University of Tehran
College of Science
School of Biology

Animal Biology Curriculum

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

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.) in Animal Biology – Cellular and Developmental Biology

No.	Course	Units			Hours			Prerequisite
		Theory	Practice	Total	Theory	Practice	Total	
1	Comparative Embryology	2	0	2	32	0	32	None
2	Comparative Embryology Lab	0	1	1	0	32	32	None
3	Developmental Neurobiology	2	0	2	32	0	32	None
4	Developmental Genetics	2	0	2	32	0	32	None
5	Animal Cell and Tissue Culture	2	0	2	32	0	32	None
6	Animal Cell and Tissue Culture Lab	0	1	1	0	32	32	None
7	Bioinformatics	2	0	2	32	0	32	None
8	Principles of Cell and Molecular Methods	2	0	2	32	0	32	None
9	Microscopic Techniques	2	0	2	32	0	32	None
10	Molecular Immunology	2	0	2	32	0	32	None
11	Research Methodology and Data Presentation in Biology	2	0	2	32	0	32	None
12	Biosafety	2	0	2	32	0	32	None
13	Aquatic Animal Histology	1	1	2	16	32	48	None
14	Techniques in histology	1	1	2	16	32	48	None
15	Seminar	2	0	2	0	0	0	None
Total		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)

Cellular and Developmental Biology

Elected Courses

Course title: Comparative Embryology
No. of units: 2
No. of hours: 32
Unit type: theoretical
Course type: elective
Prerequisites: none
Additional training: no
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Understanding different embryonic stages and comparing them in vertebrate and invertebrate animals
Topics of the course:

1- Common characteristics of development in Metazoa
2- Embryogenesis stages in diploblastic animals: Cnidarians and Porifera.
3- Embryogenesis stages in Protostomes: Annelids,Platyhelminth, Nematode, Gastropods, Arthropods(insects).
4- Embryogenesis stages in Deuterostomes: 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.
-Gilbert, S. F. (2013) Developmental biology, Tenth edition, Sinauer Associates, Sunderlaud, MA
-Balinsky (1981) An introduction to embryology. 5th ed Saunders College Publishing

Course title: Comparative Embryology Lab
No. of units: 1
No. of hours: 32
Unit type: practical
Course type: elective
Prerequisites: none
Additional training: no
Scientific expedition: no **Workshop:** yes **Lab:** no **Seminar:** no
The overall objectives of the course:
Understanding embryonic stages in different animals and using them in investigation of phylogenetic relationships between animals.
Topics of the course:

1- Embryonic development of Annelids (Leech)
2- Embryonic development of Insects (Drosophila)
3- Embryonic development of Fishes (Zebrafish)
4- Embryonic development of Amphibians (Xenopus)
5- Embryonic development of Birds (Chick)
6- Embryonic development of Mammals (Mouse)
7- Project

Table of assessment

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

References:
-Gilbert, S. F. and Raunio, A. M. (1997) Embryology, Constructing the organism, first edition, Sinauer Associates, Sanderland MA.
-Gilbert, S. F. (2013) Developmental biology, Tenth edition, Sinauer Associates, Sunderlaud, MA.
-Balinsky, B. (1981) An introduction to embryology. 5th ed Saunders College Publishing.

Course title: Developmental Neurobiology
No. of units: 2
No. of hours: 32
Unit type: theoretical
Course type: elective
Prerequisites: none
Additional training: no
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Understanding events lead to generation and differentiation of neurons, histogenesis and finally brain and spinal cord formation .
Topics of the course:

1- Introduction: lineage of neural tissue (comparison in animals), neural induction.
2- Polarity and regionalization of neural tube: determination of A-P and D-V axes, organizing centers in developing brain, role of Hox genes and Retinoic acid.
3- Birth and migration of neurons: role of cellular interaction,controlling the production of neuron and glial cell numbers, histogenesis of cerebrum and cerebellum cortex .
4- Cell fate Determination and differentiation: Determination of Cell fate in retina, spinal cord, brain cortical layers and determination of axonal projection template.
5- Axonal growth and guidance: specifications and dynamic of axonal growth cone, guiding factors of growth cone(role of cell adhesion, extra cellular matrix, neuronal pathways, attracting and ejecting factors.)
6- Target segmentation: topographic plans and selecting target cell, selecting target of retinal axons in tectum.
7- Survival and growth of neurons: apoptosis, role of synapse formation, growth factors and targeted cell released neurotropin in survival of neurons.
8- Synapse formation: synaptic localization, presynaptic and postsynaptic differentiation.
9- Refinement of synaptic connections: deletion and conversion of synaptic arrangment.
10- Neural stem cells and neural system regeneration.

Table of assessment

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

References:
-Sanes D. H. Reh T.A. Harris W.A. (2011) Development of the central nervous system. Second edition. Academic press, San Diego
-Gilbert, S. F. (2013) Developmental biology, Tenth edition, Sinauer Associates, Sunderlaud, MA.

Course title: Developmental genetics
No. of units: 2
No. of hours: 32
Unit type: theoretical
Course type: elective
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Understanding the roles of genes in control of different embryonic processes from fertilization to organogenesis, and familiarization with genetic techniques used in developmental studies
Topics of the course:

1- Introduction: transfer of genetic information from DNA to protein, gene anatomy, mutants, genetic rearrangement, human and animals genome project, genetic abnormalities
2- Study of genes functions: a review on molecular techniques used in developmental biology studies, reasons for choosing and advantages of various animal models, mutagenesis, transgenic and knock out animal production, study of mutants, study of gene function based on their spatial-temporal expression in a cell or organism, *in vitro* study of gene functions.
3- Differential expression of genes (control of gene expression): control at the level of DNA, RNA, and protein.
4- Investigating genetic development of animals:
   - Genetic control of development in drosophila (determination of polarity in embryos)
   - Genetic control of development in drosophila (sex determination)
   - Genetic control of development in C. elegance
   - Genetic control of limb development in vertebrates
   - Genetic control of differentiation of muscle cells
   - Hox genes and patterning of embryo

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.
-Moody S. A. (2014) Principles of developmental genetics, Second Edition, Academic Press, San Diego
-Slack, J.M.W. (2012). *Essential Developmental Biology*, Third edition, Blackwell Publishing, Malden, MA

Course title: Animal cell and tissue culture
No. of units: 2
No. of hours: 32
Unit type: theoretical
Course type: elective
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Understanding animal cell and tissue culture principles and methodology
Topics of the course:

1- Advantages and limitations of cell and tissue cultures, differences between *in vitro* and *in vivo* studies, different type of culture media
2- Physical and chemical characteristics of culture media, salt solution media, complete media, supplements, serum and its components, serum types and choosing the right serum
3- Serum-free medium, pros and cons of serum, replacement of serum and selection of serum-free medium
4- Cell culture experiment design, introduction of characteristics of culture room, sterilization of media
5- Primary culture and its various types, biopsy, primary culture techniques.
6- Cell line subculture, passage and proliferation, cellular selection, comparison of primary cell and cell line growth patterns (growth curve), cell freezing and number of passages
7- Cell detachment, cell density, cell adhesion strength and its basis, adhesion molecules and antibody-based cell identifying techniques
8- Cell morphology, chromosomal contents, cell line karyotypes, immortality and oncogenecity (transformation), transformation affecting agents (viruses and carcinogens)
9- Tumor cell culture and its challenges, determination of culture characteristics and types
10- Cell culture contamination and its sources, detection of contamination type through changes in culture medium pH and acidity

Table of assessment

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

References:
-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 equipment
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 title: Bioinformatics
No. of units: 2
No. of hours: 32
Unit type: theoretical
Course type: elective
Prerequisites: none
Additional training: no
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Understanding basics and principles of bioinformatics science
Topics of the course:

1- Introduction and history of bioinformatics
2- Data banks like bibliographic data banks, first type databanks for proteins and nucleic acids, second type data banks like Prosite and Blocks
3- Pair alignment of sequences like scoring matrix
4- General and positional alignment
5- Multiple alignment contains scoring way and methods of gradual and reverse alignment
6- Phylogenetic trees
7- Second structure prediction
8- Genome analysis contains gene prediction in prokaryotes and eukaryotes
9- Promoter prediction
10- Classification of proteins, prediction of spatial structure of protein

Table of assessment

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

References:
-Baxevanis, A.D., Ouellette, F.F.F., *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*, Wiley-Interscience, New York, 2001.
-Lesk, A.M., *Introduction to Bioinformatics*, Oxford, New York, 2002.
-Mount, D.W., *Bioinformatics: Sequence and Genome Analysis*, Cold Spring Harbor Laboratory Press, New York. 2001.
-Tsai, C.S., *BIOMACROMOLECULES, Introduction to Structure, Function and Informatics*, A John Wiley & Sons, Inc., Publication, New York, 2007.
-Tsai, C.S., *Biomolecules, Introduction to Structure, Function and Informatics*, A John Wiley & Sons, Inc., Publication, New York, 2007.

Course title: Principles of molecular and cellular methods
No. of units: 2
No. of hours: 32
Unit type: theoretical
Course type: elective
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Understanding principles of cellular and molecular biology methodology in animal sciences
Topics of the course:

1- Electron microscopes: including scanning (SEM) and transmission (TEM).
2- Scanning probe microscopy, atomic force microscopy, scanning tunneling microscopy, laser force microscopy
3- Investigating 3 dimensional structure (including intracellular): confocal and magnetic force microscopy.
4- Separation and identification of molecules: centrifugation based on molecular weight, sedimentation and isodensity
5- Chromatography methods: gel filtration, ion exchange chromatography, PH gradient
6- Chromatography methods: adsorption chromatography, affinity chromatography , gas chromatography, reverse phase chromatography, DHPLC
7- Protein electrophoresis methods: based on weight: SDS-PAGE. Based on weight and charge: PAGE. Based on charge: iso-electric focusing. Diagnosis methods: autoradiography, silver nitrate, coomasie- blue
8- DNA electrophoresis methods: based on weight: pulse field. Based on structure: DGGE SCCP. Gel forms: page-column. Diagnosis methods: ethidium bromide, ag-nitrate, fluorescent
9- RNA electrophoresis methods: with or without denaturation,with formaldehyde, or Urea. Diagnosis methods: Silver nitrate, ethidium bromide
10- Molecular methods, PCR, nested PCR, RT-PCR, real-time PCR
11- Blotting methods including southern, northern, western, dot blot, reverse dot blot, and their applications
12- New nucleic acid sequencing including Sanger sequencing, pyrosequencing, sequencing based on mass spectrometry, second generation sequencing protocols, and third generation sequencing protocols.
13- Microarray
14- Genome study methods
15- Antibody application, immunohistochemical localization, in situ localization, Elisa
16- SAGE

Table of assessment

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

References:
-Semwogerenot, D. and Weeks, ER (2005) Confocal Microscopy in Encyclopedia of Biomaterials and Biomedical Engineering IRL press.
-Current Protocols in Molecular Biology (2000-2006) Academic Press.
-Practical Approaches, (2000-2006) IRL Press.
-Methodes in Enzymology,(2000-2006) Academic Press.

Course title: Methods of microscopy
No. of units: 2
No. of hours: 32
Unit type: Theoretical
Course type: elective
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes

The overall objectives of the course:

Understanding the structure and applications of various types of microscopes and sample preparation methods

Topics of the course:

1- Basic physical principles of modern microscopy methods.
2- An introduction to optics.
3- The basics of image formation.
4- Light microscopy methods.
5- The basics of fluorescence and digital imaging.
6- Transmission and scanning electron microscopy.
7- Wave emission, lens distortion and distortion correction, electron probes and probe fabrication, electron scattering and dynamic theory, electron optics and spectrometers
8- The basics of confocal microscope and related techniques.

Table of assessment

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

References:

-Rogers K.,2006, The Usborne Complete Book of the Microscope
-Williams D. B.2009, Transmission Electron Microscopy: A Textbook for Materials Science, Springer.
-Bhushan B., 2011, Scanning Probe Microscopy in Nano science and Nano technology, Springer.
-Pawley J.B., 2012, Handbook of Biological Confocal Microscopy, Springer.

Course title: Molecular Immunology
No. of units: 2
No. of hours: 32
Unit type: theoretical
Course type: elective
Prerequisites: none
Additional training: no
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Understanding molecular basics of immune system, regulation of immune system, immunotherapy and common methods in immunology
Topics of the course:

1- Overview on basic concepts of immunology, innate immunity
2- Antibody structure and antigen identification, antigen identification by T cells (TCR), MHC structure
3- Genes and making variation in TCR
4- TCR and MHC genes
5- Signaling in immune system receptors
6- B lymphocyte differentiation, production of functional T cells
7- Role of dendritic cells and macrophages
8- Functional mechanism of cytotoxic T cells, APC regulation in immune response
9- Humoral immune response, adoptive immunity to infection
10- Innate immune defect, acquired immune deficiency syndrome
11- Immunity to infection, allergy and hypersensitivity mechanisms
12- Transplant rejection, response to alloantigens, self and non-self tolerance
13- Autoimmune diseases pathogenesis
14- Immune engineering responses
15- Molecular immunology of tumor
16- Vaccination, whole-cell vaccines, subunit vaccines

Table of assessment

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

References:
-Abbas AK, Lichtman AH. 2005. Cellular and Molecular Immunology, 5th ed. Philadephia: Saunders.
-Delves PJ, Martin SJ, Burton DR, Roitt IM. 2011. Roitt's Essential Immunology, 12th ed. Hoboken, New Jersey: Whiley-Blackwell.
-Kontermann R, Dubel S. 2010. Antibody Engineering, 2nd ed. New York: Springer.
-Lo, B.K.C. ed. 2010. Antibody Engineering, Methods and Protocols (Methods in Molecular Biology), New York: Humana Press.
-Roitt IM, Delves PJ. 2001. Roitt's Essential Immunology, 10th ed., Malden, Massachusetts: Blackwell Science Ltd.

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 title: Aquatic animal histology
No. of units: 2
No. of hours: 32
Unit type: Theoretical
Course type: elective
Prerequisites: none
Additional training: no
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Understanding various tissues in aquatic animals specially in fish,coral, mullusca and crustaceans .
Topics of the course:

1- Importance of histology and tissue preparation steps (fixation, dehydration, embedding, staining)
2- Investigation of tissues structure
3- Types of tissues in corals, mullusca and crustaceans
4- Comparison of skin in different fishes of different depths
5- Skeleton in fishes with skull, vertebral column, bone or cartilage ribs
6- Digestive system contains mouth, oral cavity, tooth, pharynx, esophagus,stomach, pyloric ceca, intestine
7- Digestive system glands contains liver, pancreas and spleen
8- Respiratory system contains gills, lungs and swim bladder
9- Circulatory system contains heart, blood vessels and blood
10- Nervous system contains brain and spinal cord, sensory system contains olfaction, gustation, vision and audition
11- Endocrine glands contains pituitary gland, thyroid gland, chromatin, ultimobranchial gland, islets of Langerhans, gonads and adrenal glands
12- Excretory system contains kidney and osmoregulation

Table of assessment

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

References:
-Johnson P.T. (1980) Histology of the Blue Crab, *Callinectes sapidus*: a model for the Decapoda, Praeger Publishers Inc.
-Galloway S. B., Work T. M., Bochsler V. S., Harley R. A., Kramarsky-Winters E., McLaughlin S. M., Meteyer C. U., Morado J. F., Nicholson J. H., Parnell P. G., Peters E. C., -Reynolds T. L., Rotstein D. S., Sileo L., and Woodley C. M. (2007) Coral Disease and Health Workshop: Coral Histopathology II. NOAA Technical Memorandum NOS NCCOS 56 and NOAA Technical Memorandum CRCP 4. National Oceanic and Atmospheric Administration, Silver Spring.
-Genten F., Terwinghe E. and A. Danguy (2009) Atlas of Fish Histology, CRC Press.
-Howard D.W., E.J. Lewis B.J. Keller and C.S. Smith (2004) Histological techniques for marine bivalve mollusks and crustaceans, NOAA Technical Memorandum 5, National Oceanic and Atmospheric Administration, Silver Spring.
-Kim Y., K. A. Ashton-Alcox and E. N. Powell (2006) Histological Techniques for Marine Bivalve Molluscs: Update. NOAA Technical Memorandum 27, National Oceanic and Atmospheric Administration, Silver Spring.

Course title: Histotechniques
No. of units: 2
No. of hours: 16 hours theoretical and 32 hours practical
Unit type: 1 unit theoretical and 1 unit practical
Course type: elective
Prerequisites: none
Additional training: no
Scientific expedition: no **Workshop:** yes **Lab:** no **Seminar:** yes
The overall objectives of the course:
Understanding common methods in animal histology.
Topics of the course:

1- Light microscope
2- Tissue preparation , fixatives
3- Microtomy and freeze microtomy
4- Application of microwave in histology
5- Hematoxylin and eosin staining techniques
6- Lipid staining
7- Proteins and nucleic acids staining
8- Observing connective tissue and bone as a sample
9- Immunocytochemistry techniques
10- Immunofluorescent techniques
11- Techniques of plastic embedding
12- Techniques of tissue preparation for transmission electron microscope

Table of assessment

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

References:

-Ayache J., Beaunier L., Boumendil B., Ehret G., and Laub, D. , 2010, Sample Preparation. Handbook for Transmission Electron Microscopy: Methodology, vol. 1. Springer.
-Ayache J., Beaunier L., Boumendil B., Ehret G., and Laub, D. , 2010, Sample Preparation. Handbook for Transmission Electron Microscopy:Techniques, vol. 2. Springer.
-Bancroft, J. D. and M. Gamble (2007) Theory and Practice of Histological Techniques, 6th Edition, Churchill Livingstone
-American Society for Clinical Pathology.
-Carson, F. L. and C. Hladik (2009) Histotechnology: A Self-Instructional Text 3rd Edition, - American Society for Clinical Pathology.
-Dykstra M. J. (1993) A Manual of Applied Techniques for Biological Electron Microscopy. Springer.
-Giberson R. T. and R. S. Demaree Jr. (2001) Microwave Techniques and Protocols, Humana press.
-Kiernan J. (2000) Histological and histochemical methods 3rd Edition. CRC Press.
-Smith K. C., Oloff C. M. and L. E. Kazarian (1983) Cryomicrotome Applications: Techniques for the Study of Skeletal Materials, Defense Technical Information Center.
-Suvarna K. S., Layton C. and J. D. Bancroft (2012) Bancroft's Theory and Practice of Histological Techniques, 7th Edition, Churchill Livingstone.