Anno Accademico **2026/2027**
Classe **LM-54 R-SCIENZE CHIMICHE**
Corso **6258-CHEMICAL INNOVATION AND REGULATION FOR SUSTAINABILITY**

Primo Anno di Corso

Gruppo: Group of choice 01 - Design of Safe Chemicals

TAF: B Ambito: 999 - Ambito aggregato per crediti di sede

Cfu min: 6 Cfu max: 6
Note:

Attività formativa	TIP	SSD	SSD 2024	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6258 000 000 C9589 - 0 - SAFE AND SUSTAINABLE BY DESIGN	CON	CHIM/06	CHEM-05/A	B	6	36/0/0/0	No	Voto

Ambito: 2090 - Organico-biotecnologico

Obiettivi: Students will be able to apply the SSbD methodology to a diversity of cases. They will know how to apply the existing tools for supporting SSbD. They will know how to use computational approaches for designing new alternative chemicals and forecasting their properties.
The student is expected to be able to:
1. Have a thorough understanding of the principles and applications of SSbD methodology;
2. Have a comprehensive knowledge of the existing digital tools for supporting SSbD;
3. Use the principles of structure-properties relationship for designing new products and forecasting their properties.

Obiettivi inglese: Students will be able to apply the SSbD methodology to a diversity of cases. They will know how to apply the existing tools for supporting SSbD. They will know how to use computational approaches for designing new alternative chemicals and forecasting their properties.
The student is expected to be able to:
1. Have a thorough understanding of the principles and applications of SSbD methodology;
2. Have a comprehensive knowledge of the existing digital tools for supporting SSbD;
3. Use the principles of structure-properties relationship for designing new products and forecasting their properties.

6258 000 000 C9588 - 0 - SUSTAINABLE DESIGN OF CHEMICALS	CON	CHIM/06	CHEM-05/A	B	6	36/0/0/0	No	Voto

Ambito: 2090 - Organico-biotecnologico

Obiettivi: Students will be aware of the need of finding alternative chemical products to problematic existing ones and of the use of principles of Green Chemistry for designing and discovering them. They will know how to apply the existing tools for supporting SSbD. They will know how to use computational approaches for designing new alternative chemicals and forecasting their properties.
The student is expected to be able to:
1. Design new environmentally friendly chemical products applying the principles of green chemistry;
2. Have a comprehensive knowledge of the existing digital tools for supporting SSbD;
3. Use the principles of structure-properties relationship for designing new products and forecasting their properties.

Obiettivi inglese: Students will be aware of the need of finding alternative chemical products to problematic existing ones and of the use of principles of Green Chemistry for designing and discovering them. They will know how to apply the existing tools for supporting SSbD. They will know how to use computational approaches for designing new alternative chemicals and forecasting their properties.
The student is expected to be able to:
1. Design new environmentally friendly chemical products applying the principles of green chemistry;
2. Have a comprehensive knowledge of the existing digital tools for supporting SSbD;
3. Use the principles of structure-properties relationship for designing new products and forecasting their properties.

6258 000 000 C9590 - 0 - TARGETED SUSTAINABLE PRODUCTS	CON	CHIM/06	CHEM-05/A	B	6	36/0/0/0	No	Voto

Ambito: 2090 - Organico-biotecnologico

Obiettivi: Students will know the problems of discovering and designing new pharmaceutically active substances. They will know how to apply the existing tools for supporting SSbD. They will know how to use computational approaches for designing new alternative chemicals and
forecasting their properties.
The student is expected to be able to:
1. Design and discover new drugs;
2. Have a comprehensive knowledge of the existing digital tools for supporting SSbD;
3. Use the principles of structure-properties relationship for designing new products and forecasting their properties.

Obiettivi inglese: Students will know the problems of discovering and designing new pharmaceutically active substances. They will know how to apply the existing tools for supporting SSbD. They will know how to use computational approaches for designing new alternative chemicals and
forecasting their properties.
The student is expected to be able to:
1. Design and discover new drugs;
2. Have a comprehensive knowledge of the existing digital tools for supporting SSbD;
3. Use the principles of structure-properties relationship for designing new products and forecasting their properties.

Gruppo: Group of choice 02 - Design for Environmental Sustainability

TAF: B Ambito: 999 - Ambito aggregato per crediti di sede

Cfu min: 6 Cfu max: 6

Note:

Attività formativa	TIP	SSD	SSD 2024	TAF	CFU	ORE F/E/L/N	FREQ.	VER.

6258 000 000 C9592 - 0 - EMERGING POLLUTANTS	CHIM/12	CHEM-01/B	6	36/0/0/0	No	Voto

Ambito: B

Obiettivi: Students will understand the concepts and principles of Life Cycle Assessment (LCA) and learn how to model material recycling and energy recovery in LCA. They will understand the concepts and principles of plastics chemistry, their impact on living organisms and their recycling. The student is expected to be able to:
1.Gain basic LCA modelling skills;
2.Illustrate the enviornmental fate of plastic materiasl and describe their adverse impacts on living organisms.

Obiettivi inglese: Students will understand the concepts and principles of Life Cycle Assessment (LCA) and learn how to model material recycling and energy recovery in LCA. They will understand the concepts and principles of plastics chemistry, their impact on living organisms and their recycling. The student is expected to be able to:
1.Gain basic LCA modelling skills;
2.Illustrate the enviornmental fate of plastic materiasl and describe their adverse impacts on living organisms.

6258 000 000 C9591 - 0 - ENVIRONMENTAL CONCERNS	CHIM/12	CHEM-01/B	6	36/0/0/0	No	Voto

Ambito: B

Obiettivi: Students will understand the concepts and principles of Life Cycle Assessment (LCA) and learn how to model material recycling and energy recovery in LCA. They will understand the environmental fate of organic pollutants, outlining the main distribution of an otrganic compound in environmental compartments and their main degradation pathways and sinks.
The student is expected to be able to:
1.Gain basic LCA modelling skills;
2.Understand and describe the main structural features of organic pollutants, their distribution and degradation pathways in environmental compartments.

Obiettivi inglese: Students will understand the concepts and principles of Life Cycle Assessment (LCA) and learn how to model material recycling and energy recovery in LCA. They will understand the environmental fate of organic pollutants, outlining the main distribution of an otrganic compound in environmental compartments and their main degradation pathways and sinks.
The student is expected to be able to:
1.Gain basic LCA modelling skills;
2.Understand and describe the main structural features of organic pollutants, their distribution and degradation pathways in environmental compartments.

6258 000 000 C9593 - 0 - POLLUTION REMEDIATION	CHIM/12	CHEM-01/B	6	36/0/0/0	No	Voto

Ambito: B

Obiettivi: Students will understand the concepts and principles of Life Cycle Assessment (LCA) and learn how to model material recycling and energy recovery in LCA. They will understand how chemical properties affect the behaviour of pollutants and their fate in the environment. They will understand which are the key constituents in wastewaters, their sources and monitor parameters and main unit operations involved in wastewater treatment.
The student is expected to be able to:
1.Gain basic LCA modelling skills;
2.Discuss how chemical properties of organic compounds affect behaviour and fate in soil and groundwater environments;
3.Understand and describe the main unit operations and the chemical and biological processes involved in wastewater treatment.

Obiettivi inglese: Students will understand the concepts and principles of Life Cycle Assessment (LCA) and learn how to model material recycling and energy recovery in LCA. They will understand how chemical properties affect the behaviour of pollutants and their fate in the environment. They will understand which are the key constituents in wastewaters, their sources and monitor parameters and main unit operations involved in wastewater treatment.
The student is expected to be able to:
1.Gain basic LCA modelling skills;
2.Discuss how chemical properties of organic compounds affect behaviour and fate in soil and groundwater environments;

3.Understand and describe the main unit operations and the chemical and biological processes involved in wastewater treatment.

Gruppo: Group of choice 03 - Safety and Innovation in Chemical Industry

TAF: B Ambito: 999 - Ambito aggregato per crediti di sede

Cfu min: 6 Cfu max: 6

Note:

Attività formativa	TIP	SSD	SSD 2024	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6258 000 000 94266 - 0 - NANOTECH INDUSTRY		CHIM/06	CHEM-05/A	B	6	36/0/0/0	No	Voto

Ambito:

Obiettivi: Students will understand the principles and practices necessary for ensuring safety and fostering innovation in the chemical industry, with a particular focus on applications in nanotechnology. They will explore strategies to recognize and manage chemical reactivity hazards, gain knowledge of nanoscale manufacturing processes, and learn to synthesize and characterize nanomaterials for innovative applications.
The student is expected to be able to:
1. Recognize and manage chemical reactivity hazards to ensure safety in industrial and laboratory settings;
2. Understand and apply principles of nanomanufacturing and nanoprocessing to advance innovation in the chemical industry;
3. Synthesize and characterize nanomaterials using advanced techniques and analyze their applications in areas such as biomedicine and industry.

Obiettivi inglese: Students will understand the principles and practices necessary for ensuring safety and fostering innovation in the chemical industry, with a particular focus on applications in nanotechnology. They will explore strategies to recognize and manage chemical reactivity hazards, gain knowledge of nanoscale manufacturing processes, and learn to synthesize and characterize nanomaterials for innovative applications.
The student is expected to be able to:
1. Recognize and manage chemical reactivity hazards to ensure safety in industrial and laboratory settings;
2. Understand and apply principles of nanomanufacturing and nanoprocessing to advance innovation in the chemical industry;
3. Synthesize and characterize nanomaterials using advanced techniques and analyze their applications in areas such as biomedicine and industry.

6258 000 000 C9595 - 0 - PHARMA INDUSTRY		CHIM/06	CHEM-05/A	B	6	36/0/0/0	No	Voto

Ambito:

Obiettivi: Students will understand the principles of safety and innovation critical to the chemical and pharmaceutical industries. They will explore the management of chemical reactivity hazards, the application of sustainable biocatalytic processes, and the integration of green chemistry and
advanced technologies in pharmaceutical development.
The student is expected to be able to:
1. Recognize and manage chemical reactivity hazards to ensure safety in pharmaceutical and chemical processes;
2. Apply biocatalysis principles and technologies to design sustainable and innovative processes for pharmaceutical production;
3. Understand and implement best practices in pharmaceutical development, including quality systems, green chemistry principles, and analytical technologies for efficient and innovative drug design.

Obiettivi inglese: Students will understand the principles of safety and innovation critical to the chemical and pharmaceutical industries. They will explore the management of chemical reactivity hazards, the application of sustainable biocatalytic processes, and the integration of green chemistry and
advanced technologies in pharmaceutical development.
The student is expected to be able to:
1. Recognize and manage chemical reactivity hazards to ensure safety in pharmaceutical and chemical processes;
2. Apply biocatalysis principles and technologies to design sustainable and innovative processes for pharmaceutical production;
3. Understand and implement best practices in pharmaceutical development, including quality systems, green chemistry principles, and

analytical technologies for efficient and innovative drug design.

6258 000 000 C9596 - 0 - SAFE AND SUSTAINABLE PROCESSES	CHIM/06	CHEM-05/A	6	36/0/0/0	No	Voto

Ambito: B

Obiettivi: Students will understand the principles and practices required to ensure safety and sustainability in chemical processes, with a focus on safe and sustainable production methods in the chemical industry. They will gain knowledge of chemical reactivity hazards, the assessment and management of process safety, and the production of sustainable fuels and hydrogen.
The student is expected to be able to:
1. Recognize and manage chemical reactivity hazards to prevent uncontrolled reactions, ensuring safety in chemical processes;
2. Apply thermal safety assessment principles to evaluate and mitigate risks in chemical processes, including flammability and explosion hazards;
3. Design and evaluate sustainable hydrogen and hydrocarbon production technologies, emphasizing environmental advantages and technological innovation.

Obiettivi inglese: Students will understand the principles and practices required to ensure safety and sustainability in chemical processes, with a focus on safe and sustainable production methods in the chemical industry. They will gain knowledge of chemical reactivity hazards, the assessment and management of process safety, and the production of sustainable fuels and hydrogen.
The student is expected to be able to:
1. Recognize and manage chemical reactivity hazards to prevent uncontrolled reactions, ensuring safety in chemical processes;
2. Apply thermal safety assessment principles to evaluate and mitigate risks in chemical processes, including flammability and explosion hazards;
3. Design and evaluate sustainable hydrogen and hydrocarbon production technologies, emphasizing environmental advantages and technological innovation.

Gruppo: Group of choice 04 - Safety in the use of chemicals

TAF: B Ambito: 999 - Ambito aggregato per crediti di sede

Cfu min: 6 Cfu max: 6

Note:

Attività formativa	TIP	SSD	SSD 2024	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6258 000 000 C9598 - 0 - SAFETY AND FOOD		CHIM/02	CHEM-02/A		6	36/0/0/0	No	Voto

Ambito: B

Obiettivi: Students will gain knowledge of safety in the use of chemicals, specifically addressing human health and safety aspects in food applications, in line with step 3 of the Safe and Sustainable by Design (SSbD) methodology. They will explore chemical safety principles, food formulation
and processing technologies, and hazard assessment to ensure safe and innovative food products.
The student is expected to be able to:
1. Identify and assess the physical, toxicity, and ecotoxicity hazards of chemicals and apply proper safety measures for their use, particularly in food-related contexts;
2. Understand the principles of food formulation, including ingredient selection, processing technologies, and safety in food engineering, while considering innovative and sustainable approaches;
3. Design safe and functional chemical formulations by understanding the structure-property relationships and their implications for safety and performance in food applications.

Obiettivi inglese: Students will gain knowledge of safety in the use of chemicals, specifically addressing human health and safety aspects in food applications, in line with step 3 of the Safe and Sustainable by Design (SSbD) methodology. They will explore chemical safety principles, food formulation
and processing technologies, and hazard assessment to ensure safe and innovative food products.
The student is expected to be able to:
1. Identify and assess the physical, toxicity, and ecotoxicity hazards of chemicals and apply proper safety measures for their use, particularly

in food-related contexts;
2. Understand the principles of food formulation, including ingredient selection, processing technologies, and safety in food engineering, while considering innovative and sustainable approaches;
3. Design safe and functional chemical formulations by understanding the structure-property relationships and their implications for safety and performance in food applications.

6258 000 000 C9599 - 0 - SAFETY AND RECYCLING	CHIM/02	CHEM-02/A	6	36/0/0/0	No	Voto

Ambito: B

Obiettivi: Students will develop comprehensive knowledge of safety in the use of chemicals, focusing on human health and safety aspects in final applications, and will explore safety considerations in recycling within the Safe and Sustainable by Design (SSbD) methodology. They will assess chemical hazards, understand material properties, and learn principles of designing for recycling.
The student is expected to be able to:
1. Identify and assess physical, toxicity, and ecotoxicity hazards of chemicals, and implement proper safety measures in handling and use;
2. Analyze and apply material properties and structural knowledge to ensure safety and performance in various applications, with an emphasis on sustainable practices;
3. Design materials and products with recycling in mind, considering lifecycle assessment and material recovery.

Obiettivi inglese: Students will develop comprehensive knowledge of safety in the use of chemicals, focusing on human health and safety aspects in final applications, and will explore safety considerations in recycling within the Safe and Sustainable by Design (SSbD) methodology. They will assess chemical hazards, understand material properties, and learn principles of designing for recycling.
The student is expected to be able to:
1. Identify and assess physical, toxicity, and ecotoxicity hazards of chemicals, and implement proper safety measures in handling and use;
2. Analyze and apply material properties and structural knowledge to ensure safety and performance in various applications, with an emphasis on sustainable practices;
3. Design materials and products with recycling in mind, considering lifecycle assessment and material recovery.

6258 000 000 C9597 - 0 - SAFETY IN NEW MATERIALS	CHIM/02	CHEM-02/A	6	36/0/0/0	No	Voto

Ambito: B

Obiettivi: Students will understand the principles of safety in the use of chemicals, focusing on the human health and safety aspects of new materials in their final applications. They will learn to evaluate the properties of materials, design safe and functional chemical formulations, and apply best practices for chemical handling and risk management in line with the Safe and Sustainable by Design (SSbD) methodology.
The student is expected to be able to:
1. Identify and assess the physical, toxicity, and ecotoxicity hazards of chemicals and adopt proper control measures for safe handling and use, including in the context of new materials;
2. Understand the correlation between material properties and their applications, and apply theoretical and experimental approaches to solve practical challenges in the design and use of new materials;
3. Design and optimize chemical formulations by incorporating functional ingredients, understanding their structure-property relationships, and employing sustainable approaches for creating innovative materials.

Obiettivi inglese: Students will understand the principles of safety in the use of chemicals, focusing on the human health and safety aspects of new materials in their final applications. They will learn to evaluate the properties of materials, design safe and functional chemical formulations, and apply best practices for chemical handling and risk management in line with the Safe and Sustainable by Design (SSbD) methodology.
The student is expected to be able to:
1. Identify and assess the physical, toxicity, and ecotoxicity hazards of chemicals and adopt proper control measures for safe handling and use, including in the context of new materials;
2. Understand the correlation between material properties and their applications, and apply theoretical and experimental approaches to solve practical challenges in the design and use of new materials;
3. Design and optimize chemical formulations by incorporating functional ingredients, understanding their structure-property relationships, and employing sustainable approaches for creating innovative materials.

Gruppo: Group of choice 05 - Socio-Economic Sustainability and Circular Economy

TAF: B Ambito: 999 - Ambito aggregato per crediti di sede

Cfu min: 6 Cfu max: 6
Note:

Attività formativa	TIP	SSD	SSD 2024	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6258 000 000 C9601 - 0 - GLOBAL CHANGES	CON	CHIM/04	CHEM-04/A	B	6	36/0/0/0	No	Voto

Ambito: 2072 - Chimico-industriale

Obiettivi: Students will become familiar the concept of global environmental changes, with a special focus on climatic changes. They will be aware of the threat posed by global changes to mankind and the environment and of the international agreements for protection of the global environment and reduction of the impact of global changes. Students will acquire theoretical and practical expertise of material flow analysis (MFA) techniques for the sustainable management of chemicals. They will gain knowledge about the social and economic aspects to be considered in the sustainable management of chemcials. The student will be able to:
1.Compare the guidelines and recommendation of the international agreements with the local and global trends;
2.Understand and apply material flow analysis (MFA) techniques;
3.Understand social and economic sustainability concepts and how they affect the sustainable management of chemicals.

Obiettivi inglese: Students will become familiar the concept of global environmental changes, with a special focus on climatic changes. They will be aware of the threat posed by global changes to mankind and the environment and of the international agreements for protection of the global environment and reduction of the impact of global changes. Students will acquire theoretical and practical expertise of material flow analysis (MFA) techniques for the sustainable management of chemicals. They will gain knowledge about the social and economic aspects to be considered in the sustainable management of chemcials. The student will be able to:
1.Compare the guidelines and recommendation of the international agreements with the local and global trends;
2.Understand and apply material flow analysis (MFA) techniques;
3.Understand social and economic sustainability concepts and how they affect the sustainable management of chemicals.

6258 000 000 C9600 - 0 - GLOBAL CHEMISTRY LANDSCAPE	CON	CHIM/04	CHEM-04/A	B	6	36/0/0/0	No	Voto

Ambito: 2072 - Chimico-industriale

Obiettivi: Students will gain knowledge of the current chemical industry in the global landscape, namely the main industries, resources and cirtical materials. Students will acquire theoretical and practical expertise of material flow analysis (MFA) techniques as well as understand the concepts and benefits of recycling and recover in waste management.
The student is expected to be able to:
1.Describe the current global chemical industry landscape;
2.Understand and apply material flow analysis (MFA) techniques;
3.Understand how different waste treatment practices affect the circularity of resources

Obiettivi inglese: Students will gain knowledge of the current chemical industry in the global landscape, namely the main industries, resources and cirtical materials. Students will acquire theoretical and practical expertise of material flow analysis (MFA) techniques as well as understand the concepts and benefits of recycling and recover in waste management.
The student is expected to be able to:
1.Describe the current global chemical industry landscape;
2.Understand and apply material flow analysis (MFA) techniques;
3.Understand how different waste treatment practices affect the circularity of resources

6258 000 000 C9603 - 0 - SOCIAL PERCEPTION	CON	CHIM/04	CHEM-04/A	B	6	36/0/0/0	No	Voto

Ambito: 2072 - Chimico-industriale

Obiettivi: Students will understand how psychological and sociocultural factors affect public risk perception. They will acquire theoretical and practical expertise of material flow analysis (MFA) techniques for the sustainable management of chemicals. They will gain knowledge about the social and economic aspects to be considered in the sustainable management of chemcials. The student will be able to:
1.Examine the main methods and tools in human error and human reliability assessment;
2.Understand and apply material flow analysis (MFA) techniques;
3.Understand social and economic sustainability concepts and how they affect the sustainable management of chemicals

Obiettivi inglese: Students will understand how psychological and sociocultural factors affect public risk perception. They will acquire theoretical and practical expertise of material flow analysis (MFA) techniques for the sustainable management of chemicals. They will gain knowledge about the social and economic aspects to be considered in the sustainable management of chemcials. The student will be able to:
1.Examine the main methods and tools in human error and human reliability assessment;
2.Understand and apply material flow analysis (MFA) techniques;
3.Understand social and economic sustainability concepts and how they affect the sustainable management of chemicals

Gruppo: Group of choice 06 - Green and sustainable chemistry

TAF: B Ambito: 999 - Ambito aggregato per crediti di sede

Cfu min: 6 Cfu max: 6

Note:

Attività formativa	TIP	SSD	SSD 2024	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6258 000 000 94270 - 0 - CHEMISTRY FROM NATURE		CHIM/06	CHEM-05/A	B	6	36/0/0/0	No	Voto

Ambito:

Obiettivi: Students will explore the principles of Green and Sustainable Chemistry with a focus on utilizing nature as a source for chemical production. They will learn about renewable resources, fermentation processes, and the development of biopolymers, examining sustainable strategies
to create valuable chemical products from natural materials.
The student is expected to be able to:
1. Understand and apply the principles of renewable resource utilization, including biomass conversion into bio-based products and biofuels,
and evaluate their sustainability and applications ;
2. Analyze and implement fermentation processes to produce chemicals from biological sources;
3. Develop and evaluate biopolymers as sustainable alternatives to traditional materials.

Obiettivi inglese: Students will explore the principles of Green and Sustainable Chemistry with a focus on utilizing nature as a source for chemical production. They will learn about renewable resources, fermentation processes, and the development of biopolymers, examining sustainable strategies
to create valuable chemical products from natural materials.
The student is expected to be able to:
1. Understand and apply the principles of renewable resource utilization, including biomass conversion into bio-based products and biofuels,
and evaluate their sustainability and applications ;
2. Analyze and implement fermentation processes to produce chemicals from biological sources;
3. Develop and evaluate biopolymers as sustainable alternatives to traditional materials.

6258 000 000 46072 - 0 - GREEN CHEMISTRY	CHIM/06	CHEM-05/A	6	36/0/0/0	No	Voto

Ambito: B

Obiettivi: Students will gain a comprehensive understanding of green chemistry principles, focusing on renewable resources, green metrics, and sustainable synthesis and catalysis. They will explore methods to evaluate and improve the sustainability of chemical processes and apply advanced green methodologies in organic synthesis.
The student is expected to be able to:
1. Understand and apply the principles of using renewable resources for chemical production, including the conversion of biomass into bio-based products and fuels;
2. Evaluate the environmental efficiency of chemical processes using green metrics such as Atom Economy, Reaction Mass Efficiency, and E Factor, and propose improvements;
3. Design and implement advanced green synthesis strategies, utilizing catalytic methodologies to achieve simplicity, selectivity, and sustainability in organic synthesis.

Obiettivi inglese: Students will gain a comprehensive understanding of green chemistry principles, focusing on renewable resources, green metrics, and sustainable synthesis and catalysis. They will explore methods to evaluate and improve the sustainability of chemical processes and apply advanced green methodologies in organic synthesis.
The student is expected to be able to:
1. Understand and apply the principles of using renewable resources for chemical production, including the conversion of biomass into bio-based products and fuels;
2. Evaluate the environmental efficiency of chemical processes using green metrics such as Atom Economy, Reaction Mass Efficiency, and E Factor, and propose improvements;
3. Design and implement advanced green synthesis strategies, utilizing catalytic methodologies to achieve simplicity, selectivity, and sustainability in organic synthesis.

6258 000 000 C9604 - 0 - SUSTAINABLE CHEMICAL ENGINEERING	CHIM/06	CHEM-05/A	6	36/0/0/0	No	Voto

Ambito: B

Obiettivi: Students will develop a thorough understanding of Sustainable Chemical Engineering, focusing on integrating green chemistry principles into chemical processes. They will explore the use of green metrics, alternative solvents, and sustainable chemical engineering strategies to enhance environmental efficiency and minimize the ecological footprint of chemical processes.
The student is expected to be able to:
1. Analyze and evaluate the environmental efficiency of chemical processes using green metrics such as Atom Economy, Reaction Mass Efficiency, and E Factor, and propose optimizations;
2. Select and design alternative green solvents, including biosolvents, ionic liquids, and supercritical fluids, with consideration for safety, health, and environmental impact;
3. Apply principles of Sustainable Chemical Engineering to design and optimize processes that integrate green chemistry and engineering concepts, ensuring sustainability and reduced environmental impact.

Obiettivi inglese: Students will develop a thorough understanding of Sustainable Chemical Engineering, focusing on integrating green chemistry principles into chemical processes. They will explore the use of green metrics, alternative solvents, and sustainable chemical engineering strategies to enhance environmental efficiency and minimize the ecological footprint of chemical processes.
The student is expected to be able to:
1. Analyze and evaluate the environmental efficiency of chemical processes using green metrics such as Atom Economy, Reaction Mass Efficiency, and E Factor, and propose optimizations;
2. Select and design alternative green solvents, including biosolvents, ionic liquids, and supercritical fluids, with consideration for safety, health, and environmental impact;
3. Apply principles of Sustainable Chemical Engineering to design and optimize processes that integrate green chemistry and engineering concepts, ensuring sustainability and reduced environmental impact.

Gruppo: Group of choice 07 - Hazard Assessment

TAF: B Ambito: 999 - Ambito aggregato per crediti di sede

Cfu min: 6 Cfu max: 6
Note:

Attività formativa	TIP	SSD	SSD 2024	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6258 000 000 C9605 - 0 - ECOTOXICOLOGY		BIO/10	BIOS-07/A	B	6	36/0/0/0	No	Voto

Ambito:

Obiettivi: Students will gain a comprehensive understanding of hazard assessment with a focus on ecotoxicology. This course unit integrates principles of toxicological assessment, toxicology and ecotoxicology fundamentals, and endocrine disruptors, equipping students to assess environmental and health impacts of chemical exposures.
The student is expected to be able to:
1.Understand toxicity mechanisms, dose-response relationships, and risk assessment protocols for diverse chemical exposures, considering systemic, tissue-specific, and inter-species variability;
2.Apply principles of toxicology and ecotoxicology to evaluate the effects of chemicals on organisms and ecosystems, including regulatory perspectives for establishing safe exposure levels;
3.Assess the impacts of endocrine disruptors on environmental and human health, exploring mechanisms of action and critical exposure pathways.

Obiettivi inglese: Students will gain a comprehensive understanding of hazard assessment with a focus on ecotoxicology. This course unit integrates principles of toxicological assessment, toxicology and ecotoxicology fundamentals, and endocrine disruptors, equipping students to assess environmental and health impacts of chemical exposures.
The student is expected to be able to:
1.Understand toxicity mechanisms, dose-response relationships, and risk assessment protocols for diverse chemical exposures, considering systemic, tissue-specific, and inter-species variability;
2.Apply principles of toxicology and ecotoxicology to evaluate the effects of chemicals on organisms and ecosystems, including regulatory perspectives for establishing safe exposure levels;
3.Assess the impacts of endocrine disruptors on environmental and human health, exploring mechanisms of action and critical exposure pathways.

6258 000 000 94276 - 0 - HUMAN TOXICOLOGY		BIO/10	BIOS-07/A	B	6	36/0/0/0	No	Voto

Ambito:

Obiettivi: Students will develop a detailed understanding of hazard assessment with a focus on human toxicology. This course unit integrates principles of toxicology, genotoxicity, and toxicokinetics, providing a comprehensive overview of how chemicals impact human health.
The student is expected to be able to:
1. Understand the mechanisms of genotoxicity and carcinogenesis and evaluate various methods for genotoxicity assessment, including in vitro and in vivo assays;
2. Examine the fundamental aspects of human toxicokinetics, including absorption, distribution, metabolism, and excretion (ADME), and analyze genetic determinants contributing to variability in xenobiotic safety;
3. Apply the principles of toxicology and ecotoxicology to assess chemical hazards, predict dose-response relationships, and evaluate risks associated with chemical exposures.

Obiettivi inglese: Students will develop a detailed understanding of hazard assessment with a focus on human toxicology. This course unit integrates principles of toxicology, genotoxicity, and toxicokinetics, providing a comprehensive overview of how chemicals impact human health.
The student is expected to be able to:
1. Understand the mechanisms of genotoxicity and carcinogenesis and evaluate various methods for genotoxicity assessment, including in vitro and in vivo assays;
2. Examine the fundamental aspects of human toxicokinetics, including absorption, distribution, metabolism, and excretion (ADME), and analyze genetic determinants contributing to variability in xenobiotic safety;
3. Apply the principles of toxicology and ecotoxicology to assess chemical hazards, predict dose-response relationships, and evaluate risks associated with chemical exposures.

6258 000 000 C9606 - 0 - METALS IN TOXICOLOGY	BIO/10	BIOS-07/A		6	36/0/0/0	No	Voto

Ambito: B

Obiettivi: Students will gain a thorough understanding of hazard assessment with a focus on metals in toxicology. This course unit integrates principles of toxicology, the role of metals in toxicity and health, and advanced methods for studying chemical interactions with DNA, providing view of
the molecular and systemic effects of metal exposure.
The student is expected to be able to:
1. Identify toxic metals, their sources of exposure, and their health effects, and understand the molecular mechanisms of metal toxicity, including their potential applications in therapeutic metallodrugs;
2. Analyze and apply methods to study chemical interactions with DNA, including techniques such as voltammetry, Surface Plasmon Resonance (SPR), and switchSense, with an emphasis on evaluating DNA-metal interactions;
3. Apply the principles of toxicology and ecotoxicology to assess the risks posed by metals in environmental and occupational settings, understanding their role in dose-response relationships and systemic toxicity.

Obiettivi inglese: Students will gain a thorough understanding of hazard assessment with a focus on metals in toxicology. This course unit integrates principles of toxicology, the role of metals in toxicity and health, and advanced methods for studying chemical interactions with DNA, providing view of
the molecular and systemic effects of metal exposure.
The student is expected to be able to:
1. Identify toxic metals, their sources of exposure, and their health effects, and understand the molecular mechanisms of metal toxicity, including their potential applications in therapeutic metallodrugs;
2. Analyze and apply methods to study chemical interactions with DNA, including techniques such as voltammetry, Surface Plasmon Resonance (SPR), and switchSense, with an emphasis on evaluating DNA-metal interactions;
3. Apply the principles of toxicology and ecotoxicology to assess the risks posed by metals in environmental and occupational settings, understanding their role in dose-response relationships and systemic toxicity.

Gruppo: Group of choice 08 - Regulation

TAF: C Ambito: 999 - Ambito aggregato per crediti di sede

Cfu min: 6 Cfu max: 6

Note:

Attività formativa	TIP	SSD	SSD 2024	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6258 000 000 94285 - 0 - CHEMICAL REGULATION		IUS/10	GIUR-06/A		6	36/0/0/0	No	Voto

Ambito: C

Obiettivi: Students will develop a comprehensive understanding of international chemicals management regulations, focusing on chemical regulation. This course unit integrates European, non-EU, and biocide regulations, providing insights into the legal frameworks and processes governing the management of hazardous substances.
The student is expected to be able to:
1. Understand the REACH and CLP regulations in the EU, including processes for classification, labelling, registration, and authorization of chemicals, as well as their implications for health, safety, and the environment;
2. Analyze and compare international chemical control frameworks, including GHS implementation and regulatory systems in countries such as the US, Japan, China, and Brazil, and their alignment or divergence from EU regulations;
3. Evaluate the regulatory frameworks specific to biocides, including their classification, usage, and safety requirements, as well as their impact on public health and the environment.

Obiettivi inglese: Students will develop a comprehensive understanding of international chemicals management regulations, focusing on chemical regulation. This course unit integrates European, non-EU, and biocide regulations, providing insights into the legal frameworks and processes governing the management of hazardous substances.
The student is expected to be able to:

1. Understand the REACH and CLP regulations in the EU, including processes for classification, labelling, registration, and authorization of chemicals, as well as their implications for health, safety, and the environment;
2. Analyze and compare international chemical control frameworks, including GHS implementation and regulatory systems in countries such as the US, Japan, China, and Brazil, and their alignment or divergence from EU regulations;
3. Evaluate the regulatory frameworks specific to biocides, including their classification, usage, and safety requirements, as well as their impact on public health and the environment.

6258 000 000 C9607 - 0 - ENVIRONMENTAL PROTECTION	IUS/10	GIUR-06/A	6	36/0/0/0	No	Voto

Ambito: C

Obiettivi: Students will develop a thorough understanding of international chemicals management regulations with a focus on environmental protection. This course unit integrates principles from waste material regulations, international environmental law, and REACH and CLP
frameworks, highlighting their roles in safeguarding the environment.
The student is expected to be able to:
1. Understand the legal instruments regulating environmental protection at international and EU levels, including the sustainable development paradigm, climate change laws, and rights of nature frameworks;
2. Apply the principles of REACH and CLP regulations to manage chemical risks, focusing on classification, labelling, and safe use of chemicals in supply chains;
3. Evaluate waste material regulations, analyzing their impact on reducing environmental harm, ensuring proper disposal, and promoting resource recovery within sustainable frameworks.

Obiettivi inglese: Students will develop a thorough understanding of international chemicals management regulations with a focus on environmental protection. This course unit integrates principles from waste material regulations, international environmental law, and REACH and CLP
frameworks, highlighting their roles in safeguarding the environment.
The student is expected to be able to:
1. Understand the legal instruments regulating environmental protection at international and EU levels, including the sustainable development paradigm, climate change laws, and rights of nature frameworks;
2. Apply the principles of REACH and CLP regulations to manage chemical risks, focusing on classification, labelling, and safe use of chemicals in supply chains;
3. Evaluate waste material regulations, analyzing their impact on reducing environmental harm, ensuring proper disposal, and promoting resource recovery within sustainable frameworks.

6258 000 000 94286 - 0 - FOOD AND DRUGS REGULATIONS	IUS/10	GIUR-06/A	6	36/0/0/0	No	Voto

Ambito: C

Obiettivi: Students will gain a comprehensive understanding of food and drug regulations, with a focus on the frameworks governing chemical management in these sectors. This course unit integrates regulations on general chemical substances, pharmaceuticals, and food products,
offering insights into compliance and innovation in these critical areas.
The student is expected to be able to:
1. Understand the REACH and CLP regulations in the EU, focusing on classification, labelling, and management of hazardous substances, and their implications for health and safety;
2 .Analyze the regulatory frameworks guiding drug development and pharmaceuticals, including the role of regulatory authorities, clinical development, and access to medicines and devices;
3. Evaluate food regulations, with attention to safety, labelling, and compliance requirements, ensuring the protection of public health and fostering innovation in the food industry.

Obiettivi inglese: Students will gain a comprehensive understanding of food and drug regulations, with a focus on the frameworks governing chemical management in these sectors. This course unit integrates regulations on general chemical substances, pharmaceuticals, and food products,
offering insights into compliance and innovation in these critical areas.
The student is expected to be able to:
1. Understand the REACH and CLP regulations in the EU, focusing on classification, labelling, and management of hazardous substances, and their implications for health and safety;

2 .Analyze the regulatory frameworks guiding drug development and pharmaceuticals, including the role of regulatory authorities, clinical development, and access to medicines and devices;
3. Evaluate food regulations, with attention to safety, labelling, and compliance requirements, ensuring the protection of public health and fostering innovation in the food industry.

Gruppo: Group of choice 09 - Tools for Innovation and Sustainability

TAF: B Ambito: 999 - Ambito aggregato per crediti di sede

Cfu min: 6 Cfu max: 6

Note:

Attività formativa	TIP	SSD	SSD 2024	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6258 000 000 94280 - 0 - DATA MANAGEMENT		CHIM/01	CHEM-01/A	B	6	36/0/0/0	No	Voto

Ambito:

Obiettivi: Students will be aware of the importance to manage data sets for an efficient chemical assessment. They are expected to be able to:
1. Use statistical methods to validate analytical data and to in findi out correlation and trends;
2. Identify the best experimental framework for an efficient data collection;
3. Use chemometrics techniques to extarct information from large datasets.

Obiettivi inglese: Students will be aware of the importance to manage data sets for an efficient chemical assessment. They are expected to be able to:
1. Use statistical methods to validate analytical data and to in findi out correlation and trends;
2. Identify the best experimental framework for an efficient data collection;
3. Use chemometrics techniques to extarct information from large datasets.

6258 000 000 C9608 - 0 - EXPERIMENTAL METHODS		CHIM/01	CHEM-01/A	B	6	36/0/0/0	No	Voto

Ambito:

Obiettivi: Students will be aware of the relevance of laboratory analysis and assessment. They will become familiar with the OECD standards recommended for the assessment of chemcial properties, as well as the Good Laboratory Practice (GLP) standard for Laboratory Quality Management. They are exepcted to be able to:
1. Understand the principles of Laboratory Quality Management and the GLP standard;
2. Become familiar with the OECD standards for chemical analysis and how to implement them in the laboratory;
3. Understand and promote a correct analytical approach for an experimental environmental investigation, paying partiuclar attention to sampling.

Obiettivi inglese: Students will be aware of the relevance of laboratory analysis and assessment. They will become familiar with the OECD standards recommended for the assessment of chemcial properties, as well as the Good Laboratory Practice (GLP) standard for Laboratory Quality Management. They are exepcted to be able to:
1. Understand the principles of Laboratory Quality Management and the GLP standard;
2. Become familiar with the OECD standards for chemical analysis and how to implement them in the laboratory;
3. Understand and promote a correct analytical approach for an experimental environmental investigation, paying partiuclar attention to sampling.

6258 000 000 32657 - 0 - INTELLECTUAL PROPERTY	CHIM/01	CHEM-01/A		6	36/0/0/0	No	Voto

Ambito: B

Obiettivi: Students will understand how artificial intelingence tools can be used in chemical applications and understand the concerns regarding intelectual property in chemical innovation, as well as the need to defend against industrial forgery. The students are expected to be able
to:
1. Understand and apply machine learning, deep learnign and articificial intelligence in a chemistry context;
2. Understand and apply an array of chemical and physical methods to detect industry forgery;
3. Understand the basic principles of IP right protection dealing with molecular materials and to decide the best IP strategy, from publication to patenting.

Obiettivi inglese: Students will understand how artificial intelingence tools can be used in chemical applications and understand the concerns regarding intelectual property in chemical innovation, as well as the need to defend against industrial forgery. The students are expected to be able
to:
1. Understand and apply machine learning, deep learnign and articificial intelligence in a chemistry context;
2. Understand and apply an array of chemical and physical methods to detect industry forgery;
3. Understand the basic principles of IP right protection dealing with molecular materials and to decide the best IP strategy, from publication to patenting.

Gruppo: Group of choice 10 - Management

TAF: C Ambito: 999 - Ambito aggregato per crediti di sede

Cfu min: 6 Cfu max: 6

Note:

Attività formativa	TIP	SSD	SSD 2024	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6258 000 000 94264 - 0 - BUSINESS AND ENTERPRISE		SECS-P/06	ECON-04/A		6	36/0/0/0	No	Voto

Ambito: C

Obiettivi: Students will know how to manage innovation and sustainability in the chemical business. The student will learn the guidelines of entrepreneurship and will become familiar with the problems to be faced and solutions found when starting a new enterprise. They are expected to be able to:
1.Develop and analyze a Business plan, while understanding the role of sustainability in new venture creatin processes;
2.Develop and analyze entrepreneurial opportunities;
3.Understand and apply risk management modelling, risk reduction and remediation and risk communication.

Obiettivi inglese: Students will know how to manage innovation and sustainability in the chemical business. The student will learn the guidelines of entrepreneurship and will become familiar with the problems to be faced and solutions found when starting a new enterprise. They are expected to be able to:
1.Develop and analyze a Business plan, while understanding the role of sustainability in new venture creatin processes;
2.Develop and analyze entrepreneurial opportunities;
3.Understand and apply risk management modelling, risk reduction and remediation and risk communication.

6258 000 000 C9609 - 0 - BUSINESS AND INNOVATION	SECS-P/06	ECON-04/A		6	36/0/0/0	No	Voto

Ambito: C

Obiettivi: Students will know how to manage innovation and sustainability in the chemical business. The student will learn the guidelines of entrepreneurship and will become familiar with the problems to be faced and solutions found when starting a new enterprise. They will learn how to manage the innovation in complex organization and how to boost innovation processes. Students are expected to be able to:
1.Develop and analyze a Business plan, while understanding the role of sustainability in new venture creatin processes;
2.Understand the key issues of innovation management and build innovation management indicators;
3.Understand and apply risk management modelling, risk reduction and remediation and risk communication.

Obiettivi inglese: Students will know how to manage innovation and sustainability in the chemical business. The student will learn the guidelines of entrepreneurship and will become familiar with the problems to be faced and solutions found when starting a new enterprise. They will learn how to manage the innovation in complex organization and how to boost innovation processes. Students are expected to be able to:
1.Develop and analyze a Business plan, while understanding the role of sustainability in new venture creatin processes;
2.Understand the key issues of innovation management and build innovation management indicators;
3.Understand and apply risk management modelling, risk reduction and remediation and risk communication.

6258 000 000 94267 - 0 - QUALITY AND INNOVATION	SECS-P/06	ECON-04/A		6	36/0/0/0	No	Voto

Ambito: C

Obiettivi: Students will be aware of the importance of quality management and will know the concepts of quality assurance and quality control. They will learn how to manage the innovation in complex organization and how to boost innovation processes. Students are expected to be able to:
1.Understand and apply the principles of quality management to any type of organization;
2.Understand the key issues of innovation management and build innovation management indicators;
3.Understand and apply risk management modelling, risk reduction and remediation and risk communication

Obiettivi inglese: Students will be aware of the importance of quality management and will know the concepts of quality assurance and quality control. They will learn how to manage the innovation in complex organization and how to boost innovation processes. Students are expected to be able to:
1.Understand and apply the principles of quality management to any type of organization;
2.Understand the key issues of innovation management and build innovation management indicators;
3.Understand and apply risk management modelling, risk reduction and remediation and risk communication

Secondo Anno di Corso

Gruppo: Free Choice Learning Activities

TAF: D Ambito: 1008 - A scelta dello studente

Cfu min: 9 Cfu max: 9

Note:

Attività formativa	TIP	SSD	SSD 2024	TAF	CFU	ORE F/E/L/N	FREQ.	VER.

6258 000 000 37494 - 0 - PROJECT					9	72/0/0/0	No	Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: Students will acquire the necessary skills to carry out research work, with particular focus on specific skills required for the Dissertation. These may include skills in bibliographic research, laboratory techniques or specific experimental work, computer skills, skills in bibliographic research or in database research.

Obiettivi inglese: Students will acquire the necessary skills to carry out research work, with particular focus on specific skills required for the Dissertation. These may include skills in bibliographic research, laboratory techniques or specific experimental work, computer skills, skills in bibliographic research or in database research.

Gruppo: Compulsory Activities

TAF: Ambito:

Cfu min: Cfu max:

Note:

Attività formativa	TIP	SSD	SSD 2024	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6258 000 000 C9614 - 0 - DISSERTATION AND FINAL EXAMINATION					30	0/0/0/0	No	

Ambito: 1018 - Per la prova finale E

Obiettivi: The Dissertation requires the preparation of research and development work leading to a scientific dissertation. It must involve the analysis of new situations, the collection of relevant information, the development and selection or design of the methodologies to approach and the instruments for solving the proposed problem, their resolution, the exercise of synthesis and drawing of conclusions.

Obiettivi inglese: The Dissertation requires the preparation of research and development work leading to a scientific dissertation. It must involve the analysis of new situations, the collection of relevant information, the development and selection or design of the methodologies to approach and the instruments for solving the proposed problem, their resolution, the exercise of synthesis and drawing of conclusions.

6258 000 000 60749 - 0 - INTERNSHIP					15	0/0/375/0	No	Voto

Ambito: 1146 - Tirocini formativi e di orientamento F

Obiettivi: To acquire skills related to professional practice in the area of formation of the master's course. At the end of the activity the student must have acquired skills and knowledge regarding the methods and procedures most used in the work and production environment, in industry or organizations related to one or more of the specific areas of the master's training.

Obiettivi inglese: To acquire skills related to professional practice in the area of formation of the master's course. At the end of the activity the student must have acquired skills and knowledge regarding the methods and procedures most used in the work and production environment, in industry or organizations related to one or more of the specific areas of the master's training.

Gruppo: Group of choice 11 - Transferable skills

TAF: F Ambito: 999 - Ambito aggregato per crediti di sede

Cfu min: 6 Cfu max: 6

Note: Students can choose a maxium of three modules of transferable skills to complete this group. Each year the consortium will offer a number of transferable skills modules, including: IT skills, Research Skills, Communication Skills, Laboatory Skills, Innovation Skills, Team Building.

Attività formativa	TIP	SSD	SSD 2024	TAF	CFU	ORE F/E/L/N	FREQ.	VER.

Legenda:

CFU: crediti formativi universitari
TAF: tipologia attività formativa (A-di base; B-caratterizzanti; C-affini o integrative; F-ulteriori attività formative; D-a scelta autonoma dello studente; S- stages e tirocini presso imprese, enti pubblici o privati, ordini professionali; E-per la prova finale)
SSD: settore scientifico disciplinare
F/E/L/N: indica le ore Frontali/Esercitazioni/Laboratori/Ore di esercitazione e/o laboratorio tenute da non docenti
Freq.: segnala l'esistenza di un obbligo di frequenza
Ver.: indica la modalità di verifica del profitto finale
TIP.: indica la tipologia delle forme didattiche. Queste possono essere CON: convenzionali, E-L: in e-learning, MIX: miste, C/E: convenzionali e/o e-learning. Il corso di studio può definire annualmente una delle modalità.