University of Tehran
College of Science
School of Biology

Animal Biology Curriculum

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

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-Biosystematics

No.	Course	Units			Hours			Prerequisite
		Theory	Practice	Total	Theory	Practice	Total	
1	Species and Speciation	2	0	2	32	0	32	None
2	Zoogeography	2	0	2	32	0	32	None
3	Principles of Phylogenetic Systematics	2	0	2	32	0	32	None
4	Research Methodology and Data Presentation in Biology	2	0	2	32	0	32	None
5	Comparative Embryology	2	0	2	32	0	32	None
6	Vertebrate and Invertebrate Taxonomy	1	1	2	16	32	48	None
7	arthropodTaxonomy	1	1	2	16	32	48	None
8	Ichthyology and Batrachology	1	1	2	16	32	48	None
9	Herpetology and Ornithology	1	1	2	16	32	48	None
10	Mammalogy	1	1	2	16	32	48	None
11	Insect Ecology	2	0	2	32	0	32	None
12	Parasite Ecology	2	0	2	32	0	32	None
13	Ecology of Marine Animals	2	0	2	32	0	32	None
14	Biosafety	2	0	2	32	0	32	None
15	Seminar	2	0	2	0	0	0	None
Sum		24	4	28	352	128	480	-

A student requires 10 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)

Biosystematics

Elective Courses

English course name: Species and Speciation
Number of units: 2
Hours: 32 hours
Unit type: Theoretical
Course type: specialized - elective
Prerequisite: None
Additional education: No.
Scientific trip: has Workshop: no Laboratory: no Seminar: has

The overall objective of the course:
The purpose of this course is to introduce master students to the concepts of species and speciation mechanisms.

Topics of the course:
1. Mentioning evolutionary biology and species status as functional unit in biosystematic studies.
2. Logic behind Binomial nomenclature and morphology concepts as well as its application issues
3. Logic in the biological concept of the species and the problems with its application
4. Schools derived from the biological concept of the species and the weaknesses and problems of each school
5. The evolutionary concept of species and determining boundaries of fossilized species
6. The combined concept of the species
7. Speciation and evolutionary biogeography
8. The role of variation in speciation
9. The origin of genetic variation and examples of genetical speciation (mutation-recombination)
10. Origin of genetic variation and examples of genetic speciation (chromosomal evolution, hybridization and polyploidy)
11. Population structure and genetic drift (intra-population reproduction and genetic flow)
12. Population structure and neutral theory, molecular evolution rate, phylogenetic tree and molecular clock
13. Natural selection and adaptation
14. Sympatric and allopatric speciation models
15. Speciation mechanisms in terrestrial organisms
16. Speciation mechanisms in marine organisms

Table of assessment

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

References:
-Barigozzi C. (1982) Mechanisms of speciation. Alan R. Liss, Inc., NewYork.
-Claridge M. F., H. A. Dawah and M. R. Wilson (1997) Species: The units of biodiversity. Chapman & Hall, London. First edition.
-Futuyma D. J. (1998) Evolutionary Biology. Sinauer Associates Inc. Sundeland, USA. Third edition.
-Mayer, E. and P.D. Ashlock (1991) Principles of Systematic Zoology. MacGraw-Hill, Singapore. Second edition.
-Otte D. and J. A. Endler (1989) Speciation and its consequences. Sinauer Associates Inc. Sundeland, USA.
-Ridley, M. (1993) Evolution. Black-Well Scientific Publications, Boston.

English course name: Zoogeography
Number of units: 2
Hours: 32 hours
Unit type: Theoretical
Course type: specialized - elective
Prerequisite: None
Additional education: No.
Scientific trip: has Workshop: no Laboratory: no Seminar: has

The overall objective of the course:
The purpose of this course is to introduce master students to the distribution of animal populations and classification of geographic areas.
Topics of the course:
1. Biogeography and zoogeography in animal biosystematic studies
2. Paleoclimatological studies
3. Plate tectonics and geological periods
4. Methods of studying dispersion of a particular species and styles of displaying data by map and GIS
5. Distribution of animal populations (the role of tectonic, frost)
6. Classification of geographic regions related to terrestrial organisms
7. Classification of geographic regions related to fauna Maritime (fauna of polar, temperate, tropical and deep ocean regions)
8. Dispersion of animals, speciation and periodic extinction of species
9. Models of animal distribution
10. Globalization and indigenization
11. Historical reconstruction of the zoogeography
12. Island biogeography
13. Diversity and distribution of model animals in terrestrial and aquatic environment
14. Zoogeography and protection of species
15. Zoogeography in the past, present and future
16. New perspectives on zoogeography (human species, invasion of species into new geographic regions, global warming and its effect on species distribution, species displacement by human - phylozoogeography)

Table of assessment

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

References:
-Cox C. B. and P. D. Moore (2000) Biogeography, an ecological and evolutionary approach. 6th edition, Blackwell Science, Oxford.
-Browm J. H, and M. V. Lomolino (1998) Biogeography. Second edition. Sinauer Associates Inc. Sundeland.
-Craw R. C., J. R. Grehan and M. J. Heads (1999) Panbiogeogry (Tracking the history of life). Oxford University press, NewYork.
-Ekman, S. (1967) Zoogeography of the Sea. Sidgwick and Jackson, London

English course name: Principles of Phylogenetic Systematic
Number of units: 2
Hours: 32 hours
Unit type: Theoretical
Course type: specialized - elective
Prerequisite: None
Additional education: No.
Scientific trip: no Workshop: no Laboratory: no Seminar: has

The overall objective of the course:
The purpose of this course is to introduce master students to the basics of phylogeny and phylogenetic classification methods.

Topics of the course:
1. The concept of species in phylogenetic classification
2. Definition and history of phylogeny
3. Familiarity with various evolutionary trees and terminology related to these trees.
4. Familiarity with the different taxonomic traits, trait equilibrium methods, the concept of homology, and the criteria for deducing homology (phylogenetic homology and variation series).
5. Familiarity with the concept of homoplasia, its types and methods of recognition of homeoplasia
6. Methods for analyzing coded data and tree mapping (numerical method, based on traits and based on probability)
7. Methods of translating the topology to the classification and proposing evolutionary hypotheses associated with the classification

Table of assessment

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

References:
-Hennig, Willi (1966), Phylogenetic systematics (tr. D. Dwight Davis and Rainer Zangerl), Urbana, IL: Univ. of Illinois Press (reprinted 1979 and 1999), ISBN 0-252-06814-9
-Hennig, Willi (1999), Phylogenetic systematics (3rd edition of 1966 book), Urbana: University of Illinois Press, ISBN 0-252-06814-9 Translated from manuscript in German eventually published in 1982 (Phylogenetische Systematik, Verlag Paul Parey, Berlin).
-Hull, David (1988), Science as a Process, University of Chicago Press, ISBN 978-0-226-36051-5.
-Mayr, Ernst (1974), "Cladistic analysis or cladistic classification?", Zeitschrift fűr Zoologische Systematik und Evolutionforschung 12: 94–128, doi:10.1111/j.1439-0469.1974.tb00160.x, retrieved 14 December 2010.
-Wiley, E.O.; Siegel-Causey, D.; Brooks, D.R. & Funk, V.A. (1991), "Chapter 1 Introduction, terms and concepts", The Compleat Cladist: A Primer of Phylogenetic Procedures, The University of Kansas Museum of Natural History.

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.

English course name:
Number of units: 2
Hours: 32 hours
Unit type: Theoretical
Course type: specialized - elective
Prerequisite: None
Additional education: No.
Scientific trip: has Workshop: no Laboratory: no Seminar: has

The overall objective of the course:
The purpose of this course is to introduce master students to different embryonic stages and their comparison in vertebrate and invertebrate animals

Topics of the course:
1. Common Characteristics of development in metazoan
2. Studying embryogenic stages in diploblastic animals: Porifera and Cnidarians
3. Studying embryogenic stages in protostomes (first mouth) :, Nematode, Platyhelminthes: Annelids, Gastropods, Arthropods (insects)
4. Studying embryogenic stages in deuterostomes (second mouths): Echinoderms, Tunicates, Cephalochordates, Fishes, Amphibian, Birds, Mammals

Table of assessment

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

References:
-Gilbert, S. F. and Raunio, A. M. (1997) Embryology, Constructing the organism, first edition, Sinauer Associates, Sanderland MA.
-Balinsky (1981) An introduction to embryology. 5th ed Saunders College Publishing

English course name: Vertebrates and Invertebrates Taxonomy
Number of units: 2
Hours: 16 hours theoretical and 32 hours practical
Unit type: 1 theoretical unit and 1 practical unit
Course type: specialized - elective
Prerequisite: None
Additional education: No.
Scientific trip: has Workshop: no Laboratory: has Seminar: has

The overall objective of the course:
The purpose of this course is to introduce master students to the principles of taxonomy and identification of the main animal groups.
Topics of the course:
1. Fish collection methods for demographic, phonological and phylogenetic studies
2. Sample fixation methods and preparing skeleton, squama, histological sectioning of vertebra, fins and otoliths - preparation of radiography- staining skeleton and fins - depicting fish components
3. Phylogenetic classification of fish
4. Amphibian collection methods
5. An introduction to morphological and psychological traits (skeletal preparation, studying surfacial tubercles of the legs in amphibian)
6. Phylogenetic classification of amphibians
7. Reptiles collection and fixation methods (turtles, snakes and lizards)
8. Fin counting, studying body patterns, preparing the skeletons of the reptiles
9. Phylogenetic classification of reptiles
10. Collection methods and taxonomic study of the birds
11. Studying birds, studying their patterns and staining them, preparing the skeleton of the birds
12. Phylogenetic classification of birds
13. Methods of collecting and studying typical samples from different mammals (herbivores, carnivores, rodents and insects)
14. Skeleton preparation and studying mammalian dental designs
15. Phylogenetic classification of mammals
16. Methods of vertebrate conservation in the museum

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	-	60%- written 30% - practical	-

References:

- Belgovad, H. Translated by Eetemad A. and Makhir B. (1370) Persian Gulf Fish. Tehran University Press. 366 pages
.- Abdoli, A. (1378) Iranian domestic fish. Publication of Naghshe Mana - Museum of Iran Nature and Wildlife. First print, 377 pages
- Balooch, M. And Kami H. (1373) Amphibians of Iran. Tehran University Press, 177 pages
- Latifi, M. (1370) snakes of Iran . Publications of the Environmental Protection Agency. 223 pages
- Scott, D. V. and Moraveje Hamedani (1362) Birds of Iran . Publications of the Environmental Protection Agency. 404 pages.
- Eetemad , A. (1363) Mammals of Iran. Publications of the Environmental Protection Agency. 3 vols
-Anderson, S. C. (1999) The Lizards of Iran. Society for the study of Amphibians and reptiles. Oxford, Ohio.
-Terentev, P. V. and S. A. Cherov (1965)Key to amphibians and reptiles. 3rd Edition. Translated from Russian by L. Kochwa.

English course name: Vertebrates and Invertebrates Taxonomy
Number of units: 2
Hours: 16 hours theoretical and 32 hours practical
Unit type: 1 theoretical unit and 1 practical unit

Course type: specialized - elective
Prerequisite: None
Additional education: No.
Scientific trip: has Workshop: no Laboratory: has Seminar: has

The overall objective of the course:
The purpose of this course is to introduce master students to the body patterns, diversity, and systematics of the arthropods' members.
Topics of the course:
1. Review of anatomy and systems in arthropods
2. Introduction to the collection of ecdysozoa and their common ancestor
3. Diversity in ecdysozoa and ecological adaptations
4. Other assumptions related to the classification of ecdysozoa and related groups (a history)
5. Sinapomorphies and common ancestor in the superclade of panarthropoda
6. Sinapomorphies and common ancestor in the clade of arthropods
7. Diversity in arthropods and causes associated with the blossom of arthropods
8. Body structure pattern in arthropods
9. Arthropod classification (classification history - strengths and weaknesses of contemporary classifications)
10. Coevolution and examples in arthropods
11. Behavior and its evolution in arthropods (emphasis on evolution of social behaviors)

Table of assessment

Continuous evaluation	**Midterm**	**Final exam**	**Project**
10%	**-**	**60%- written** **30% - practical**	**-**

References:
-Anderson, D. T. (1973) Embriology and Phylogeny In Annelids and Arthropodes. Pergamon Press, Oxford.
-Forty R. A. and R. H. Thomas(1997) Arthropod relationship. Chapman & Hall, London.
-Koenemann, S. and R. A. Jenner (2005) Crustacea And Arthropod relationships. Taylor & Francis, Boca Raton.
-Ruppert, E. E., R. S. Fox & R. D. Barnes (2004), Invertebrate Zoology (7th ed.), Brooks/Cole.
-Schram,F. R. (1980) Crustacea. Oxford University Press, Oxford.
-Schram,F. R. (1983) Crustacean Phylogeny. Crustacean Issues, No.1, A. A. Balkema, Rotterdom.

English course name: Ichthyology and Batrachology
Number of units: 2
Hours: 16 hours theoretical and 32 hours practical
Unit type: 1 theoretical unit and 1 practical unit
Course type: specialized - elective
Prerequisite: None
Additional education: No.
Scientific trip: has Workshop: no Laboratory: has Seminar: has

The overall objective of the course:
The purpose of this course is to introduce master students to the fish and amphibian

Topics of the course:
1. History, importance, method of collecting and conserving fish and amphibian
2. General familiarity with the morphology and anatomy of fish and amphibian
3. Familiarity with the general characteristics of the main groups of fish and amphibian
4. Reproductive strategies of fish and amphibian
5. Some aspects of ecology and etiology of fish and amphibian
6. Familiarity with systematics and phylogeny of fishes and amphibian
7. Biogeography of fish and amphibian
8. Protection
9. Seminars on special topics
10. Participate in various field operations

Table of assessment

Continuous evaluation	**Midterm**	**Final exam**	**Project**
10%	**-**	**60%- written** **30% - practical**	**-**

References:

- Belgovad, H. Translated by Eetemad A. and Makhir B. (1370) Persian Gulf Fish. Tehran University Press. 366 pages
- Abdoli, A. (1378) Iranian domestic fish. Publication of Naghshe Mana - Museum of Iran Nature and Wildlife. First print, 377 pages
- Balooch, M. And Kami H. (1373) Amphibians of Iran. Tehran University Press, 177 pages
-Helfman, G. S., Collette. B. B, Facey, D. E. and Bowen, B. W. (2009). The diversity of fishes.
-Moyle, Petert B. & Cech, Joseph J. (2004): Fishes: An Introduction to Ichthyology.
-Nelson, Joseph J. (2006): Fishes of the World.
-Khanna, S.S. (1993). An Introduction to Ichthyology.
-Lagler, k.F., Bardach, J.E. & Miller, R.R. (1962). Ichthyology.
-Nikolsky, G.V. (2008). The Ecology of Fishes.
-Norman, J.R. (2007). A History of Fishes.

English course name: Herpetology and Ornithology
Number of units: 2
Hours: 16 hours theoretical and 32 hours practical
Unit type: 1 theoretical unit and 1 practical unit

Course type: specialized - elective
Prerequisite: None
Additional education: No.
Scientific trip: has Workshop: no Laboratory: has Seminar: has

The overall objective of the course:
Understanding the relationships between reptiles and birds and their environment are essential for any type of scientific work, including research or the implementation of a successful management plan for the study of species and conservation.

Topics of the course:
1. An introduction to the history of herpetology and ornithology in Iran and neighboring countries and famous researchers who have traveled to Iran and have investigated.
2. Familiarize with the techniques of collecting and sampling reptiles and birds and preparing them for study in the laboratory.
3. Familiarity with the techniques of studying and detecting reptiles and birds in the environment and in the laboratory.
4. Familiarity with special tools necessary for studying reptiles and birds in the environment and laboratory.
5. Familiarity with method of fixation and conservation of the reptiles and birds to archive them for later studies.
6. Familiarity with tissue preparation techniques from reptiles and birds for taxonomic, phylogenic, and biogeographical studies.
7. Familiarity with various molecular laboratory techniques used in taxonomy and phylogeny of reptiles and birds.
8. Familiarity with the reptiles and birds of Iranian plateau and their habitats, as well as their recognition, study and classification.
9. Familiarity with the use of all kinds of detection keys related to reptiles and birds.

Table of assessment

Continuous evaluation	**Midterm**	**Final exam**	**Project**
10%	**-**	**60%- written** **30% - practical**	**-**

References:
-Anderson, S.C. (1999). The Lizards of Iran. Society for the Study of Amphibians and Reptiles. Oxford, Ohio.
-Arnold, E.N., J.A. Burton, and D. W. Ovenden (1978). Reptiles and Amphibians of Britain and Europe. Harper Collins Publishers.
-Latifi, M. (1998). The Snakes of Iran. Dept. of Environment Publications.
-Leviton, A. A., S.C. Anderson, K. Adler, S.A. Minton (1992). Handbook to Middle East Amphibians and Reptiles.
-Nikolski, A.M. (1915). Fauna of Russia and Adjacent Countries. Published for the National Science Foundation, Washington D.C., by the Israel Program for Scientific Translations, Jerusalem 1963.
-Rastegar-Pouyani, N. (1996-----2013). Different Papers on Taxonomy, Phylogeny, and Biogeography of the Iranian Plateau Reptiles, with Special Reference to Suborder Sauria (Lizards).
-Rastegar- Pouyani, N., Johari, M. and Parsa, H. (2006). Field Guide to the Reptiles of Iran (Volume 1: Lizards). Iran: Razi University Publishing (in Farsi) (First edition).
-Rastegar-Pouyani, N., Johari, M., Rastegar-Pouyani, E. (2007). *Field Guide to the Reptiles of Iran*. Volume 1: Lizards. Second edition. (In Farsi). Razi University Press.

English course name: Mammalogy
Number of units: 2
Hours: 16 hours theoretical and 32 hours practical
Unit type: 1 theoretical unit and 1 practical unit

Course type: specialized - elective
Prerequisite: None
Additional education: No.
Scientific trip: has Workshop: no Laboratory: has Seminar: has

The overall objective of the course:
The purpose of this course is to familiarize master students with the foundations of morphology and anatomy of the mammalian class, their diversity and evolution.

Topics of the course:
1. Mammalogy as a science, history of mammalogy and basic concepts of mammals taxon
2. Characteristics of Mammals (cranial characteristics- post cranial skeleton - Dental Characteristics)
3. The origin of mammals: The evolution and paleontology of mammals
4. Familiarity with the main groups of mammals including: monotremata-Marsupials-placentals (syudy in Order level)
5. Zoogeography of mammals of Iran
6. Field and laboratory methods in the study of mammals and mammalian identification keys
7. Contemporary Mammals Classification

Table of assessment

Continuous evaluation	**Midterm**	**Final exam**	**Project**
10%	**-**	**60%- written** **30% - practical**	**-**

References:
- Darwish, J. Vertebrate Zoology. Publication of Mohaqeq
- Sadrzadeh, E. Comparative Anatomical study of vertebrates. Tehran University Press.

English course name:
Number of units: 2
Hours: 32 hours
Unit type: Theoretical
Course type: specialized - elective
Prerequisite: None
Additional education: No.
Scientific trip: has Workshop: no Laboratory: no Seminar: has

The overall objective of the course:

Topics of the course:
1. Importance of insect ecology and review of ecology of insects: history of ecology and entomology, insect class and classification, number and diversity of insects, habitat heterogeneity, pests, carriers, helpful insects
2. herbivorous insects, feeding strategies of herbivorous insects, plant defenses, physical defense, chemical defense, natural enemies as one of the plant defenses, costs of tolerance and resistance against herbivorous insects
3. Restrictive factors of insect population, competition for limited resources, types of competition, competition models, insect competition in natural and laboratory populations, intra and inter-species competition in herbivorous insects, competition between non-herbivorous insects
4. Natural enemies and the dynamics of the population of insects, the various natural enemies, predators and parasites, the impact of natural enemies on the population of insects, studying the tables of life, examining natural enemies and their prey, modeling hunting and predator relationships, population discontinuous models and dependence on density
5. Relationships between the time of access and functional response, interrelationships (the effect of host density, the effect of natural enemy congestion), the spatial modeling of the relationships between the natural enemies and host , the Huling population models, the impact of natural enemies and other factors on the dynamism of insect populations
6. Interaction of plants and herbivorous insects, interactions of predator and prey in insects, interaction of parasites and host
7. Behavior, mating systems and sexual selection in insects, sexual strategies, increasing reproductive capacity, non-sexual reproduction, gradual evolution (various examples related to this section)
8. Social insects, evolution and ecological consequences of biodiversity and conservation, biodiversity measurement, species diversity, species abundance and diversity indices, insect diversity patterns, threats to diversity, insect protection
9. Non-carrier insects, carrier insect, ecology of carriers, distribution of carriers, human activities and carrier insects
10. Pollen Ecology
11. Insects as regulators of processes in the ecosystem
12. The concept of pest, why the pests flood, pest ecological management
13. Biological control, biological restrictive controlling, biological control using predators, parasites and pathogens
14. Ecological tactics for the management of agricultural and health pests, regulators of insect growth, pheromones
15. Scientific trips, gathering insects and surveying various habitats and ecologic niches

Table of assessment

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

References:
-Schowalter, T.D. (2011). Insect Ecology, an ecosystem approach. Third Edition. Elsevier.

-Speight, M.R., Haunter, M.D., Watt, A.D. (2008). Ecology of Insect: concept, and applications
-Freeland, J.R. (2005). Molecular Ecology. John Wiley and Sons, Ltd.
-Ricklefs, R.E. (2008) The economy of nature. W.H. Freeman and Company
-Southwood, T. R. E., Handerson, P. A. (2000) Ecological methods. Blackwell Science Ltd., 575pp.

English course name: Parasite Ecology
Number of units: 2
Hours: 32 hours
Unit type: Theoretical
Course type: specialized - elective
Prerequisite: None
Additional education: No.
Scientific trip: has Workshop: no Laboratory: no Seminar: has

The overall objective of the course:
The goal of this course is to familiarize master students with ecology and strategies that are very complex in the life cycle of parasite species.
Topics of the course:
1. Introduction to the ecology of parasites - an introduction
2. Parasitic life origins and complex life cycles
3. Host-feature
4. Evolution of life cycle strategy
5. Usage and exploitation strategies of the host
6. Parasite congregation: factors, processes, and outcomes
7. The population dynamism of the parasites
8. Interaction between species of parasites
9. Supra-community structure of parasites
10. Components of parasitic communities and parasitic faunas
11. Parasitic worm communities in saltwater fish and freshwater fish
12. Parasitic worm communities in amphibians and reptiles
13. Parasitic worm communities in birds
14. Parasitic worms in mammals
15. New information in the ecology of parasites

Table of assessment

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

References:
-Esch G. W. , A. O. Bush and J. M. Aho (1990) Parasite Communities: patterns and processes. Chapman & Hall, London.
-MacKenzie A., A. S. Ball and S. R. Virdee (2000) Instant notes in Ecology. BIOS Scientific Publishers Ltd. Oxford, UK.
-Poulin R. (1997) Evolutionary Ecology of Parasites. Chapman & Hall, London.
-Roberts L. S. and J. Janovy, Jr. (2000) Foundation of Parasitology. McGrawHill Higher education, Boston. 6th edition.

English course name: Ecology of Marine Animals
Number of units: 2
Hours: 32 hours
Unit type: Theoretical
Course type: specialized - elective
Prerequisite: None
Additional education: No.
Scientific trip: has Workshop: no Laboratory: no Seminar: has

The overall objective of the course:
The purpose of this course is to introduce master students to the marine organisms' ecology
Topics of the course:
1. Classification of marine biological areas
2. Polar sea ecosystems
3. Seasonal sea ecosystems
4. Tropical sea ecosystems
5. Coral reef ecosystems
6. Sandy beach communities
7. Tidal area communities
8. Beal and desert communities
9. Mangroves and mudflat communities
10. Benthic communities and pelagic communities
11. Deep sea communities
12. Scientific methods of marine ecological research
13. Design, implementation and presentation of the results of the project in the environment

Table of assessment

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

References:

-Eleftheriou A., 2013 Methods for the study of marine benthos, Hellenic Centre for Marine Research, Crete, Greece and Department of Biology, University of Crete, Greece. Fourth edition.
-Clarke K.R., Warwick, R.M., 1994 Changes in Marine communities: an approach to statistical analysis and interpretation Natural Environment Research Council. UK.
-Bakus G.J. 2007. Quantitative Analysis of Marine Biological Communities Field Biology and Environment. John Wiley & Sons, Inc., Hoboken, New Jersey.
-Wahl M. (2009) Marine Hard Bottom Communities. Springer
-Gray J.S. and Elliott M. 2009. Ecology of Marine Sediments. Oxford University Press.

English course name: Ecology of Marine Animals
Number of units: 2
Hours: 32 hours
Unit type: Theoretical
Course type: specialized - elective
Prerequisite: None
Additional education: No.
Scientific trip: has Workshop: no Laboratory: no Seminar: has

The overall objective of the course:

Topics of the course:
1. Safety principles of working with chemicals. Storage of chemicals, working with gases and explosive chemicals
2. Safety principles, working with chemical, . labeling of chemicals, solvents, volatile substances, warning signs and labeling principles acquaintance with liquid and gas refrigerants , explosive materials, safety with acids and alkalis, corrosive and irritating substances, incompatible chemicals and reactive substances, inflammable chemicals, safety wit laboratory chemical , ingle and electricity and providing MSDSS
3. Radiation safety principles. basic principles of radiation safety, biological effects of ultraviolet radiation and how to protect against it.
4. Safety principles of working with biomaterials and biological quaternary levels 1, 2, 3 and 4, Safety and personal protective equipment, type I laboratories, second and third level laboratories, essentials, symptoms and abbreviations
5. Classification of pathogen microorganisms, infectious organisms and epidemics, ways to control biological risks in diagnostic, treatment and research processes, such as the design and construction of bio centers, personal safety equipment, pollution prevention and isolation
6. Study of technical and statistical problems in microbial sampling and ways of diagnosis, counting and identification of germs in the environment.
7. The liberation of genetically modified organisms in nature, the rules and regulations of work with, preservation and production of biological products of genetically modified organisms
8. Problems and concerns of biotechnology products (foods, vaccines and medicines, environmental organisms)
9. Safety considerations of recombinant DNA technology and biological expression systems, risk assessment of genetically modified organisms, biological safety for working with common materials in genetic laboratories and genetic engineering, principles of transportation and transportation of biological materials
10. Equipment and safety in the laboratories of chemistry and biology
11. First aid in biological labs
12. Regulations on safety signs in laboratories

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	-	**90%- written**	-

References:
-Laboratory Biosafety Manual. 2004; 3rd ed; World Health Organization (WHO); Geneva; Switzerland.
-Biological Safety Manual. 2007; University of Pennsylvania; Pennsylvania; USA.
-The Laboratory Biosafety Guidelines. 2004; 3rd ed; Public Health Agency of Canada; Canada.
-Biosafety in Microbiological and Biomedical Laboratories; 2007; 5th ed, US Government Printing Office; USA.
-Guidance on Regulations for the Transport of Infectious Substances; 2007–2008; World Health Organization; USA.