
<td>3+0</td>
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<tr>
<td>AP 712</td>
<td>Comparative Physiology of Ruminant Digestion</td>
<td>3+0</td>
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<tr>
<td>AP 713</td>
<td>Advances in Neuro-endocrinology</td>
<td>3+0</td>
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<tr>
<td>AP 714</td>
<td>Advances in Biosynthesis and Secretion of milk</td>
<td>3+0</td>
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<td>AP 715</td>
<td>Physiology of Stress</td>
<td>3+0</td>
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<tr>
<td>AP 719</td>
<td>Doctoral Seminar I</td>
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**SEMESTER - II**

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<tr>
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<tr>
<td>AP 721</td>
<td>Physiology of Animal Behaviour</td>
<td>3+0</td>
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<tr>
<td>AP 722</td>
<td>Advances in Reproductive Physiology</td>
<td>3+0</td>
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<tr>
<td>AP 723</td>
<td>Advances in Bioenergetics and Growth</td>
<td>3+0</td>
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<tr>
<td>AP 724</td>
<td>Advances in Immunophysiology</td>
<td>3+0</td>
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<tr>
<td>AP 729</td>
<td>Doctoral Seminar II</td>
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<tr>
<td>AP 799</td>
<td>Doctoral Research</td>
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B. Minor Courses to be taken up by Ph.D. students of Animal Physiology from any one of the following disciplines (Minimum 6 credits).

Animal Nutrition
Animal Biochemistry
Animal Biotechnology

C. Supporting Courses (Minimum 3 credits)

DES&M
Animal Biochemistry
Animal Biotechnology

**Non-credit courses for M.V.Sc., Ph.D.(if not done in M.V.Sc.) in 3rd Semester**

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<tr>
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<td>GS-632</td>
<td>Technical Writing</td>
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<tr>
<td>GS-633</td>
<td>Intellectual Property and its Management in Agriculture</td>
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<tr>
<td></td>
<td>1+0</td>
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<tr>
<td>GS-634</td>
<td>Basic concepts in Laboratory Techniques/Practices</td>
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<tr>
<td></td>
<td>0+1</td>
</tr>
<tr>
<td>GS-635</td>
<td>Disaster Management</td>
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<td></td>
<td>1+0</td>
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**Note:** Total credit hours should be minimum 30 in both Semester I and II.
AP 611 HAEMATOLOGY, CARDIOVASCULAR AND RESPIRATORY PHYSIOLOGY
(2+1)

Objective
To acquaint the students about haematology of different animals and to teach function and regulation of heart, recording of ECG and respiration in ruminants

Theory

UNIT I
Red blood cells, anaemia, different types of anaemia, polycythemia and their effect on circulation in ruminants

UNIT II
Resistance of the body to infection, leukocytes, tissue macrophage system and inflammation, immunity, immunoglobulins

UNIT III
Hemostasis and coagulation factors, role of platelets, fibrinolysis. Blood groups, transfusion of blood.

UNIT IV
Heart muscle, heart as pump, origin and propagation of heart beat. Electrophysiology of heart, rhythmic excitation of heart, cardiac cycle, heart sound.

UNIT V

UNIT VI
Circulation and hemodynamics, coronary, systemic and pulmonary circulation, their regulation, energetics of circulation.

UNIT VII
Respiration, mechanism of ventilation, hemoglobin, oxygen and carbondioxide transport. Respiratory gas exchange. Respiratory adjustment at high altitude. Neural and chemical control of respiration.

Practical
Collection of blood, separation of plasma and serum
Enumeration of RBC, WBC, DLC
Estimation of Hb, PCV and ESR
Blood group typing
Measurement of blood pressure
Determination and recording of cardiac output and Electrocardiogram
Estimation of lung volumes and capacities by spirometry
Estimation of blood gases.

Suggested Readings
Objective
To impart knowledge regarding excretory system of mammals and maintenance of body fluid homeostasis.

Theory
UNIT I
An overview of nephron structure and function. Renal homeostatic function and renal excretory function.
UNIT II
Renal haemodynamics. Glomerular filtration- its mechanism and measurement. Permselectivity of the glomerular capillary wall, structural basis of GFR, tubular reabsorption and transport.
UNIT III
UNIT IV
Skin- general anatomy of epidermis, dermis, hypodermis, mechanical protection, permeability, sweat glands, sebaceous glands. Immune properties of skin.
UNIT V
Composition of body fluids and their regulation.

Practical
Collection and preservation of urine. Physical and chemical analysis of urine. Qualitative urine analysis, Body fluid estimation-Total body water, blood volume and extra cellular blood volumes, Examination of urine sediments

Suggested Readings

Objective
To acquaint the students about energetics of different productive processes.

Theory
UNIT I
UNIT II
UNIT III
Physiological interpretation of ageing, control mechanisms and exercise. Adaptation to stressors.
UNIT IV
Physiology and energetics of work production, interrelationship between load, speed, horsepower and efficiency. Factors affecting work efficiency, muscle fatigue and hypoxia.
UNIT V
Physiological efficiency of milk production, relationship between net energy and energetic efficiency of productive processes, Factors contributing to efficiency complex of productive processes.

Practical
Measurement of surface area in animals.
Measurement of heat production by open (Mask) and closed circuit spirographic methods.
Animal growth measurements and growth constants.
Blood lactic acid estimation
Calculation of efficiency of work, milk and growth.

Suggested Readings
Bioenergetics and Growth
S.Brody(1945), Publisher- Reinhold Publ.Co,. USA
Bioenergetics, A.L. Lehninger (1965) Publisher WA Benjamin, New York
The fire of life, Max Kliber Publ. John Willy and sons Inc.

AP 614 Physiology of Animal Reproduction (2+1)

Objective
To impart knowledge of male and female reproductive system of different species of animals.

Theory
Unit – I
Functional histomorphology of male and female reproductive system, development of male and female sex organs. Hormones and growth factors in reproduction.

Unit – II
Sexual cycles and mating behaviours in females. Oogenesis, folliculogenesis and ovulation. Secretions of female reproductive tract in different species of animals.

Unit - III
Male mating behavior, spermatogenesis, spermiogenesis, Seminiferous epithelial cycles. Spermatozoa – structure and composition, maturation and transportation. Secretions of male reproductive tract.

Unit IV
Unit V

Practical
Heat detection in rats (vaginal smear techniques).
Palpation of reproductive organs.
Physical and biochemical evaluation of semen.
  Determination of sperm enzyme, (acrosomal enzymes & transaminase activity).
  Preservation of semen
RIA of steroid hormones.
Preparation of Semen extenders.

Suggested Readings
  Panima
Objective
To teach comparative physiology of digestive system of monogastric animals and ruminants.

Theory
UNIT I
Basic characteristics and comparative physiology of digestive system of domestic animals.
UNIT II
Gastro-intestinal motility, secretary functions of gastro-intestinal tract, their regulation and gastro-intestinal hormones.
UNIT III
Absorption, metabolism and excretion of various nutrients, appetite and control of feed intake.
UNIT IV
Development of ruminant system and rumen environment, Ruminant microbial digestion, its advantages and disadvantages. Rumino- reticular motility and its control and significance.

Practical
Recording of rumen movements.
Estimation of digestive metabolites such as glucose, ketone bodies, triglycerides, cholesterol, urea nitrogen alpha amino nitrogen, NEFA and total proteins.
Liver function tests-sGOT, sGPT and alkaline Phosphatase.

Suggested Readings
Objective: To teach comparative aspects of mammary development, milk synthesis and secretion in laboratory animals, small and large ruminants

Theory
UNIT I

UNIT II

UNIT III

Practical

Suggesting Readings:
Lactation (I to IV) (1974-1978)
Edited by B.L. Larson & V.R. Smith, Publisher-Academic Press.
Biology of Lactation
G.H. Schmidt (1971), Publisher-W.H. Freeman & Co. San Franscisco
Comparative Aspects of Lactation
Edited by M.Peaker (1977), Publisher-Academic Press, London.
Lactation
Edited by B.L. Larson (1985), Publisher-Iowa Uni. Press. Iowa.
AP 623  NEUROMUSCULAR PHYSIOLOGY  (2+0)

Objective
To impart knowledge of coordination of body functions and regulation of brain functions and sense organs.

Theory
UNIT I
Types and classification of muscles, comparative histopathology of muscles. Skeletal muscle fibers, membrane and action potential at myoneuronal junction. Molecular characteristics of contractile filaments, molecular mechanism of muscle contraction, relationship between actin and myosin filaments, overlap and tension developed by the contracting muscles. Contractile process of smooth muscles.

UNIT II

UNIT III
Nervous system, synapse, transmission and processing of information, receptors, brain and spinal reflexes, motor functions of brain stem, limbic system, memory, sleep, learning, autonomic nervous system.

UNIT IV
Special senses and somatic senses.

Suggested Readings

AP 624  CHEMICAL BIOREGULATION IN PHYSIOLOGICAL FUNCTIONS  (2+1)

Objective
To acquaint the students about different endocrine glands of the body and their relationship with production.

Theory
UNIT I

UNIT II
Methods of study bioregulation including endocrine methodologies. Hormone assay. Manipulation and disruption of biorhythms in homeostatic and natural ecosystem

UNIT III
Regulation and metabolism of hypothalamic, hypophyseal, thyroid and adrenal hormones. Endocrine control of carbohydrate and calcium homeostasis. Hormonal regulation of gastro-intestinal activity.

UNIT IV

UNIT V
Hormones and adaptation to environment. Hormones in fertility regulation and production augmentation.

Practical
Examination of endocrine glands.
Histological examination of endocrine glands.
RIA and EIA of hormones.
Detection of stages of estrous cycle in rats.
Ovariectomy and Adrenalectomy

Suggested Readings

AP-625 Environmental Physiology (2+1)

Objective
Impart knowledge regarding Environmental Stress on Physiological functions in ruminants.

Theory

UNIT I
Introduction to environmental physiology; climate, weather definition and classification. Components of physical environment, energy exchange between animal and its environment. Heat tolerance, its concept and measurement.

UNIT II
Principles of thermo regulation in dairy animals, homeothermy, homeostasis body temperature and its neural control. Thermal gradient, thermal balance, heat production and heat loss. Physiological responses of farm animals to heat or cold. Defence against heat or cold.

UNIT III
Critical environmental temperature, lethal body temperature, zone of thermoneutrality, zone of survival, regulation of body temperature and its neural control set point, fever.

UNIT IV

Practical

Principle and methods of measuring climatic elements.
Determination of heat tolerance, thermal index in farm animals.
Climograph
surface area measurement,
measurement of sweating and \( O_2 \) consumption.
Recording of physiological responses in dairy animals.

Suggested Readings

Adaptation of domestic animals ESE Hafez (1968), Publisher Lea & Filiger, USA.
Objective
To impact knowledge in animal biotechniques used for augmenting reproduction & production.

Theory

Unit I

Unit II
Endocrine therapeutic and regulatory techniques – induction of parturition, early growth and maturity, ovulation and lactation. Estrus synchronization, superovulation.

Unit III

Unit IV

Suggested Readings
Reproduction in Mammals-5
Physiology and Technology of Reproduction in Female Domestic Animals, R.H.F. Hunter (1980), Publisher – Academic Press
Ova Transport in Fertility Regulation
Edited by M.J.K. Harper et al (1972), Proceeding of WHO Symposium
Egg Transfer in Cattle
Edited by L.E.A. Rowson, Proceeding of Seminar held at ARC Cambridge
Immunological Approaches to Fertility Control Karolinska Symposium, Proceeding No.7
Genes by Lewin. Ed. VIII, Oxford University Press 2000
AP 712  
Comparative Physiology of Ruminant Digestion  
(3+0)  
Theory  
Unit I  
Functional development of ruminant system and rumen environment, ruminant microbial digestion, rumen motility and its control.  
Unit II  
Salivary secretion and its regulation, buffering system. Intra ruminal environment, rumen metabolites and their assimilation. NPN feeding, nitrogen recycling in ruminants.  
Unit III  
Synthesis of microbial protein and vitamins. Comparative aspects of digestion and absorption in dairy animals, rumen dysfunctions.  
Unit IV  
Manipulation of rumen fermentation, protected nutrients feeding, probiotics supplementation. Rumen flow rate and ruminal content.  
Suggested Readings  
Dukes Physiology of domestic animals Edited by M.J. Swensen, Publisher – Panima Publishing Corporation, New Delhi.  
Animal Nutrition by P. Mc Donald.

AP 713  
ADVANCES IN NEURO-ENDOCRINOLOGY  
(3 + 0)  
Objective  
To acquaint the students about neuro-endocrine integrating mechanism in animals.  
Theory  
UNIT I  
Neuroendocrine integrating mechanism. Structure of hypothalamus, pituitary gland, limbic and other neural pathways and endocrine functions.  
UNIT II  
Neural control of oxytocin, adrenocorticotropic hormone, aldosterone, thyrotropic hormone, growth hormone, gonadotrophins etc. Hypothalamic releasing factors and the neuro-vascular link between brain and anterior pituitary.  
UNIT III  
Role of afferent impulses from genitals and other regions in reproductive system. Influence of hormones on brain activity.  
UNIT IV  
Interaction of nervous, endocrine and immune system in animal production and reproduction.  
Suggested Readings  
Blackwell Publ.

Selected articles from journals.

AP 714 Advances in Biosynthesis and Secretion of Milk (3+0)

Objectives To acquaint students about the advances in physiology and mechanism of lactation

Theory
Unit I
Hormonal and non-hormonal factors influencing the mammary gland development in domestic animals. Recent developments in hormonal requirement of mammary gland during pregnancy and lactation.

Unit II
Role of hypothalamus and pineal on galactopoietic hormones. Growth hormone, GH-releasing factor and other biotechniques to enhance milk production in dairy animals. Neural factors influencing milk let-down, milk ejection, milk yield and composition, feedback inhibitor of lactation.

Unit III
Environmental factors influencing galactopoietics hormones in lactating animals. Endocrine Responses to Photoperiod and Melatonin in Lactating Cows, Partitioning of nutrients in high and low producing animals, Tissue culture techniques for evaluating mammary gland metabolism.

Suggested readings
Lactation (I to IV) (1974-1978)
Edited by B.L. Larson & V.R. Smith, Publisher-Academic Press.

Biology of Lactation
G.H. Schmidt (1971), Publisher-W.H. Freeman & Co. San Francisco

Comparative Aspects of Lactation
Edited by M.Peaker (1977), Publisher-Academic Press, London.

Lactation
Edited by B.L. Larson (1985), Publisher-Iowa Uni. Press. Iowa.

Selected articles from journals

AP-715 Physiology of stress (3+0)

Theory
Unit 1
Definition of stress, various types of stresses their effect on animal production and reproduction.

Unit II
Adaptation of domestic animals to tropics, deserts, cold and high altitude. Physiological and nutritional adaptation.

Unit III
Animal shelters and management in tropical zones and amelioration of climatic stress.

Unit IV

Effect of various stresses on endocrine status of animals. Physico chemical changes of blood composition due to exercise and work. Energy utilization and requirement of muscles during work and exercise.

Suggested Readings

Adaptation of domestic animals ESE Hafez (1968) Publisher Lea & Febiger, USA.

AP 721  PHYSIOLOGY OF ANIMAL BEHAVIOUR  (3+0)

Objective
To impart knowledge on various aspects of animal behaviour viz. communication in animals, sexual behaviour, feeding behaviour etc.

Theory
UNIT I
Introduction to animal ethology. Neurophysiological basis of animal behaviour. Components of animal behaviour
UNIT II
Behaviour in relation to changes in the environment. Feeding behaviour, herding behaviour, grazing, stall feeding and rumination.
UNIT III
UNIT IV
Social behaviour, communication in animals, animal temperament.
Response of dairy animals to training and Mechanization.

Suggested Readings
Selected articles from journals.

AP 722  Advances in Reproductive Physiology  (3+0)

Objective: To acquaint the students of latest developments in animal reproduction.

Theory
Unit I
Advances in hypothalamo-hypophysial gonadal relationship. Circulating hormones and receptor affinity. Involvement of hormone agonists and antagonists in reproductive rhythm. Nitric oxide and reproductive functions.
Unit II
Unit III
Immunological concepts in male and female reproduction. Immuno neutralization approaches to augment reproduction. Current concepts in bovine infertility Prostaglandins and reproduction.
Unit IV

Suggested Readings:
Objective
To acquaint the students about energetics of productive processes and growth in relation to performance of animals.

Theory
UNIT I
Current concepts and developments in bioenergetics of growth, milk and work production, factors limiting growth and work efficiency, efficiency complex, influence of biological and seasonal rhythms, metabolic catalysts in efficiency complex.

UNIT II
Current concepts in heat flux and thermodynamical control; cardiovascular adjustments to work heat and combined thermal and metabolic stress, circulatory and body fluid adjustments.

UNIT III
Competition between thermoregulation and other homeostatic systems, peripheral and deep receptor interactions, microcirculation in relation to thermal stress.

UNIT IV
Brain body temperature – role of carotid rete, respiratory and blood gas adjustments, muscle fatigue and its assessment, Adaptation to pressure and electrical gradients.

UNIT V
Neuro Endocrine strategies during adaptation to stress. Aging – Physiological interpretation, control mechanisms and exercise, gerontology and adaptation to stressors.

Suggested Readings
Bioenergetics and Growth
S.Brody(1945), Publisher- Reinhold Publ.Co., USA
Bioenergetics, A.L. Lehninger (1965) Publisher WA Benjamin, New York
The fire of life , Max Kliber Publ. John Willy and sons Inc.

Selected articles from journals

AP 724 ADVANCES IN IMMUNOPHYSIOLOGY (3+ 0)

Objective
To study cellular basis of immunity, organs of immune system, its development and role in physiological functions and immunomodulation.

Theory
UNIT I
Cellular basis of immunity, organs of immune system, ontogeny and phylogeny of immune system, vertical transmission of immunity and difference between vertebrates and invertebrates.

UNIT II
Structure, class, subclass of immunoglobulins, functions of antibody molecules, hematopoiesis, T-cell and B-cell-evolution, development and their functions, species specific immunity, cytokines-sources and actions, MHS, genetic organization of immunoglobulin, MHC and complement system.

UNIT III
Immune-endocrine interactions, immune system in reproduction, lactation, ageing, stress and other physiological functions, immunomodulation.

UNIT IV
Hypersensitivity, diseases related to immune system, dysfunction, autoimmune disorders and their genesis, immunodeficiency. Immunological techniques.

**Suggested Readings**
Tizzard IR. 2004. Veterinary Immunology. 5th Ed. WB. Saunders.
Veterinary Immunology and Immunopathology (An International Journal of Comparative Immunology), Elsevier.

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**VETERINARY PHYSIOLOGY**

**List of Journals**
* Acta Endocrinologica
* Advances in Clinical Chemistry
* Advances in Reproductive Physiology
* Advances in Veterinary Sciences
* American Journal of Clinical Nutrition
* American Journal of Physiology
* American Journal of Veterinary Research
* Animal Nutrition and Feed Technology
* Animal Reproduction Science
* Animal Sciences
* Annual Review of Physiology
* Buffalo Journal
* Domestic Animal Endocrinology
* Indian Journal of Animal Reproduction
* Indian Journal of Animal Nutrition
* Indian Journal of Animal Physiology
* Indian Journal of Animal Research
* Indian Journal of Animal Science
Suggested Broad Topics for Master’s and Doctoral Research

- Physiological manipulation to enhance growth and productivity in ruminants
- Physiological adaptation to environmental stress and its amelioration in domestic animals
- To study the mechanism of regulation of various hormones involved in production and reproduction in domestic animals
- Dietary effects on growth and production in livestock