University of Tehran
College of Science
School of Biology

Description of program and course syllabi
Animal Science- Animal biosystematics
Ph.D.

Table 1) Required/Optional courses

Animal Science-Animal biosystematics **Ph.D.**

No.	Course Title	Units			Hours			Pre-requisite/Co-requisite
		Theoretical	Practical	Total	Theoretical	Practical	Total	
1	Analytical Biogeography	2	0	2	32	0	32	None
2	Biodiversity	2	0	2	32	0	32	None
3	Methods in Biosystematics	2	0	2	32	0	32	None
4	Ecology and Evolution of Behavior	2	0	2	32	0	32	None
5	Contemporary Animal Classifications	2	0	2	32	0	32	None
6	Molecular Biosystematics	2	0	2	32	0	32	None
7	Evolutionary Developmental Biology	2	0	2	32	0	32	None
8	Molecular Ecology	2	0	2	32	0	32	None
9	Biological Adaptations	2	0	2	32	0	32	None
10	Coevolution	2	0	2	32	0	32	None
11	Analytical Phylogeny	2	0	2	32	0	32	None
12	Modeling in Ecology and Phylogeny	2	1	3	32	32	64	None
13	Seminar	2	0	2	32	0	32	None
14	Neuroanatomy	2	0	2	32	0	32	None
15	Seminar	2	0	2	32	0	32	None
Total		12	0	12	192	0	192	-

- Students are required to pass 14 units pertaining to courses in this table

Prerequisites for Ph.D. in Animal Biology- Animal Physiology

The student's supervisor may require the student to take up to 6 units of lower level courses

The Topics of Required/Optional Courses in Animal Biology-Animal Biosystematics Ph.D.

Course name: Analytical Biogeography
Credits: 2
Hours: 32 hours
Course type: Theoretical
Course type: specialized - elective
Prerequisite: None
Follow-ups: No.
Field work: Yes; Workshop: None; Lab work: None; Seminar: Yes

Objectives:
Understanding how animals are distributed on earth, both at present and in the past, as well as understanding the underlying processes.
Topics:
1- Biological processes in biogeography - adaptation. By emphasizing on species distribution, inter- and intraspecific comparisons, adaptation and stressful environments.
2- Speciation: nature of the species, modes of speciation, biogeography and speciation.
3- Extinction. Interspecific diversity, Turnover, extinction patterns and processes, extinction susceptibility, extinction causes and processes.
4- Ecological interactions, emphasizing on community characteristics, species characteristics, complementarities in species distribution and abundance (connecting individual-species and community approaches).

Biogeographic Patterns
5- Patterns, Approaches to biogeography, Aims of biogeography, Biogeographical systems (pure biogeography), levels and their application in historical patterns.
6- Species diversity of species, with the emphasis on definition and measurements, different patterns, hypothesis and evaluation of different hypothesis.
7- Relationship of species number to area, distance and other variables.
8- Endemism, its biogeographic significance, measure of endemism, Extent of ecological variation in endemism, endemism from various viewpoints, Endemism in contemporary biogeography.

Biogeographic reconstruction
9- Refugia and their importance in biogeographic reconstruction schemes, with emphasis on the Pleistocene rain forest refugia hypothesis, testing strategies.
10. Phylogenetic Biogeography, Vicariance biogeography, Dispersal biogeography, Significance of fossil to biogeographic hypothesis.
11- Cladistics biogeography: Cladistics hypothesis and biogeography, application of cladistics in biogeography.
14- Global biogeography and phylogenetics, Dispersal and vicariant models in global biogeography.
15- Applied historical biogeography. Relevant parts of the biogeographic systems and overview of methods, Constrains, Methods based on distributional change, methods based on originations.
16- Experimental-applied biogeography, equilibrium theory, application of Island biogeography theory.

Evaluation Scheme

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

References:

-Myres A. A. & P. S. Giller 1994. Analytical biogeography: an integrated approach to the study of animal and plant distributions. Chapman & Hall, London.

-Cox C. B., & P. D, Moore 1993. Biogeography: An ecological and evolutionary approach. Blackwell Scientific Publications.

-Lomolino, Mark V., Riddle Brett R., Whittaker Robert J., Brown James H. (2010), Biogeography. Forth Edition. Sinauer Associates, Inc. Sunderland, Massachusetts. 878 P

-Hugget R. J. 1998. Fundamentals of Biogeography. Rootledge fundamentals of physical geography (London).

-Pielou E. C. Biogeography. John Wiley & Sons, New York.

-MacArthur R. H. 1972. Geographical Ecology: Patterns in the distribution of species. Princeton Univ. Press (New Jersey).

-MacArthur R. H. & Wilson E. O. 1967. The theory of island biogeography. Princeton Univ. Press (New Jersey).

-Spellerberg I. F. & J. W. D. Sawyer 1999. Introduction to Applied biogeography. Cambridge Univ. Press (U. K).

-Wallace A. R. 1963. Geographical distribution of animals. Hafner Publisher Company (New York).

-Darlington P. T. 1966. Zoogeography: The Geographical distribution of animals. John Willey and Sons, Inc).

-Udvardy M. D. F (1970) Dynamic zoogeography. Van Nostrand Reinhold Company (New York).

Course name: Biodiversity
Credits: 2
Hours: 32 hours
Course type: Theoretical,
Course type: specialized - elective
Prerequisite: None
Follow-ups: No.
Field trip: yes, Workshop: no, Lab work: no, Seminar: yes
The overall objective of the course:
Knowing and approaching natural animal biosystems, its structural units, understanding the process of animal biodiversity phenomena (units with some degree of homogeneity and heterogeneity) and classifying it with an applied attitude and achieving access to optimal and sustainable exploitation of natural animal resources.
Topics of the course:
1. The knowledge, attitudes, assessment.
2- From intra-species variation to inter-species variation (genetic diversity).
3- Comparison of the diversity of characteristics within biological units (Biotas).
4- Frequency of species: measurement and evaluation.
5- Defining and measuring the functional aspects of biodiversity.
6 - Biodiversity patterns.
7- Intra-species genetic diversity in space, time and space.
8- Spatial patterns in taxonomic diversity.
9- Spatial variables in biodiversity: Identifying and finding the patterns and its cause.
10- Spatial and temporal patterns of the functional diversity of the biosystems (intra-species, inter-species).
11- Concepts, logic and necessity of diversity in biological systems throughout the nature
12- Evaluation of the conservation and maintenance of species
13- Understanding the priorities in order to conserve the biodiversity.
14- Conservation and management of biodiversity.
15. Transformation of the world and the fate of biodiversity - natural and anthropological factors.

Table of assessment

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

References:

-Gaston K, J., 1996. Biodiversity: A biology of numbers and differences. Blackwell science Ltd. PP. 369+X.
-Groombridge, B., 1992. Global biodiversity: status of the Earth's living resource. Chapman and Hall, London.
-Magguran A. E., 1988. Ecological diversity and its measurement. Chapman and Hall. London.
-Miller R. L. 1994. Mapping the diversity of Nature. Chapman and Hall. London.
-Pielov E. C., 1975. Ecological diversity. John Willey and sons.
-Blackwelder R. E. & Garion G. S. 1986. Handbook of animal diversity CRC Press.

Course name: Methods in Biosystematics
Credits: 2
Hours: 64 hours
Course type: practical
Prerequisite: None
Follow-ups: No.
Field trip: yes, Workshop: no, Lab work: yes, Seminar: yes
The overall objective of the course:
Familiarity with the methods of work in nature and the laboratory, familiarity with the facts, data collection, sampling, work with samples in nature, and transferring samples to the laboratory, data collection and biosystematical analysis of statistical and genetic data and revising methods .

Topics of the course:
Theoretical
1- Introduction to biosystematic software and databases
2. Introduction to various biosystematic associations around the world
3- Nomenclature methods according to the International Nomenclature Code
4- How to compose biosystematics articles
5- Practical methods to understanding the uncertainty principle of classifications

Practical
1- Sampling procedures for vertebrates and invertebrates
2- Procedures for preparing and transferring samples to laboratory
3- Sampling procedure for fossils of vertebrates and invertebrates
4- Scientific procedures to determine the density of animals
5- Identification procedures for animal specimens in field at different
6- Field guides and methods for preparing field guides.
7- Statistical sampling method: dispersal models
8- Mapping, visualization
9- Determining the status of specimens in nature
10- Field-based methods of sound recording, imaging, mapping, measuring altitude, temperature and humidity.
11- Preparation procedures of specimens in the laboratory
12- Measurement methods of characters, data basing and analysis of the results
13- Methods of morphological analysis and analysis of results, introduction to the means of depiction (microscopy), photography and printing.
14- Analysis of results based on natural classification (museum and museology including coding and international standards)
15- Data analysis based on numerical classification
16- Preparation of the data set
17-Coding and determining the states of characters
18- Using different methods to determine distance and similarity
19. Preparation of cluster diagrams manual and by computer
20- Various types of multifactorial analysis
21- Analysis of the main components
22- Controlling analysis
23- Analysis of related Factors
24- Methods of chromosomal studies, analysis of results.

25- Introduction to electrophoresis and analysis of results (biochemistry genetics of populations).
26- Introductory tools to enzyme study and methods for extracting biosystematics results
27- Introduction to PCR, RFLP and mitochondrial genomic DNA and biosystematics analysis of results.
28- Methods of DNA quantification, isolation and analysis of mt DNA
29- Practical methods of phylogenetic reconstruction in supraspecific taxa
30- Studying the level of compatibility between morphological and morphometric results with molecular and chromosomal results.

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**0%**	**90%- written**	**0%**

References:

-Winston J. E. 1999. Describing Species. Colombia University Press, New York. 473 P
-Lemey P., , Marco S., vanDamme A. 2009. The Phylogenetic Handbook. Cambridge University Press. 723 P.
-Batley, S. 2005. Classification in Theory and Practice. Chandos Publishing (Oxford) Limited. Oxford. 181 P.

Course name: Ecology and Evolution of Behavior
Number of units: 2
Hours: 32 hours
Unit type: Theoretical
Course type: specialized - elective
Prerequisite: None
Additional education: No.; Field work: yes; Workshop: no; Laboratory: no; Seminar: yes;
The overall objective of the course:
Finding and understanding involved in evolution of a Behavior (interactions between behavioral systems and forces selecting behavior) and specification of population/species behaviors in space and time place and time in interaction with environmental forces.

Topics of the course:
1. Similarities, dissimilarities and specificities of the nervous system
2. Biological value of response to environmental triggers
3. Ecology of advantages of information use
4. Utilization of paid price (utilized energy – energy saving - optimization)
5. Cognitive systems in animals: comparison of cognition types and ecological advantage of each one; evolution of these systems
6. Specifications at species and subspecies levels
7. Reproductive behaviors and their differentiation under ecological forces (natural selection),
8. Mating systems
9. Sperms' competitions
10. Pre-Mating and Mating Behaviors
11. Intra-specific behaviors of individuals and communities (species specific)
12. Evolution of signals and signs, sexual selection and mate selection
13. Socialization and kin selection
14. Ecology of communications
15. Genes, Genetics and communities
16. Life history
17. Adaptation history of phylogenetic and populations
18. Basis of phylogeny of Behavioral Ecology
19. Causes and consequences of population structure
20. The position of individual and population in preservation of natural world

Table of assessment

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

References:

-Krebs J. R.J., & Davis N. B., 1978. Behavioural ecology: an evolutionary approach. Blackwell science Ltd. London, Fourth edition 1997.
-Slater P. J. B. & T. R. Halliday 1994. Behaviour and evolution. Cambridge. Univ. Press.
-Barnard C. J., 1983. Animal behaviour: Ecology and evolution. Croom Helm. London.
-Plotkin H. C., 1988. The role of behavior in evolution. MIT Press.
-Swingland I. R., & P. T. Greenwood. 1984. The ecology of animal movement. Clanderton Press-Oxford.
-Brooks D. R., & D. A. McLennan 1991. Phylogeny, ecology and behavior. The University of Chicago Press.
-Alcock, J. 2013. Animal behavior: An evolutionary approach. Sinauer Associates. Massachusetts

Course name: Contemporary Animal Classifications
Number of units: 2
Hours: 32 hours
Unit type: Theoretical
Course type: specialized - elective
Prerequisite: None Additional education: No. Scientific trip: yes Workshop: no
Laboratory: no Seminar: yes
The overall objective of the course:
Familiarity with the logical structure of compiling resources related to the classification of different groups of animals, the study of the of descriptive, analytical, validity, revisions and correction capacity of the rank of the discussed taxa components with emphasis on the Iran fauna for the purpose of transforming natural classifications..

Topics of the course:
1. Selecting a meta-taxon and discussing about it.
2. Introduction to animal groups and the methods of their classification.
3. Principles of compilation and classification in discussed taxon.
4. The degree of validity of particular taxon components.
5. The degree of character weight in taxon
6. Morphological, biochemical, chromosomal traits and …
7. The Taxon author's view and the reasons to describe the discussed taxon, lower and upper bounds of the discussed taxon in terms of fluctuation in different ranks, considering the degree of credibility of the discussed traits.
8. Procession of synonymous names emergence after introducing the discussed taxon and its components, interpretations and arguments.
9. Reasons for revising the components of the introduced taxa in the discussed group: arguments.
10. New paleontological reasons.
11. New embryological reasons.
12. New taxonomic reasons, the discovery of new taxon.
13. Analytical reasons due to the equilibrium and weight of the characters, the homology
14. Genetic and cytogenetic reasons
15. An old taxon fracture reasons and its division into new taxa or vice versa.
16. Discovering Homoplasy
17 Convergences
18. Parallelism
19. Reversals
20. Analytic Reasons: Cladistic and Numerical view: Studying and comparing of the viewpoints.
21. Taxonomy grouping: ranking reasons.
22. Documents for analysis of the discussed taxa.
23. Revision of the validity of characters in the discussed taxon.
24. The difficulties of correct compilation of a supraspecific taxon
25. The requirement of using specific characters: Ribosomal RNA, segmentary, larvae, development and ...
26-The origin of metatoxones and ancestral groups: the evolutionary model of the use of ancestral descent.
27. Ancestrology: Reasons for selecting a fossil taxon as the ancestor of the discussed taxa. Horse model and etc...
28. Principles of ranking in the discussed group based on evolutionary and Cladistic methods.

29. The evaluation of specific data from the discussed taxon with respect to different perspectives and accomplished works.
30. Determination of the present status of the discussed taxon with respect to the different perspectives and accomplished works.

Table of assessment

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

References:

-Hull D. L. 1988. Science as a process. The University of Chicago Press.
-Hull D. L. & Ruse M. 1998. The Philosophy of Biology. Oxford reading in Philosophy Oxford University Press.

Course name: Molecular Biosystematics
Credits: 2
Hours: 32 hours
Course type: theoretical, elective
Prerequisite: None
Follow-ups: No, Field trip: yes, Workshop: no, Laboratory: no, Seminar: yes
The overall objective of the course:
Studying the different molecular methods so as to studying genome and populations, the diagnosis of sibling species, semispecies and species complex in one genus, using them in understanding genetic diversity and its expression in meta-phylogenic levels.
Topics of the course:
1. Paying attention to molecular attitude in the study of populations, species and supra-specific taxa, genetic diversity in natural populations, nature, severity, and rate of mutation distribution in populations and their role in evolution and phylogeny. Paying attention to different theories about the nature of mutations in terms of selection and turn-over mechanisms in DNA.
2. Molecular methods in analysis of genetic diversity: Electrophoresis of enzymes, studying nucleic and mitochondrial nucleic acids using restriction enzymes, blotting, hybridization of DNA markers, isolating and analyzing them using PCR and finally the DNA sequencing.
3. Statistical methods in genetic diversity interpretation and calculation of genetic distances between taxa, heterozygosity variance and genetic distance, migration effect in population diversity, population size effect, and kinship analysis.
4. Examples of the application of molecular methods in problem solving of populations.
5. Effect of selection in population patterns and demographic structures. MtDNA in the fishes of the Cichlidae family of Lake Victoria, mtDNA and human evolution.
6. Nuclear DNA and mating behavior, parental care, inbreeding and demographic structure.
7. Determination of genetic structure and its application in species problem solving.
8. Determination of genetic structure and genealogy using RAPD-PCR methods.
9. Macrospatial genetic structure and speciation- gene drift measurement.
10. The molecular methods of invasions, including the identification of the invader, the discontinuous distribution, evolutionary changes in the invaders using microsattelite, the invasion into the twin species' territory.
11. Reconstructing the history of the invasion (using fossils climatic, geographic and geological information).
12. Application of genetic methods in the study of the genetic mating systems.
13. Strategies to find microsatellite loci in polymorphic DNA in order to study genetic linkages and Pedigrees.
14. Genetics and related issues of growth and development in order to study specific anomalies and disorders in populations, evolution in various environments and physiological adaptations.
15. Respiratory proteins during crustacean evolution.
16. Controlling reproductive behaviors and sexual derivation in the brain using molecular methods.
17. The role of the genome in organogenesis and setting forth development theories.
18. Application of molecular methods in applied fields such as fisheries, agriculture, and pest management.

Table of assessment

Continuous evaluation	Midterm	Final exam	Project

10%	**-**	**70%- written**	**20%**

References:

-Li, H. W. 1997. Molecular evolution. Sinauer associates. Masschusetts.
-Ferraris, J. D. and S. R. Palumbi 1996. Molecular zoology, Wiley-liss. New York.
-Hoelzel, A. R. and G. A. Dover 1991. Molecular genetics ecology. Oxford Univ. Press. New York.
-Ferguson, A. 1980. Biochemical systematics and evolution. Blackie. Glasgow.

Course name: Evolutionary Developmental Biology
Number of units: 2
Hours: 32 hours
Unit type: theoretical
Course type: specialized - elective
Prerequisite: None; Additional education: No; Field work: yes; Workshop: no; Laboratory: no; Seminar: yes
The overall objective of the course:
Studying the morphological and molecular mechanisms and processes of development through evolution and their roles in shaping evolutionary changes.

Topics:
1. History of the relationship between study of developmental and evolution
2. Macroevolution: Evidences from molecular taxonomy, phylogeny, and fossil records
3. Common Characteristics in early developmental stages of animals: Phylotypic stage, Zootype, Hox genes, sensory organs, Dorsoventral pattern
4. The role of developmental changes in Macroevolution
5. Developmental characteristics required for Macroevolution: (a) Modular specificity of embryological development (Modularity)
6. Developmental characteristics required for Macroevolution: (B) Using similar factor and molecules in the development of different animals (Molecular parsimony), homologous pathways in the development
7. Mechanisms of Macroevolutionary changes: Heterotopy, Heterochrony, Heterotypy, Heterometry, Recruitment.
8. Developmental constraints: Physical, morphogenetic and phylogenic constraints

Table of assessment

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

References:

-Wilkins AS (2002) The Evolution of developmental pathway. 1st Edition, Sinauer Association Inc., Sunderland, MA
-Gilbert S.F. (2013) Developmental biology, Tenth edition, Sinauer Associates, Sunderlaud, MA
-Wilt F.H. and Hake S.C. (2004) Principles of developmental biology. 1st edition, Norton & company, Inc. New York
-Slack JMW (2012) Essential developmental biology. Third edition, Blackwell Science Ltd, Oxford.
-Wallace A. (2010) Evolution: A developmental approach. Wiley-Blackwell.
-Journals: Evolution and Development; Development Gene and Evolution; Evolution and Development; Development Gene and Evolution

Course name: Molecular Ecology
Number of units: 2
Hours: 32 hours
Unit type: theoretical
Course type: specialized - elective
Prerequisite: None Additional education: No. Scientific trip: yes Workshop: no
Laboratory: no Seminar: yes
The overall objective of the course:
Familiarity with the application of molecular methods to better understanding of evolutionary ecology concepts.
Topics of the course:

1. Molecular genetic in ecology.
2. Molecular markers in ecology.
3. Genetic analysis of single populations.
4. Genetic analysis of multiple populations.
5. Studying ecologically important traits: ecogenomics, QTL analysis, and reverse genetics
6. Phylogeography
7. Behavioural ecology.
8. Conservation Genetics.
9. Clonality, unisexuality, and hermaphroditism.
10. Hybridization and introgression phenomena.
11. Genetic parentage, kinship, and mating behaviors.
12. Genetic diagnoses of endangered species.

Table of assessment

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

References:
-Avise J. C. (2010) Molecular ecology and evolution: The organismal side. World Scientific publishing company.
-Freeland J. R., Petersen S. D. and H. Kirk (2011) Molecular ecology. Wiley- Blackwell.

Course name: Biological Adaptations
Number of units: 2
Hours: 32 hours
Unit type: theoretical
Course type: specialized - elective
Prerequisite: None Additional education: No. Scientific trip: yes Workshop: no
Laboratory: no Seminar: yes
The overall objective of the course:
Understanding how animals are responding to forces and pressure from their environment, and their consequences - basis for understanding "why" and "how" in structures and functions of animal.
Topics:
1. Theory of Adaptation
2. The beginning of life and metabolic pathways
3. Genetic of adaptation
4. Biodiversity, biological molecular clocks and speciation
5. Kinetic enzyme and protein structure
6. Outcomes and effects of appearance of oxygen, the temperature, hydrostatic pressure, water and ions
7. Consistent and well-established patterns
8. Simple nervous systems
9. Adaptation of different sensors and systems (electron-, voice- and light- sensors) and behavior
10. Adaptations in bioelectric properties of cell membrane
11. Adaptations in responses, movements; muscles
12. Adaptations of genetic systems
13. Adaptations and selection in morphology
14. Adaptations and selection in reproductive physiology and behavior
15. Adaptations and selection in groups and populations
16. Social adaptations
17. Spatial and temporal adaptations and selections in evolution (Phylogeny) and examination and improvement of references

Evaluation Scheme

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

References:
-Prosser C. L. 1986, Adaptational biology: molecules to organisms. John Wiley and sons.
Adaptation and natural selection. 1996. Princeton University Press.
-Brandon. R. N. 1990. Adaptation and environment. Princeton Univ. Press.
-Burnett a. L. & T. Eisner. 1964. Animal adaptation. Holt. Rinehart & Winston.

Course name: Coevolution
Number of units: 2
Hours: 32 hours
Unit type: theoretical
Course type: specialized - elective
Prerequisite: None Additional education: No. Scientific trip: yes Workshop: no
Laboratory: no Seminar: yes
The overall objective of the course:
Understanding of how evolutionary processes take place in natural systems or in interactions between biological units.
Topics:
1. Perspectives and discoveries of pioneers about coevolution
2. The pursuit of that view until the synthetic theory of evolution
3. Specification and coevolution after the synthetic theory of evolution
4. Phylogeny of specifications
5. Evolutionary genetic of specifications
6. Development of specifications
7. Specifications in parasitism
8. Selection among multiple hosts
9. Simultaneous collision with several enemies or geography of defense
10. The most advanced specification in Mutualism
11. Specifications' boundaries in symbiosis
12. Coevolution genetics
13. The geographic mosaic theory of coevolution
14. Diversifiable coevolution
15. Asymmetry in specifications and coevolution
16. The boundaries of coevolution and its trends
17. Geophysical mosaic in evolutionary interactions
18. Specifications, coevolution and its preservation

Table of assessment

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

References:

-Thompson, J. N. 1994. The coevolutionary process. The University of Chicago Press.
-Howe. H. F. and L. C. Westley. 1988. Ecological relationships of plants and animals Oxford Univ. Press.
-Gibert, N. et al 1976. Ecological relationships. Freeman and Company.
-Bernay, E. A. and R. E. Chapman. 1994. Host-Plant Selection by phytophagons insects. Chapman and Hall.
-Barth. F. G. 1985. Insect and flowers, the biology of a partnership. Princeton Univ. Press.

Course name: Analytical Phylogenetics
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: yes

Objectives:

Introduction to and evaluation of different phylogenetic approaches, comparing viewpoints.

Topics:
1. Logic and informational contents of contemporary views on phylogeny
2- Relationship between phylogenetic classifications and animal phylogeny in different viewpoints.
3. The concept of similarity in different viewpoints.
4- The concept of phylogenetic relationships and its interpretation in classification from different points of views.
5. Evolutionary classification views and logic
6. Species in evolutionary classification
7. Mosaic evolution and the rate of changes
8. Different concepts of monophyly
9. Polyphyly, paraphyly and the status of paraphyletic taxa
10. The concept of common ancestor and its role in construction of phylogeny.
11- Methods in preparation of phyilogram
12. Views and logic of Phylogenetic classification
13. Species in phylogenetic classification
14. Concepts of Semaphronts, Tokogeny, Plesiomorphy, and Apomrophy.
15. Evaluation of traits, polarity, approaches to calculation and depiction of cladograms.
16. Processing and evaluation of cladogram, Validity range.
17. Parsimony, parsimony calculation methods, how to apply
18. Homology, similarities, consistency, results of homology test.
19. Analysis types: compatibility method, Camin-Sokal
20. Evaluation and processing of fossil data: studying the validity of paleontology in cladistic analysis.
21. Evaluation of genetic traits, nucleotides - Methods for calculating rootless trees (lack of polarity) and rooted (existence of polarity) in interspecific molecular data.
22. Data processing, matrix methods and...
23. Determining the stem group and branch groups
24. Animal Geography and Cladistics
25. Utilizing patterns and connections in animal geography to make a global zoocladogram.
26. Panbiogeography and Cladistics: Evaluating the assumptions of endemism levels and relationship of distribution and ultra-distribution.
27. Determination of rank and name of taxa
28. Equivalent taxa in cladograms, branches and taxonomic subgroups in cladograms.
29. Prioritization of taxa in hierarchal ranking based on sister groups
30 - Introduction to softwares: NTSYS, PAUP, PHYLIP, MCCLADE, Hennig 86
31- Sokal and Sneath views and logic of Numerical Classification confronting phylogeny

Table of assessment

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

References:

-Farey, P. L., C. L. Humphries, I. L. Kitching, R. W. Scotland, D. J. Siebert and D. M. Williams. 1992. Cladistics: A Practical course in systematics. Oxford University.
-Platnick N. I. and V. A. Funk. 1983. Advances in cladistics: Proceeding of the second meeting of the Willi Hennig society.
-Nelson G. and N. I. Platnick 1981. Systematic and biogeography. New York Columbia University Press.
-Eldredg N. and J. Cracraft. 1980. Phylogenetic pattern and the evolutionary process.
-Cracraft J. and N. Eldredg 1979. Phylogenetic analysis and paleontology. Columbia university press.
-Duncan T. and T. F. Stuessy 1984. Cladistics: Perspectives on the reconstruction of evolutionalry history.
-Henning W. 1979. Phylogenetic Systematics. University of Illinois Press.
-Hull D. L. 1988. Science as a Process. An Evolutionary account. The University of Chicago Press.
-Szalay F. S., M. J. Novacek, M. C. McKenna 1992. Mammal Phylogeny. Springer-Verlag.

Course name: Modeling in Ecology and Phylogeny
Number of units: 3
Hours: 32 hours theoretical and 32 hours practical
Unit type: theoretical and practical
Course type: specialized - elective
Prerequisite: None Additional education: No. Scientific trip: yes Workshop: No.
Laboratory: No. Seminar: yes
The overall objective of the course:
Introduction to the factors affecting the distribution of animals, the climatic categories of Iran and the world, the climate impact on the distribution patterns, introduction to different models and methods of modeling including the characteristics of each model, their differences and distinctions, introduction to the geographical information system (GIS) and its applications in distribution modeling. Animal phylogeny principles based on morphological and molecular traits and their applications in distribution modeling, determining the past, present and future animals distribution models by combining climatic and phylogenic data, determining the effect of earth warmth on distribution models. Introduction to standard sites of climate data of Iran and rest of the world.

Topics:
1. Geographic information systems terminology, distribution and phylogeny modeling
2. Modeling software's, geographic and phylogeny information systems
3. Climatic categories of Iran and the rest of the world, factors affecting the categorization
4. Factors affecting the animals' distribution model with emphasis on climate
5. Impact of climate change on the animal distribution model, with emphasis on global warming
6. Identifying endangered species and approaches to their conservation, applying distribution modeling
7. Phyloclim modeling and its applications
8. The role of molecular and morphological data in distribution modeling
9. Distribution modeling position in animal biosystematic studies
10. Status of distribution modeling in animal ecology studies

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**0**	**70%- written 30% practical**	**0**

References:
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