



University of Tehran

College of Science

School of Biology

Description of program and course syllabus
Animal Biology-Cell and Developmental Biology
Ph.D

Table 1- Required courses

Major: Animal Biology-Cell and Developmental Biology

Program: PhD

No.	Course name	Units			Hours			Prerequisite
		Theoretical	Practical	Total	Theoretical	Practical	Total	
1	Basics of Developmental Biology	2	0	2	32	0	32	None
2	Cellular and Molecular Mechanisms in Development	2	0	2	32	0	32	None
3	Organogenesis in Vertebrates	2	0	2	32	0	32	None
4	Comparative Embryology	2	0	2	32	0	32	None
5	Developmental genetics	2	0	2	32	0	32	None
6	Developmental Neurobiology	2	0	2	32	0	32	None
Total		12	0	12	192	0	192	-

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

Table 2- optional courses

Major: Animal Biology-Cell and Developmental Biology

Program: PhD

No.	Course name	Units			Hours			Prerequisite
		Theoretic al	Practica l	Total	Theoretica l	Practic al	Total	
1	Patterning of Embryo	2	0	2	32	0	32	None
2	Biology of Stem Cells	2	0	2	32	0	32	None
3	Cell Signaling in Development and Diseases	2	0	2	32	0	32	None
4	Regeneration and Molecular Histogenesis	2	0	2	32	0	32	None
5	Development and Evolution	2	0	2	32	0	32	None
6	Embryo and Reproductive Biotechnology	2	0	2	32	0	32	None
7	Experimental Methods in Developmental Biology	1	1	2	16	32	48	None
8	Cell and Tissue Engineering	2	0	2	32	0	32	None
9	Growth Factors in Embryonic Development	2	0	2	32	0	32	None
10	Special Topics in Cell and Developmental Biology	2	0	2	32	0	32	None
11	Cancer and Stem Cells	2	0	2	32	0	32	None
12	Cellular Biomechanics and Morphogenesis	2	0	2	32	0	32	None
13	Biology of Reproduction	2	0	2	32	0	32	None
14	Epigenetic Control of Development	2	0	2	32	0	32	None
15	Gene Therapy	2	0	2	32	0	32	None
16	Tissue Interaction and Biomaterials	2	0	2	32	0	32	None
17	Genomics and Proteomics	3	0	3	48	0	48	None
18	Cellular and Molecular Mechanisms of Cancer	2	0	2	32	0	32	None
19	Seminar	2	0	2	32	0	32	None
total		39	1	40	608	32	640	-

Students must take 14 units of courses listed in this table.

Topics of elective courses

Major: Animal Biology-Cell and Developmental Biology

Program: Ph.D

Course title: Embryo patterning

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 different principles and mechanisms of body formation in vertebrates and invertebrates.

Topics of the course:

- 1- Introduction: principles of development and basic concepts of patterning, review on designing the vertebrate's body.
- 2- Determination of embryonic axes: determinants and mechanisms.
- 3- Fate determination of the embryonic germinal layers: determinants and mechanisms.
- 4- Regional specification of embryonic layers along anterior-posterior axis: Patterning paraxial mesoderm, endoderm and neural tube.
- 5- Local pattern formation in tissues and organs: patternings neural crest and limb bud,
- 6- Investigation on the mechanisms of polarization and cell fate determination: Regulation of RNA localization and translation.
- 7- Signal transduction and cell fate determination: Role of Wnt signaling pathway.

Table of assessment

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

References:

– Ektin LD and Jean KW (2001) Cell lineage specification and patterning of embryo. First edition, Academic Press, San Diego

–Tickle C. (2003) Patterning in vertebrate development. First edition. Oxford University press, New York.

–Gilbert S. F. (2013) Developmental biology, Tenth edition, Sinauer Associates, Sunderland, MA

Course title: Biology of Stem Cells

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:

Introduction to different types and characteristics of stem cells, methodology and their application in research projects.

Topics of the course:

- 1- Introduction to stem cells: types and characteristics of stem cells, key concepts.
- 2- Investigation on basic characteristics of stem cells:
Molecular basis of their pluripotency
Niches of stem cells
Self renewal mechanisms and cell cycle control of stem cells
- 3- Embryonic stem cells
- 4- Adult tissue-derived stem cells: Cord blood stem cells, mesenchymal stem cells, hematopoietic stem cells, epithelial skin stem cells, skeletal stem cells, adult liver stem cells, stem cells in gastrointestinal tract, pancreatic stem cells
- 5- Cancer stem cells
- 6- Epigenetic and reprogramming
- 7- Tissue engineering
- 8- Methods and techniques
- 9- Application methods of stem cells in the: treatment of neurodegenerative diseases, spinal cord injuries, cardiac tissue regeneration, repairment of skin burns and wounds
- 10- Biological ethics

Table of assessment

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

References:

-Lanza R, Gearhart J, Hogan B, Melton, D, Pederson R, Thomas ED, Thomson, J and West, M (2013) Essential of stem cell biology. Third Edition, Elsevier Academic Press, London

-Gilbert, S. F. (2013) Developmental biology, Tenth edition, Sinauer Associates, Sunderland, MA

Course title: Cell Signaling in Development and Diseases

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:

An introduction to principles of different intracellular signaling pathways, their roles in developmental processes and diseases.

Topics of the course:

- 1- Introduction to general principles of cell signaling, key concepts, signaling molecules and their roles in cellular responses.
- 2- Extracellular signals and cell receptors.
- 3- Phosphorylation of signaling proteins, kinases and phosphatases.
- 4- G-proteins and their roles in signal transduction.
- 5- Different signal transduction pathways and their relevance in developmental mechanisms and human diseases
 - Wnt signaling pathway
 - TGF- β signaling pathway
 - PI3K/AKT signaling pathway
 - JAK-STAT signaling pathway
 - Delta-Notch signaling pathway
 - Sonic Hedgehog signaling pathway
 - RTK signaling pathway
 - NF- κ B signaling pathway
 -

Table of assessment

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

References:

-Hancock J.T.(2010) Cell signaling. Third edition. Oxford University Press Inc., New York.

-Nelson, J. (2008) Structure and function in cell signaling. First edition, Willey

-Gilbert, S. F. (2013) Developmental biology, Tenth edition, Sinauer Associates, Sunderland, MA

Course title: Regeneration and Molecular Histogenesis

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:

An introduction to cellular and molecular principles of regeneration in vertebrates and invertebrates compared to the histogenesis mechanisms of Development

Topics of the course:

- 1- Reviewing cellular and molecular mechanisms of histogenesis.
- 2- Regenerative potentials of tissues, types of regeneration methods, key concepts.
- 3- Epimorphic regeneration, stem cells and dedifferentiation.
- 4- Morpholactic regeneration, positional information, regeneration polarity, limb bud regeneration.
- 5- Intercalary regeneration
- 6- Origin of cells in regenerating systems
- 7- Epithelialization: general characteristics, models and different steps.
- 8- Impacts of extracellular environment in regeneration: roles of cellular matrix, nerves, growth factors etc. ...
- 9- Morphogenesis of regenerating structures: methods of morphogenesis and its effectors
- 10- Regeneration and embryonic development.
- 11- Regeneration and aging.
- 12- Stem cells and regeneration.
- 13- Tissue engineering and regeneration.
- 14- Stimulation of regeneration.

Table of assessment

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

References:

- Carlson B (2007) Principles of regenerative biology. 1st Edition, Academic Press
- Stocum DL (2012) Regenerative biology and medicine. Second edition, Academic Press
- Gilbert S.F. (2013) Developmental biology, Tenth edition, Sinauer Associates, Sunderland, MA
- Kordower J and Tuszynski MH (2007) CNS regeneration 2nd Edition, Academic press

Course title: Development and Evolution

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:

Investigating morphological and molecular processes as well as the mechanisms of development during evolution; roles in evolutionary changes

Topics of the course:

- 1- Introduction: The history of the association between evolution and development.
- 2- Macroevolution: Evidence of molecular taxonomy, phylogeny and fossil information.
- 3- Common specifications during early stages of animal development: The phylotypic stage, zootype, Hox genes, sensory organs and dorso-ventral pattern formation.
- 4- Role of developmental changes in macroevolution.
- 5- Essential developmental specifications for macroevolution: (A) Modularity
- 6- Essential developmental specifications for macroevolution: (B) using common factors and molecules in development of different animals (Molecular parsimony), homologue pathways in development.
- 7- Different mechanisms of macroevolution: Heterotopy, Heterochrony, Heterotypy, Heterometry and recruitment.
- 8- Developmental constraints: physical, morphogenetic and phylogenetic limitations

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, Sunderland, 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.

Course title: Reproductive and Developmental Biotechnology

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:

Introduction to principles and methodologies in reproductive biotechnology, its potential advantages as well as limitations, ethical principles and marketings

Topics of the course:

- 1- History and basics of reproductive biotechnology: Potentiality and limitations
- 2- Folliculogenesis and the roles of essential genes
- 3- Oocyte maturation and the roles of essential genes
- 4- *In vitro* maturation of oocyte and its applications
- 5- Spermatogenesis and the roles of essential genes
- 6- The basis of azospermia-oligospermia and Y chromosome microdeletion
- 7- Investigation on sperm fertility: the related clinical tests
- 8- Clinical protocols of stimulating the oogenesis
- 9- Different types of *in vitro* fertilization
- 10- The role of epigenetics in folliculogenesis
- 11- The role of epigenetics in spermatogenesis
- 12- Investigation on the oocyte aneuploidy and genetic analysis of the embryos during the pre-implantation
- 13- Polycystic ovary syndrome
- 14- Role of the immunity in fertility
- 15- Investigation on the *in vitro* fertilization and its consequences
- 16- How to make the transgenic mice and to understand the related reproductive processes
- 17- Investigation on marketings in reproductive biotechnology and its challenges

Table of assessment

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

References:

-Gardner DK., Weissman A., Howles CM., Shoham Z. (2009) Assisted Reproductive Technologies, 3^{ed} Edition. Informa Health. United Kingdom.

-Gardner DK., Lane M., Watson AJ. (2004) A Laboratory Guide to the Mammalian Embryo, 1th Edition. Oxford University Press.

Course title: Experimental Methods in Developmental Biology

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: yes

Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes

The overall objectives of the course:

Understanding classic and modern methods used in developmental biology

Topics of the course:

Theoretical:

- 1- Immuno-cytochemistry and -histochemistry
- 2- Advanced ultrastructural microscopy
- 3- Cell and tissue culture
- 4- Protein quantification methods: electrophoresis, HPLC and flow cytometry
- 5- RNA detection methods:
 - Reverse transcriptase-polymerase chain reaction (RT-PCR)
 - Real Time PCR
 - Microarrays
 - *In situ* hybridization
- 6- Methods of gene functional studies during development:
 - Transgenic cells and organisms
 - Conditional knockouts
 - Transfection
 - Gene targeting experiments
 - Using antisense RNAs for mRNA function analysis
 - Gene editing methods: CRISPR/CAS9

Practical:

- 1- Immunohistochemistry
- 2- Cell culture
- 3- Microscopy
- 4- Electrophoresis, Western blotting
- 5- PCR

Table of assessment

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

References:

- Bancroft J and Gamble M (2007) Theory and practice of histological techniques. 6th Edition, Elsevier Science Limited.

Course title: Cell and Tissue Engineering

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:

Investigation on principles of cell and tissue engineering and their applications.

Topics of the course:

- 1- Introduction to cell and tissue engineering: basic concepts and applications
- 2- Review on tissue structure and organization: role of cell contacts and adhesions, extracellular matrix and cell-cell interactions
- 3- Biomaterials in tissue engineering and their cellular interactions
- 4- The use of polymeric scaffolds for tissue engineering
- 5- Investigation on nutritious materials and metabolites transfer in tissues
- 6- Basics of immunology in tissue grafting
- 7- Regulation of cell migration in tissue engineering
- 8- Tissue microenvironment and bioreactor designing
- 9- Effects of physical forces on gene and metabolism control
- 10- Neural tissue engineering
- 11- Cartilaginous tissue engineering
- 12- Muscle tissue engineering

Table of assessment

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

References:

-Robert Lanza (2013) Principles of Tissue Engineering, Fourth edition, Elsevier Science USA.

-Atala, A., Lanza, R., Thomson, J.A. and Nerem, R (2010) Principles of regenerative medicine, second edition, Academic press

-Temenoff, J.S. and Mikos, A (2008) Biomaterials: The Intersection of Biology and Materials Science. First edition. Prentice hall

-Minuth WW, Strehl R and Schumacher K (2005) Tissue engineering

Course title: Growth Factors in Embryonic Development

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:

Investigation on growth factors and their roles in different stages during embryonic development.

Topics of the course:

- 1- Introduction: properties and varieties of growth factors, key concepts
- 2- Roles of growth factors in early stages of embryogenesis:
 - Implantation, cell movements during early stages of vertebrates' morphogenesis, induction and head formation
- 3- Embryonic boundaries and body segmentation, cellular variation and molecular basis of directional cell movements and migration
- 4- Roles of growth factors during organogenesis:
CNS patterning in vertebrates, development of the eye and inner ear, development of skin, digestive tract, molecular genetics of liver and pancreas development, molecular network in heart development

Table of assessment

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

References:

-Unsicker K and Kriegstein K (2006) Cell signaling and growth factors in development; from molecule to organogenesis. 1st Edition, Wiley-VCH. Weinheim

-Gilbert, S. F. (2013) Developmental biology, Tenth edition, Sinauer Associates, Sunderland, MA

Course title: Special Topics in Cell and Developmental Biology

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:

Analyzing the most recent scientific discoveries and advanced methods reported in developmental biology related articles.

Topics of the course:

The highlighted journals of interest includes:

- 1- Current Opinions in Genetics and Development
- 2- Current Opinions in Cell Biology
- 3- Annual Reviews of Cell and Developmental Biology
- 4- Stem cells
- 5- Development, Genes and Evolution
- 6- Developmental Biology
- 7- Development
- 8- Developmental Dynamics
- 9- Mechanisms of Development

Articles of these journals present the most recent scientific progresses on different topics in developmental biology which can help the students to design their PhD thesis projects.

Table of assessment

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

Course title: Cancer and Stem Cells

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 cellular and molecular factors involved in transformation of stem cells to cancer stem cells; regulators and inhibitors of their proliferation

Topics of the course:

- 1- Molecular approaches in cancers based on their origins
- 2- Stem cell in development and cancer
- 3- Cancer stem cells niches
- 4- The relationship between genetic instability and cancer stem cells
- 5- Role of reprogramming and epigenetics in generating cancer stem cells
- 6- microRNAs as important regulators of cancer stem cells
- 7- Signaling pathways in cancer stem cells: Hedgehog, Wnt and Notch signaling
- 8- Regulation of the immune system by cancer stem cells
- 9- Roles of stromal stem cells in prostate cancer
- 10- Roles of cancer stem cells in angiogenesis
- 11- Chemotherapy resistance and cancer stem cells
- 12- Cancer stem cells in prostate cancer
- 13- Cancer stem cells in ovary and breast cancers
- 14- Cancer treatment by targeting cancer stem cells: challenges

Table of assessment

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

References:

-Molecular cell biology, Lodish , Publisher: H. Freeman and Company, , sixth edition, 2008

-Essential in stem cell biology, Edited by R. Lanza and A. Atala, third edition, publisher: Elsevier, 2013

-Cancer Stem Cells Theories and Practice. Edited by Stanley Shostak, Publisher: InTech, 2011

Course title: Cellular Biomechanics and Morphogenesis

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 physical and biomechanical principles during cellular processes of morphogenesis

Topics of the course:

- 1- Molecular mechanics: intermolecular forces and their origin, thermodynamics and statistical mechanics, mechanochemistry, muscle mechanics
- 2- Tissue mechanics: elastic behavior, tissues visco elasticity, electromechanical and physico chemical properties of tissues
- 3- Physical regulation of cellular metabolism: static and dynamic cell processes, adhesion, migration and aggregation, mechanics of biological membranes, cytoskeleton and cortex, mechano transduction
- 4- Chemo mechanical basis of morphogenesis (Howard, et al., Nat. Rev. Mol. Cell. Bio., 2011)
- 5- Measurement of physical positions of cells in biologic system: positional information, morphogenes and the gradients concentrations (Dubuis, et al., PNAS, 2013)
- 6- Role of cytoskeleton re-arrangement and physical requirements in cell polarity, asymmetric division, cell shapes and movements (Mayer, et al., Nature, 2010)
- 7- Cell adhesion as a mechanical scaffold for cell movements during morphogenetic processes (Maitre et al., Nature, 2012)
- 8- Roles of cell signalings in making the accurate boundaries and contact inhibition patterns during morphogenesis. (gene expressions in response to the amount of signaling molecules)

Table of assessment

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

References:

-Layton, B. (2015) Molecular and cellular biomechanics. First edition, Pan Stanford

-Goentoro and Kirschner, *Mol. Cell*, 2009 Sprinzak, et al., *Nature*, 2010

Course title: Biology of Reproduction

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:

Investigation of the sexual reproduction mechanisms from gametogenesis and fertilization to sexual maturation, fertility and infertility as well as the role of environmental factors

Topics of the course:

- 1- Introduction: sexual versus asexual reproduction, parthenogenesis in the animals
- 2- Evolution of reproduction and its strategies
- 3- Gonad development, lineage and differentiation of primordial germ cells (PGCs) in the animals (comparative)
- 4- Cellular and molecular mechanisms of gametogenesis and fertilization
- 5- Endocrinology of reproduction
- 6- Sex determination and its mechanisms in the animals
- 7- Maturation, menopause and rhythms of reproduction
- 8- Endocrinology of pregnancy
- 9- Lactation and mammary glands
- 10- Infertility and causes
- 11- *In vitro* fertilization
- 12- Reproductive toxicology
- 13- New methods in reproduction studies

Table of assessment

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

References:

-Johnson M (2013) Essential reproduction, 7th Edition, Wiley-Blackwel

-Gilbert S.F. (2013) Developmental biology, 8th Edition, Sinauer Associates, Sunderland, MA

-Hardy DM (2002) Fertilization. 1st Edition. Sinauer Association Inc., Sunderland, MA

Course title: Epigenetic Control of Development

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 important epigenetic events and their roles in regulating basic mechanisms during development.

Topics of the course:

- 1- Introduction to epigenetics: definition, mechanisms (chromatin changes, histon variants, chromatin remodelers, noncoding RNAs, polycombs and trithorax proteins)
- 2- Post-fertilization epigenetic reprogramming in zygote and the early embryos, genomic demethylation, chromatin organization
- 3- Stem cell epigenetics, transcription and chromatin factors in pluripotency, bivalent domains
- 4- Activation of paternal X chromosome, accidental inactivation of X chromosome, the escape from inactivation
- 5- Epigenetic changes during differentiation of pluripotent stem cells
- 6- Reprogramming of the epigenome in PGCs, active and inactive demethylation of genome
- 7- Imprinted genes, mechanisms of imprinting, imprinting paternal X chromosome
- 8- Epigenetic control of lymphopoiesis, role of epigenetics in differentiation of multipotent cells like hematopoietic stem cells
- 9- Epimutation, trans-generational and inter-generational epigenetic inheritance
- 10- Epigenetics of the induced pluripotent stem cells (iPSCs)
- 11- Seminars in related topics

Table of assessment

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

References:

-Tollefsbol, T. (2011). Handbook of epigenetics, Academic Press.

-Allis, D. et al (2008) Epigenetics, Cold Spring Harbor Laboratory Press

-Orkin, S. and Hochedlinger, K. (2011) Chromatin connections to pluripotency and cellular reprogramming, *Cell 145*, 835-850

-Saladi, S.V. and De la Serna, I.L. (2010) ATP dependent chromatin remodeling enzymes in embryonic stem cells. *Stem Cell Review 6*(1): 62-73

-Surani, M.A. et al (2007) Genetic and epigenetic regulators of pluripotency, *Cell 128*, 747-762

Course title: Gene Therapy

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 gene therapy, viral and non-viral recombinant gene structures, to repair genetic and cellular abnormalities or to make changes in cell behaviours

Topics of the course:

- 1- Introduction to gene therapy (somatic and germ line gene therapy, gene replacement and gene editing)
- 2- *In vivo*, *in vitro* and *ex vivo* gene therapy
- 3- History and introduction to gene transfer
- 4- Non-viral gene transfer methods (physical and chemical methods, transposons, episomes, minichromosomes, naked DNA)
- 5- Introduction to viral vectors
- 6- Retroviruses molecular biology
- 7- Retroviral vectors
- 8- Adenoviral vectors
- 9- Adeno-associated viruses (AAV) vectors
- 10- Herpes viruses and Pax viruses vectors
- 11- Rhabdoviral vectors
- 12- Gene therapy of cancer (killer genes)
- 13- Genome editing (TALEN, ZFN, CRISPR)
- 14- Noncoding RNAs, RNAi
- 15- Reviewing gene therapy of Duchenne, cystic fibrosis, SCID, AIDS
- 16- Clinical trials

Table of assessment

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

References:

-Daniel Scherman, 2014, Advanced Textbook on Gene Transfer, Gene Therapy and Genetic Pharmacology, Imperial College Press; 1 edition

-Nancy Smyth Templeton, 2015, Gene and Cell Therapy, CRC Press; 4 edition

-Kelly K. Hunt, 2007, Gene Therapy for Cancer, Humana Press

-Curtis A. Machida, Viral, 2002, Vectors for Gene Therapy: Methods and, Humana Press

Course title: Tissue Interaction and Biomaterials

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 biological and physical principles of the interaction between cells and biomolecules with the commonly used biomaterials for tissue engineering

Topics of the course:

- 1- Tissue environment and the implanted biomaterials: Cellular processes
 - Tissue structure and cellular processes, integrins and cell adhesion molecules
 - Cellular processes in response to wound healing
 - Cellular processes in tissue engineering
 - Structure and function of extracellular matrix
 - Extracellular matrix does not recover automatically
- 2- Cell-surface interactions
 - Analysis of biomaterial surfaces and protein absorption
 - Phenotypic changes after using biomaterials
 - Structure determinants of the active biologic materials
 - Methodology for cell-surface interactions
- 3- *In vivo* and clinical studies
 - Tissue response to the implants (biocompatibility)
 - Epithelialization (epidermal regeneration) and endothelialization of vascular prostheses
 - *In vivo* synthesis of skin

Table of assessment

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

References:

-Yannas, I. V.(2001) Tissue and Organ Regeneration in Adults. New York, NY: Springer,

Course title: Genomics and Proteomics

No. of units: 3

No. of hours: 48

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:

Investigation on genomics and proteomics sciences and the study of genetic mapping, classification of genes and types of genome in different organisms, methods of sequencing amino acids in proteins and determining phosphorylation sites, study of protein complexes

Topics of the course:

- 1- Introduction to genomics and proteomics sciences
- 2- Organizing genome
- 3- Genome mapping using the genetic approaches (general and physical mapping)
- 4- gene sequencing and molecular phylogenetic studies
- 5- Classification of genes according to their activities
- 6- Comparative genomics of the bacteria
- 7- Arabidopsis genome
- 8- Comparative genomics of mouse, rat, chicken, human and chimpanzee
- 9- Intra species variations and haplotypes
- 10- Proteomics: chemical methods of sequencing amino acids in proteins
- 11- Sequencing of amino acids by mass spectrophotometry
- 12- Peptide mapping
- 13- Determining phosphorylation sites
- 14- Investigation on protein complexes

Table of assessment

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

References:

-Thangadurai, D. and Sangeetha, J (2015) Genomics and proteomics: principles, technologies and application. First edition, Apple Academic Press.

-Twyman, R. (2013) Principles of proteomics. Second edition, Garland Science

-Gibson (2004) A primer of Genomes Science 2nd edition simaues Assoc.

-Gffraser, Tdrod and Nelson (2004) Microbial Genomes Human Press.

-Lander ES et al. (2001) Initial Sequencing and analysis of the human genome Nature 406: 860-921.

Course title: Cellular and Molecular Mechanisms of Cancer

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 cellular and molecular mechanisms of cancer

Topics of the course:

- 1- Introduction: Steps of transformation of a normal cell into a cancerous cell and comparing these steps with solid tumors
- 2- Molecular mechanisms of epithelial mesenchymal transition (EMT)
- 3- Intercellular junctions and their relevance to cancer
- 4- Deregulation of G1→S transition in cancer
- 5- Deregulation of G2 →M transition in cancer
- 6- Senescence of cancer cell
- 7- Apoptosis and cancer
- 8- Oncogenes and their activation mechanisms in human cancers
- 9- Tumor suppressor genes and their inactivation mechanisms in human cancers
- 10- The most important signal transduction pathways and mechanisms of their deregulation in human cancers
- 11- Genetic instability in cancer
- 12- Cellular and molecular mechanisms of angiogenesis in tumors
- 13- Cellular and molecular mechanisms of metastasis
- 14- New methods in human cancer therapy

Table of assessment

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

References:

-Volgelstein B and kinzler, KW (2002) The Genetic Basis of Human cancer. Mc Graw Hill
2nd edition