University of Tehran
College of Science
School of Biology

Animal Biology Curriculum

Post-graduate Program Syllabuses (M.Sc. degree)
Animal physiology

Table 1. List of required courses for Master of Science (M.Sc.) degree in Animal Biology – Biosystematics, Animal Physiology, Cellular and Developmental Biology

No.	Course	Credits			Hours			Prerequisite
		Theory	Practice	Total	Theory	Practice	Total	
1	Animal Biosystematics	2	0	2	32	0	32	None
2	Comparative Anatomy of Vertebrates	2	0	2	32	0	32	None
3	Organogenesis in Vertebrates	2	0	2	32	0	32	None
4	Physiology of Central Nervous System	2	0	2	32	0	32	None
5	Reproductive Physiology	2	0	2	32	0	32	None
6	Cellular and Molecular Mechanisms of Development	2	0	2	32	0	32	None
Total		12	0	12	192	0	192	-

A student requires 12 credits shown in Table 1.

Table 2. List of elective courses for Master of Science (M.Sc.) degree in Animal Biology –Animal Physiology

No.	Course name	Units			Hours			Prerequisite
		Theory	Practice	Total	Theory	Practice	Total	
1	Membrane Physiology	2	0	2	32	0	32	None
2	Animal Cell and Tissue Culture	1	1	2	0	32	32	None
3	Animal Cell and Tissue Culture Lab	0	1	1	0	32	32	None
4	Physiology of Senses	2	0	2	32	0	32	None
5	Physiology of Nerve and Muscle	2	0	2	32	0	32	None
6	Neurophysiology of Behavior	1	1	2	0	32	32	None
7	Structure and Function of Synapses in Brain	2	0	2	32	0	32	None
8	Physiology of Blood Cells	2	0	2	32	0	32	None
9	Advanced Endocrinology	2	0	2	32	0	32	None
10	Research Methodology and Data Presentation in Biology	2	0	2	32	0	32	None
11	Flight Physiology	2	0	2	32	0	32	None
12	Fish Physiology	2	0	2	32	0	32	None
13	Physiology of Diving Animals	2	0	2	32	0	32	None
14	Insect Physiology	1	1	2	16	32	48	None
Total		24	4	28	352	128	480	-

A student requires 14 credits shown in Table 2.

Prerequisites for Master of Science (M.Sc.) degree in Animal Biology

The student's supervisor may ask to study up to 612 credits from Bachelor of Science (B.Sc.) program syllabuses.

Animal Biology Curriculum

Post-graduate Program Syllabuses (M.Sc. degree)
Biosystematics
Animal physiology
Cellular and Developmental Biology

Required Courses

Course name: Animal Biosystematics
Number of units: 2
Hours: 32 hours
Unit type: theoretical
Course type: required
Prerequisite: None
Additional education: No.
Scientific trip: yes Workshop: No. Laboratory: No. Seminar: yes
The overall objective of the course:
The purpose of this course is to familiarize master students with the principles of animals biosystematic attitudes toward taxa.

Topics of the course:

1. Biosystematics position, taxonomy and classification in pure and applied sciences.
2. Taxonomy and biodiversity in the past, present and future.
3. Microtaxonomy (phenon, taxon, order and species classification).
4. A glance at species, nominal, morphological, evolutionary and biological concepts.
5. Species taxon, subspecies and superspecies levels.
6. Population taxonomy and intra-population variations.
7. Specimen and Speciation and determination of species boundaries.
8. Viewpoints in the evolutionary school of thought.
9. Viewpoints in the phenetical School of thought.
10. Viewpoints in the Cladistic School of thought.
11. Taxonomic traits.
12. Museum and museuming.
13. Taxonomy publications.
14. Animal Naming Rules
15. Special subjects in animal biosystematics.

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%- written**	**20%**

References:

Darvish, j. (1384) populations, species, evolution. vajegane kherad Publishing, Mashhad ---Kapoor V. Translation by Sahragard, A. V. J. Hajizadeh (2001) The principles of animal classification. Gilan University Press.

-ICZN (1999) International Code of Zoological Nomenclature, 4th edition. ICZN (International Commission on Zoological Nomenclature). London, Berkeley.

-Mayer, E. and P.D. Ashlock (1991) Principles of Systematic Zoology. MacGraw-Hill, Singapore. Second edition.

-Minelli, A. (1993) Biological Systematics: The state of Art. Chapman & Hall, London.

Course name: Comparative Anatomy of Vertebrates
Number of units: 2
Hours: 48 hours
Unit type: 1 unit theoretical - 1 unit practical
Course type: required
Prerequisite: None
Additional education: No.
Scientific trip: No. Workshop: No. Laboratory: No. Seminar: yes
The overall objective of the course:
The purpose of this course is to familiarize master students with the principle of homology in structures from a dissectional and developmental point of view.
Topics of the course:
1. An overview of vertebrate total position in taxonomy and fossil science
2. A brief overview of the general models of embryonic development and embryonic layers
3. The structure of the skin and its derivatives from fishes to mammals
4. Structure of axial and skull skeleton
5. Skin Comparative laboratory
6. Skeletal structure of the motor organs
7. Skeleton Comparative laboratory
8. Muscular system from fishes to mammals.
9. Gastrointestinal tract - evolution and ecological adaptations from fishes to mammals.
10. Respiratory system: Origin - Variability and structural adaptations from fishes to mammals.
11. Comparative laboratory of digestion, muscle and respiration
12. Circulatory system: From amphioxus to fish and the development of the mammalian circulation system
13. Genitourinary system: origin and evolution of the genitourinary system from fishes to mammals
14. Sensory and nervous system, a comparison from fishes to mammals
endocrine tissues and their position - Embryo source and homology examination

16. Comparative analysis and adaptation

17. Comparative laboratory of circulatory, genitourinary, nervous and sensory and endocrine systems

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
0%	**0%**	**75%- written** **25% - practice**	**0%**

References:

- Kont J. C. and L. Miller translated by Sadrzadeh Tabatabai M. H. (2008) Comparative anatomical study of vertebrates. Tehran University Press.
-Kardong, K. V. (2002) Vertebrates: Comparative Anatomy, Function, Evolution. Tata McGraw-Hill, New Delhi.6th edition.

Course name: Organogenesis in Vertebrates
Number of units: 2
Hours: 32 hours
Unit type: theoretical
Course type: required
Prerequisite: None
Additional education: No.
Scientific trip: No. Workshop: No. Laboratory: No. Seminar: yes
The overall objective of the course:
familiarity of students with the process of organogenesis in the vertebrate embryo at morphology, tissue, and cellular and molecular levels.
Topics of the course:
1. Introduction: The formation of three layers of fetal (reminder), the role of epithelium and mesenchyme interactions in organogenesis
2. Ectoderm development.
• Formation and differentiation of the neural tube.
• Neuron differentiation, histogenesis of the neural tube (migration of axons to the target tissues).
• Development of vertebrates' eye.
• Development of skin and its attachments.
•Development of neural-crest cells and their derivative structures
3. Mesoderm Development:
• Paraxial mesoderm: formation of somite and its derivatives, myogenesis and osteogenesis
• Intermediate mesoderm: Development of the urinary system
• Lateral mesoderm: the development of fetal external membranes, the development of the cardiovascular system
• Development of the motor organs
4. Endoderm development:
• Gastrointestinal development: liver, pancreas, gastrointestinal tract (in mammals and amphibians)
• Development of the respiratory tract

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%- written**	**20%**

References:
-Gilbert, S. F. (2013) Developmental biologyTenth edition, Sinauer Associates, Sunderlaud, MA
-Kalthoff, K. (2001) Analysis of Biological development. Second edition. Mc Graw – Hill, New York.
-Wilt F. H. and Hake S. C. (2004) Principles of developmental biology. First edition, Norton & company, Inc. New York

Course: Physiology of the Central Nervous System
Number of credits: 2
Hours: 32 hours
Type of credit: Theory
Type of course: Required

Pre-requisite: No	Supplementary training: No	Educational Expedition: No
Workshop: No	Laboratory: No	Seminar: Yes

Course objective

Study of various parts of the brain and the spinal cord with emphasis on the function of each part, the cerebroventricular system

Course syllabus

1. Overview of the central nervous system (CNS) ontogenesis in vertebrates, research methods in neurophysiology including stereotaxic surgery and electrophysiological techniques
2. Advanced neurophysiology of spinal cord, Spinal cord anatomo-physiological design, connective functions and reflexes
3. Brain stem: medulla oblongata, its connective pathways and functions
4. Brain stem reticular structures: upward and downward reticulocortical systems, the regulation of skeletal muscle tonus, the adjustment or adaptation level of the reticular formation, the neurophysiology of sleep and waking
5. Brain stem specific nuclei: structures and functions
6. Cerebellum: neuroanatomo-physiological structures and functions, cerebellar cortex and pathways, deep nuclei, cerebellar disorders
7. Thalamus: thalamic nuclei, thalamic information processing, thalamocortical and corticotalamic systems
8. Basal ganglia: neuroanatomo-physiology of the different parts of basal ganglia, the disorders
9. Neuroanatomo-physiology of the hypothalamus, cortical and subcortical areas of the brain ventricles.
9. Limbic system, neuroanatomo-physiology of the amygdala, the hippocampal formation, the major neurotransmitter pathways in the brain
10. Cortical motor and sensory centers, pyramidal and extrapyramidal pathways, Cortical communications, neuroanatomo-physiological differences between brain hemispheres

Evaluation

Continuous evaluation (Quiz)	Mid-term	Final exam-Writing	Seminar
10%	-	70%	20%

References for additional reading

Hall, J.E., 2016. Guyton and Hall Textbook of Medical Physiology, 13th Edition, Elsevier.
[Translated by Sepehri, H., et al., 1394, Andayesh Javid Publications, 1394.]
William Ganong, General Physiology of Medicine. Translated by Farrokh Shadan et al., Last edition
Purves., D., 200٨. Neuroscience, ٣rd edition. Mass.sinauer Associates
Thompson. R. F. 20١٠. The brain: a neuroscience primer, ٤rd edition, Worth Publishers

Course: Reproductive Physiology
Number of credits: 2
Hours: 32
Type of credit: Theory
Type of course: Required

Pre-requisite: No	Supplementary training: No	Educational Expedition: No
Workshop: No	Laboratory: No	Seminar: Yes

Course objective

Recent methods of cellular and molecular biology provided us with better understanding of reproduction and inheritance. The aim of the present course is to learn reproductive physiology from basic science to clinical perspectives.

Course syllabus

1. Structure and function of the testis, Spermatogenesis and its stimulants, Sperm maturation, Sertoli and Leydig cells, Blood-testicular barrier
2. Hormonal regulation of testicular function, Acrosomal enzymes, Sperm penetration into an oocyte
3. Studying factors that affect spermatogenesis, sperm passage through reproductive organ
4. Physiological functions of the accessory glands, epididymis, prostate, Neural stimulation of mating
5. Regulatory roles of hypothalamic and pituitary hormones on reproduction and sexual behavior
6. Abnormal spermatogenesis and fertility in male, Cryptorchidism, Pineal gland and its function on fertility
7. Folliculogenesis and ovulation, Regulatory mechanisms of Follicular growth, Menstrual cycle: regulatory roles of gonadotropins, physiological interactions between ovarian, pituitary, and hypothalamic hormones to maintain the cycle
8. Synthesis of estrogens and progestins: Their effects on reproductive and skeletal organs
9. Fertilization, Sperm capacitation, Sperm-Egg communication, Placenta hormones
10. Pregnancy, Hormonal regulation of pregnancy, Parturition: Hormonal regulation of delivery, Separation and excretion of placenta, Prostaglandins, Lactation, and Prolactin function
11. In vitro fertilization: Methods and hormonal manipulation

Course evaluation

Continuous evaluation (Quiz)	Mid-term	Final exam-Writing	Seminar
10%	-	70%	20%

References for additional reading

Hall, J.E., 2016. Guyton and Hall Textbook of Medical Physiology, 13th Edition, Elsevier. [Translated by Sepehri, H., et al., 1394, Andayesh Javid Publications, 1394.]
Thiboult, C., 2001. Mammalian and Human Reproduction. INRA Editions, France.
Jones, R.E., Lopez, K.H., 2006, Human Reproductive Biology, Academic Press.

Course name: Cellular and Molecular Mechanisms of Development
Number of units: 2
Hours: 32 hours
Unit type: theoretical
Course type: required
Prerequisite: None
Additional education: No.
Scientific trip: No. Workshop: No. Laboratory: No. Seminar: yes
The overall objective of the course:
Students' familiarity with the main stages of embryonic development by relying on its cellular and molecular controlling mechanisms
Topics of the course:
1. Introduction: The history of developmental biology establishment and the origin of Embryonic Cells
2. Types of reproduction, development of gonads
3. Overview of early stages of embryogenesis: fertilization, cleavage, gastrolation
4. The basis of development: proliferation, differentiation, morphogenesis, growth, modeling
5. Modeling of the embryo: determining the embryonic axis in Drosophila
6. The mechanisms of determining the cell fate :
a) the role of the maternal factors (determining the fate of Tunicate embryos and the differentiation of sexual cells in Zenopus and Drosophila);
b) the role of cell-cell interactions (Mesoderm induction in amphibian embryos and development of vulve in C. elegans, differentiation of germ cells in mammals)
7. Cellular mechanisms of morphogenesis: (cellular and molecular basis of changes in cell morphology, cell death, and cell migration)
8. The regulatory mechanisms of growth and reproduction: (studying the mechanisms which determine the shape and size of the tissue)
9. The role of Hox genes in controlling developmental mechanisms

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%- written**	**20%**

References:
-Gilbert, S. F. (2013) Developmental biology, Tenth edition, Sinauer Associates, Sunderlaud, MA.
-Wolpert, L., Beddington, R., Jessell, T., Lawrence, P., Meyerowitz, E. and Smith, J. (2011) Principles of development. fourth edition, Oxford University Press.
-Slack, J. (2012) Essential developmental biology. Third edition, Blackwell Science Ltd, Oxford.
-Wilt F. H. and Hake S. C. (2004) Principles of developmental biology. First edition, Norton & company, Inc. New York.

Animal Biology Curriculum

Post-graduate Program Syllabuses (M.Sc. degree)

Animal Physiology

Elective Courses

Course: Membrane Physiology
Number of credits: 2
Hours: 32
Type of credit: Theory
Type of course: Elective

Pre-requisite: No	Supplementary training: No	Educational Expedition: No
Workshop: No	Laboratory: No	Seminar: Yes

Course objective

To study the new achievements in cellular and molecular physiology particularly membranes and receptors, and laws that are implied in absorption and disposal of substances. The goal of the course is to study substances and molecules transports through the membrane, and to study the structure and function of receptors and membrane carriers.

Course syllabus

1. Membrane isolation via differential gradient centrifugation, study of membrane morphology using X-rays and electron microscopy, freezing and imaging methods
2. The structure of all types of signaling pathways, signal reception by receptors and signal transduction proteins (protein kinases, phosphatases, GTPase, carrier proteins)
3. Hormones and their chemical nature (protein, peptide, amino acid, fatty acid derivatives, nucleotides, steroids, retinoid, inorganic molecules such as NO), agonists and antagonists
4. Interactions of hormones and their receptors, stimulation of cAMP synthesis by adrenaline and noradrenaline, receptor and the signal response variability in target cell
4. Nuclear receptors and signal transduction of these receptors
5. The structure of transmembrane receptors, the signaling pathway of G protein coulled receptors, the characteristics of different types of G proteins, message transmission mechanism of signal transduction via G protein subfamilies Gs, Gi and Gq
6. Membrane dependence of G proteins, regulatory GTPases and their regulation, inhibition by GTP analogs and termination of message transmission
7. The function of secondary messengers, the main messenger molecules involved in processes such as sight, cell proliferation, gene expression and secretion
8. Calmodulin, target proteins, lipid (ceramide) messengers, NO messenger molecules (regulatory and toxic function)
9. PKC family, the structure and activation of Ca-linked kinase proteins
10. Messages transmission by Ras proteins, ATP hydrolysis, mechanism of action of GAP protein, Ras protein membrane settlement, Raf kinase interactions with this protein
11. Ion channels and message transmission, electrical (neural) and chemical communication (synapse), membrane potential and its electrical status, voltage dependent ion canals, channel activation and deactivation, direct linkage of G proteins and ion channels
12. Neurotransmitters and the opening mechanism of gated-voltage-dependent ion channel

Evaluation

Continuous evaluation (Quiz)	Midterm	Final exam-Writing	Seminar
10%	-	70%	20%

References for additional reading:

Krauss, G., 201٥. Biochemistry of signal transduction and regulation, 3th edition, Wiley Co.
Albert, B., et al., 2007. Molecular Biology of the Cell, 5th edition, Garland science Co.
Lodish, H., et al., 2012. Biology of the Cell, 7th edition, 2012, W.H. Freeman Co.

Course: Animal Cell and Tissue Culture
Number of credits: 2
Hours: 32
Type of credit: Theory
Type of course Elective

Pre-requisite: None	Supplementary training: Yes	Educational Expedition: No
Workshop: None	Laboratory: None	Seminar: Yes

Course objective

The progress in cellular and molecular biology requires the science of cell and tissue culture. In this course, which is associated with the laboratory students get to learn about new teqniques of animal cell culture.

Course syllabus

1. Benefits of cell and tissue culture, limitations, differences of In vivo and in vitro condition, types of culture medium
2. Physical and chemical properties of culture media, salt solutions, complete medium, supplements, serum and its components, serum types and the appropriate serum selection.
3. Serum free medium, advantages and disadvantages of serum, serum free medium and its disadvantages, replacement of serum and selection of serum free medium
4. Designing a cell culture laboratory, the required characteristics of a cell culture room, sterilization of the environment
5. Primary culture and its types, tissue extaction, primary culture techniques
6. Subculture and cell lines, passage and proliferation, cell selection, comparison of primary cells and cell line growth pattern (growth curve), embryonic cells, cryopreservation of cells and theirviability
7. Cell isolation, cell confluency in the medium, adhesion strength and cause of adhesion, adhesion molecule types and cell detection techniques based on the antibody
8. Cell morphology, chromosomal content, cell line karyotype, immortality and transformation, factors involved in the transformation (viruses and carcinogens)
9 Tumor cell culture and troubles involved, tumor cell characterization
10. Cell culture contamination and its sources,
11. Apoptosis, Bcl2 family, caspase activation
12. Necrosis and apoptosis detection with flourscent stainig, TUNEL staining, Annexin-PI assay and DNA laddering
13. Designing an animal cell culture, required facilities and solutions
14. Different animal cell lines, cell thawing and cell viability
15. Cell passaging and cell counting
16. MTT assay and cell freezing

Evaluation

Continuous evaluation (Quiz)	Midterm	Final exam-Writing	Seminar
10%	-	70%	20%

References for additional reading:

-Masters, J. R. W. 2000. Animal cell culture .Oxford university press.
-Freshnney, I. 2005. Animal cell culture. Wiley Liss pub.

Course: Animal Cell and Tissue Culture Lab
Number of credits: 1
Hours: 32
Type of credit: Practice
Type of course: Elective

Pre-requisite: No	Supplementary training: No	Educational Expedition: No
Workshop: No	Laboratory: Yes	Seminar: No

Course objective

The purpose of the course is to study the basics and principles of various stages of animal cell and tissue culture

Course syllabus

1. The principles of cell and tissue culture
2. Laboratory equipments
3. Different culture media
4. Different cell lines
5. Principles of cell freezing and storage
6. Cell thaw, primary culture
7. Cell counting and viability.
8. Passage, subculture
9. Cell lysis and total protein measurement

Evaluation

Continuous evaluation (Quiz)	Midterm	Final exam-Writing	Seminar
10%	0%	90%	0%

References for additional reading

Aschner, M., Sunol, C., Bal-Pricem, A., 2009. Cell Culture Techniques, Springer.
Harrison, M.A., Rae, I.F., 2010, General Technique of Cell Culture, Cambridge University Press.
Freshney, I.R., 2011, Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition, Wiley.

Course: Physiology of Senses
Number of credits: 2
Hours: 32
Type of credit: Theory
Type of course: Elective

Pre-requisite: No	Supplementary training: No	Educational Expedition: No
Workshop: No	Laboratory: Yes	Seminar: Yes

Course objective

To study and recognize different senses, the structure and function of sensory systems, and the central processing pathways

Course syllabus

1. General physiology of senses, types of sensory stimuli and receptors, definitions of the absolute and relative stimulation threshold and the law of Weber Fechner
2. Receptor potential, the adaptation of receptors to stimuli, difference between sensation and perception, encoding and processing of sensory information.
3. Processing pathways of sensory information, types of nerve fibers, ascending and descending sensory pathways, synaptic fatigue
4. Physiology of somatosensory system
5. Spinothalamocortical pathways of somatosensory system
6. Sense of pain, stimuli and receptors of pain, central pathways and sites, the nature of transient pain (referential) and phantom pain, inadaptability against pain, physiological systems of pain control, reflexive, vegetative and psychological reactions against pain, referring to types of migraines and its causes, the study and properties of thermoreceptors, and thermoreception, central thermal pathways and sites
7. Somatosensory, muscle spindles structure and Golgi's receptors, cerebellar pathways, the processing signals of proprioceptors and exteroreceptors, tactile sensations
8. Physiology of visual system, the visual pathways and centers
9. Physiology of auditory system, auditory pathways and centers, auditory reflexes
10. Chemical senses and their receptors, the olfactory pathway from receptors to the cortex, olfactory cortex
11. Gustatory sensation, receptors, pathways and centers, the role of genetic factors in olfactory and gustatory sensations

Table of assessment

Continuous evaluation (Quiz)	Midterm	Final exam - Writing	Seminar
10%	-	70%	20%

References:

Moys, C.D., Schulte, P.M., The Basics of Animal Physiology. Translated by Rezayof, A., et al., Volume I, 2011, Fatemi Publication.
Hall, J.E., 2016. Guyton and Hall Textbook of Medical Physiology, 13th Edition, Elsevier.
[Translated by Sepehri, H., et al., 1394, Andayesh Javid Publications, 1394.]William Ganwong, General Physiology of Medicine, Translated by Farrokh Shadan et al., Last edition

Course: Physiology of Nerve and Muscle
Number of credits: 2
Hours: 32
Type of credit: Theory
Type of course: Elective

Pre-requisite: No	Supplementary training: No	Educational Expedition: No
Workshop: No	Laboratory: Yes	Seminar: Yes

Course objective

To study cellular and molecular structure of excitable cells, various types and functional mechanisms

Course syllabus

1. Neuronal cytology: the structure and function of neuron organelles
2. Neuritogenesis
3. Structural and functional characteristics of non-myelinated and myelinated neuron fibers, ion permeability of excitable membranes
4. Types of membrane potential changes, methods in the study of membrane potential
5. Structure and function of various ion channels in the excitable membranes
6. The structure and function of electrical and chemical synapses
7. Synthesis, storage and axonal transport of neurotransmitters and neuropeptides
8. Theories and functional mechanisms of exocytosis, endocytosis and recycling of synaptic vesicles
9. Neuronal receptors and signaling pathways
10. Structure and function of neuromuscular synapse
11. Cellular and molecular mechanisms of the excitation-contraction coupling in skeletal muscle
12. Types of skeletal muscle fibers, isometric and isotonic muscle contractions, muscle contraction energy sources, metabolism and heat production
13. Dystrophin-glycoprotein (DGC) complex and its disorders, muscle weakness and fatigue, muscle paralysis
14. Structure and organization of various types of cardiac muscle cells, ionic currents in cardiac muscle
15. Electrocardiography, cardiac excitation-contraction coupling, autonomic nervous system control of the cardiac function
16. Structure and organization of smooth muscle, smooth muscle excitation-contraction coupling, mechanism of smooth muscle contraction, electrical and mechanical properties of smooth muscle, The latch-bridge mechanism in smooth muscle

Evaluation

Continuous evaluation (Quiz)	Midterm	Final exam - writing	Seminar
10%	-	70%	20%

References for additional reading

Keynes, R.D., Aidley, D.J., Huang, C.L.H., 2011 . Nerve and Muscle, 4th edition. Cambridge University Press.
Matthews, G.G., 2003. Cellular Physiology of Nerves and Muscles, 4th edition. Wiley-Blackwell.
Kandel, E., Schwartz, J., Jessell, T., 2013. Principles of Neural Science, 5th edition. McGraw-Hill Medical

Course: Neurophysiology of Behavior
Number of credits: 2
Hours: 32
Type of credit: Theory
Type of course: Elective

Pre-requisite: No	Supplementary training: No	Educational Expedition: No
Workshop: No	Laboratory: Yes	Seminar: Yes

Course objective

To study nervous systems, neurotransmitter receptors and signaling in various behaviors such as learning and memory processes, To get familiar with various research methods to study behavioral neurophysiology

Course objective

1. The biological basis of behavior
2. Research methods in behavioral neurophysiology and the animal models
3. Neuroimaging techniques in behavioral neurophysiology
4. Cellular and molecular mechanisms of learning and memory processes
5. Types of learning and memory formation and the research models
6. Function of neurotransmitter systems in learning and memory processes
7. Mesocorticolymbic dopaminergic system, reward reinforcement and p
ing pathways, encouragement, punishments and hatred processes.
8. Psychological dependence on drug and neurobiology of addiction
9. Neurophysiological functions of the most important neurotransmitter systems in cognitions, mood and behaviours
10. Biological rhythms, sleep and dreaming
11. Neurophysiology of fear and anxiety; the animal models; the study of neurotransmitters in behaviours
12. The effects of sex hormones on behaviors

Evaluation

Continuous evaluation (Quiz)	Midterm	Final exam - Writing	Seminar
10%	-	70%	20%

References for additional reading

Feldman, R.S., Meyer, J.S., Quenzez, L.F., 20١٢. Principles of Neuropsychopharmacology. Sinauer
Domenici, P., Blake, R.W., 2000. Biomechanism in Animal Behavior. Oxford: BIOS.
Feinberg, T.E., Farah, M.J., 2003. Behavioral Neurology and Neuropsychology. New York: McGraw-Hill

Course: Structure and Function of Synapses in the Brain
Number of credits: 2
Hours: 32
Type of credit: Theory
Type of course: Elective

Pre-requisite: No	Supplementary training: No	Educational Expedition: No
Workshop: No	Laboratory: Yes	Seminar: Yes

Course objective

The study structure and function of synapses, excitatory and inhibitory synapses, synaptic plasticity, synaptic changes during aging, and synaptic neurological diseases

Course syllabus

1. Molecular mechanisms of synaptogenesis
2. The role of cell adhesion molecules in formation of synapses and synaptic transmission
3. The structure and complexity of dendrites and their diversity and signaling dynamics
4. Architectural and molecular organization of the active zone
5. Synthesis of local proteins and their role in synapses
6. Extracellular matrix molecules and synaptic plasticity
7. Mechanisms in excitatory synaptic plasticity
8. Mechanisms in inhibitory synaptic plasticity
9. Plasticity of electrical synapses
10. The effect of regressive signals on the expansion and modulation of synapse function
11. The role of astrocytes in the regulation of synapse and synaptic disorders
12. Sex hormones effect on hippocampal synapses
13. The role of synaptic structural changes in neurodegeneration
14. Synaptic coordination in aging and discognitions
15. Research techniques to study synapses

Evaluation

Continuous evaluation (Quiz)	Midterm	Final exam - Writing	Seminar
10%	-	70%	20%

References for additional reading

Hell, J.W., Ehlers, M.D., 2008. Structural and Functional Organization of The Synapse. Springer.
Pickel, V., Segal, M., 2010.The synapse: structure and function. Cornell University.

Course: Physiology of Blood Cells
Number of credits: 2
Hours: 32
Type of credit: Theory
Type of course: Elective

Pre-requisite: No	Supplementary training: No	Educational Expedition: No
Workshop: No	Laboratory: No	Seminar: Yes

Course objective

Recognizing blood tissue, immune system and lymphatic system, studying all types of blood cells and their function in physiologic and pathologic conditions.

Course syllabus

1. Blood components, physicochemical properties of blood, haematocrit, and blood volume
2. Function of blood, plasma and its proteins, blood elements
3. The generation of blood cells, the aging and the destruction of blood cells
4. ABO and Rh system, acid-base homeostasis
5. Erythrocytes (RBC), morphology, characteristics, number, longevity, role of RBCs
6. Iron metabolism, hemoglobin, structure, types, components-types of abnormal hemoglobin
7. Fate of red blood cells, role of the liver, colon and kidney, biliverdin and bilirubin, transferrin
8. Leukocytes (white blood cells), morphology, characteristics, number, Role of white blood cells, types of white blood cells, Function and longevity, Inflammation
9. Introduction of the immune system and various types of immunity, the role of leukocytes in immunity
10. Platelets, morphology, characteristics, number, longevity, platelet roles and hemostasis
11. Lymph nodes and their function
12. Coagulation of blood and mechanisms involved in it, decomposition of blood clots
13. Bleeding and its types
14. The mechanism of inflammation and blood cells involved in it

Evaluation

Continuous evaluation (Quiz)	Midterm	Final exam-Writing	Seminar
10%	**-**	**70%**	**20%**

References for additional reading

Hall, J.E., 2016. Guyton and Hall Textbook of Medical Physiology, 13th edition, Elsevier. [Translated by Sepehri, H., et al., 1394, Andayesh Javid Publications, 1394.]
Koeppen, B.M., et al., 2011. Berne & Levy Physiology. 6th edition, Elsevier Co.
Yawata, Y., 2006. Cell Membrane. The Red Blood Cell as a Model. 2nd edition, Wiley Co.

Course: Advanced Endocrinology
Number of credits: 2
Hours: 32
Type of credit: Theory
Type of course: Elective

Pre-requisite: No	Supplementary training: No	Educational Expedition: No
Workshop: No	Laboratory: No	Seminar: Yes

Course objective

The aim of the course is to study structures, functions and biosyntheses of hormones, neurohormones, neuropeptides, and neurotransmitters.

Course syllabus

1. Definition of the endocrine system:Its association with the nervous and immune systems and homeostasis, Classification and biosynthesis of hormones, Hormonal regulation of secretion, Hormone and receptor kinetics, Definition of the dose-response curve and Scutchardplot curve
2. Molecular and cellular mechanisms of hormonal functions: G protein-coupled receptors, second messengers, transcription factors, Tyrosin-dependent receptors
3. Steroid receptors: Genomic and non-genomic modes of action
4. Methods to quantify hormones, Biological tests to analyse hormonal activities; Hormonal transport in circulatory system
5. Prostaglandins: Structures and functions; Endocrinological functions of serotonin, histamine, acetylcholine, and catecholamines
6. The metabolism of proteins, lipids and carbohydrates during absorption and post-absorption stages, Pancreatic hormones: Their role in the metabolism, Gastrointestinal and intestinal hormones (Secretin, Gastrin, CCK, etc.): Their role in the metabolism
7. Appetite stimulating hormones including Neuropeptide Y, Ghrelin, Leptin: Their roles in food intake and energy expenditure (energy hemostasis)
8. Cellular and molecular insulin function: Roles of IRS1 and IRS2
9. Types of diabetes, Role of insulin receptors and intracellular kinases in insulin resistance syndrome
10. Hormonal regulation of phosphate and calcium balance: Regulatory functions of parathyroid hormone, Vitamin D, Calcitonin,
11. Anterior pituitary hormones (Adrenocorticotropic hormone, Growth hormone, Prolactin, Thyroid-stimulating hormone, LH, FSH): Structures, biosynthesis, functions
12. Posterior pituitary hormones (Oxytocin, Vasopressin): Structures, biosynthesis, functions
12. Adrenal gland hormones and functions, System of Renin-Angiotensin- Aldosterone in regulation of body water and salt, Glucocorticoids: Their metabolic functions, Glucocorticoids and immune system
13. Catecholamines: Biosynthesis and functions, Roles of catecholamines and cortisol in stress
14. Sex hormones (Androgens, estrogens and progestins): Functions and regulation of secretions
15. Recent articles on regulatory functions of gonadotropins

Evaluation

Continuous evaluation (Quiz)	Midterm	Final exam – Writing	Project
10%	-	70%	20%

References for additional reading

Berne, R.M. Levy, M.N., Koeppen B.M., Stanton, B.A., 2004. Physiology, 5th edition. Chapters 39-46. Mosby.

Brook, C.G.D., Marshall, N.J., 2001. Essential Endocrinology, 4th ed. Blackwell.
Portefield, S., 2001. Endocrinephysiology; 2nd ed. Mosby.

Course: Research Methodology and Data Presentation in Biology
Number of credits: 2
Hours: 32
Type of credit: Theory
Type of course: Elective

Pre-requisite: No	Supplementary training: No	Educational Expedition: No
Workshop: No	Laboratory: No	Seminar: Yes

Course objective

To study statistics from basic sciences to practical/applied perspective with emphasize on significance of statistics in biological studies, optimizing research design, data processing, and presentation of the results in a proper manner.

Course syllabus

1. Philosophy of science - the scientific method of cognition: Philosophy and its relation to the known, Methods of cognition, The goals of science, The assumptions of science, The requirements of scientific observation)
2. Types of observations and scientific Research: Natural observations used in descriptive research, Natural observation techniques and approaches with application in descriptive research, Observation of experiments used in descriptive-experimental research
3. Steps in the scientific method: Describing the initial and secondary stages, The formulation of the problem and the question (1^{st} step), The formulation of the hypotheses and questin (2^{nd} step)
4. Variables in experiments: Design structure (step 3), Variables, Main variables in an experiment, Accuracy and stability of variables, Circular reasoning
5. Initial and final stages of research: Search of references, Research proposals, Pilot studies, Unexpected results, Report, and Research)
6. Ethics in research: Ethics in studies that not include a living organism, Ethics in studies that include living organism
7. Control in experiment: Control concepts, Types of external variables, Variable concepts and good design of experiment, Resources of various variables, Various variables, Minimizing variables error
8. Experiment design: General concepts and principles, Pre-experiment design, Quasi-experimental design, Types of designing, Intra-group and inter-group design
9. Sampling and generalization: Concepts, Basic and fundamental decisions about time, Types and methods of sampling, Statistics and parameters, Sampling reliability, Validity and sampling accuracy, Generalization from sample to whole, Sampling techniques
10. Examination of a hypothesis and statistical significance (Types of assumptions, Zero hypothesis test, Proving and rejection, Potential errors to distinguish statistical difference, To evaluate level of significant difference, Strength and sensitivity of the statistical tests, Distribution of data, Differences between pairs and means, Difference between statistical and real significant values
11-14. Presentation: Preparation of a report, Preparation of a research n article(Title, Affiliation, Abstracts, Introduction, Materials and methods, Results, Discussion, Acknowledgement, References Figures, Tables, Submission, Review process), Preparation of a review article, Prpearation of an abstract for a conference, Preparing and writing a dissertation, Preparation and presentation of a lecture, Preparing and presentation of a poster, Copy-wright and ethics

Evaluation

Continuous evaluation (Quiz)	Midterm	Final exam - Writing	Seminar
10%	-	70%	20%

References for additional reading

Goald, J., 2002. Experimental Methods for the Behavioral and Biological Sciences. CRC press, Boca Raton.
Mepham, B., 2005. Bioethics, An introduction for the Biosciences. Oxford University Press, Oxford.
Jones A., Rreed, R., Weyers, J., 1998. Practical Skills in Biology. Longman, Essex.
Zar, J.H., 1998. Biostatistical Analysis. 4th edition. Prentic Hall International Inc. New Jersey.
Sokal, R.R., Rohel, F.J., 1995. Biometry. 3rd Edition. Freeman, New York.
Booth, V., 1990. Communicating in Science: writing and speaking. Cambridge University Press. Cambridge.
Day, R., 1991. How to write and publish a Scientific Paper. 3rd edition. Cambridge University Press. Cambridge.

Course: Flight Physiology
Number of credits: 2
Hours: 32
Type of credit: Theory
Type of course: Elective

Pre-requisite: No	Supplementary training: No	Educational Expedition: No
Workshop: No	Laboratory: No	Seminar: Yes

Course objective

The purpose of the course is to study the principles of flight and physiological mechanisms regulating flight in flying animals.

Course syllabus

1. Structural characteristics of the body of birds: In comparison to non-flying species
2. Principles of aerodynamics
3. Characteristics of feather and bones
4. Flight muscles and flight skeleton characteristics
5-Wing: A structure of flight in birds, bats and insects
6. Tail: Morphology and function
7. Flight operation: Pectoralis force, Muscle action while taking off, launch and recovery cycle
8. Taking off, Types of flight, Landing
9. Structure of lungs structure, Respiratory gas exchange and its adaptation
10. Metabolic cost of flight: Cost relative to body mass, Comparison of flying birds with other animals

Evaluation

Continuous evaluation	Midterm	Final exam - Writing	Seminar
10%	**-**	**70%**	**20%**

References for additional reading

Norberg, U.M., 2011. Vertebrate Flight. Springer-Verlag-London.
Videler, J.J., 2006. Avian Flight. Oxford ornithology series- Oxford University Press.

Course: Fish Physiology
Number of credits: 2
Hours: 32
Type of credit: theory
Type of course: Elective

Pre-requisite: No	Supplementary training: No	Educational Expedition: No
Workshop: Yes	Laboratory: No	Seminar: Yes

Course objective
The aim is to provide post-graduate students with recent knowledge on the principles of fish physiology.

Course syllabus:
1. Morphological variations in fishes
2. Motion and Energy: Swimming, Floating, Nutrition and digestion, Growth and metabolism)
3. Homeostasis or co-stasis:Ionic and osmotic regulation, Acid-base regulation, Excretion of nitrogen-containing substances
4. Breathing: Gill structure in cartilaginous and bony fishes,Gas exchange, Breathing from atmospheric air
5. Cardiovascular system: Heart structure, Arterial system, Venous system
6. Central nervous system: Brain and peripheral nervous system
7. Vision and audition
8. Mechanical-chemical-electrical receptors
9. Endocrinology in comparison with higher vertebrates: Anatomy, Cell structure, Hormonal syntheses, Secretions, and Function
10. Reproduction: Internal fertilization, External fertilization, Viviparity, Nesting, Parental care

Evaluation

Continuous evaluation	Midterm	Final exam-Writing	Seminar
10%	-	70%	20%

References for additional reading

Evans, D.H.,1998. The Physiology of Fishes. CRC press. NewYork.
Bone, Q., Moore, R.H., 2008. Biology of Fishes. Taylor and Francis

Course: Physiology of Diving Animals
Number of credits: 2
Hours: 32
Type of credit: Theory
Type of course: Elective

Pre-requisite: No	Supplementary training: No	Educational Expedition: No
Workshop: No	Laboratory: No	Seminar: Yes

Objective course

To study principles of physiology of diving animals in groups of reptile, birds and mammals.

Course syllabus

1. Introducion: Diving animals in reptiles (sea snakes, sea turtles, iguanas), birds (Penguin, Pelican, Anhinga) and mammals (whales, seals, dolphins, sea otter, sea cows, Manatee)
2. The physiological reasons for diving and capabilities according to demands
3. Anatomical adaptations necessary for diving
4. Diving and moving in water (promoter limb, progression and maneuvering)
5. Temperature control: Adaptations in generation, adjustment and maintenance of the body temperature
6. Metabolism and metabolic cost of diving: Movementand maintainance of the body temperature in homoeothermic animals
7. Difference of heart and vessels of diving animal with those of terrestrial animals with similar size
8. Cardiovascular and respiratory systems in homoeothermic and poikilothermic diving species
9. Physiological adaptation while moving away from the surface of the water
10. Physiological alternations to change swimming depth and approaching surface of water

Evaluation

Continuous evaluation	Midterm	Final exam - Writing	Seminar
10%	-	70%	20%

References:
Butler, PJ., Jones, D.R., 1997. Physiology of diving birds and mammals. Physiological reviews, Vol 77(3): 837–899.
Duarte, C. M., Helgueras, A.L., 2009. Marine ecology, volume 1. eBook- EOLSS.
Shirihai, H., Jorrett, B., 2006. Whales, Dolphines and other marine mammals of the world. Princeton University Press.
Hoelzel, A.R., 2002.Marine mammal biology (An evolutionary approach). Blackwell.

Course: Insect Physiology
Number of credit: 2
Hours: 32
Type of credit: theoretical
Type of course: required-specialty

Pre-requisite: No	Supplementary training: No	Educational Expedition: Yes
Workshop: No	Laboratory: No	Seminar: Yes

Course objective

To study environmental physiology in insects which provide us with significant information to develop our studies in the area of insect physiology and to manage using insecticides .

Course syllabus

1. Homeostasis: Extracellular and intracellular fluids, Environmental osmolality, Methods for water intake and excretion
2. Acid and base balance: Water ionization, pH, Weak acid and base ionization, Buffer systems (phosphate and bicarbonate buffers)
3. Cuticle structures: Cuticle composition (Chitin, proteins, lipids, phenolic compounds), Physicla characteristics of cuticle
5. Cuticle sclerotization and melanization: Diversity and amounts of phenolic compounds in the cuticule, circulatory catecholamins, Hydroxylation of tyrosine to 3,4-dihydroxyphenylalanine (DOPA), Decarboxylation of DOPA to dopamine,
6-8. Moulting, Imaginal disc, Hormonal regulation of moulting processes, Moulting fluid (composition [including enzymes] and secretion), Chitin (metabolic pathway of chitin biosynthesis)
9-10. Fat organ (structure and function, cellular compartment of fat organ), Physiology, phospholipid biosynthesis, Fatty acids (di- and triglycerides), regulation of fat metabolism
11. Circulatory system: Circulatory system compartments, Blood characteristics (osmolality and buffers), Physiological functions of blood, Blood cells, Blood coagulation
12- Immune system: Immune system compartments, Cellular immune system, Capsule formation, Non-cellular or humoral immune system
13. Cytochrome P450: Biological characteristics, Nomenclature , Physiological functions, Metabolism of endogenous and exogenous compounds
14. Body temperature: Classification of animals, Temperature hemostasis (Preservation against cooling, Behavioral adaptation and non-morphologic, Physiological adaptation)
15 - Excretory system: Malpighian tubules secretion mechanism, Excretion physiology: hormonal regulation of excretion
16-Respiratory system, Chip system, Stimulatory mechanisms of oxygen uptake, Discontinuous gas exchange, Breathing in aquatic insects
17. The nervous system: Evolution and structure, Central nerve system (CNS), Stomatogastric nerve system (SNS), Peripheral Nerve system (PNS), Sensory receptors/neurons, Hormones of the prothoracic gland: Moulting induction and growth

Evaluation

Continuous evaluation (Quiz)	Midterm	Final exam - Writing	Seminar
10%	-	70%	20%

References for additional reading

Chown, S.L., Nicolson, S.W., 2004. Insect Physiological Ecology. Oxford University Press.
Klowden, M., 2007. Physiological system in insects. Elsevier, UK.

Lawrence, I.G., 2012. Insect Endocrinology. Elsevier.