Regolamento Biotechnologies and Applied Artificial Intelligence for Health

Corso di studi: Biotechnologies and Applied Artificial Intelligence for Health (Laurea magistrale)

Denominazione: Biotechnologies and Applied Artificial Intelligence for Health
Dipartimento : DIPARTIMENTO DI BIOLOGIA
Classe di appartenenza: LM-9 BIOTECNOLOGIE MEDICHE, VETERINARIE E FARMACEUTICHE
Interateneo: No
Interdipartimentale: No
Obiettivi formativi: The Master's Degree in "Biotechnologies and Applied Artificial Intelligence for Health" is aimed to provide students with a solid knowledge and competences in the understanding of complex biological processes as well as in the application of artificial intelligence and bioengineering systems in the fields of health biotechnologies. Main learning objectives of the Master Degree are the following: knowledge on development and application of artificial intelligence systems; advanced knowledge on biochemical processes, mechanisms and cellular signaling pathways relevant for biotechnological applications; advanced knowledge on physio-pathology and on the biology of sensory systems; knowledge on principles of organization, access and handling of big data, with specific focus on those of biomedical relevance; advanced knowledge on omics science (genomics, transcriptomics, proteomics, microbiomics, imaging); knowledge on bioinformatic methodologies and techniques used for management, building and access to omics data collections and repositories; advanced knowledge of innovative methods of complex experimental modeling, from the in vitro and in silico modeling towards the development and application of in vivo modeling.
Teaching activities of the Master's Degree are organized with classroom lessons, exercises and laboratory activities differentially distributed in the teaching units.
To the extent of recruiting foreign students, and thus, further increase the interdisciplinarity and multi-cultural approach of the Master's Degree, all the learning and teaching activities of the Master's Degree will be in English. The adoption of English language will also improve the preparation of graduates with a professional profile ready for accessing a job market in the field of biotechnologies for health characterized by a global approach. Moreover, the Master's Degree will increase the number of courses held in English by the University of Pisa, in agreement with the strategic program of our University to the progressive internationalization of the learning activities. Finally, the English language will also increase the possibilities for students, both outgoing and incoming, of exchange periods in European Universities with Degree programs focused on biotechnologies, artificial intelligence and health.
The learning course is organized in a common and shared part and in two separated tracks (curricula). The two curricula are held in the first year and are composed of teaching units aimed to integrate and complete the knowledges of those different 1st level graduates who can access the course. The "Biology" curriculum will provide students with disciplines and knowledges in the fields of bioinformatics and bioengineering. The "Engineering" curriculum will provide students with disciplines and knowledges in the fields of biology and biotechnology. All the students will reconvene in the common learning track, held across part of the first and the full second year of the course, characterized by interdisciplinary teaching units focused on the application of artificial intelligence in health biotechnologies. The second semester of the second year of the course is almost entirely dedicated to the activities related to the internship for advanced laboratory training and thesis preparation. The thesis will be an original report related to the laboratory activities and research findings performed by the student in dedicated research laboratories and infrastructures of the University of Pisa or in research laboratories and structures of research institutes or companies, upon the reciprocal signing of a learning agreement.
The achievement of learning objectives for each teaching unit will be verified by means of written tests and/or oral interviews. The achievement of learning objectives of the thesis work will be verified by the supervisor teacher and by a committee at the end of the entire course.

Numero stimato immatricolati: 40
Requisiti di ammissione e modalità di verifica: Students with the following prerequisites will be eligible for the access to the Master's Degree in "Biotechnologies and Applied Artificial Intelligence for Health":
- Those who have earned a first level degree in Biotechnologies (L-2 class) or Biological Sciences (L-13 class), and have acquired, in their previous educational programs, knowledge corresponding to at least 30 ECTS in biology disciplines (SSD from BIO/01 to BIO/19) and at least 18 ECTS in Biochemistry (BIO/10), Genetics (BIO/18) and Molecular Biology (BIO(11)
- Those who have earned a first level degree in Engineering (L-8 or L-9 classes) or Informatics (L-31 class), and have acquired, in their previous educational programs, knowledge corresponding to at least 30 ECTS in informatics, biomedical engineering, mathematics, statistics (SSD INF/01, ING-INF/05, ING-INF/06, MAT/01-MAT/09, SECS-S/01) and at least 6 ECTS in Mathematics (MAT/01-MAT/09), and 12 ECTS in INF/01, ING-INF/05, ING-INF/06, SECS-S/01
- Those who have earned a first level degree in other classes and have acquired, in their previous educational programs, knowledge corresponding to at least 90 ECTS in SSD indicated as 'basic' in the schemes of class L-2 - Biotechnologies (from FIS/01 to FIS/08 - INF/01 - from MAT/01 to MAT/09 - MED/01 - SECS-S/01, SECS-S/02 - CHIM/01, CHIM/02, CHIM/03, CHIM/06 - BIO/01, BIO/10, BIO/11, BIO/13, BIO/17, BIO/18, BIO/19) or L-13 Biological Sciences (BIO/01, BIO/02, BIO/04, BIO/05, BIO/06, BIO/07, BIO/09, BIO/10, BIO/11, BIO/18, BIO/19 - from FIS/01 to FIS/ 08 - INF/01 - ING-INF/05 - from MAT/ 01 to MAT/09 - CHIM/01, CHIM/02, CHIM/03, CHIM/06)

Eligible students must also demonstrate a B2 level of knowledge in English language.

The same criteria of eligibility as above will be applied to those students who earned their university degree in foreign countries: the degree will be evaluated for eligibility by the committee composed by the teachers of the Master's Degree.

For all the eligible students it is required an adequate knowledge and preparation in fundamental disciplines such as mathematics, physics, informatics, biology (cellular systems and organisms).

The eligibility of students will be evaluated by an Admission Committee. In case of educational deficits, admitted students will be advised about specific teaching activities to compensate the lack of that specific ECTS.
For all the eligible students there will be the verification of the basic knowledge, required for being admitted to the Master's Degree, by means of a test, held in english. The calendar and details of the admission tests will be notified to eligible students by publication on the internet page of the Department of Biology (https://www.biologia.unipi.it)
Specifica CFU: ECTS features
In regards to teaching activities that include lectures, each ECTS corresponds to 8 hours of class teaching and 17 hours of individual study. For activities including class exercises, each ECTS corresponds to 12 hours of lessons and 13 hours of individual study. For activities involving laboratory experiences, each ECTS corresponds to 16 hours of laboratory and 9 hours of individual study.
Modalità determinazione voto di Laurea: The discussion of the master's thesis takes place in the presence of an official committee consisting of 5 to 7 faculty members. The committee includes permanent voting members (the president and 1 to 3 commissioners), the student's supervisor and two appointed thesis examiners. The list of the 7 permanent members (including the president) is defined each year by the Board of the Course, based on the proposal of the Graduation Committee, and

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remains in office from June 1st to May 31st of the following year.
The commission takes into examination the evaluation provided 20 days before the graduation session to the Didactic Office by the supervisor and the thesis examiners; the supervisor, according to the assessment criteria used for development, writing and discussion of the thesis, suggests a graduation grade and the thesis examiners express their opinion on itscongruity according to the previous evaluation expressed during the interview and the discussion of the thesis, regarding the following aspects:
- acquisition of the fundamental concepts embedded in the research
- capacity of critical attitude also with respect to the experimental approach
- autonomy in laboratory activities, especially related to the used methodologies
- autonomy in the evaluation and interpretation of results
- autonomy in the elaboration of the manuscript and language skills
- property of technical and scientific language, clarity of presentation, correctness in the presentation of the manuscript.

After a reading of the student's curriculum, a secret vote on the graduation grade is taken by the Commission regardless of the previous results. The grade is determined by the overall curriculum of studies, the thesis and its discussion, in accordance with the University's Didactic Regulations and further general criteria formulated by the Board of the Course. The vote is expressed on the basis of 110 points. For the attribution of the honors, the unanimous vote of the committee is required. The final grade is then determined by the commission in front of which the candidate discusses the thesis. The maximum grade is 110/110 with the possible addition of honors. The final graderesults from the sum of the following components:
A) marks average expressed in thirtieths, weighted with the credits, on the profit examinations passed within the Master's Degree Course (75% of the total weight);
B) average of the grades assigned in thirtieths by each of the 5 to 7 members of Commission (2 to 4 fixed members, the supervisor and the two thesis examiners) based on the outcome of the test and taking into consideration the supervisor's and examiners' assessments (25% of the total weight).
The final grade is defined according to the following formula (A x 3 + B) x 115/120.
The supervisor or the Commission's president may recommend, after consultation with thesis examiners, awarding the honors in the case the student reaches a final grade of 110 out of 110without rounding up. In the awarding of the honors it is mandatory that the student has reached a grade of 30 out of 30 with honors in at least 2 fundamental exams of the master degree course or that he/she has a curricular average of at least 29 out of 30.

Attività di ricerca rilevante: The Master's Degree course in "Biotechnologies and Applied Artificial Intelligence for Health" is an innovative teaching project focused on the application of artificial intelligence systems in the most advanced health biotechnological innovations. The professors and researchers in charge of the teaching activities of the Master's Degree course are involved in research projects and activities in different fields of biotechnologies for health. Those teachers who are also faculties at the Department of Biology, are leading scientists in the omics sciences (genomics, transcriptomics), genetic epidemiology, microbial biotechnologies, in vivo experimental modeling, cell signaling, genetic biotechnologies and engineering, nanomedicine. Furthermore, the Master's Degree project is also characterized by an interdisciplinary approach, realized also by the contribution to the teaching activities of leading scientists and faculty staff of other departments of the University of Pisa: Department of Information Engineering, Department of Computer Science, Department of Pathology, Surgery and Molecular Medicine, Department of Farmacy.
The contribution in the research fields is documented by the following publications on peer-reviewed journals:
- Genovese M, Imperatore C, Casertano M, Aiello A, Balestri F, Piazza L, Menna M, Del Corso A, Paoli P. Dual Targeting of PTP1B and Aldose Reductase with Marine Drug Phosphoeleganin: A Promising Strategy for Treatment of Type 2 Diabetes. Mar Drugs. 2021;19(10):535. doi: 10.3390/md19100535
- Balestri F, Poli G, Pineschi C, Moschini R, Cappiello M, Mura U, Tuccinardi T, Del Corso A. Aldose Reductase Differential Inhibitors in Green Tea. Biomolecules. 2020;10(7):1003. doi: 10.3390/biom10071003
- Migliarini S, Scaricamazza S, Valle C, Ferri A, Pasqualetti M, Ferraro E. Microglia Morphological Changes in the Motor Cortex of hSOD1G93A Transgenic ALS Mice. Brain Sci. 2021;11(6):807. doi: 10.3390/brainsci11060807
- Moretti G, Aretini P, Lessi F, Mazzanti CM, Ak G, Metintaş M, Lando C, Filiberti RA, Lucchi M, Bonotti A, Foddis R, Cristaudo A, Bottari A, Apollo A, Del Re M, Danesi R, Mutti L, Gemignani F, Landi S. Liquid Biopsies from Pleural Effusions and Plasma from Patients with Malignant Pleural Mesothelioma: A Feasibility Study. Cancers (Basel). 2021;13(10):2445. doi: 10.3390/cancers13102445
- Corrado A, Aceto R, Silvestri R, Dell'Anno I, Ricci B, Miglietta S, Romei C, Giovannoni R, Poliseno L, Evangelista M, Vitiello M, Cipollini M, Garritano S, Giusti L, Zallocco L, Elisei R, Landi S, Gemignani F. Pro64His (rs4644) Polymorphism Within Galectin-3 Is a Risk Factor of Differentiated Thyroid Carcinoma and Affects the Transcriptome of Thyrocytes Engineered via CRISPR/Cas9 System. Thyroid. 2021;31(7):1056-1066. doi: 10.1089/thy.2020.0366
- Bonini A, Poma N, Vivaldi F, Biagini D, Bottai D, Tavanti A, Di Francesco F. A label-free impedance biosensing assay based on CRISPR/Cas12a collateral activity for bacterial DNA detection. J Pharm Biomed Anal. 2021;204:114268. doi: 10.1016/j.jpba.2021.114268
- Zoppo M, Fiorentini F, Rizzato C, Di Luca M, Lupetti A, Bottai D, Colone M, Stringaro A, De Bernardis F, Tavanti A. Role of CpALS4790 and CpALS0660 in Candida parapsilosis Virulence: Evidence from a Murine Model of Vaginal Candidiasis. J Fungi (Basel). 2020;6(2):86. doi: 10.3390/jof6020086
- Burgalassi S, Ceccanti S, Vecchiani S, Leonangeli G, Federigi I, Carducci A, Verani M. Objectionable microorganisms in pharmaceutical production: Validation of a decision tree. Eur J Pharm Sci. 2021 Nov 1;166:105984. doi: 10.1016/j.ejps.2021.105984.

Rapporto con il mondo del lavoro: The Master's Degree in "Biotechnologies and Applied Artificial Intelligence for Health" has been presented to several Academic Institutions, Research Centres, and national/international companies operating in the biotechnology, bio-engineering and artificial intelligence fields. The Academic Institutions include the University of Marseilles, the University of Barcelona, the University of Ghent, and the University of Stockholm (video-conference meeting held on November, 2nd, 2021). All these Universities will be partners, together with the University of Pisa, of an international joint Master's Degree in "Biotechnologies and Artificial Intelligence for Health", the preparation of which is presently on going.
National pharmaceutical and bio-technology companies have been consulted in the context of the "Comitato di Indirizzo" of the Department of Biology of the University of Pisa, which also includes representative members of the National Health Organisation and the National Biologist Association (video-conference meeting held on October, 18th, 2021). The Master's Degree (structural organisation of the teaching project and topics of different teaching courses) has been also presented to representative members of the Tuscany Industrial Organisation (Confindustria – sezione Toscana), as wells as to innovative companies, such as the "Genome up" and "Kode", involved in translational activities of artificial intelligence and bioinformatics tools to health applied biotechnologies (meeting held on November, 4th, 2021).
All parties appreciated the extremely innovative approach of the Master's Degree, and underlined the importance of the choice of English as main language for teaching activities as a relevant tool to improve the multi cultural character of the Master's Degree. Importantly, they also emphasised the pioneristic vision of the Master's Degree, which is aimed at developing professionals with a very competitive multi-disciplinary background in different domains of biotechnologies.
They pointed out the importance of including seminars and meetings between students and representatives of national and international enterprises and companies operating in the pharmaceutical field, or in bio-engineering and artificial intelligence domains applied to biotechnologies. This input has been carefully taken into account during the planning of the teaching activities, and a course entitled "Job Placement Activities" has been included. Furthermore, stages, internship and laboratory

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training activities for the preparation of the master thesis in research centres or biotechnology companies are also included among the activities proposed by the Master's Degree.
In order to progressively improve the quality and the performance of the Master's Degree, meetings and consulting events with relevant industrial representative enterprises will be periodically scheduled in the next few years.

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Curriculum: Engineering

Primo anno (60 CFU)

Advanced Biochemistry (6 CFU)

	CFU	SSD	Tipologia	Ambito
Advanced Biochemistry	6	BIO/10	Caratterizzanti	Discipline biotecnologiche comuni

Artificial Intelligence I (6 CFU)

	CFU	SSD	Tipologia	Ambito
Artificial Intelligence I	6	ING-INF/05	Caratterizzanti	Discipline di base applicate alle biotecnologie

Artificial Intelligence II (6 CFU)

	CFU	SSD	Tipologia	Ambito
Artificial Intelligence II	6	INF/01	Caratterizzanti	Inglese scientifico e abilità linguistiche, informatiche e relazionali, pedagogia medica, tecnologie avanzate e a distanza di formazione e comunicazione

Biotechnology applied to sense physiology (6 CFU)

	CFU	SSD	Tipologia	Ambito
Biotechnology applied to sense physiology	6	BIO/09	Caratterizzanti	Discipline biotecnologiche comuni

Genetics and Molecular biology (12 CFU)

	CFU	SSD	Tipologia	Ambito
Genetics and Genomics	6	BIO/18	Caratterizzanti	Discipline biotecnologiche comuni
Molecular biology	6	BIO/11	Caratterizzanti	Discipline di base applicate alle biotecnologie

Physio-pathology (6 CFU)

	CFU	SSD	Tipologia	Ambito
Physio	6	BIO/09	Caratterizzanti	Discipline biotecnologiche comuni
Segmento Pathology	*3*	*MED/04 PATOLOGIA GENERALE*		*lezioni frontali*

Microbiology and public health (12 CFU)

	CFU	SSD	Tipologia	Ambito
Microbiology and microbial biotechnology	6	BIO/19	Caratterizzanti	Discipline biotecnologiche comuni
Health risk assessment	6	MED/42	Affini o integrative	Attività formative affini o integrative

Biology of Cellular Systems (6 CFU)

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	CFU	SSD	Tipologia	Ambito
Biology of Cellular Systems	6	BIO/06	Affini o integrative	Attività formative affini o integrative

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Curriculum: Engineering

Secondo anno (60 CFU)

Cell signaling and imaging tools (6 CFU)

	CFU	SSD	Tipologia	Ambito
Cell signaling	6	BIO/10	Caratterizzanti	Discipline biotecnologiche comuni
Segmento Imaging tools	*3*	*BIO/19 MICROBIOLOGIA GENERALE*		*lezioni frontali*

Omics: Biotechnology and AI for health (6 CFU)

	CFU	SSD	Tipologia	Ambito
Omics: Biotechnology and AI for health - A	6	BIO/18	Caratterizzanti	Discipline biotecnologiche comuni
Segmento Omics: Biotechnology and AI for health - B	*3*	*BIO/11 BIOLOGIA MOLECOLARE*		*lezioni frontali+laboratorio*

Bioengineering and Experimental Models in Health and Disease (6 CFU)

	CFU	SSD	Tipologia	Ambito
Bioengineering in Experimental Modeling	6	ING-INF/06	Affini o integrative	Attività formative affini o integrative
Segmento Experimental Modeling in Health and Disease	*3*	*BIO/06 ANATOMIA COMPARATA E CITOLOGIA*		*lezioni frontali*

Gruppo: Elective classes (12 CFU)

Descrizione	Tipologia	Ambito
To be chosen among		

Internship (6 CFU)

	CFU	SSD	Tipologia	Ambito
Internship	6	NN	Altre attività - Tirocini formativi e di orientamento	Tirocini formativi e di orientamento

Job placement activities (3 CFU)

	CFU	SSD	Tipologia	Ambito
Job placement activities	3	NN	Altre attività - Altre conoscenze utili per l'inserimento nel mondo del lavoro	Altre Conoscenze Utili per l'Inserimento Nel Mondo del Lavoro

Thesis (21 CFU)

	CFU	SSD	Tipologia	Ambito
Thesis	21	PROFIN_S	Altre attività - prova finale	Per la prova finale

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Curriculum: Biology

Primo anno (60 CFU)

Advanced Biochemistry (6 CFU)

	CFU	SSD	Tipologia	Ambito
Advanced Biochemistry	6	BIO/10	Caratterizzanti	Discipline biotecnologiche comuni

Artificial Intelligence I (6 CFU)

	CFU	SSD	Tipologia	Ambito
Artificial Intelligence I	6	ING-INF/05	Caratterizzanti	Discipline di base applicate alle biotecnologie

Artificial Intelligence II (6 CFU)

	CFU	SSD	Tipologia	Ambito
Artificial Intelligence II	6	INF/01	Caratterizzanti	Inglese scientifico e abilità linguistiche, informatiche e relazionali, pedagogia medica, tecnologie avanzate e a distanza di formazione e comunicazione

Biotechnology applied to sense physiology (6 CFU)

	CFU	SSD	Tipologia	Ambito
Biotechnology applied to sense physiology	6	BIO/09	Caratterizzanti	Discipline biotecnologiche comuni

Physio-pathology (6 CFU)

	CFU	SSD	Tipologia	Ambito
Physio	6	BIO/09	Caratterizzanti	Discipline biotecnologiche comuni
Segmento Pathology	*3*	*MED/04 PATOLOGIA GENERALE*		*lezioni frontali*

Probability and Biostatistics (6 CFU)

	CFU	SSD	Tipologia	Ambito
Probability and Biostatistics	6	ING-INF/06	Caratterizzanti	Discipline di base applicate alle biotecnologie

Smart materials and sensors (12 CFU)

	CFU	SSD	Tipologia	Ambito
Sensors	6	ING-INF/01	Affini o integrative	Attività formative affini o integrative
Smart materials	6	ING-INF/06	Caratterizzanti	Discipline di base applicate alle biotecnologie

Bionformatics in silico models (12 CFU)

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	CFU	SSD	Tipologia	Ambito
Bionformatics - A	6	ING-INF/05	Affini o integrative	Attività formative affini o integrative
Segmento Bioninformatics - B	*3*	*INF/01 INFORMATICA*		*lezioni frontali*
In silico models	6	CHIM/08	Affini o integrative	Attività formative affini o integrative

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Curriculum: Biology

Secondo anno (60 CFU)

Cell signaling and imaging tools (6 CFU)

	CFU	SSD	Tipologia	Ambito
Cell signaling	6	BIO/10	Caratterizzanti	Discipline biotecnologiche comuni
Segmento Imaging tools	*3*	*BIO/19 MICROBIOLOGIA GENERALE*		*lezioni frontali*

Omics: Biotechnology and AI for health (6 CFU)

	CFU	SSD	Tipologia	Ambito
Omics: Biotechnology and AI for health - A	6	BIO/18	Caratterizzanti	Discipline biotecnologiche comuni
Segmento Omics: Biotechnology and AI for health - B	*3*	*BIO/11 BIOLOGIA MOLECOLARE*		*lezioni frontali+laboratorio*

Bioengineering and Experimental Models in Health and Disease (6 CFU)

	CFU	SSD	Tipologia	Ambito
Bioengineering in Experimental Modeling	6	ING-INF/06	Affini o integrative	Attività formative affini o integrative
Segmento Experimental Modeling in Health and Disease	*3*	*BIO/06 ANATOMIA COMPARATA E CITOLOGIA*		*lezioni frontali*

Gruppo: Elective classes (12 CFU)

Descrizione	Tipologia	Ambito
To be chosen among		

Internship (6 CFU)

	CFU	SSD	Tipologia	Ambito
Internship	6	NN	Altre attività - Tirocini formativi e di orientamento	Tirocini formativi e di orientamento

Job placement activities (3 CFU)

	CFU	SSD	Tipologia	Ambito
Job placement activities	3	NN	Altre attività - Altre conoscenze utili per l'inserimento nel mondo del lavoro	Altre Conoscenze Utili per l'Inserimento Nel Mondo del Lavoro

Thesis (21 CFU)

	CFU	SSD	Tipologia	Ambito
Thesis	21	PROFIN_S	Altre attività - prova finale	Per la prova finale

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Gruppi per attività a scelta nel CDS Biotechnologies and Applied Artificial Intelligence for Health

Gruppo Elective classes (12 CFU)

Descrizione: To be chosen among

Attività contenute nel gruppo

Focused Lab training (6 CFU)

Modulo	CFU	SSD	Tipologia	Caratteristica	Ambito
Focused Lab training	6	NN No settore	Altre attività - scelta libera dello studente	laboratorio e/o esercitazioni	A scelta dello studente

Metagenomics (6 CFU)

Modulo	CFU	SSD	Tipologia	Caratteristica	Ambito
Metagenomics - A	6	BIO/18 GENETICA	Altre attività - scelta libera dello studente	lezioni frontali	A scelta dello studente
Segmento Metagenomics - B	*3*	*BIO/19 MICROBIOLOGIA GENERALE*		*lezioni frontali + esercitazioni*	

Molecular Genetics and Molecular Medicine in the AI-era (6 CFU)

Modulo	CFU	SSD	Tipologia	Caratteristica	Ambito
Molecular Genetics and Molecular Medicine in the AI-era	6	BIO/18 GENETICA	Altre attività - scelta libera dello studente	Lezioni frontali+Esercitazioni+Laboratorio	A scelta dello studente

The Law and Ethics of A.I.-driven biomedical innovation (6 CFU)

Modulo	CFU	SSD	Tipologia	Caratteristica	Ambito
The Law and Ethics of A.I.-driven biomedical innovation Denominazione	6	IUS/02 DIRITTO PRIVATO COMPARATO	Altre attività - scelta libera dello studente	lezioni frontali + esercitazioni	A scelta dello studente

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Attività formative definite nel CDS Biotechnologies and Applied Artificial Intelligence for Health

Advanced Biochemistry (6 CFU)

Denominazione in Inglese: Advanced Biochemistry
Obiettivi formativi in Inglese: The course will offer an integrated view of the most relevant metabolic pathways and of their regulation in specific organs and tissues. The metabolic alterations occurring in pathological conditions will be examined in order to understand the molecular basis of most relevant diseases.

Student who successfully completes the course will be able to understand the biochemical basis and the functional implications of most relevant diseases.
CFU: 6
Reteirabilità: 1
Modalità di verifica finale: Oral interview
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Advanced Biochemistry	6	BIO/10 BIOCHIMICA	Caratterizzanti	lezioni frontali	Discipline biotecnologiche comuni

Artificial Intelligence I (6 CFU)

Denominazione in Inglese: Artificial Intelligence I
Obiettivi formativi in Inglese: This course aims to introduce the main concepts and techniques used in machine learning and data mining to extract knowledge from data. In particular, the course will focus on the following aspects: data pre-processing, frequent pattern extraction, classification, prediction, clustering. In practical exercises, the algorithms proposed during the course will be tested on health-related datasets.
CFU: 6
Reteirabilità: 1
Modalità di verifica finale: Oral interview / Written
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Artificial Intelligence I	6	ING-INF/05 SISTEMI DI ELABORAZIONE DELLE INFORMAZIONI	Caratterizzanti	lezioni frontali + esercitazioni	Discipline di base applicate alle biotecnologie

Artificial Intelligence II (6 CFU)

Denominazione in Inglese: Artificial Intelligence II
Obiettivi formativi in Inglese: The course aims to introduce the paradigms of neural networks and deep learning, including basics of recurrent neural networks and models for complex data, model design and validation, and applications to health/bio-medical problems and case studies
CFU: 6
Reteirabilità: 1
Modalità di verifica finale: Written test and individual or small team project work
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Artificial Intelligence II	6	INF/01 INFORMATICA	Caratterizzanti	lezioni frontali	Inglese scientifico e abilità linguistiche, informatiche e relazionali, pedagogia medica, tecnologie avanzate e a distanza di formazione e comunicazione

Bioengineering and Experimental Models in Health and Disease (6 CFU)

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Denominazione in Inglese: Bioengineering and Experimental Models in Health and Disease

Obiettivi formativi in Inglese: Starting from a quantitative description of cell, tissue and organ assembly, and of their requirements in terms of resources, microenvironmental conditions, cooperation and competition, the course covers fundamental design principles for generating cell, tissue and organ models . It also provides a comprehensive overview of stem cell, organoid and on-chip technology as well as mathematical models of self-assembly, growth and differentiation. Project work will include design and simulation of in vitro models.
The objective is to build knowledge and instruments such that the student can design experimental and computational models of tissues and organs for biotechnology applications such as regenerative medicine, toxicity testing, precision medicine etc. The knowledge will be compounded by solving problems using computational finite element methods.

Students will learn the principles of in silico, in vitro and in vivo modeling using different experimental systems (e.g. organoids, iPSCs, vertebrate animal models). With these tools they will learn the mechanisms of cellular and tissue process regulation. They will also explore the molecular etiology of the onset of diseases, with particular attention to neurodevelopmental syndromes with neurological and neuropsychiatric impact.
CFU: 6
Reteirabilità: 1
Modalità di verifica finale: Written test and oral interview
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Bioengineering in Experimental Modeling	6	ING-INF/06 BIOINGEGNERIA ELETTRONICA E INFORMATICA	Affini o integrative	lezioni frontali + esercitazioni	Attività formative affini o integrative
Segmento Experimental Modeling in Health and Disease	*3*	*BIO/06 ANATOMIA COMPARATA E CITOLOGIA*		*lezioni frontali*	

Biology of Cellular Systems (6 CFU)

Denominazione in Inglese: Biology of Cellular Systems
Obiettivi formativi in Inglese: The purpose of this course is to share with the students the basic knowledge concerning prokaryotic and eucaryotic cell structure and ultrastructure. More specifically, the structure and function of cell compartments i.e. the bacterial cell wall, the eucaryotic cell plasma membrane, the cytoskeleton, mitochondria, peroxisomes, lysosomes, the endoplasmic reticulum, the Golgi apparatus and the nucleus will be described. Also, cell-to-cell junctions, cell-to-matrix junctions, the cell cycle, mitosis and meiosis will be summarized, as well as signal transduction, the main features of stem cells, cell differentiation, cell death, the first stages of mammal embryo development, and the general features of the different tissues.

Examples of cell biology issues unraveled with the aid of the artificial intelligence will be illustrated. Also, examples of not solved biological issues will be described as potential subjects for future studies that would benefit of new methodologies and of cutting-edge methods of data acquisition and analysis.
The final goal of this course is making possible the communication between the not-biologist and the biologist, in the attempt to address, in a joint way, cell biology issues potentially beneficial for the organism health in its relationship with its environment.
CFU: 6
Reteirabilità: 1
Modalità di verifica finale: Oral interview
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Biology of Cellular Systems	6	BIO/06 ANATOMIA COMPARATA E CITOLOGIA	Affini o integrative	lezioni frontali	Attività formative affini o integrative

Bionformatics in silico models (12 CFU)

Denominazione in Inglese: Bionformatics in silico models
Obiettivi formativi in Inglese: Module: Bioinformatics. The course aims to provide both conceptual and computational tools for data analysis in Molecular Biology, getting also to an advanced use of Python, one of the most popular languages in Bioinformatics and in Machine Learning. The most prominent topics in Bioinformatics are developed in the course: usage of data banks, algorithms for sequence analysis (and assembly), modelling of proteins and other biomolecules, algorithms for handling of molecular models, analysis of molecular pathways

Module in silico models:
The course aims to provide the basic elements of in silico modeling of biological and physio-pathological systems. In particular, the course will deal with the objectives and tools for the formulation of theoretical models, the computational techniques for their simulation and for parameters identification using experimental data. Specifically, the course will focus on in silico models for protein analysis, basic in silico drug-design techniques and chemometric analyses able to support in

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vivo toxicity studies. The main objective is to provide the student with conceptual and operational tools that allow him/her to develop the entire modeling process for some significant biomedical applications.
CFU: 12
Reteirabilità: 1
Modalità di verifica finale: Written test and/or oral interview
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Bionformatics - A	6	ING-INF/05 SISTEMI DI ELABORAZIONE DELLE INFORMAZIONI	Affini o integrative	lezioni frontali	Attività formative affini o integrative
Segmento Bioninformatics - B	*3*	*INF/01 INFORMATICA*		*lezioni frontali*	
In silico models	6	CHIM/08 CHIMICA FARMACEUTICA	Affini o integrative	lezioni frontali+laboratorio	Attività formative affini o integrative

Biotechnology applied to sense physiology (6 CFU)

Denominazione in Inglese: Biotechnology applied to sense physiology
Obiettivi formativi in Inglese: The course is organized around various biotechnological strategies and their impact on the analysis of sensory information in the brain. It is centered on the use of various neuronal interfaces and other experimental approaches as strategies to regulate the physiology of the senses. Particular emphasis is placed on the way in which such devices/approaches are able to translate or induce the translation of external stimuli into electrical activity at the level of impaired neuronal networks in different sensory modalities. For this purpose, various experimental approaches such as nano-technologies, micro-technologies, optogenetics, transcranial magnetic stimulation, as well as the nature of the smart materials used in the construction of the aforementioned devices, will be examined both in vitro and in vivo. The impact of these biotechnological approaches on the perception of the world around us will be the subject of particular attention. At the end of the course, students should acquire critical tools to understand: (i) physiological mechanisms of sensory processing and (ii) the application of various biotechnological tools as a strategy for restoring sensory perception in various pathological cases.
CFU: 6
Reteirabilità: 1
Modalità di verifica finale: Oral interview
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Biotechnology applied to sense physiology	6	BIO/09 FISIOLOGIA	Caratterizzanti	lezioni frontali	Discipline biotecnologiche comuni

Cell signaling and imaging tools (6 CFU)

Denominazione in Inglese: Cell signaling and imaging tools
Obiettivi formativi in Inglese: Description: Signaling pathways mediated by enzyme-linked receptor, G-protein-coupled receptors and ion channel receptors. Signaling pathways involving protein covalent modification. Dysregulation of signaling pathways in diseases. Strategies for the specific targeting of biological macromolecules. Principles of optics. Light microscopy applied to eukaryotic and prokaryotic cells. Principle of fluorescence and confocal laser scanning microscopy. Examples of advanced fluorescence microscopy techniques. High and super resolution imaging of microorganisms and live cells. Electron microscopy for ultrastructural analysis of microorganisms, cells and tissues.
Learning outcomes: The student who successfully completes the course will have a basic knowledge of the main strategies of intracellular and intercellular communication, main microscopy techniques to be applied to study microbial and eukaryotic cells, and their processes at single molecule level. Moreover, students will be able to analyse microscopy imaging and discuss the application of different experimental approaches based on advanced microscopy tools.
CFU: 6
Reteirabilità: 1
Modalità di verifica finale: Oral exam attesting the student ability to have understood the main contents of the course topics
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Cell signaling	6	BIO/10 BIOCHIMICA	Caratterizzanti	lezioni frontali	Discipline biotecnologiche comuni
Segmento Imaging tools	*3*	*BIO/19 MICROBIOLOGIA GENERALE*		*lezioni frontali*	

Focused Lab training (6 CFU)
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Denominazione in Inglese: Focused Lab training

Obiettivi formativi in Inglese: Students of the “Focused Lab Training” course will be provided with a specific training in those innovative and advanced laboratory techniques that will improve their laboratory skills with particular regards to their thesis topic. The course’s activities will be performed in dedicated facilities and laboratories of the University of Pisa or, upon reciprocal agreement between the involved institutions, in private or public research institutes, universities or companies. Each student will be assigned to a tutor/teacher that will monitor and supervise the laboratory training.
CFU: 6
Reteirabilità: 1
Modalità di verifica finale: Written report on the focused laboratory topic
The evaluation will consist in "pass" or "fail" based on the quality of the reports. Students will not receive a numerical mark
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Focused Lab training	6	NN No settore	Altre attività - scelta libera dello studente	laboratorio e/o esercitazioni	A scelta dello studente

Genetics and Molecular biology (12 CFU)

Denominazione in Inglese: Genetics and Molecular biology
Obiettivi formativi in Inglese: Learning outcomes
Genetics and Genomics. The students who successfully complete the course will have acquired the knowledge of Genetics and some types of genomic analysis. They will have the ability to define the laws governing the inheritance of Mendelian traits and the inheritance linked to sex. Students will also acquire knowledge about the molecular basis of genotype-phenotype relationships, the basics to analyze gene and chromosomal mutations and will learn the basic principles for carrying out genetic mappings. They will also acquire knowledge that will allow them to understand the genetic structure of populations.

Molecular Biology. The student who successfully completes the course will be able to demonstrate a solid knowledge of the main issues related to Molecular Biology: structure and properties of nucleic acids and proteins and their functions during replication, transcription, and translation mechanisms. Concepts of gene expression regulation will be acquired. The student will be aware of modern approaches of recombinant DNA technology for biotechnological purposes.
CFU: 12
Reteirabilità: 1
Modalità di verifica finale: The exam consists in a written elaboration (Genetics and Genomics) and an oral dissertation (Molecular Biology).
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Genetics and Genomics	6	BIO/18 GENETICA	Caratterizzanti	lezioni frontali + esercitazioni	Discipline biotecnologiche comuni
Molecular biology	6	BIO/11 BIOLOGIA MOLECOLARE	Caratterizzanti	lezioni frontali + esercitazioni	Discipline di base applicate alle biotecnologie

Internship (6 CFU)

Denominazione in Inglese: Internship
Obiettivi formativi in Inglese: The course involves 6 ects of coursework, which may supplement the preparation of the master's thesis, to be completed under the supervision of the thesis mentor.
CFU: 6
Reteirabilità: 1
Modalità di verifica finale: Assessment based on the evaluation of the thesis mentor.
The evaluation will consist in "pass" or "fail" based on the quality of the reports. Students will not receive a numerical mark
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Internship	6	NN No settore	Altre attività - Tirocini formativi e di orientamento	tirocinio	Tirocini formativi e di orientamento

Job placement activities (3 CFU)

Denominazione in Inglese: Job placement activities
Obiettivi formativi in Inglese: The course is aimed to provide students with the potential job positions and related professional skills which are required in the field of biotechnologies and applied artificial intelligence. The course is

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structured in seminars and lectures given by research and development directors, laboratory managers, principal investigators, academic researchers and professors from public or private research centers, universities, companies active in the field of biotechnologies. Each seminar will be focused on the description of interdisciplinary and innovative technologies for health, with particular regards to those based on biotechnologies and applied artificial intelligence.
CFU: 3
Reteirabilità: 1
Modalità di verifica finale: The evaluation will consist in "pass" or "fail" based on the basis of attendance (at least 75%) and quality of the reports. Students will not receive a numerical mark
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Job placement activities	3	NN No settore	Altre attività - Altre conoscenze utili per l'inserimento nel mondo del lavoro	seminario	Altre Conoscenze Utili per l'Inserimento Nel Mondo del Lavoro

Metagenomics (6 CFU)

Denominazione in Inglese: Metagenomics
Obiettivi formativi in Inglese: The main goal of the course is to provide the student with a basic knowledge of metagenomic studies aimed at identifying the impact of microorganism composition in human phenotypes as well as of the analytical methods commonly applied in metagenomic studies
The course will be divided into three parts. In the first part, general features of microbial taxonomy and genetics will be discussed with a particular interest on those characteristics that are used in metagenomics studies. Taxonomic and functional metagenomics approaches will also be analysed.
The second part will focus on current methodologies to produce and analyse meta-genomics data. Next Generation Techniques used to generate metagenomics data will be introduced and the statistical methods commonly utilized to analyse the data will be proposed to the students.
In the last part metagenomics data will be analysed in the context of human health
CFU: 6
Reteirabilità: 1
Modalità di verifica finale: Oral interview
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Metagenomics - A	6	BIO/18 GENETICA	Altre attività - scelta libera dello studente	lezioni frontali	A scelta dello studente
Segmento Metagenomics - B	*3*	*BIO/19 MICROBIOLOGIA GENERALE*		*lezioni frontali + esercitazioni*	

Microbiology and public health (12 CFU)

Denominazione in Inglese: Microbiology and public health
Obiettivi formativi in Inglese: Description: The course is focused on the analysis of cellular organization of microorganisms (Eubacteria and Archea, Virus and Yeast), microbial growth and conditions influencing the yield and survival, as well as mechanisms of microbial virulence and host-parasite interaction. Other topics of the course are the mechanisms of gene transfer and recombination, global regulation of microbial cell functions, and techniques for microbial genomics, metagenomic and microbial gene manipulation. Application of microorganisms in biotechnology: examples of: i) innovative strategies for detecting, preventing or treating infections; microbial engineering for production and delivery of therapeutic molecules; ii) food-related applications.
Learning outcomes: The student who successfully completes the course will have a basic knowledge of cellular and molecular organization of the main groups of Eubacteria and Archea, Virus and Yeast as well as a comprehension of microbial physiology and growth kinetics. Students will be aware of basic methods for genetic recombination and microbial gene manipulation as well as of the main virulence/pathogenicity factors of microorganisms and their interaction with the host. Finally, students will be able to discuss examples of how microorganisms may serve as biotechnological tools to produce goods and services.
CFU: 12
Reteirabilità: 1
Modalità di verifica finale: Oral exam attesting the student ability to have understood the main contents of the course topics
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito

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Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Microbiology and microbial biotechnology	6	BIO/19 MICROBIOLOGIA GENERALE	Caratterizzanti	lezioni frontali	Discipline biotecnologiche comuni
Health risk assessment	6	MED/42 IGIENE GENERALE E APPLICATA	Affini o integrative	lezioni frontali	Attività formative affini o integrative

Molecular Genetics and Molecular Medicine in the AI-era (6 CFU)

Denominazione in Inglese: Molecular Genetics and Molecular Medicine in the AI-era
Obiettivi formativi in Inglese: Students will be provided with knowledge on the most advanced concepts in molecular genetics and molecular medicine, with regards on recent advancements given by the application of artificial intelligence and machine learning technologies to genetics and genomics. Practical examples will be taken also from the field of ophthalmology, assessing how integration with AI is introducing a revolution of disease diagnose pattern with a significant clinical impact. Methods of AI analysis of high-resolution diagnostic images obtained from both genetic and age-related diseases will be discussed and effects of combining imaging and molecular data in an AI context will be critically evaluated. Covered topics: from the "monogenic disease" concept to the multi-gene and genome contributions to hereditary diseases; the genetic and genomic complexity of cancer, how the genetics and the genomics contribute to the definition of cells, mutations heterogeneity, drug resistance and tumor evolution; the genetic and phenotype complexity of ocular diseases (i.e., glaucoma, macular degeneration etc.). Genotype-phenotype correlation and ocular gene therapy design: the support of AI.
CFU: 6
Reteirabilità: 1
Modalità di verifica finale: Oral interview
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Molecular Genetics and Molecular Medicine in the AI-era	6	BIO/18 GENETICA	Altre attività - scelta libera dello studente	Lezioni frontali+Esercitazioni+Laboratorio	A scelta dello studente

Omics: Biotechnology and AI for health (6 CFU)

Denominazione in Inglese: Omics: Biotechnology and AI for health
Obiettivi formativi in Inglese: The student will learn the principles of high throughput sequencing and data analysis to understand the effect of human genetic variation in health and disease and model gene expression regulation in eukaryotic cells. The student will acquire theoretical and practical expertise in the transcriptome analysis at the gene, exon and alternative splicing level given a microarray or NGS dataset. In addition, the student will learn current applications of genomics data in relation to human health such as, for example, Genome Wide Association studies (GWAs), NGS for resequencing studies to discover rare variants and meta-genomic. The course will be divided into two parts. In the first part, the basic knowledge on omics techniques and an overview of web tools and databases will be provided. The common for DNA and RNA omic analysis will be analyzed such as microarray (SNPs arrays and expression arrays) and next generation sequencing platforms. The strategies for sequencing the whole transcriptome or sub-transcriptomes (actively transcribed RNA or actively translated RNA or epi-transcriptome) will be described. DNA/RNA extraction, quality check, library preparation (including single cell omics and low-input analysis) will be considered. Data cleaning and filtering, quality check, mapping against a reference genome (both for genomic and transcriptomic data), gene counting, algorithm for gene count normalization, modality for data plotting and principal component analysis will be discussed. In the second part of the course the focus will be on the analytic approaches used for omics data that will be described with a particular focus on advanced epidemiologic/statistics and Artificial Intelligence methodologies. The interpretation of -omics data will be understood by coupling data analysis with AI algorithmic approaches (e.g., gene set enrichment analysis, GSEA, KEGG, WikiPathways). The analysis of feature selection with machine learning algorithms will be performed to define the molecular signature of cells and tissues and for the identification of biomarkers. ChipSeq data will be considered for the study of the interaction between regulatory elements (eg, promoters and enhancers), DNA and proteins, topologically associated domains (TAD) and the epigenetic signature in order to analyze the modulation of gene expression through Genome Segmentation algorithms. The use of artificial intelligence algorithms will be also considered for the study of the protein interactome and protein-protein interactions. The students will also learn on how to use web tools to analyze genomic data and to relate the genetic variability with possible functions of the variants (RegulomeDB, The Genotype-Tissue Expression (GTEx) project, Haploreg, etc.)
All these data will be integrated by AI approaches to build a gene expression regulation model and to explore the possible interaction of genetic variability with environmental variables.
CFU: 6
Reteirabilità: 1
Modalità di verifica finale: Oral interview; discussion of results from a dataset analyzed by the student
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Omics: Biotechnology and AI for health - A	6	BIO/18 GENETICA	Caratterizzanti	lezioni frontali+laboratorio	Discipline biotecnologiche comuni

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Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Segmento Omics: Biotechnology and AI for health - B	*3*	*BIO/11 BIOLOGIA MOLECOLARE*		*lezioni frontali+laboratorio*	

Omics data analysis (6 CFU)

Denominazione in Inglese: Omics data analysis
Obiettivi formativi in Inglese: The course will introduce the basic technologies available to analyze omics data and will provide the student with a roadmap to select the best algorithms depending on the biomedical problem to be analyzed.
CFU: 6
Reteirabilità: 1
Modalità di verifica finale: Oral interview / Written
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Omics data analysis	6	INF/01 INFORMATICA	Altre attività - scelta libera dello studente	lezioni frontali	A scelta dello studente

Physio-pathology (6 CFU)

Denominazione in Inglese: Physio-pathology
Obiettivi formativi in Inglese: The class of Physio-pathology considers different diseases of the central nervous system and of peripheral organs with high socio-economic impact. In each case, an in-depth analysis of the physiology of the organs or of the systems involved in the disease will be performed and it will be followed by the study of the mechanisms that affect the normal function and cause the pathology. The objective of the course is to provide an overview of the possible pathways through which health may turn into pathology with the aim of setting the basis for the use of A.I. and biotechnology to reverse the path from pathology to health.
CFU: 6
Reteirabilità: 1
Modalità di verifica finale: Oral interview
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Physio	6	BIO/09 FISIOLOGIA	Caratterizzanti	lezioni frontali	Discipline biotecnologiche comuni
Segmento Pathology	*3*	*MED/04 PATOLOGIA GENERALE*		*lezioni frontali*	

Probability and Biostatistics (6 CFU)

Denominazione in Inglese: Probability and Biostatistics
Obiettivi formativi in Inglese: The student will learn the basics of probability theory and statistical inference and will be able to apply appropriate methodologies for applications in biology and, in general, for the study of life sciences. In addition to the planning, collection and analysis of experimental data, the following topics will be discussed: theory of probability, discrete and continuous random variables, descriptive statistics of statistical samples, multivariate random variables, sums of random variables and associated limit theorems, interval estimation, inferential statistics and hypothesis testing, non-Gaussianity and chi-square tests, inference through non-parametric methods, regression analysis, and evaluation of diagnostic tests: sensitivity, specificity, and ROC curves.
CFU: 6
Reteirabilità: 1
Modalità di verifica finale: Written test and oral interview
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Probability and Biostatistics	6	ING-INF/06 BIOINGEGNERIA ELETTRONICA E INFORMATICA	Caratterizzanti	lezioni frontali	Discipline di base applicate alle biotecnologie

Smart materials and sensors (12 CFU)

Denominazione in Inglese: Smart materials and sensors

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Obiettivi formativi in Inglese: The class of “Smart materials and Sensors” is composed by two modules: “Smart Materials” and “Sensors”.
The purpose of the course of Smart materials and Sensors is to provide the student with the know-how to address measurements of physical, chemical, and biochemical parameters of biotechnological interest.
The objectives of the Smart Materials and Sensors modules are to provide the student with knowledge on : 1) intelligent and bio-responsive materials, such as hydrogels, nanomaterials, piezoelectrics, electro and magneto-responsive materials; 2) design constraints for (bio)sensors and biomimetic systems to be used in vitro and in vivo; 3) fabrication of (bio)sensors and transducers based on smart materials; 4) design of smart sensors and systems for biomedical applications; 5) ability to make critical choices about the appropriate sensor technologies for a given application.
CFU: 12
Reteirabilità: 1
Modalità di verifica finale: Written test and/or oral interview
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Sensors	6	ING-INF/01 ELETTRONICA	Affini o integrative	lezioni frontali	Attività formative affini o integrative
Smart materials	6	ING-INF/06 BIOINGEGNERIA ELETTRONICA E INFORMATICA	Caratterizzanti	lezioni frontali	Discipline di base applicate alle biotecnologie

The Law and Ethics of A.I.-driven biomedical innovation (6 CFU)

Denominazione in Inglese: The Law and Ethics of A.I.-driven biomedical innovation
Obiettivi formativi in Inglese: This course addresses some fundamental regulatory questions concerning A.I.-driven biomedicine. As the convergence of ‘omics’ science and advanced data analyses rises a tide of biomedical innovation, it is essential for future professionals in this field to understand its social implications and keep abreast of the relevant legal and ethical frameworks.
Participants will earn an understanding of the legal and ethical implications of the process of development of A.I.-based biotechnological applications from lab to market.
After a comparative overview of the regulatory strategies in the European Union and the United States, we will address some of the most relevant problems raised by the application of A.I. to biomedicine, such as the tension between informed consent procedures and ‘black-box’ algorithms; how data safety and transparency requirements vary, depending on the tasks and the risks; the potential for discrimination and unfairness inherent in some machine-learning applications; the risks for patients privacy, well beyond the patient-doctor relationship.
We will then analyze the response of legal systems to these concerns, with a focus on the European Union. Participants will learn how to identify and minimize legal liabilities; comply with relevant regulations concerning product standardizations and certification; embed fundamental rights protection and fairness considerations within the development of A.I. applications; adopt risk assessment and IPRs protection strategies, also concerning data management. We will give particular attention to the more technical areas of expertise gained in other courses which this teaching complements.
CFU: 6
Reteirabilità: 1
Modalità di verifica finale: Oral interview and presentation of a student’s choice topic
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
The Law and Ethics of A.I.-driven biomedical innovation Denominazione	6	IUS/02 DIRITTO PRIVATO COMPARATO	Altre attività - scelta libera dello studente	lezioni frontali + esercitazioni	A scelta dello studente

Thesis (21 CFU)

Denominazione in Inglese: Thesis
Obiettivi formativi in Inglese: The activity consists in the production of a master thesis regarding an original experimental work done by the student and guided by a main supervisor (chosen by the student within the professors of the course or members of affiliated structures) and two assistant supervisors (assigned by the board of the course).
CFU: 21
Reteirabilità: 1
Modalità di verifica finale: The discussion of the master’s thesis takes place in the presence of an official committee consisting of 5 to 7 faculty members.
Lingua ufficiale: Inglese

Moduli

Denominazione	CFU	SSD	Tipologia	Caratteristica	Ambito
Thesis	21	PROFIN_S Prova finale per settore senza discipline	Altre attività - prova finale	prova finale	Per la prova finale