

**İZMİR INSTITUTE OF TECHNOLOGY**  
**GRADUATE SCHOOL OF ENGINEERING AND SCIENCES**  
**DEPARTMENT OF BIOTECHNOLOGY AND BIOENGINEERING**  
**CURRICULUM OF THE Ph.D. PROGRAM IN BIOENGINEERING**

**Core Courses**

BENG 505	Bioengineering	(3-0-3) ECTS 9
BENG 510	Physiology	(3-0-3) ECTS 9
BENG 598	Seminar	(0-2) Non-credit ECTS 9
BENG 600	Ph.D. Thesis	(0-1) Non-credit ECTS 26
BTEC 8XX	Special Studies*	(8-0) Non-credit ECTS 4

**Core-Elective Courses \*\***

İYTE-MBG 507	Advanced Cell Biology	(3-0-3) ECTS 9
İYTE-CHEM 503	Advanced Biochemistry	(3-0-3) ECTS 9
İYTE-BENG 585	Biomechanics	(3-0-3) ECTS 9
İYTE-BENG 549	Biotransport	(3-0-3) ECTS 9
İYTE-BENG 530	Bioinstrumentation	(3-0-3) ECTS 9
İYTE-BENG 506	Biomaterials	(3-0-3) ECTS 9

\* Students must register for the 8XX courses offered by the departments of their advisors.

\*\*At least two courses (6 credits) from core elective courses list must be taken.

Total credit (min.) : 21 (for students with M.S. degree)

Number of courses with credit (min.): 7 (for students with M.S. degree)

Total credit (min.) : 42 (for students with B.S. degree)

Number of courses with credit (min.): 14 (for students with B.S. degree)

**Elective Courses**

İYTE-BENG 580	Special Topics in Bioengineering	(3-0-3) ECTS 9
İYTE-BENG 586	Stem Cells in Bioengineering	(3-0-3) ECTS 9
İYTE-BENG 587	Neutral Lipid Metabolism in Health and Disease	(3-0-3) ECTS 9
İYTE-BENG 588	Protein Engineering and Design	(3-0-3) ECTS 9
İYTE-BENG 589	Tissue Engineering Techniques	(3-0-3) ECTS 9
İYTE-BENG 590	Immunology and Applications	(3-0-3) ECTS 9
İYTE-BENG 591	Diagnostic Tools for Biomedical Applications	(3-0-3) ECTS 9
İYTE-BENG 592	Cell Culture Techniques	(3-0-3) ECTS 9
İYTE-BENG 593	Introduction to Medical Imaging	(3-0-3) ECTS 9
İYTE-BENG 594	Biosynthesis of Secondary Metabolites	(3-0-3) ECTS 9
DEU-HSI 503	Medical Ethics	(2-2-3)
DEU-HSI 515	Basic Separation and Assay Methods of Biomolecules	(3-3-4.5)
DEU-HSI 607	Planning, Applying and Evaluating Experimental Research	(4-0-4)
DEU-BIO 610	Biochemistry of Extracellular Matrix	(2-0-2)
DEU-BIP 607	Systems Theory of the Brain I	(2-2-3)
DEU-BIP 602	Systems Theory of the Brain II	(2-2-3)
DEU-BIP 603	Biophysics	(2-0-2)
DEU-BIP 618	Neurobiology and Cognition	(1-2-2)
DEU-MIF 505	Introduction to Database Design	(3-2-4)
DEU-PHAR 505	Introduction to Autonomic Nervous System	(2-0-2)

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**COURSE DESCRIPTIONS**

**BENG 505 Bioengineering (3-0-3) ECTS 9**

Principles of bioengineering, interdisciplinary nature of bioengineering and its interactions with other scientific fields, biomechanics, biomaterials and their applications, tissue engineering, bioprocess, bioimaging, current techniques in bioengineering and their applications, ethical issues in bioengineering applications.

**İYTE-BENG 506 Biomaterials (3-0)3 ECTS 9**

Classification and characterization of materials which are used in biomedical area. Metals, metal-alloys, ceramics, polymers and their structure property relationships. Tissue and blood response to implants and their tests.

**BENG 510 Physiology (3-0-3) ECTS 9**

Introduction to physiology. Membrane physiology. Blood cells, immunity and blood clotting. Heart. Physiology of circulation system. Physiology of respiratory system. Physiology of digestion system. Physiology of neural system. Physiology of sport. Special senses.

**İYTE-BENG 530 Bioinstrumentation (3-0-3) ECTS 9**

Methods and instruments measuring biologically and medically important electrical signals especially emitted by heart, blood pressure of the body. Basic principles of biosensors. Biopotentials and measurements in EMG, ECG and EEG. Measurement of blood flow and volume. Measurement of respiratory system. Medical imaging systems.

**İYTE-BENG 549 Biotransport (3-0-3) ECTS 9**

Introduction to physiologic fluid mechanics. Methods for analysis of complex physiologic fluid mechanics. Fundamentals and applications of mass transfer in biological systems. Effects of mass transfer on biochemical interactions. Transportation in organ systems.

**İYTE-BENG 580 Special Topics in Bioengineering (3-0-3) ECTS 9**

This course introduces a selected topic in the field of Bioengineering depending on the instructor's expertise. Course content may vary between years, but subjects are often selected from recent advancements in the field.

**İYTE-BENG 585 Biomechanics (3-0-3) ECTS 9**

Movement and vibration. Fluid dynamics. Blood circulation in heart, lung and vessels. Micro and macro circulation. Gas circulation. Basic transport equations. Tension, extension and organ stabilization. Trauma. Tissue engineering.

**İYTE-BENG 586 Stem Cells in Bioengineering (3-0-3) ECTS 9**

The course will be focused on the biology and application of mammalian stem cells with the emphasis on bioengineering. Embryonic and adult stem cells will be covered with their applicability in regenerative medicine and the ethical considerations that arise from usage of stem cells.

**İYTE-BENG 587 Neutral Lipid Metabolism in Health and Disease (3-0-3) ECTS 9**

Lipid Chemistry, Classification and Metabolism, Cholesterol and Triglyceride Metabolism, Effects of Signaling Pathways on the Neutral lipid metabolism, Lipid Droplets: Structure, Function and Metabolism, Hormonal Regulation of Neutral Lipid Metabolism, Metabolic Syndrome and Neutral Lipid Metabolism, Cancer, Drug Resistance and Neutral Lipid Metabolism, Microbial Infections and Neutral Lipid Metabolism, Neurological Diseases and Neutral Lipid Metabolism, Lipidomics, Nutrigenomics and Experimental Approaches, Dietary Issues, Exercise and Neutral Lipid Metabolism.

- İYTE-BENG 588 Protein Engineering and Design** (3-0-3) ECTS 9  
 The course starts with the discussion of the fundamental biochemistry and structure of proteins, and various genetic, biochemical and chemical techniques required to purify and characterize proteins. Followed by description of rational and combinatorial methods of protein engineering and specific examples of engineered proteins and their applications.
- İYTE-BENG 589 Tissue Engineering Techniques** (3-0-3) ECTS 9  
 The context of the course will be tissue engineering techniques and biological applications. Mainly following topics will be covered under this course; 3D cell culture, biomaterials for tissue engineering, tissue engineering methods, artificial tissue and organs.
- İYTE-BENG 590 Immunology and Applications** (3-0-3) ECTS 9  
 The course will be focused on the immunology basics, mechanisms, techniques and its applications with the emphasis on bioengineering. Students will search the literature on the topic of interest related to the immunology applications in bioengineering. They will be further asked to prepare a presentation as well as write a review on this issue. Thus, they will learn recent and scientific programs such as end-note which will definitely contribute to their academic life.
- İYTE-BENG 591 Diagnostic Tools for Biomedical Applications** (3-0-3) ECTS 9  
 This course will be covering following subtopics; Materials and fabrication techniques of diagnostic tools, micro fluidics, microarrays, point-of-care and lab-on-a chip technologies, bioimaging methods, and biomedical applications of diagnostic tools.
- İYTE-BENG 592 Cell Culture Techniques** (3-0-3) ECTS 9  
 The course will be focused on the animal cell culture basics, techniques, applications as well as the important issues to be considered in animal cell culture laboratory with the emphasis on bioengineering. Students will be further asked to prepare a presentation as well as write a review on this issue. Thus, they will learn recent and scientific programs such as end-note which will definitely contribute to their academic life.
- İYTE-BENG 593 Introduction to Medical Imaging** (3-0-3) ECTS 9  
 The course is conducted formal lectures. At the beginning it focuses on the mathematical principles used in medical imaging. Then most of the medical imaging technologies are discussed along with the underlying physical principles. This followed by the hardware used in each imaging modality.
- İYTE-BENG 594 Biosynthesis of Secondary Metabolites** (3-0-3) ECTS 9  
 This course covers the following topics: Photosynthesis, Biological oxidation, Building blocks of secondary metabolism and basic mechanisms, Acetate pathway, Shikimate pathway, Mevalonate pathway, Biosynthesis of some important alkaloids, Biosynthesis of carbohydrates
- BENG 598 Seminar** (0-2) Non-credit ECTS 9  
 A seminar must be given by each student on his research area which is graded by academic member of staff. The topic of the seminar can be decided by the student and his supervisor. To this seminar engineers, specialists and scientists can be invited in order to create public opinion on the environmental problems.
- BENG 600 Ph.D. Thesis** (0-1) Non-credit ECTS 26  
 Original research work done by the student under supervision of and an advisor written in the graduate thesis format.
- İYTE-MBG 507 Advanced Cell Biology** (3-0-3) ECTS 9  
 The main objective of this course is to introduce all the components of the animal eukaryotic cells including plasma membrane structure and functions, nucleus, protein sorting and transport, energy conversion, cell cycle and apoptosis.

**İYTE-CHEM 503    Advanced Biochemistry****(3-0-3) ECTS 9**

Chemistry of materials of biochemistry interest. Carbon hydrates, lipids, proteins, amino acids, nucleic acids, porphyrins. Biochemistry of blood. Enzymes, metabolism, protein and nucleic acid biosynthesis.

**DEU-HSI 503            Medical Ethics****(2-2-3)**

What is medical ethics, different approaches about ethics, human rights and ethics, patient rights, children rights, women rights, patient-Physician relationships, malpractice, privacy, informed consent, genetics and ethics, health technology and ethics, pharmaceuticals and ethics, research ethics, publication ethics, ethics committees

**DEU-HSI 515            Basic Separation and Assay Methods of Biomolecules    (3-3-4.5)**

1-) General laboratory procedures: introduction to laboratory (safety in laboratory, laboratory equipment, preparation and storage of solutions, dilutions), pH, buffers (preparation of buffer solutions, measurement of pH, centrifugation, basic principles of centrifugation, centrifuge types), spectrophotometry and spectrofluorometry (basic principles, types)

2-) Separation methods: based on charge (ion exchange chromatography, electrophoresis, isoelectric focusing), based on polarity (paper chromatography, reverse-phase chromatography, hydrophobic interaction chromatography), based on size (dialysis and ultrafiltration, gel electrophoresis, gel filtration chromatography, ultracentrifugation), based on specificity (affinity chromatography)

3-) Basic immunochemical techniques: antigen-antibody (definition, structure, theory of interaction, epitopes and paratopes, affinity and avidity, cross reactions), agglutination based techniques (passive agglutination, hemagglutination, latex agglutination), complement agglutination tests (Immunotoxicity tests), enzyme immuno assay (EIA), immunofluorescence antibody techniques (IFAT), indirect fluorescence antibody techniques, direct fluorescence antibody techniques, ELISPOT assay

4-) Basic molecular techniques: DNA extraction methods, polymerase chain reaction, blotting techniques (Western, Southern, Northern blotting), cell culture technique

**DEU-HSI 607            Planning, Applying and Evaluating Experimental Research (4-0-4)**

Reading and understanding articles in scientific literature, understanding and interpreting the data given in an article, finding a connection between the research data and the information obtained from literature, preparing a research project, understanding experimental methodologies and recording the experimental results, preparing a poster, making an oral presentation, writing an article

**DEU-BIO 610            Biochemistry of Extracellular Matrix****(2-0-2)**

Introduction, collagen, problem solving; a pathology related with collagen, non-collagenous matrix proteins, adhesive glycoproteins, elastin, problem solving; a pathology related with elastin, matrix proteoglycans, regulation of gene expression by ECM, ECM and cell surface receptors, extracellular matrix proteolysis, wound healing and ECM, the role of the ECM in tumor invasion and metastasis

**DEU-BIP 607            Systems Theory of the Brain I****(2-2-3)**

Introduction, fourier analysis, macro systems, micro systems

**DEU-BIP 602            Systems Theory of the Brain II****(2-2-3)**

Wavelet decomposition, amplitude frequency characteristics, new methods, whole brain theory

**DEU-BIP 603            Biophysics****(2-0-2)**

Introduction, biophysical measurement basics, transducers, bioenergetics

**DEU-BIP 618            Neurobiology and Cognition****(1-2-2)**

Neurobiology of consciousness, cognitive experiments, necker cube paradigms, new applications

**DEU- MIF 505      Introduction to Database Design      (3-2-4)**

Overview of database systems, introduction to database design, the relational model, relational algebra and calculus, SQL: queries, constraints, triggers, database application development, internet applications, midterm, database design (Normalization I: 1NF, 2NF, 3NF, BCNF, Normalization I: Higher normal forms), overview of transaction management (concurrency control, crash recovery), overview of storage and indexing (storing data: disks and files, tree-structured indexing, hash-based indexing), overview of query evaluation (external sorting, evaluating relational operators, typical relational query optimizers), additional topics, introduction (overview of database systems, definition, history, introduction to database design, DML, DDL), the relational model (E/R data model), relational algebra, SQL: Queries, database application development, internet applications, midterm exam, database design (Normalization: 1NF, 2NF, 3NF, BCNF), overview of transaction management (concurrency control, crash recovery), overview of storage and indexing, security (privacy, ethical issues, future of DBMS)

**DEU- PHAR 505      Introduction to Autonomic Nervous System      (2-0-2)**

Autonomic nervous system parts, neurotransmitters of autonomic nervous system, secretion mechanism of parasympathetic system's neurotransmitter, secretion mechanism of sympathetic system's neurotransmitter, non-adrenergic and non-cholinergic system's neurotransmitters, parasympathetic system's receptors, sympathetic system's receptors, autoreceptors and their types, innervation of sympathetic system, innervation of parasympathetic system, effect mechanisms of parasympathetic and sympathetic system neurotransmitters, post synaptic regulation of sympathetic system, post synaptic regulation of parasympathetic system, description of parasympathetic and sympathetic systems.

**BTEC 8XX      Special Studies      (8-0) Non-credit ECTS 4**

Graduate students supervised by the same faculty member study advanced topics under the guidance of their advisor.